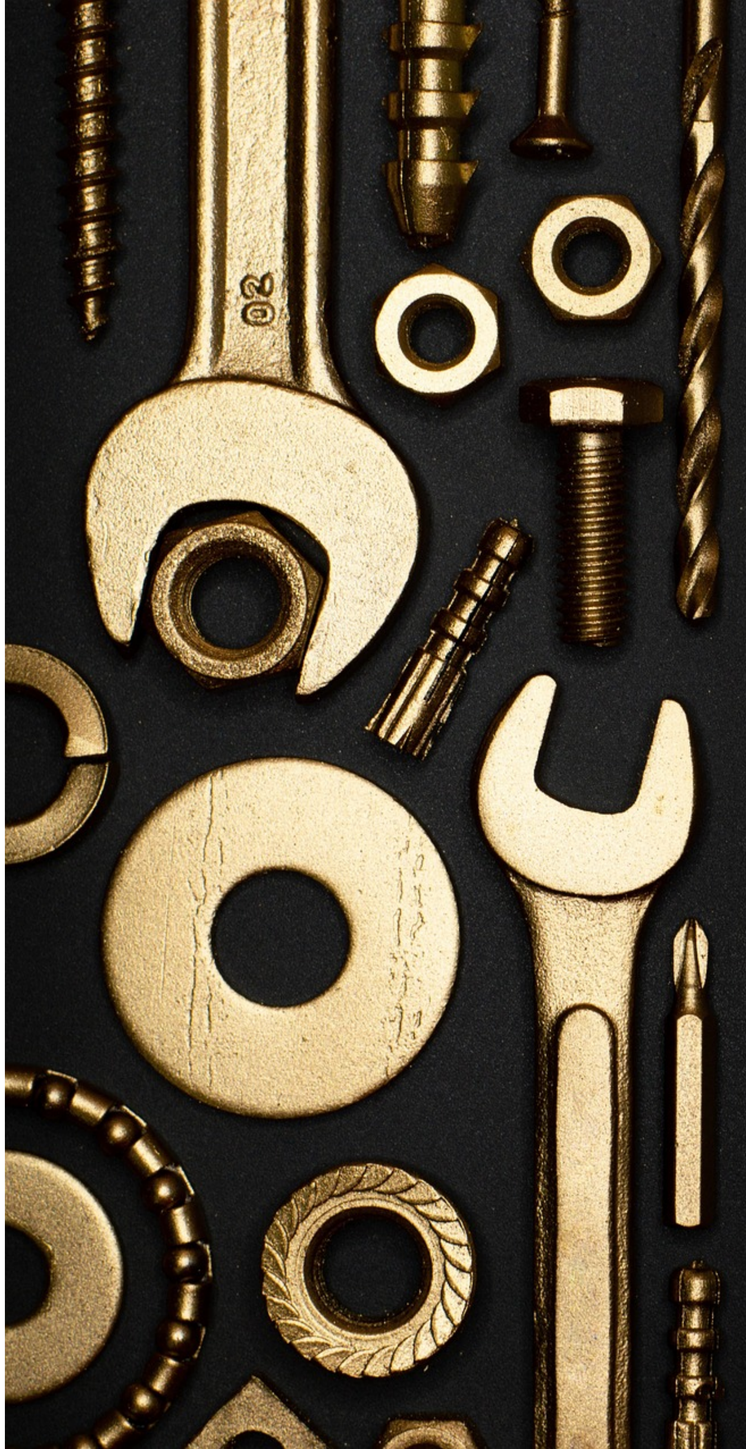
Course overview &
Theoretical foundations of network analysis

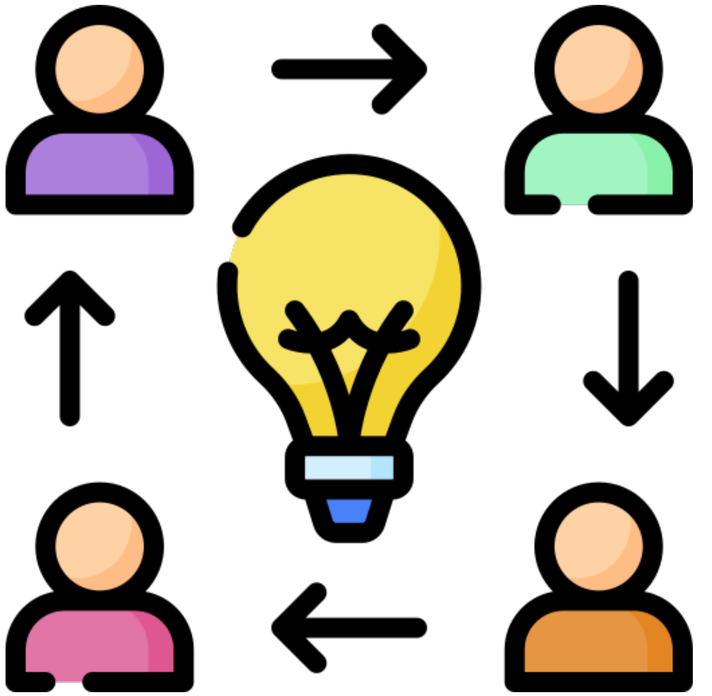
Tessa Blanken
Ria Hoekstra



Overview

- Course overview
- Theoretical foundations of network analysis
- Roadmap to network analysis:
  - Research questions
  - Data types
  - Analyses

Course overview



https://www.menti.com/alnf7zyin8h8

how

why

network analytical toolbox

Schedule Network Analysis Course 2022

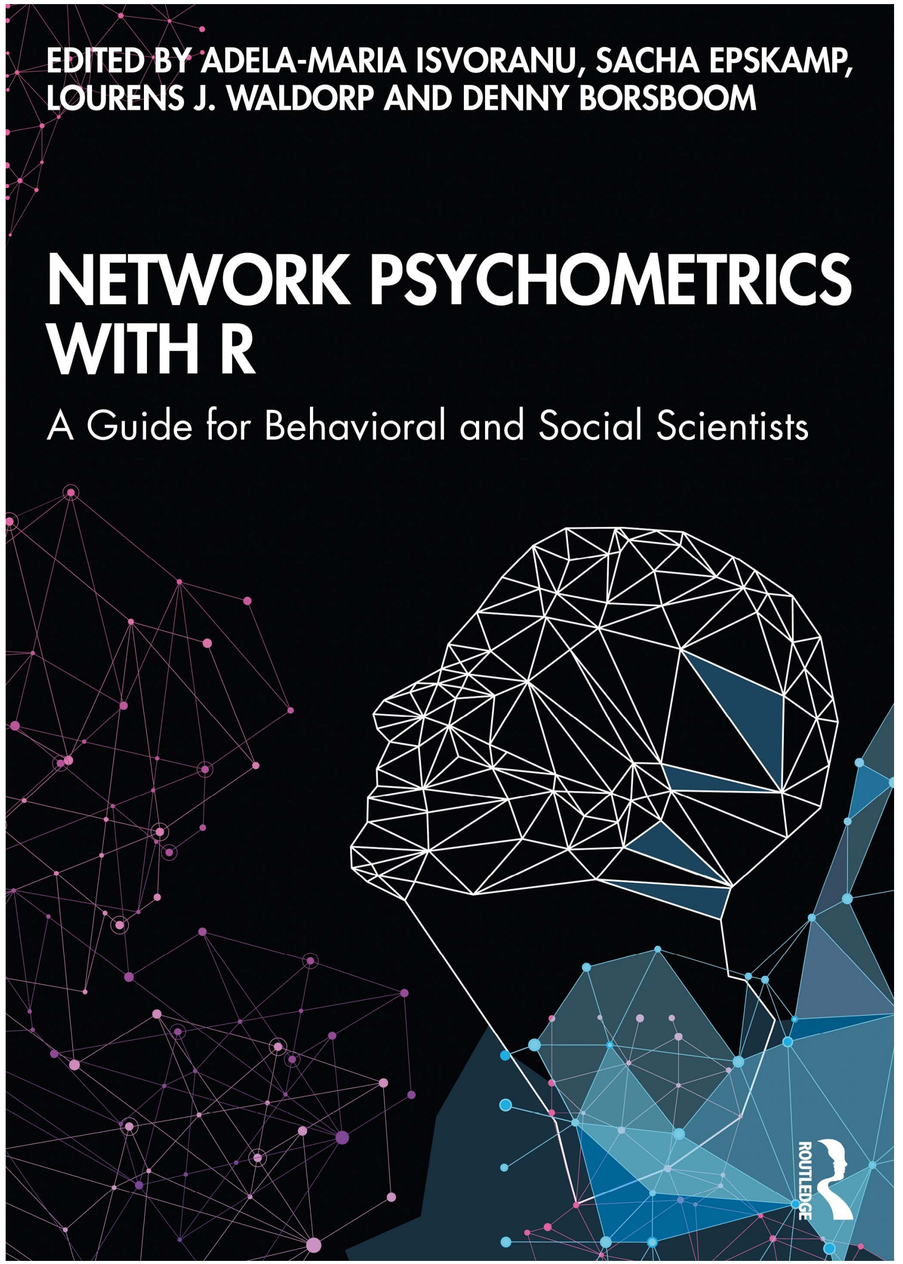
Week	Tuesday Practical 13:00-15:00 GS.11		Thursday Lecture 13:00-15:00 GS.11		Notes & Deadlines
44			3/11	**Course overview & Theoretical foundations of network analysis** Tessa Blanken, Ria Hoekstra	• Form groups • A1 available 3/11 at 15:00
45	8/11	**Discuss final project & Practical on drawing networks in R** Tessa Blanken, TAs	10/11	**Causality, conditional dependence, and Pairwise Markov Random Fields** Lourens Waldorp	• Kickstart final project: find dataset or make plan for data collection
46	15/11	**'How to report networks' as a thinking tool to design final project** Julian Burger (Tessa Blanken, TAs)	17/11	**Estimating networks, model selection, stability, comparison, and replicability** Tessa Blanken	• A1 deadline 17/11 at 13:00 • A2 available 17/11 at 15:00
47	22/11	**Pitch project idea** Tessa Blanken, Ria Hoektra, TAs	24/11	**Network estimation from time series data** Ria Hoekstra	• A2 deadline 24/11 at 13:00 • Project idea deadline 24/11 at 13:00 • A3 available 24/11 at 15:00
48	29/11	**Work on final project** (optional) Tessa Blanken, Ria Hoekstra, TAs	1/12	**Theoretical reflections of network analysis** Denny Borsboom	• A3 deadline 1/12 at 13:00
49	6/12	**Pitch analysis plan** Tessa Blanken, Ria Hoekstra, TAs	8/12	**Simulating network dynamics and interventions** Gaby Lunansky	• Analysis plan deadline 8/12 at 13:00
50	13/12	**Work on final project** (optional) Tessa Blanken, TAs	15/12	**Symposium** René Freichel, Tessa Blanken, Inga Marie Freund, Maarten van den Ende	• Work on final project • Questions for symposium speakers 15/12 at 09:00
51	20/12	**Poster presentations** Tessa Blanken, Ria Hoekstra, TAs	22/12	TBD	• Deadline final project (22/12 at 13:00)

how

why

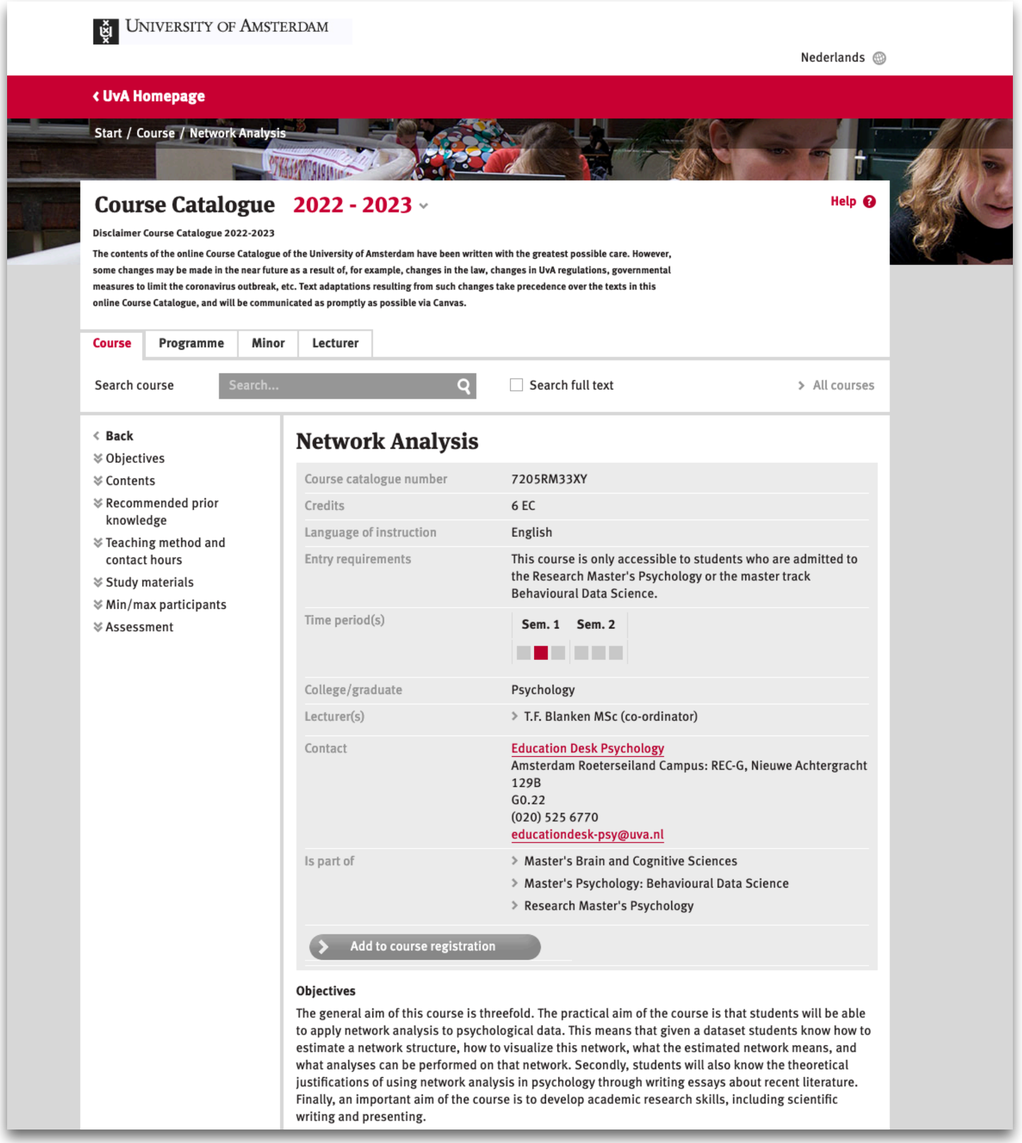
Course info: materials

- Book “Network Psychometrics with R”
  - Can be accessed through the university’s library
  - Additional materials will be made accessible through canvas
- Articles
- Additional reading
  - Optional



Course info: practical info

- Lectures every Thursday (13:00-15:00, GS.11)
- Practicals every Tuesday (13:00-15:00, GS.11)
- Attendance is mandatory, unless explicitly stated otherwise. See course catalogue for more details on what happens if sessions are missed.



Course info: people

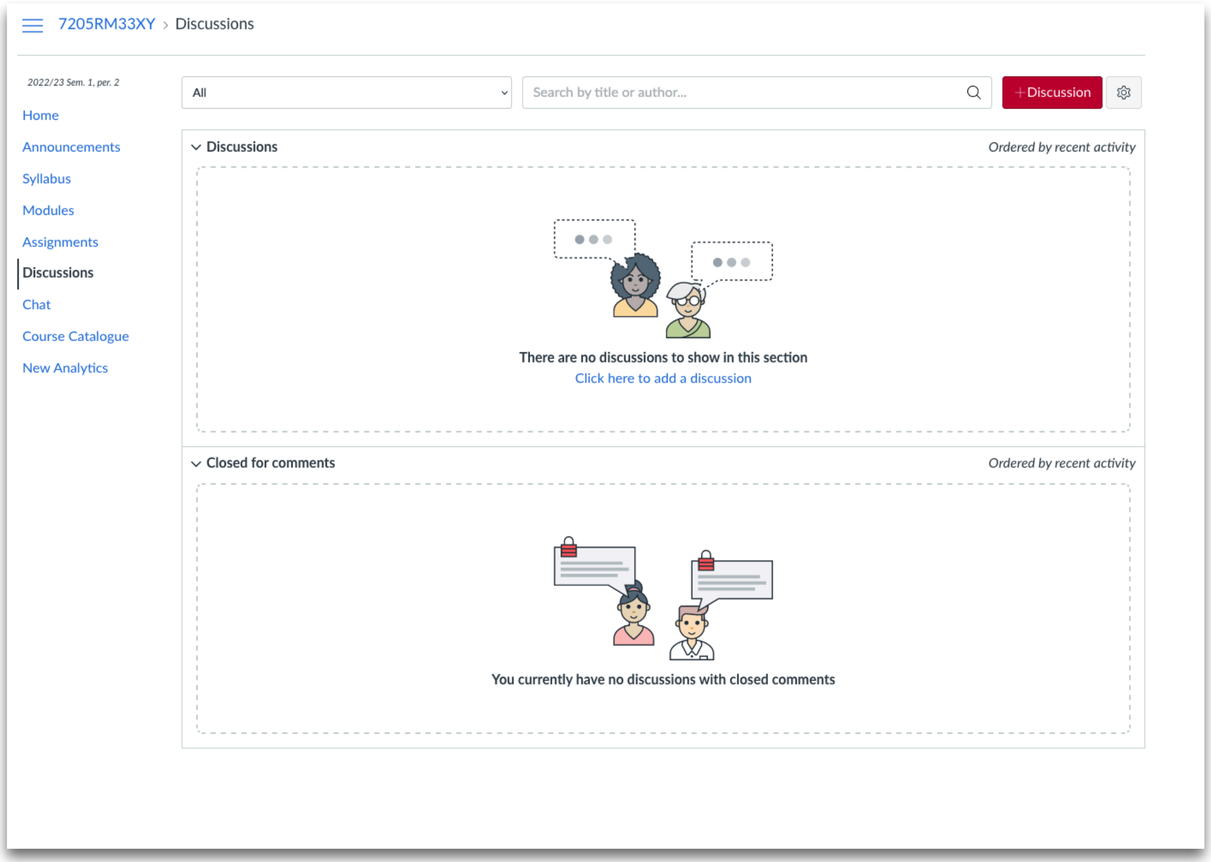
- Coördinator: Tessa Blanken
- Invited lecturers:
  - Ria Hoekstra
  - Lourens Waldorp
  - Julian Burger
  - Denny Borsboom
  - Gaby Lunansky

Course info: people

- Coördinator: Tessa Blanken
- Teaching assistants:
  - Leonhard Volz
  - Emily Campos Sindermann

Course info: people & contact

- Use Canvas (“Discussion”) for communication and questions (general questions and questions about the assignments and final project). This way everyone can learn from the communication.
- In exceptional cases, when canvas cannot be used, you can contact us by e-mail. Note that the TAs are responsible for the assignments, so always contact them first with questions about the assignments.
- Coördinator: Tessa Blanken, t.f.blanken@uva.nl
- Teaching assistants:
  - Leonhard Volz, l.volz@uva.nl
  - Emily Campos Sindermann, emily.campos.sindermann@student.uva.nl



Course info: structure

- Goal of the course is to provide you with a ‘network analytical toolbox’ that enables you to (i) conduct network analyses (*how*), and (ii) design network analytical projects (*why*).

- To accomplish this goal, the course is structured into roughly three parts:

  1. Kickstarting the final group project in which you will design your own network analysis project

  2. Equipping you with the practical tools on how to conduct the network analysis

     - Emphasis on individual assignments

  3. Reflect on the network approach in general and your own group project in particular

- See also course syllabus for more information on the course structure

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51	20/12	**Poster presentations** Tessa Blanken, Ria Hoekstra, TAs	22/12	TBD	• Deadline final project (22/12 at 13:00)

Course info: final group project

- Goal of the final project is to design and complete a research project in which you will use network analysis. This project will combine the ‘how’ and ‘why’. You will work through all the steps and complete a research project in which you will use network analysis and go from research question to final report.

  - More detailed information during the first practical (Tuesday November 8)

Course info: final group project *in short*

- Group project (3-4 students per group)
    - Make sure to have formed groups *before* the practical on November 8
- Throughout the course you will work on the final assignment, and the first two practicals (8/11 and 15/11) will be devoted to the final project to give you the materials to **kickstart** this project.
- There will be time to work together with your group on this final project during the practical of 29/11 and 13/12. This also gives you the opportunity to ask questions and ask for feedback.
- Throughout the process you will pitch your project idea (22/11) and data and analysis plan (6/12). After the pitch you have 1,5 days to incorporate feedback and potential new ideas before handing in your project idea (24/11 at 13:00) and data and analysis plan (8/12 at 13:00). This will not be graded and no individual feedback will be given. It is meant to keep you on track, to learn from each other through the pitches, and to make sure that the project idea and analysis plan is feasible.
- You will report on the project in a poster (group-assignment, 20%) and reflect on the project individually (20%)
- Final project submission: poster, R-code used for analyses, individual report (more on this next Tuesday!)

Course info: individual assignments

- Goal of the individual assignments is to provide you with the practical tools to conduct network analyses. Therefore the second part of this course will place an emphasis on these individual assignments. Afterwards, you can use these skills to conduct the analyses in your final group project.

Course info: individual assignments

- The assignments correspond to the lectures:
  - Assignment 1 will cover the topics of ‘theoretical foundations of network analysis’ (lecture 1) and ‘causality, conditional dependence, and Pairwise Markov Random Fields’ (lecture 2)
  - Assignment 2 will cover the topic of ‘estimation, model selection, and stability’ (lecture 3)
  - Assignment 3 will cover the topic of ‘longitudinal network estimation’ (lecture 4)

Course info: individual assignments

- The assignments correspond to the lectures:
  - Assignment 1 will cover the topics of ‘theoretical foundations of network analysis’ (lecture 1) and ‘causality, conditional dependence, and Pairwise Markov Random Fields’ (lecture 2)
    - Available after first lecture (3/11 at 15:00)
    - Deadline before third lecture (17/11 at 13:00)
  - Assignment 2 will cover the topic of ‘estimation, model selection, and stability’ (lecture 3)
    - Available after third lecture (17/11 at 15:00)
    - Deadline before fourth lecture (24/11 at 13:00)
  - Assignment 3 will cover the topic of ‘longitudinal network estimation’ (lecture 4)
    - Available after fourth lecture (24/11 at 15:00)
    - Deadline before fifth lecture (1/12 at 13:00)

Course info: individual assignments

- Three individual assignments (each 20% of final grade)
  - Both conceptual and practical questions.
  - Make sure your PDF report can be read in stand alone format as much as possible. E.g., if you are asked to report a network, then include a plot in the PDF and not just say “look at .R file”.
  - Make sure that your code within the .R file runs smoothly.
  - If you have questions post these through canvas so that TAs can help you.
- Handing in your assignment
  - Name your assignment: Assignment<number>_<lastname student>_<student number> (e.g., Assignment1_Blanken_1234567)
  - Hand in assignments as PDF through Canvas. If you encounter problems with handig in the assignments, e-mail the assignment to the TAs *before* the deadline.
  - Hand in before deadline. If handed in after deadline but before solutions are made available the assignment will be graded with a maximum of a 6. Otherwise it will be graded with a 1.

Course info: grading

- Final grade is based on:
  - Individual assignments: 60% of the final grade
    - 3 assignments, 20% each
  - Final project: 40% of the final grade
    - 20% poster (grade for the whole group), based on:
      - Rationale, match between dataset and RQ, analysis, code quality, poster quality (more details during the practical on November 8th)
    - 20% individual reflection
- Note that the average of the three individual assignments as well as the poster and the individual reflection should *all* be graded at least 5.5 to pass the course.

Course info: overview of deadlines

- All deadlines are prior to the lecture/ practical (at 13:00; with one exception)
  - Thursday 17/11: deadline assignment 1
  - Tuesday 22/11: pitch project idea (1-2 slides)
  - Thursday 24/11: deadline assignment 1 + hand in project idea
  - Thursday 1/12: deadline assignment 2
  - Tuesday 6/12: pitch data and analysis plan
  - Thursday 8/12: deadline data and analysis plan
  - Thursday 15/11: hand in questions for symposium speakers (deadline at 09:00)
  - Tuesday 20/12: poster presentation
  - Thursday 22/12: hand final project: poster, R-code (group), reflection (individual)

Course info: syllabus

- All information discussed here can be found in the course syllabus.
- Syllabus gives detailed overview of topics during each of the lectures, including reading materials and learning goals.

NETWORK ANALYSIS 2022

COURSE SYLLABUS

Theoretical foundations to network analysis

2010

today

- **From observations & questions to new directions**
- What is a network? The network approach
- Network theory of psychopathology
- Network models in psychopathology
- Note on theory and models

The Harvard Gazette

HEALTH & MEDICINE

Lower risk of depression with elevated exercise

NEWS • NATIONAL •

12:49pm, Nov 12, 2019

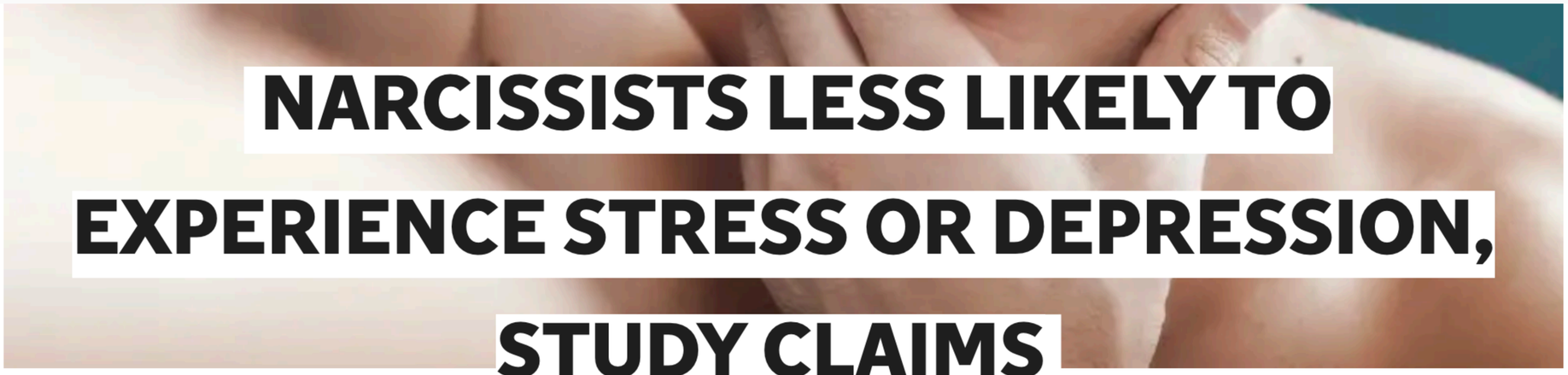
Too much TV time may raise depression risk

CNN health Food Fitness Wellness Parenting Vital Signs E

Smokers may be at greater risk of depression and schizophrenia, study finds

By Jack Guy, CNN

Updated 1245 GMT (2045 HKT) November 6, 2019



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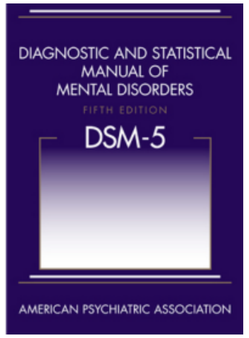
What do we refer to when we talk about *depression*?

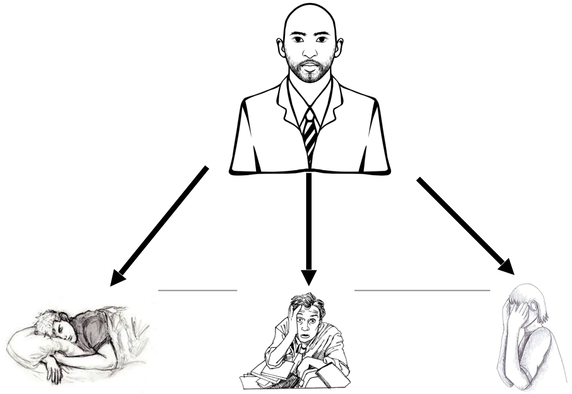
What do we refer to when we talk about ***depression***?

sleeping problems

concentration problems

depressed mood





Sleep problems

Concentration problems

Feeling guilty

Depressed mood

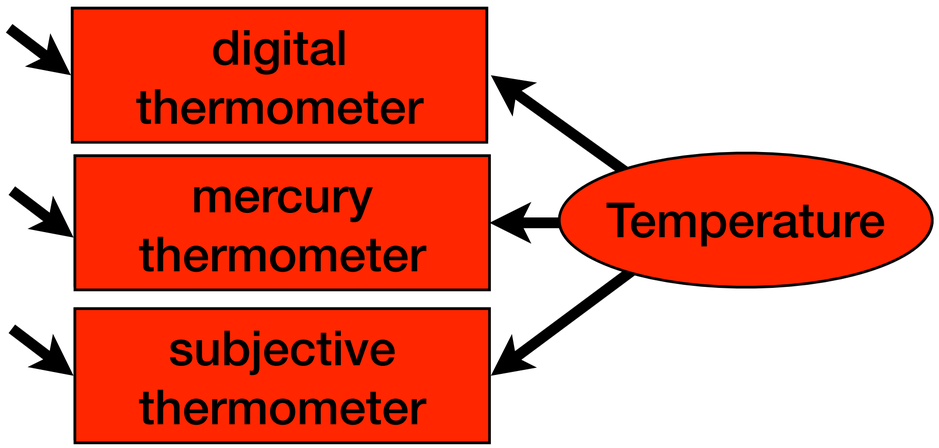
Symptom probability

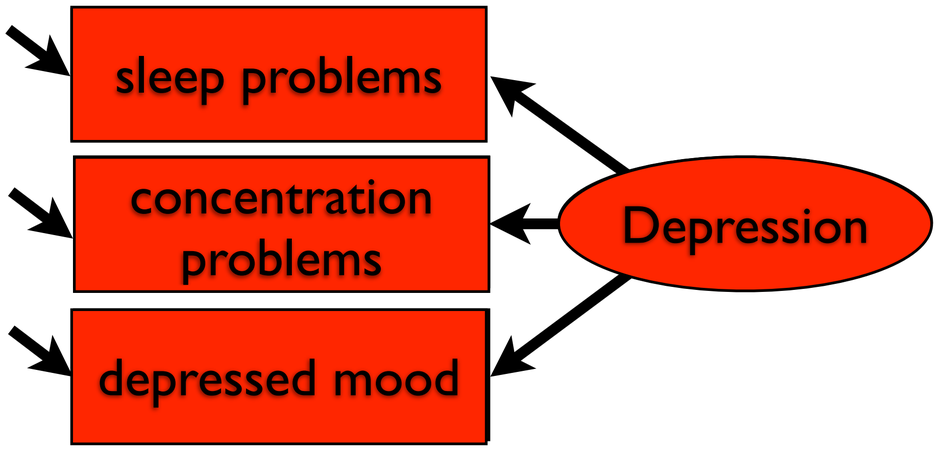
1

0

Depression severity

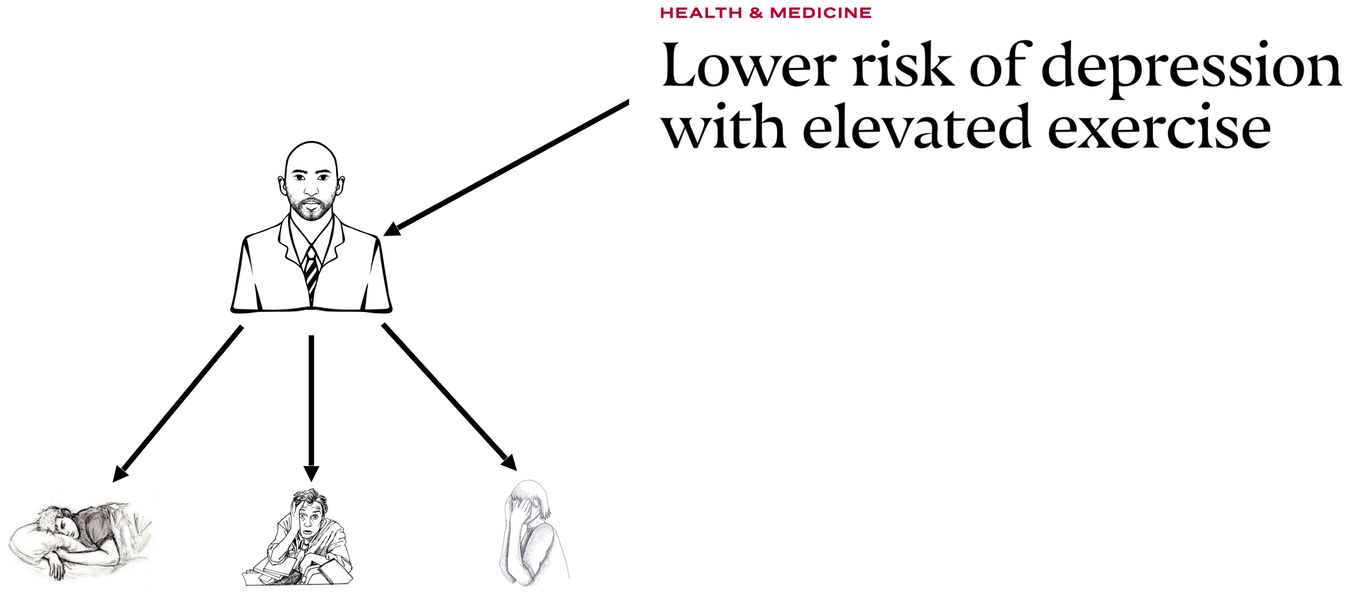
Measurement





Implications

- Disorder *precedes* symptom development
- Disorder is *common cause* of its symptoms
- Symptoms are *statistically interchangeable*



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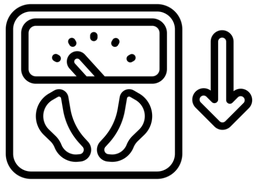
NARCISSISTS LESS LIKELY TO EXPERIENCE STRESS OR DEPRESSION, STUDY CLAIMS

What do we refer to when we talk about *depression*?

Do these ***implications*** match our ***observations***?

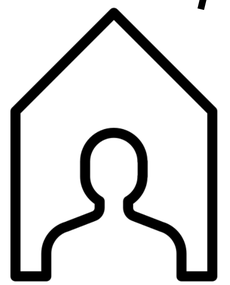
painful
break-up

loss of
appetite

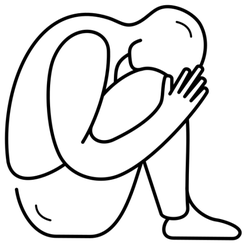


weight
loss

loss of
energy



loss of
interest



feelings of
worthlessness

painful
break-up

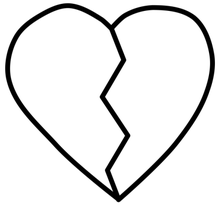
feelings of
worthlessness

loss of
appetite

weight
loss

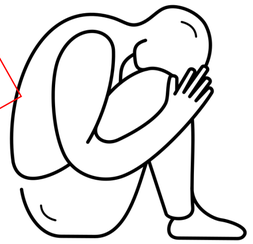
loss of
energy

loss of
interest



painful
break-up

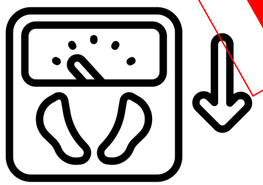
DEPRESSION



feelings of
worthlessness

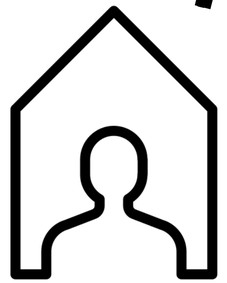
loss of
appetite

suicidal
thoughts



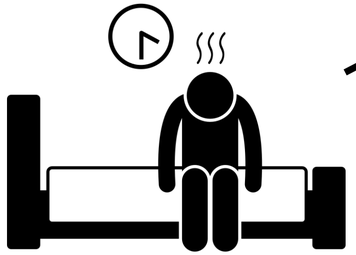
weight
loss

loss of
energy

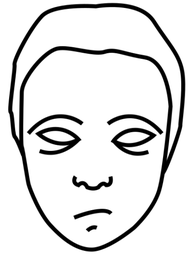


loss of
interest

chronic
pain

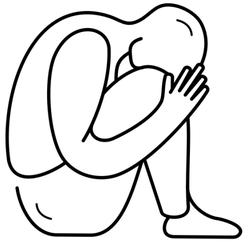


sleep
problems



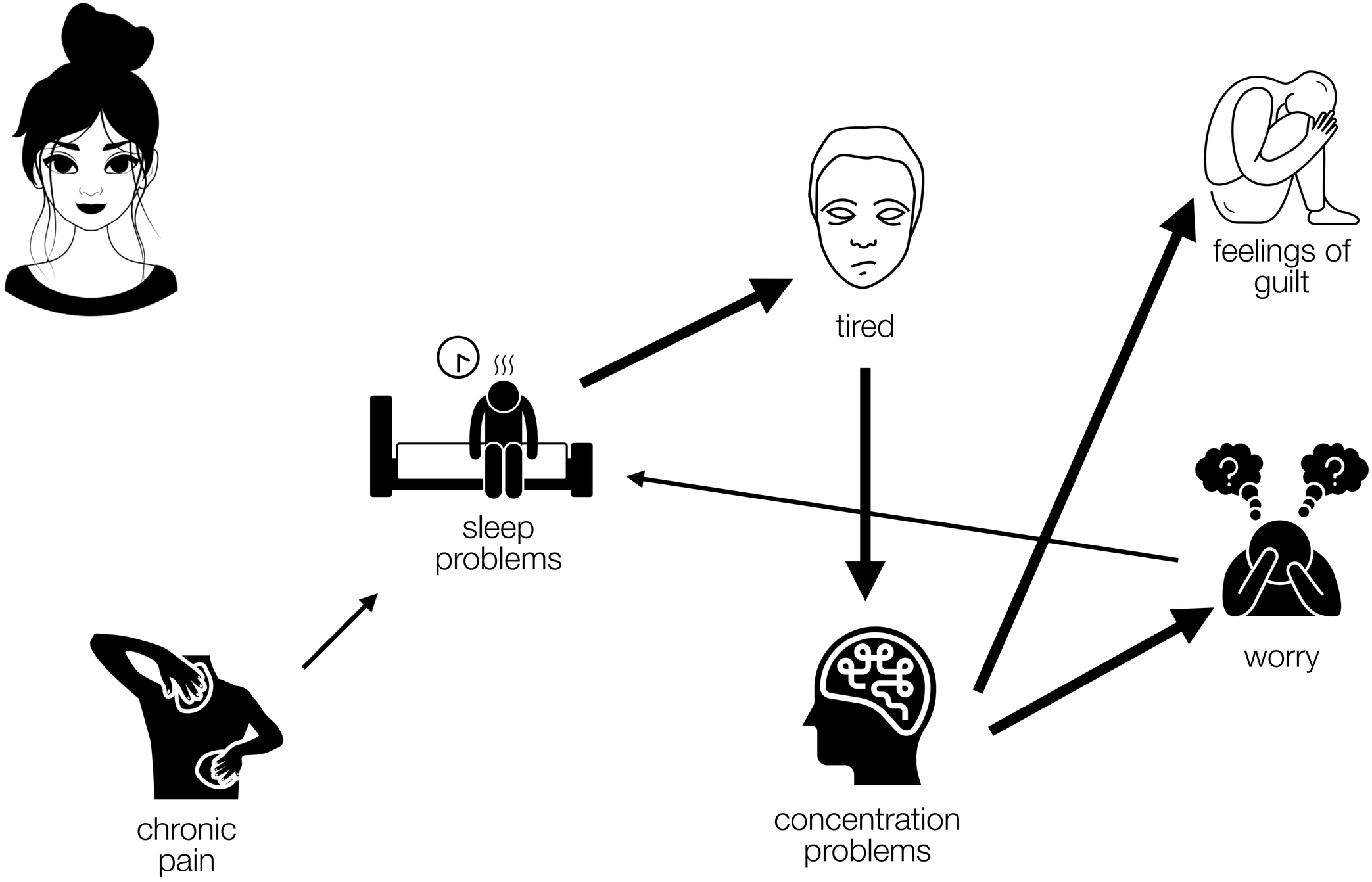
tired

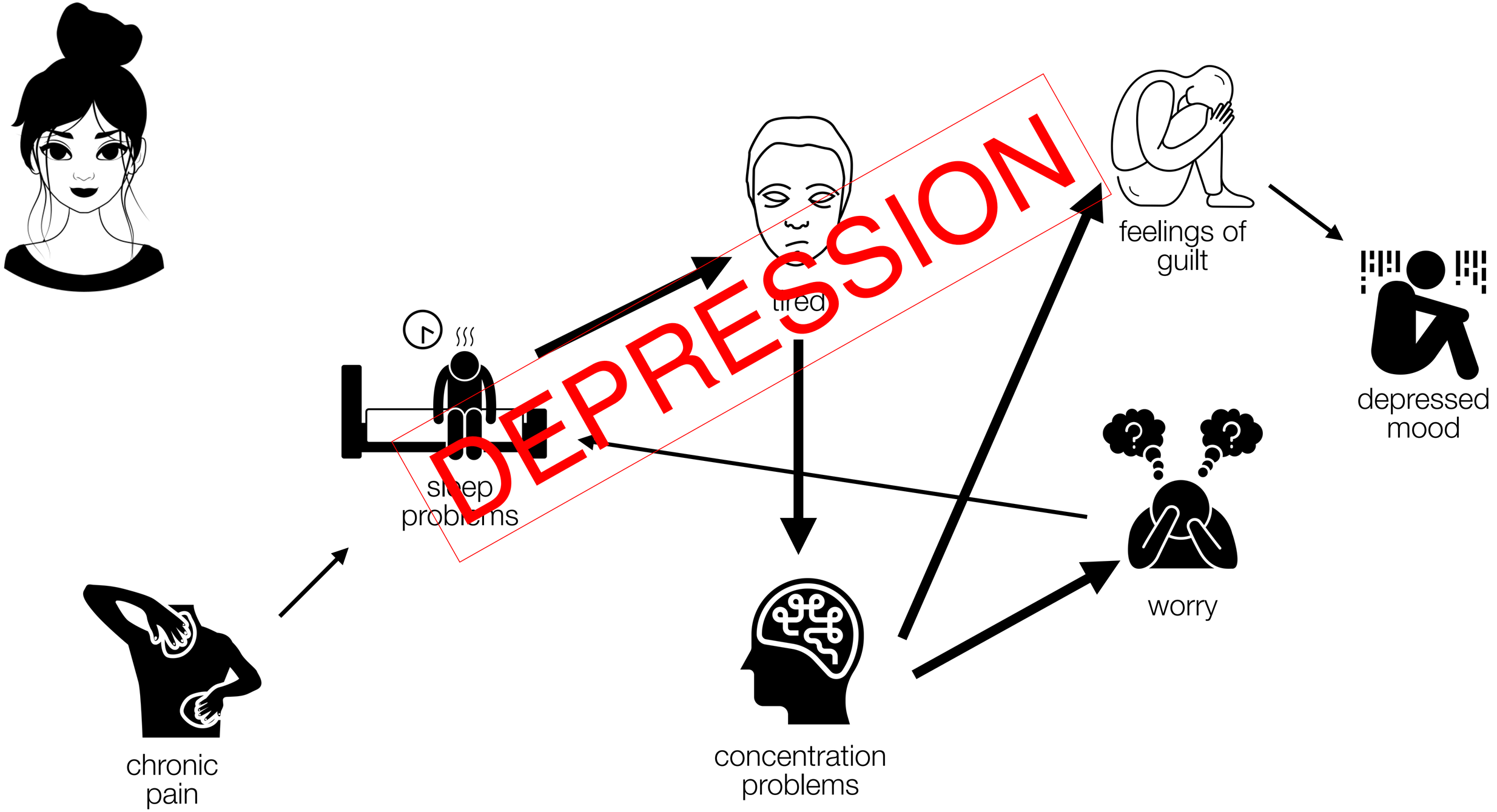
concentration
problems



feelings of
guilt

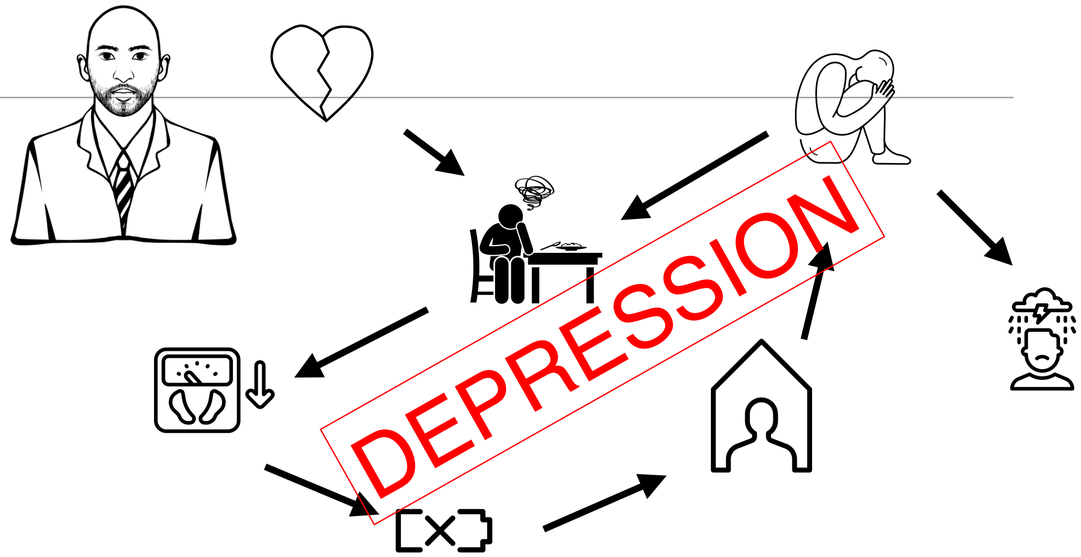
worry

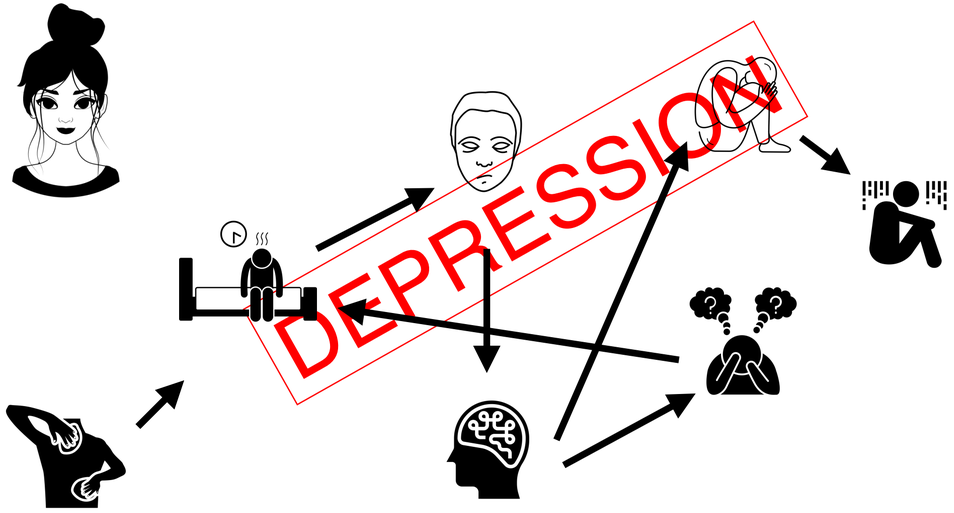

tired
feelings of guilt
sleep problems
worry
chronic pain
concentration problems


DEPRESSION
tired
feelings of guilt
depressed mood
sleep problems
worry
chronic pain
concentration problems

Observations

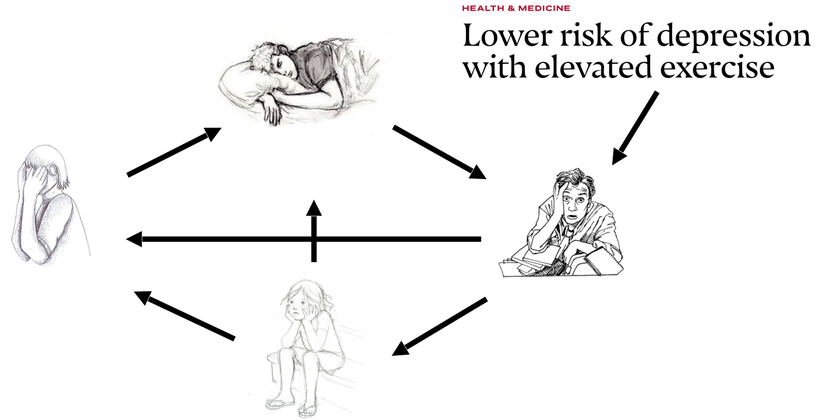
- Very different pathways, *same diagnosis*
- *Direct relations* among symptoms
- A *network* of symptoms





Implications

- There are *direct relations* between symptoms
  - Implication: symptom-based interventions
- The system evolves in individuals *over time*
  - Implication: personalised interventions



What do we refer to when we talk about ***depression***?

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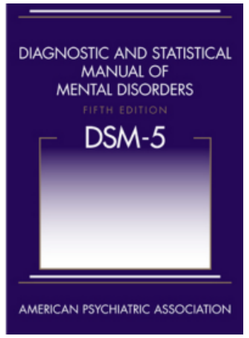
concentration problems

depressed mood

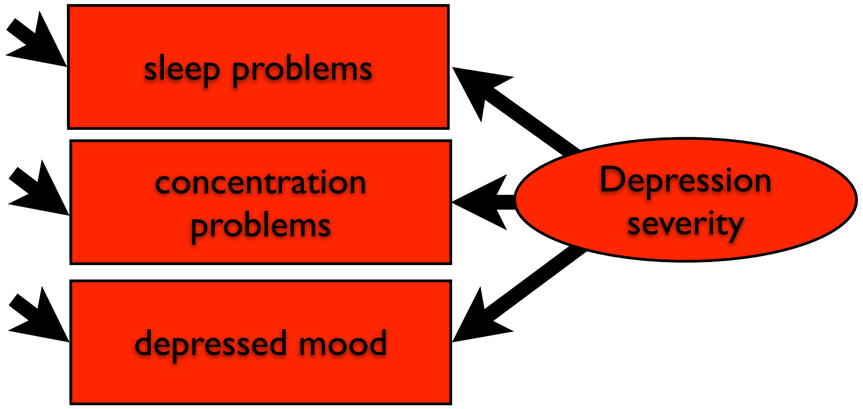


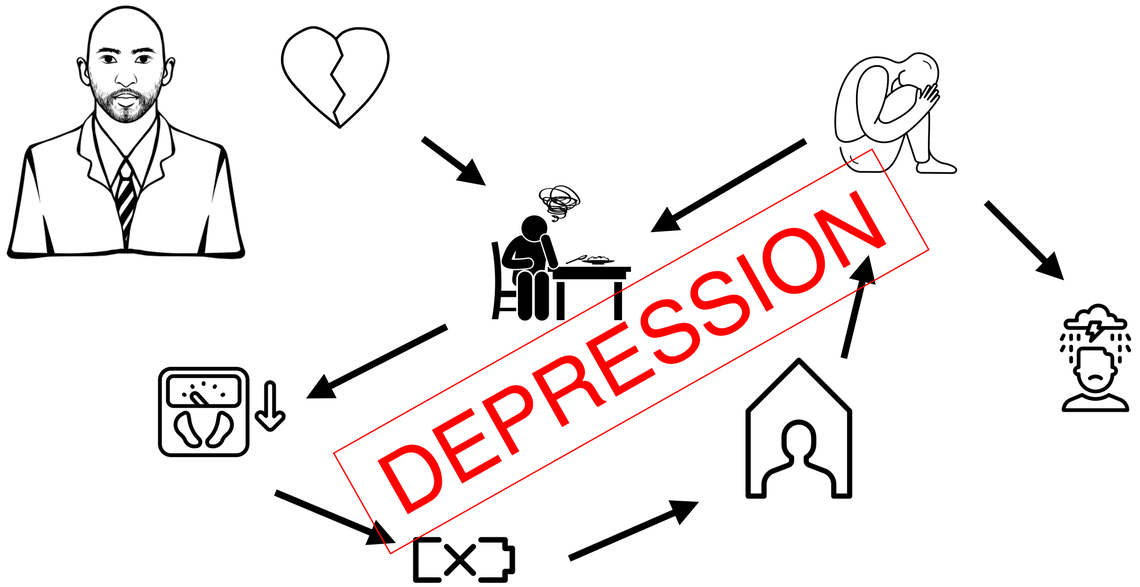
sleeping problems

depressed mood

concentration problems

guilt





- No direct relations among symptoms
- Disorder *precedes* symptom development

- Direct relations
- System evolves over time
- Intervention at symptom-level

OPEN ACCESS Freely available online

PLoS one

The Small World of Psychopathology

Denny Borsboom*, Angélique O. J. Cramer, Verena D. Schmittmann, Sacha Epskamp, Lourens J. Waldorp

Department of Psychology, University of Amsterdam, Amsterdam, The Netherlands

Abstract

Background: Mental disorders are highly comorbid: people having one disorder are likely to have another as well. We explain empirical comorbidity patterns based on a network model of psychiatric symptoms, derived from an analysis of symptom overlap in the Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV).

Principal Findings: We show t
connections conforms to a sm
c) distances between disord
Depressive Episode and Gen
statistics for these disorders.

Conclusions: In the network r
neuroscientific, and etiologica
structure and dynamics of me

BEHAVIORAL AND BRAIN SCIENCES (2010) **33**, 137–193
doi:10.1017/S0140525X09991567

Comorbidity: A network perspective

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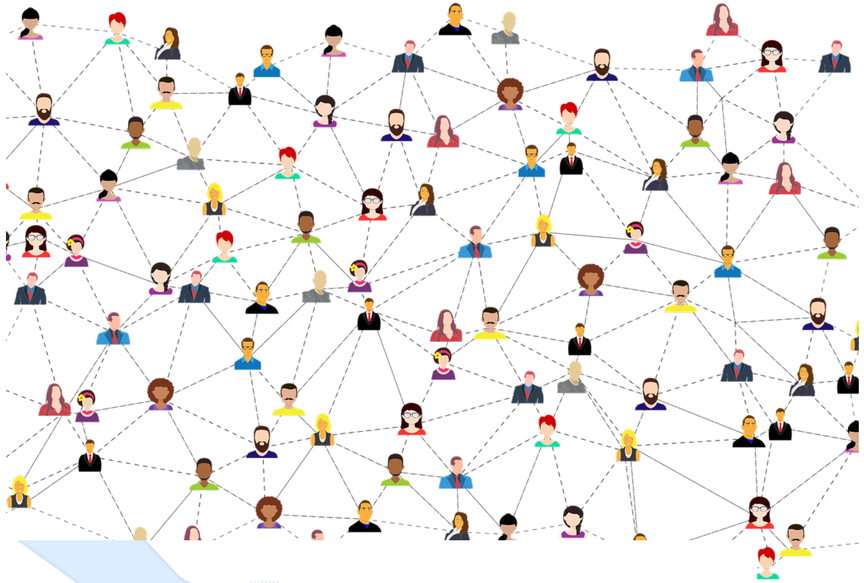
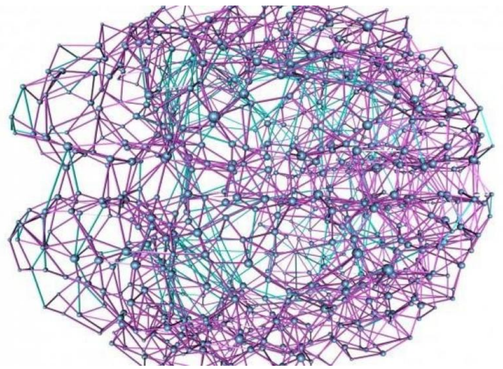
2010

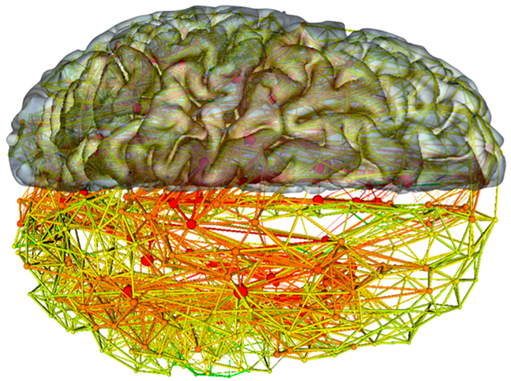
today

- From observations & questions to new directions
- **What is a network? The network approach**
- Network theory of psychopathology
- Network models in psychopathology
- Note on theory and models

What is a network?



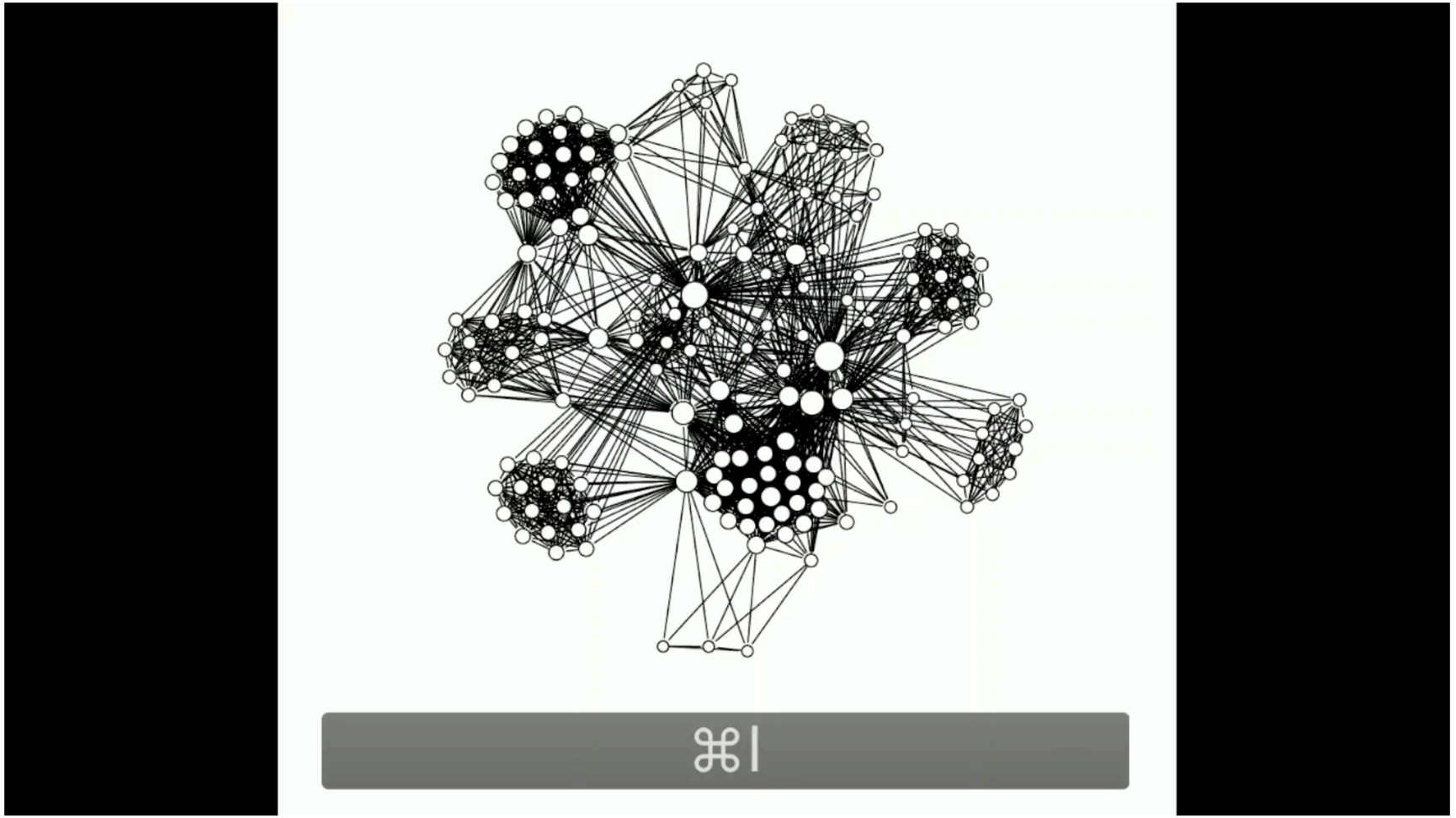




Networks

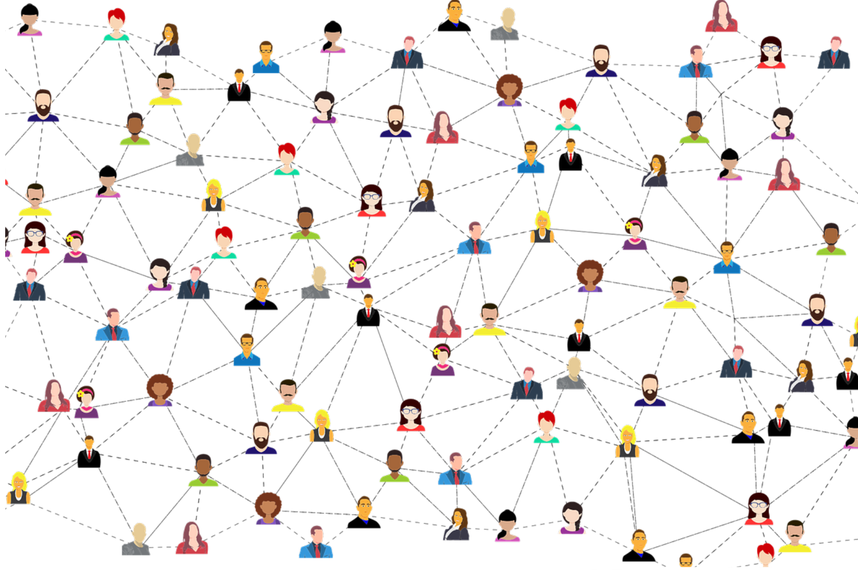
- A network is a set of entities called *nodes*, which are connected to each other by *edges*
- To construct a network, one requires:
  - The identification of a node set
  - A construction rule that says when two nodes should be connected
- Two dominant ways in psychological networks:
  1. Estimating edges from data (e.g., co-occurrence of symptoms)
  2. Self-report

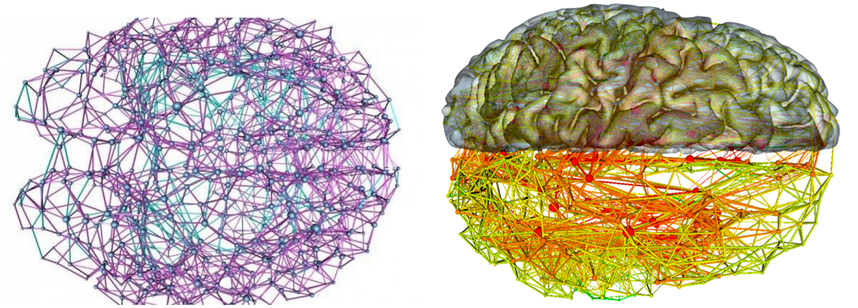
Many analogies: virus spreading

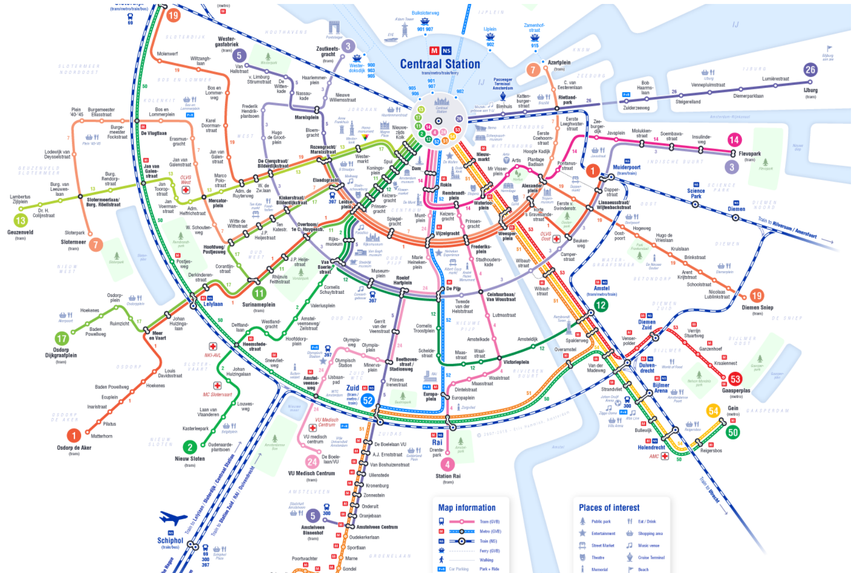


Network approaches across fields

- Allows to borrow concepts across fields (e.g., ‘graph theory’)
- Be aware of crucial differences
  - For example: what do the nodes and edges represent?
  - Psychological networks differ from many other networks in that the edges are *unobserved* and have to be *estimated* from data







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Network theory of psychopathology

SPECIAL ARTICLE

A network theory of mental disorders

Denny Borsboom

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In recent years, the network approach to psychopathology has been advanced as an alternative way of conceptualizing mental disorders. In this approach, mental disorders arise from direct interactions between symptoms. Although the network approach has led to many novel methodologies and substantive applications, it has not yet been fully articulated as a scientific theory of mental disorders. The present paper aims to develop such a theory, by postulating a limited set of theoretical principles regarding the structure and dynamics of symptom networks. At the heart of the theory lies the notion that symptoms of psychopathology are causally connected through myriads of biological, psychological and societal mechanisms. If these causal relations are sufficiently strong, symptoms can generate a level of feedback that renders them self-sustaining. In this case, the network can get stuck in a disorder state. The network theory holds that this is a general feature of mental disorders, which can therefore be understood as alternative stable states of strongly connected symptom networks. This idea naturally leads to a comprehensive model of psychopathology, encompassing a common explanatory model for mental disorders, as well as novel definitions of associated concepts such as mental health, resilience, vulnerability and liability. In addition, the network theory has direct implications for how to understand diagnosis and treatment, and suggests a clear agenda for future research in psychiatry and associated disciplines.

Key words: Psychopathology, network approach, mental disorders, symptom networks, mental health, resilience, vulnerability, diagnosis, treatment

(World Psychiatry 2017;16:5–13)

Network theory of psychopathology

- Five principles

1. *Complexity*
2. *Symptom-component correspondence*
3. *Direct causal connections*
4. *Mental disorders follow network structure*
5. *Hysteresis*

Network theory of psychopathology

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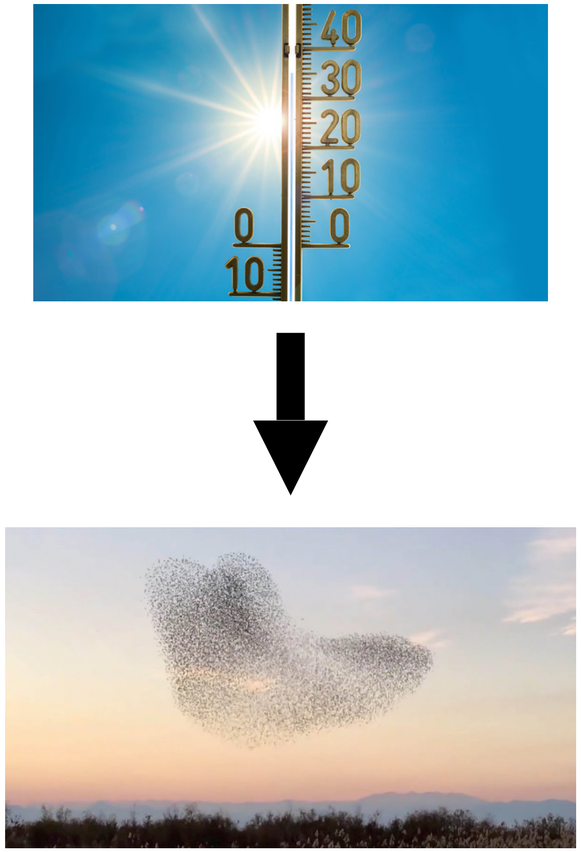

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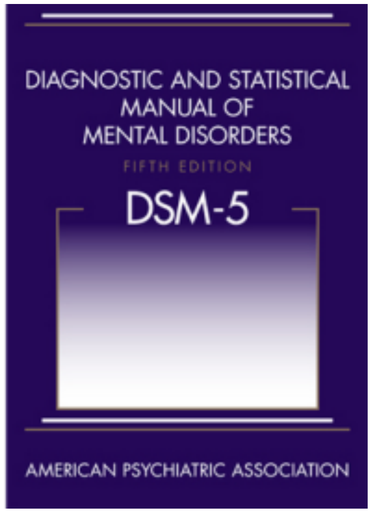

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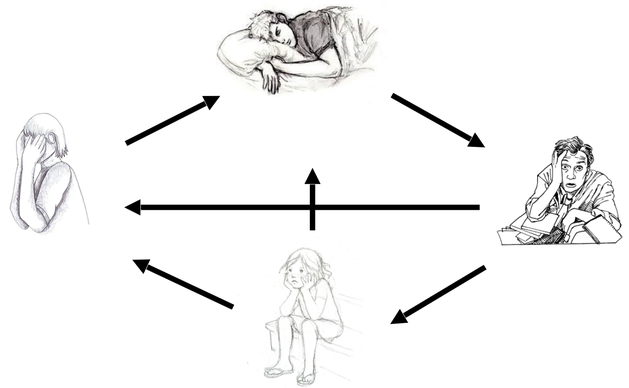

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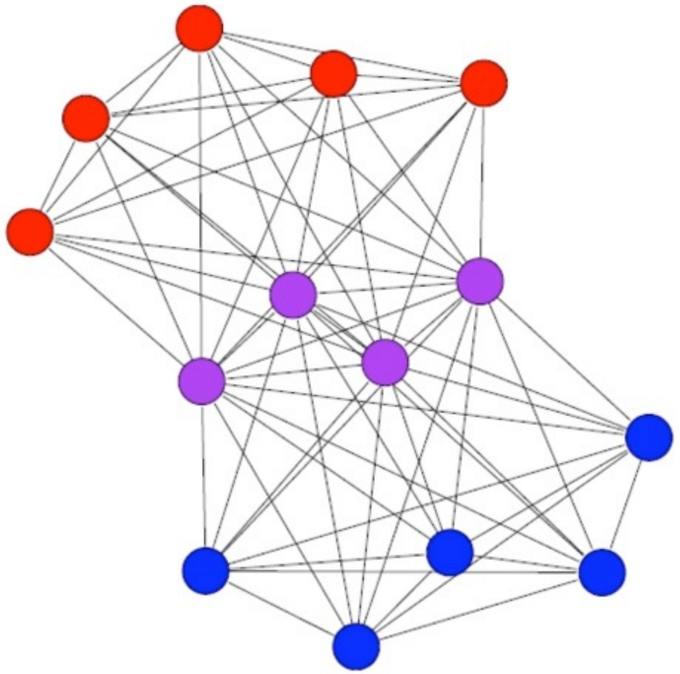
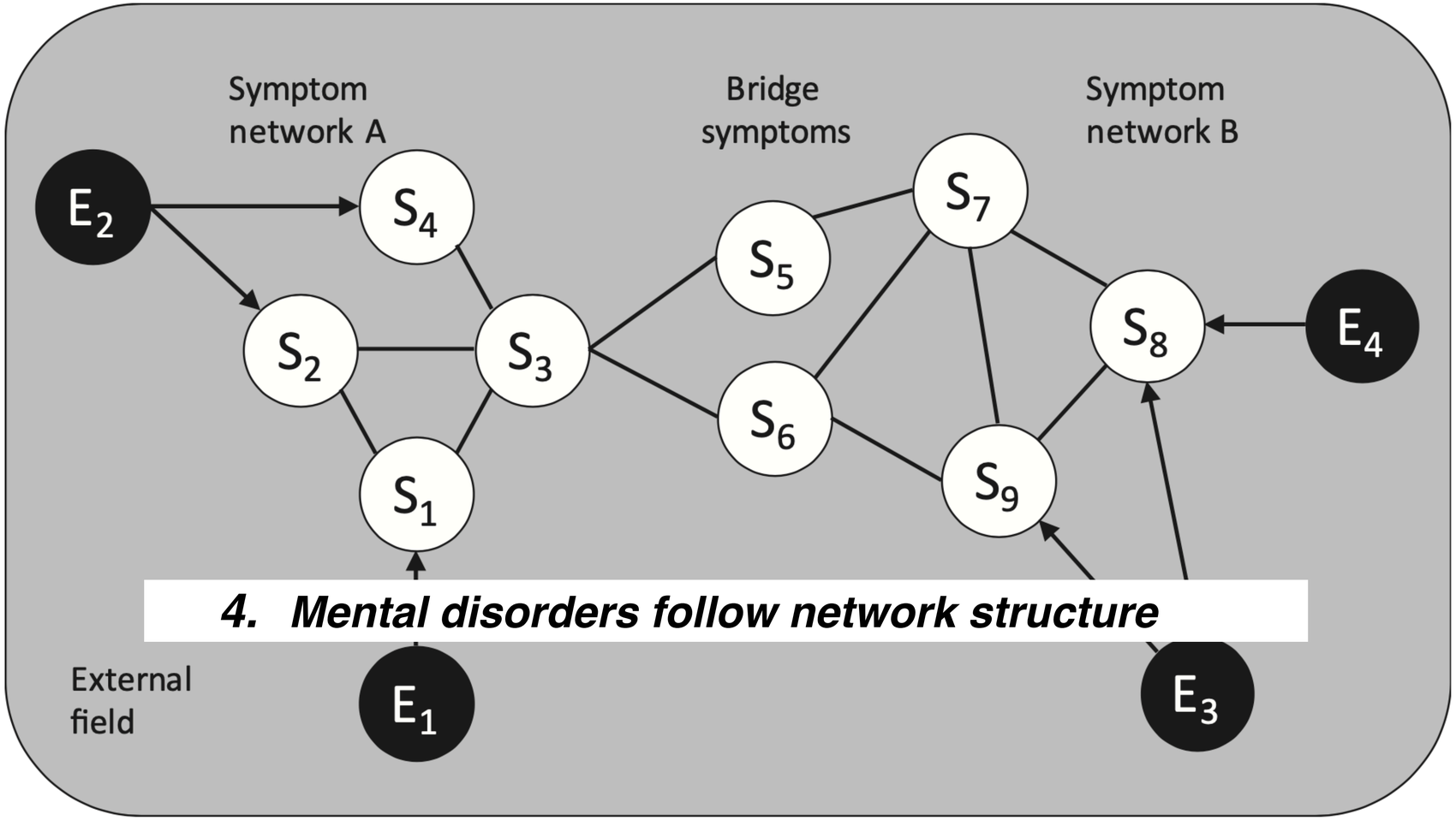
MDD-GAD

Major depressive episode	*Generalized anxiety disorder*
Depressed mood	Feels Anxious
Loss of interest	Anxious on multiple events
Fatigue	Fatigue
No concentration	No concentration
Sleep problems	Sleep problems
Agitation	Restlessness
Weight disturbance	Cannot control worry
Reproach	Irritability
Suicidal ideation	Muscular tension



Comorbidity



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Network theory of psychopathology

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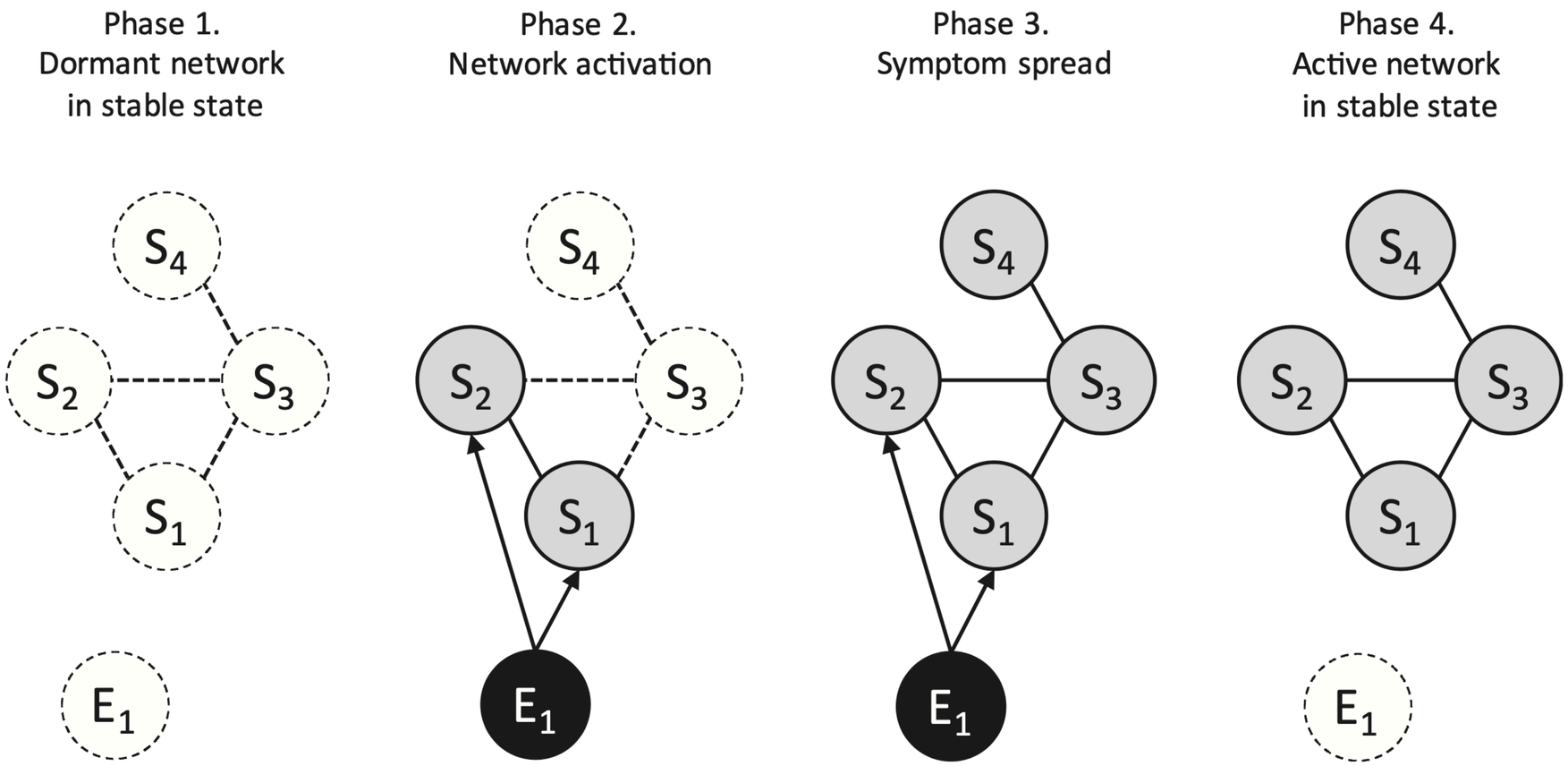
Developing psychopathology



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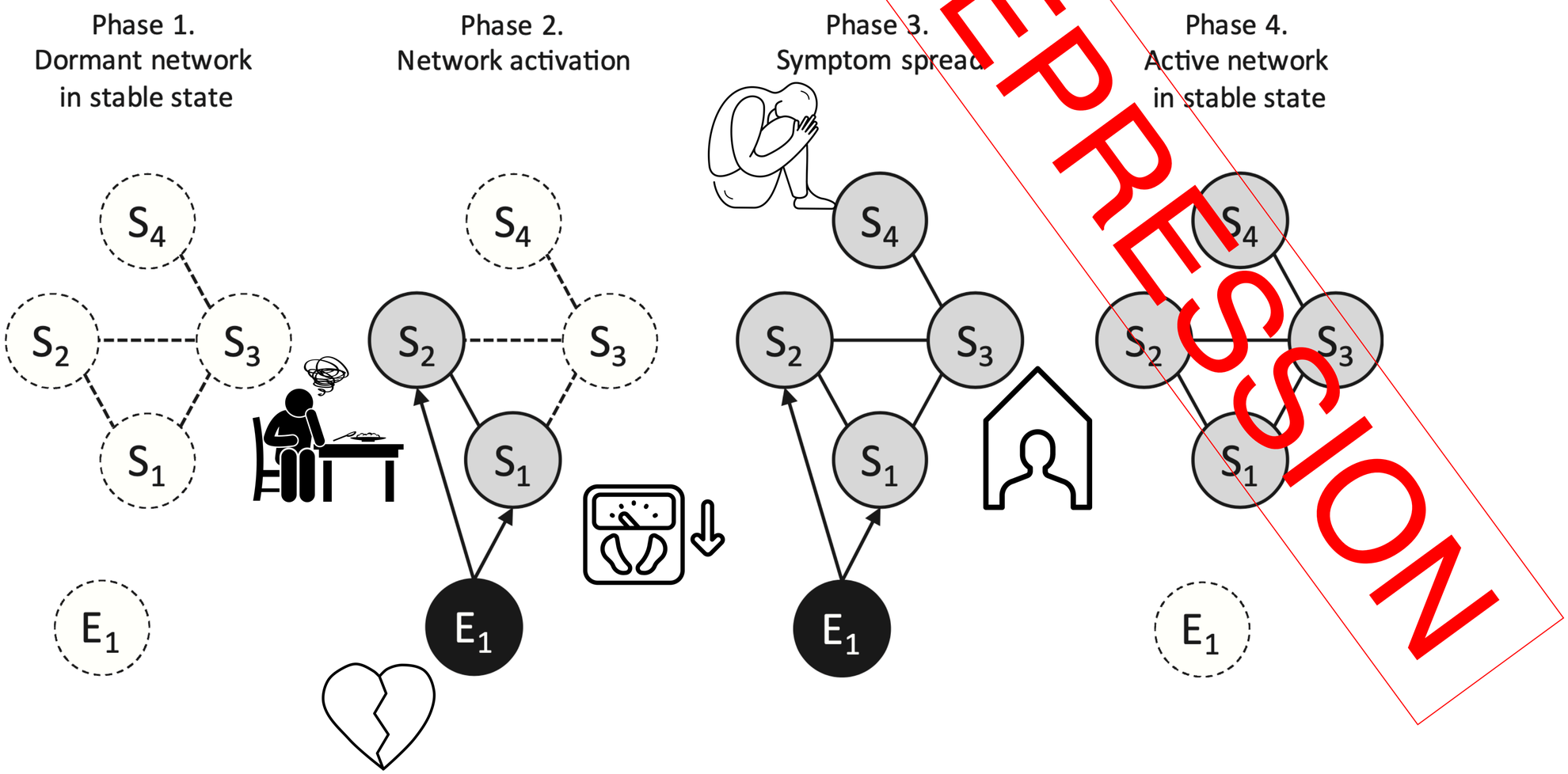

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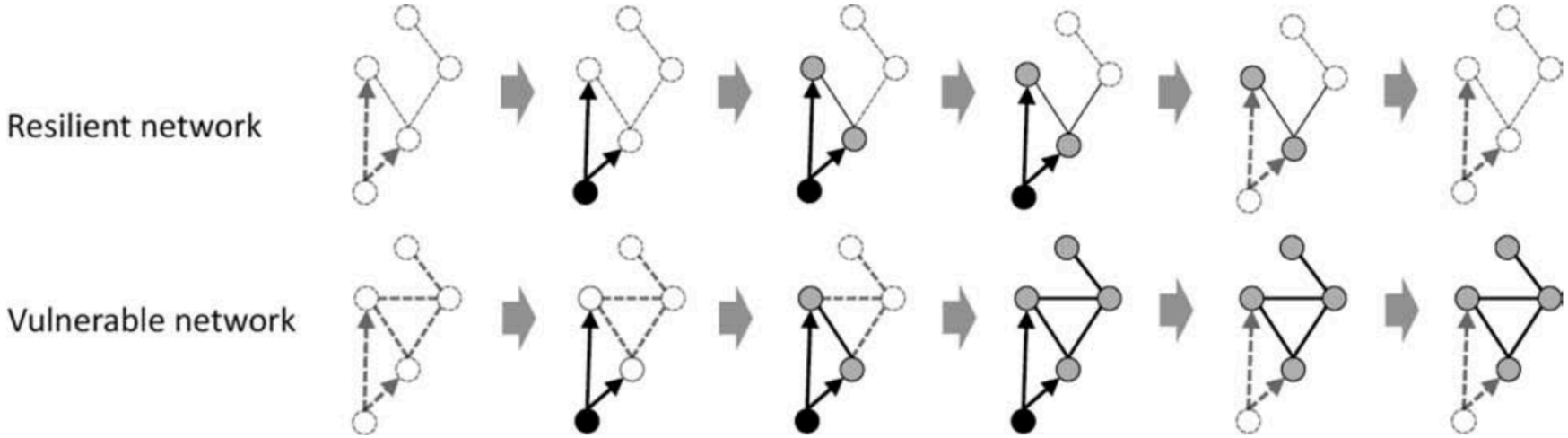
Vulnerability



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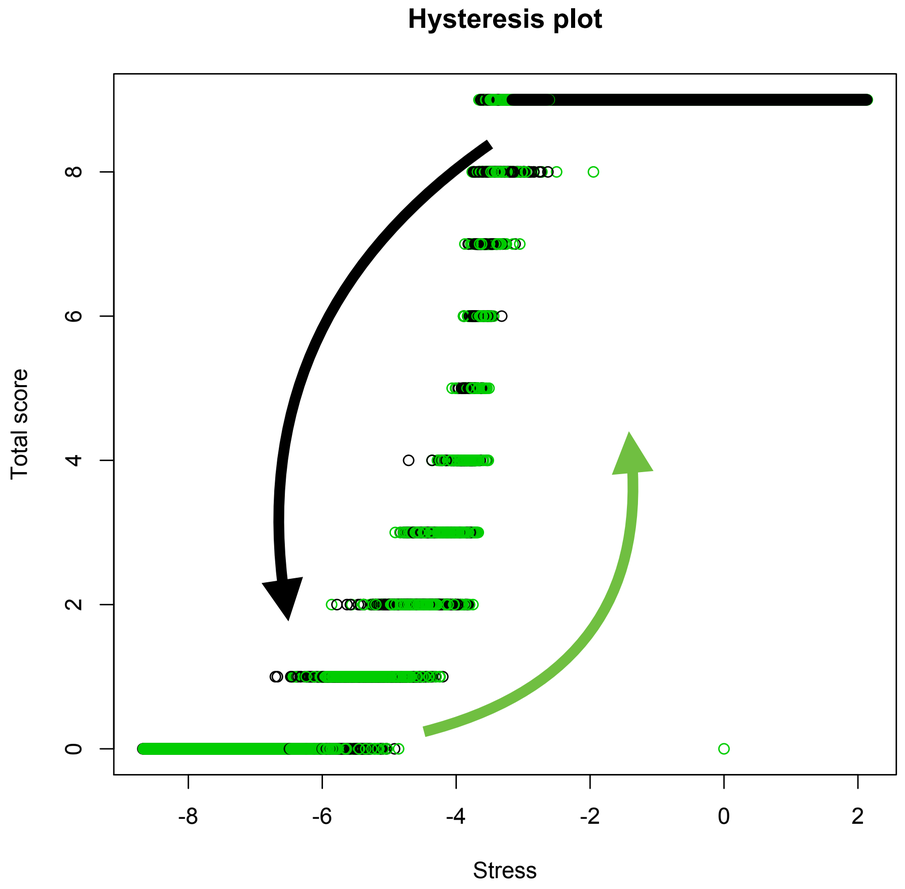
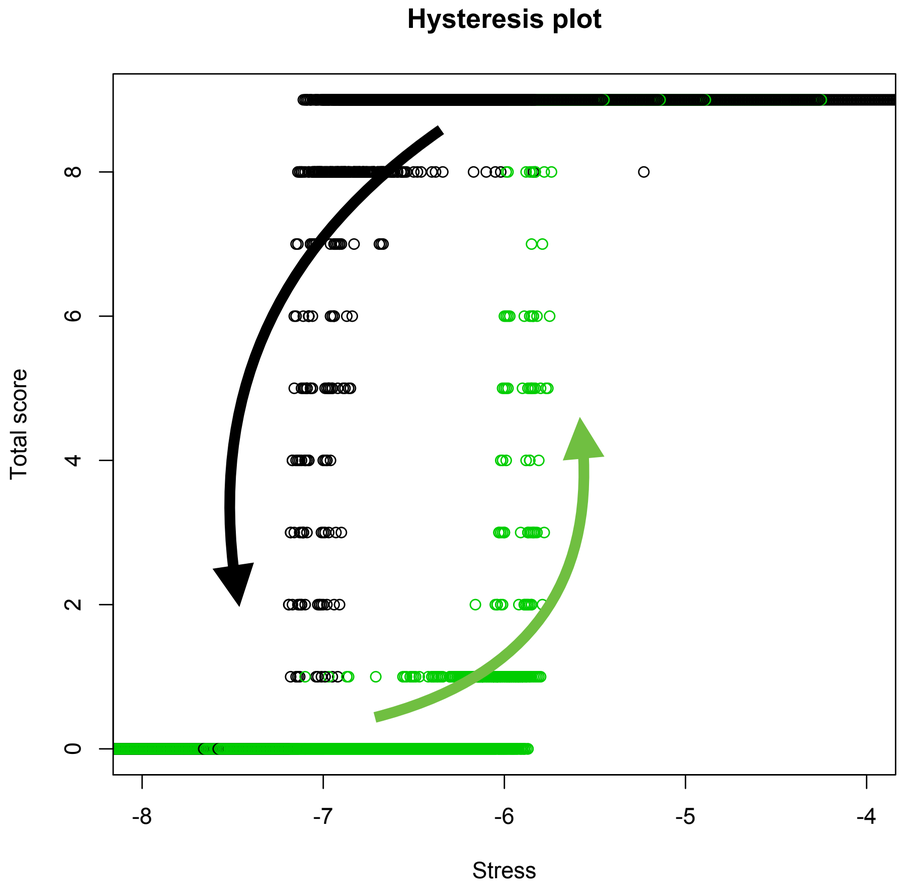
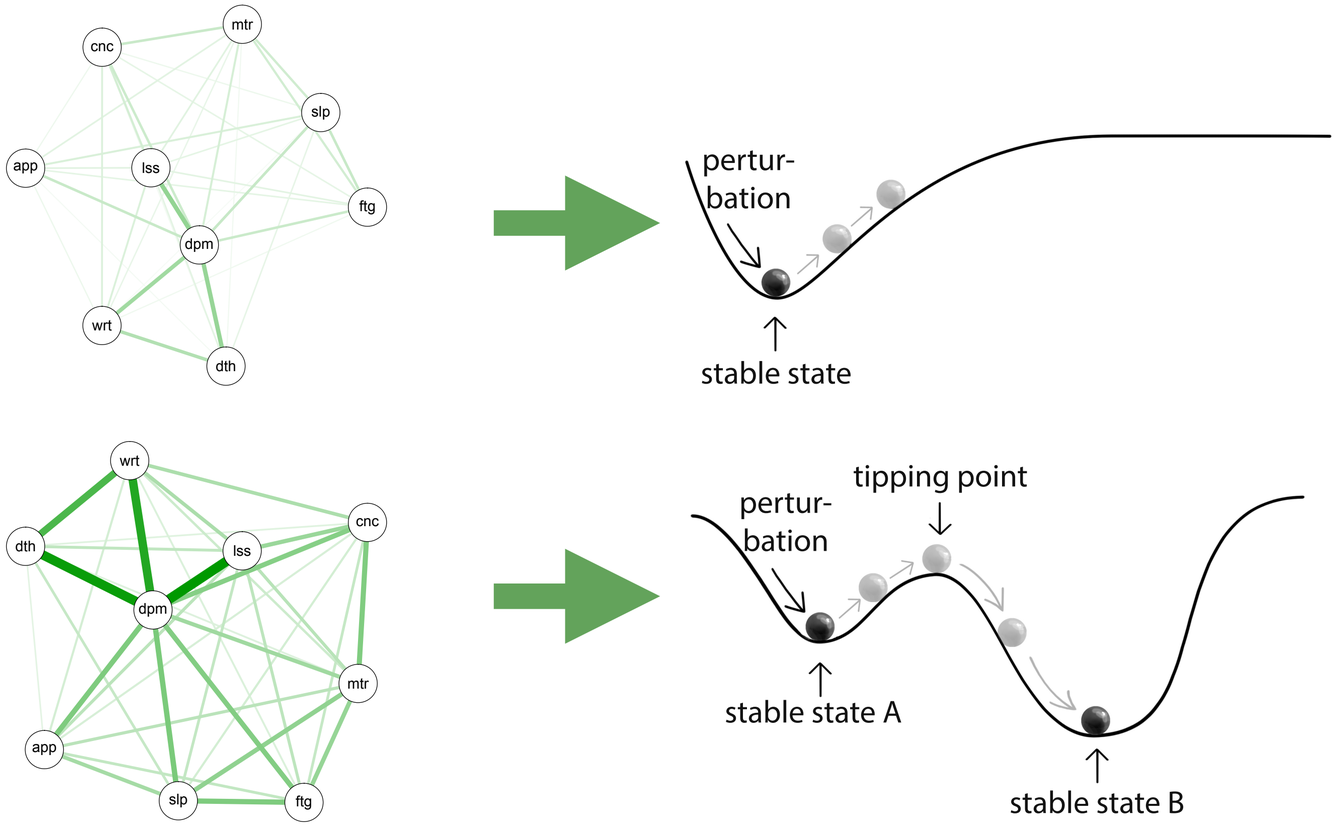
Weakly connected



Strongly connected

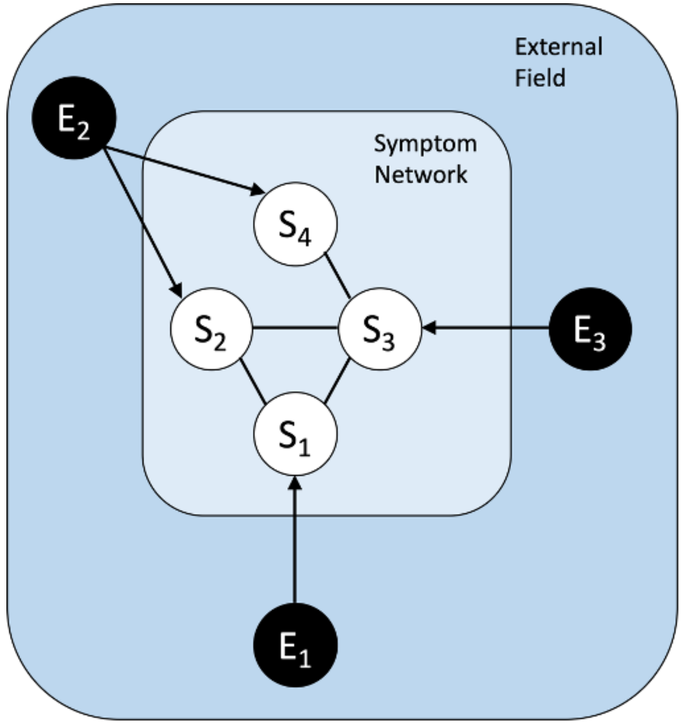


Strong connectivity yields sudden transitions to alternative attractors



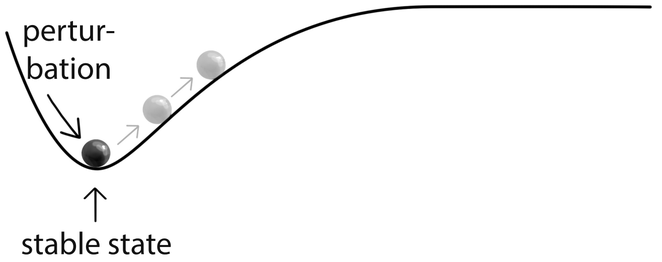
Symptom network

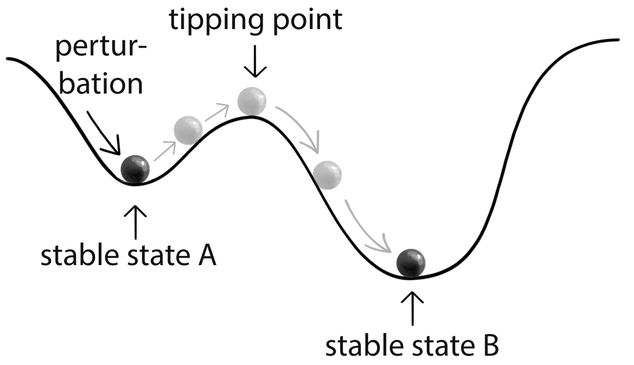
- The simplest symptom network consists of:
  - Node thresholds: how easily a symptom is activated
  - Connections: how easily does activation spread
  - External factors: outside influences that activate symptoms



Mental disorders as attractor states

- Network theory: *Mental disorders are alternative stable states in a symptom network*
- Mental disorders arise from (local) hyper-connectivity of the symptom network in combination with (possibly random) perturbations
- This leads the network to get “stuck” in its disordered state
- Whether this shift is permanent depends on the size of the hysteresis effect





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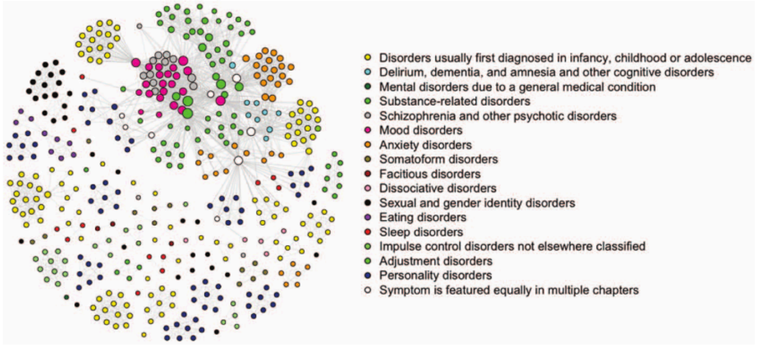
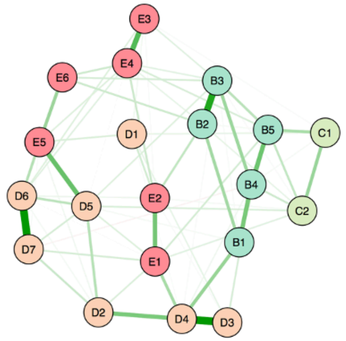
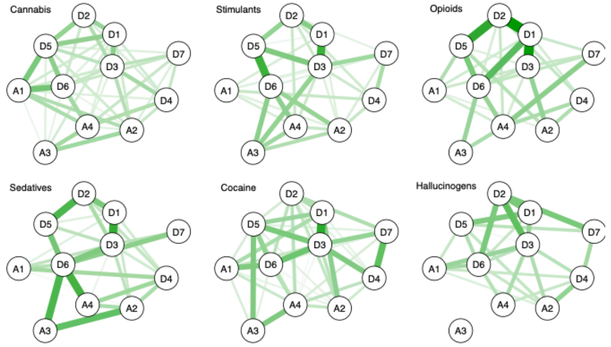
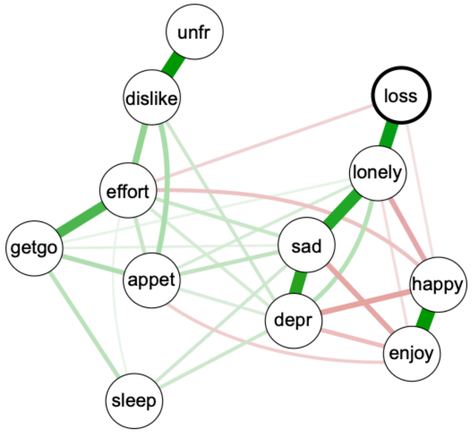
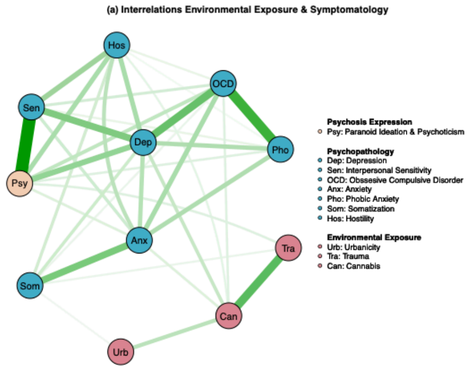


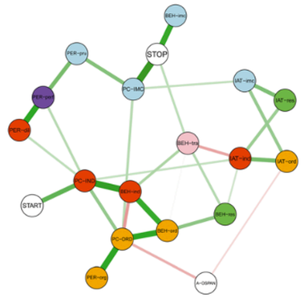


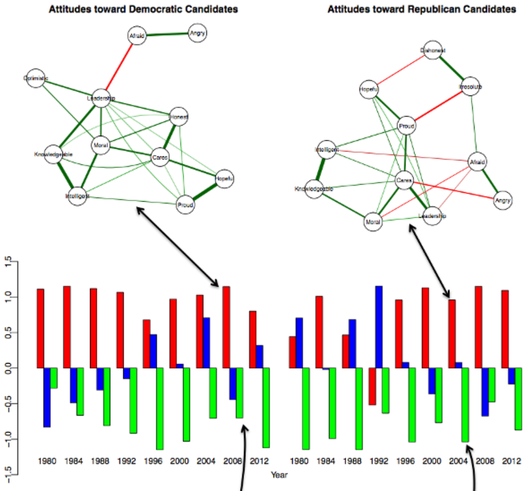
B1 - Intrusive thoughts
B2 - Nightmares
B3 - Flashbacks
B4 - Emotional cue reactivity
B5 - Physiological cue reactivity
C1 - Avoidance of thoughts
C2 - Avoidance of reminders
D1 - Trauma-related amnesia
D2 - Negative beliefs
D3 - Blame of self other others
D4 - Negative trauma-related emotions
D5 - Loss of interest
D6 - Detachment
D7 - Restricted affect
E1 - Irritability/anger
E2 - Self-destructive/reckless behavior
E3 - Hypervigilance
E4 - Exaggerated startle response
E5 - Difficulty concentrating
E6 - Sleep disturbance

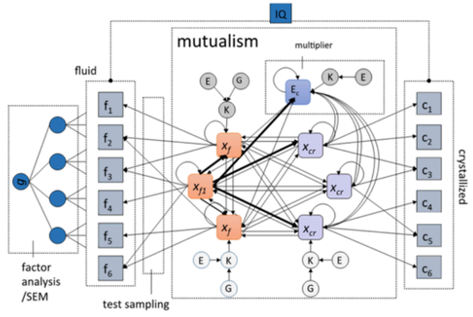


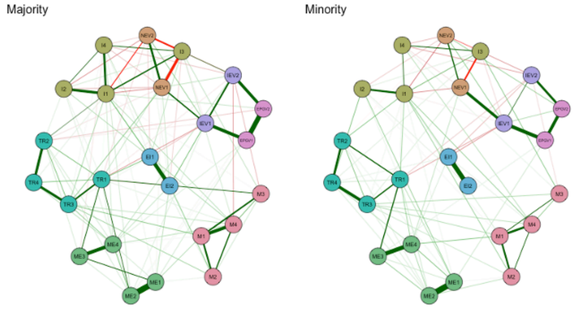




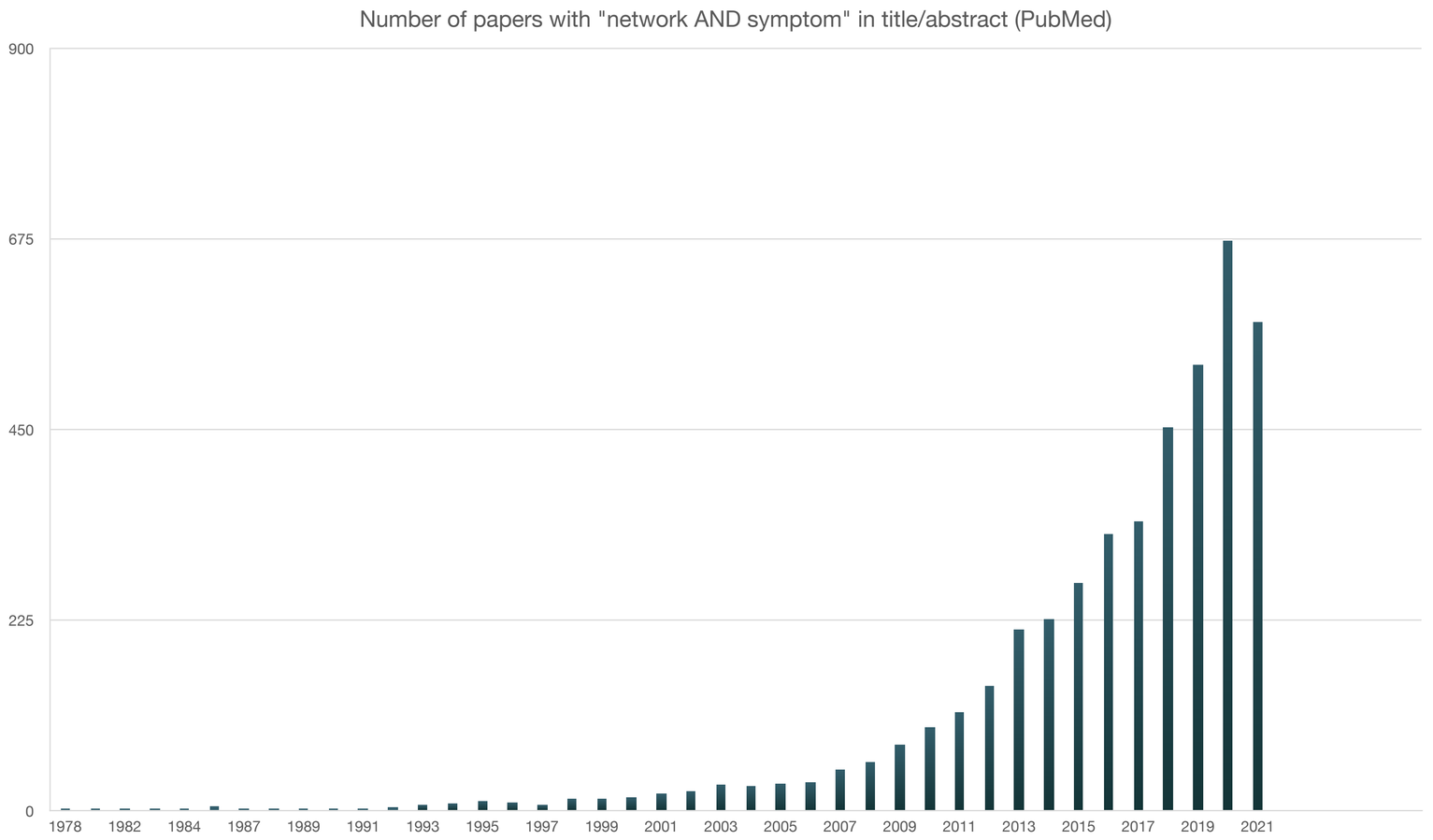








Networks in psychology



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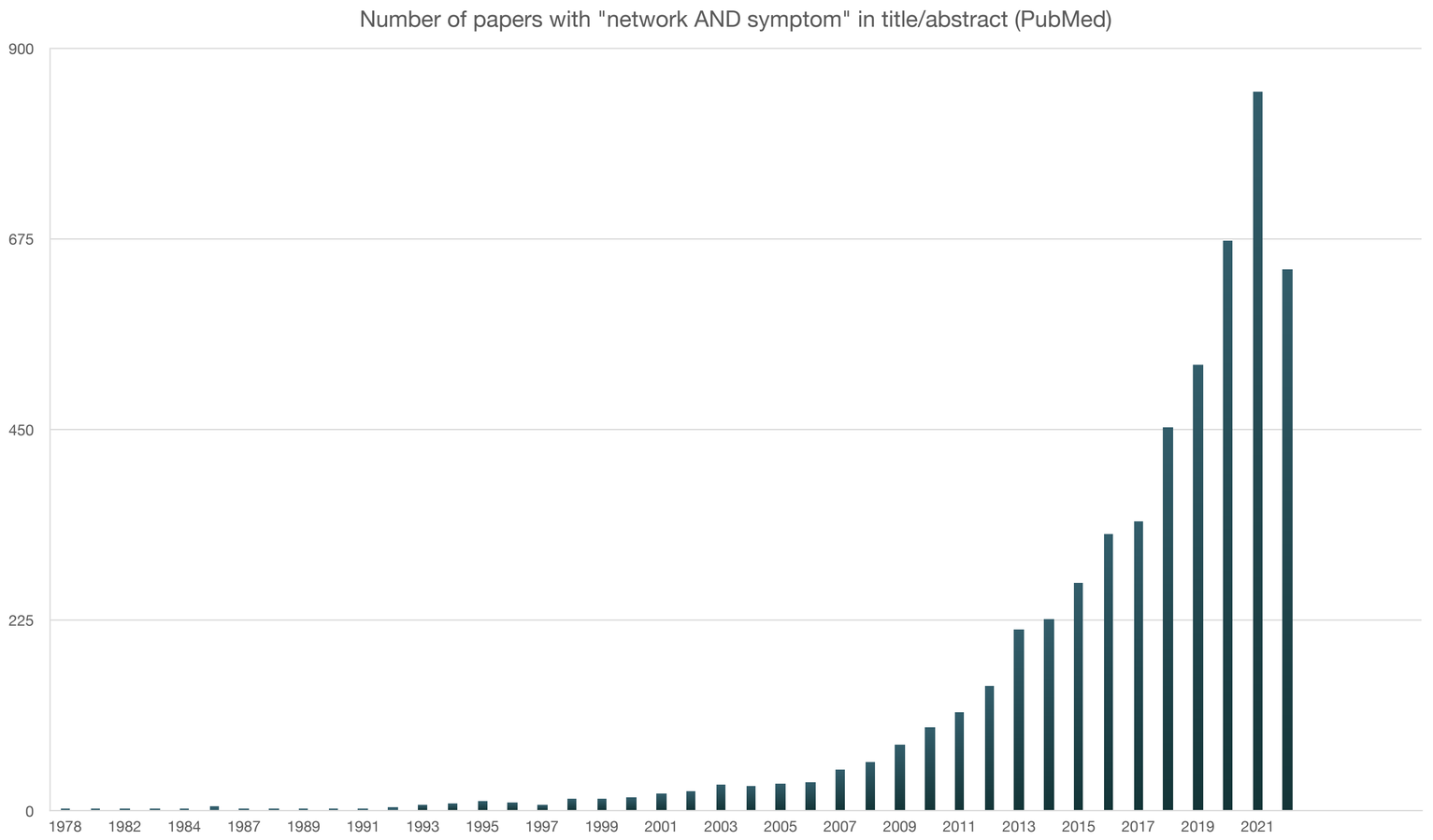

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network approach

- map out complexity

network theory

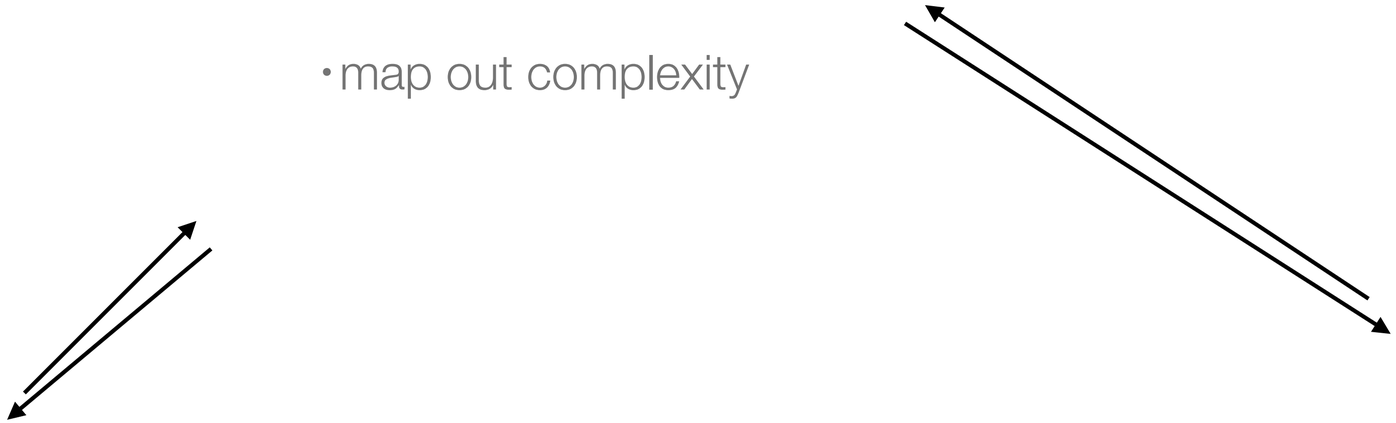
- system of causal relations to explain phenomena

network model

- represents statistical relations between variables in a dataset

network approach

- map out complexity



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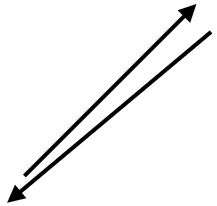

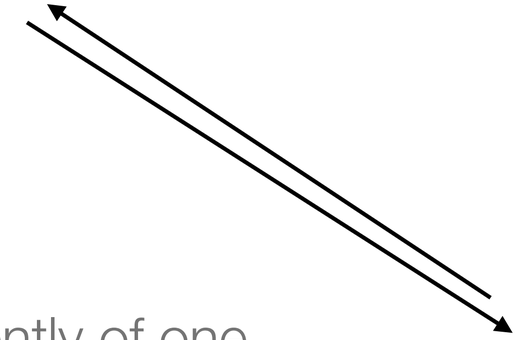

can also exist independently of one another: one can adhere to the theory without using models, or use models without believing in the theory

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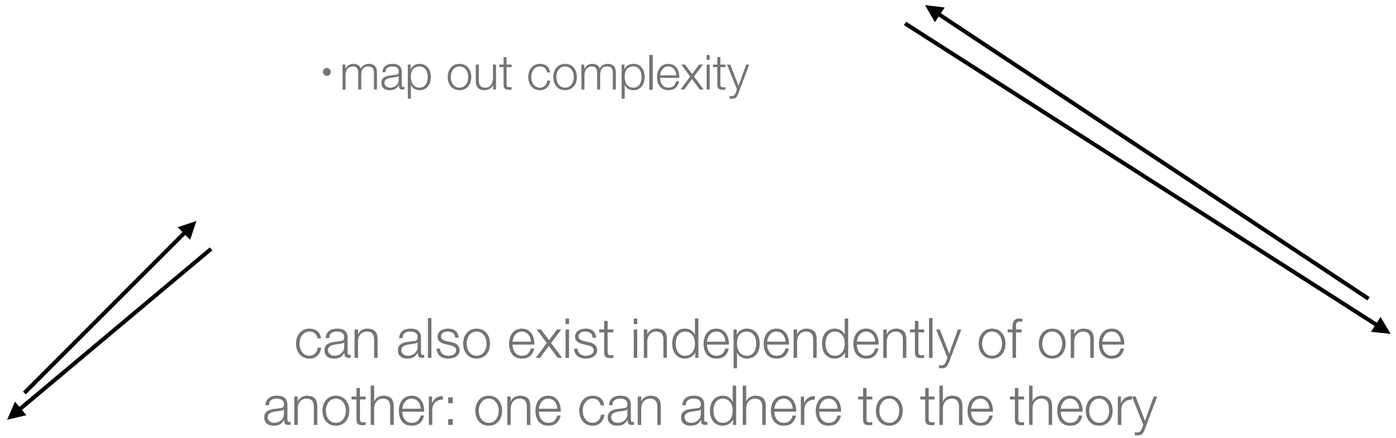

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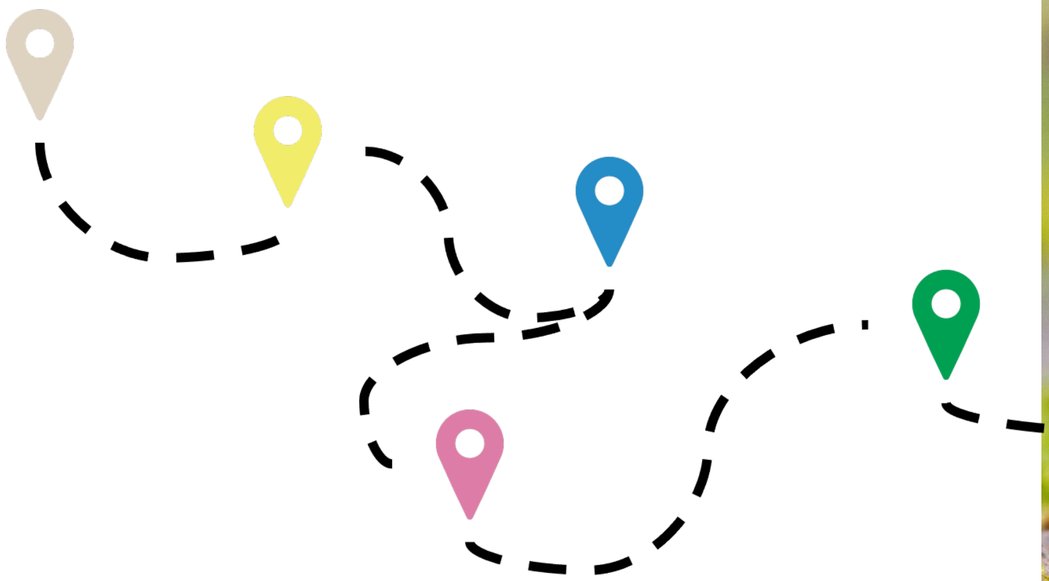
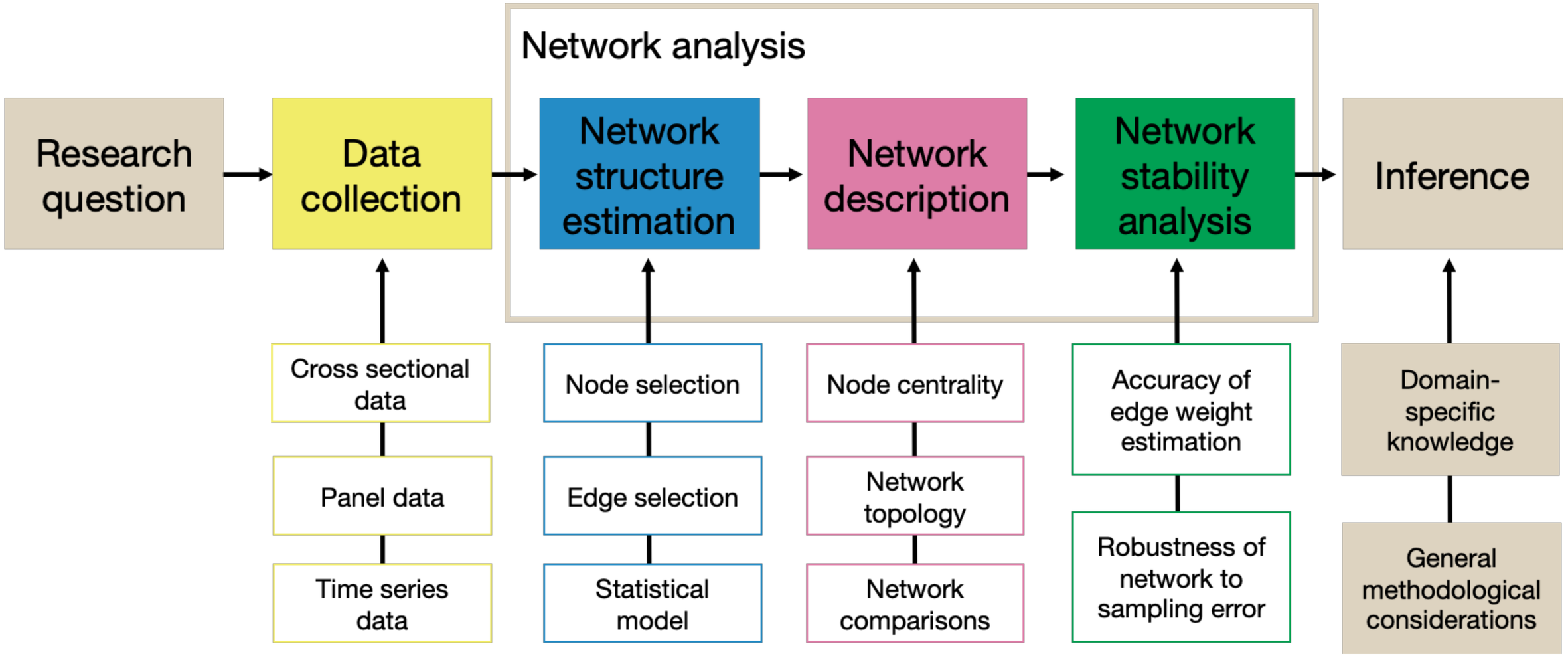
More on this in lecture by Denny Borsboom (December 1st)

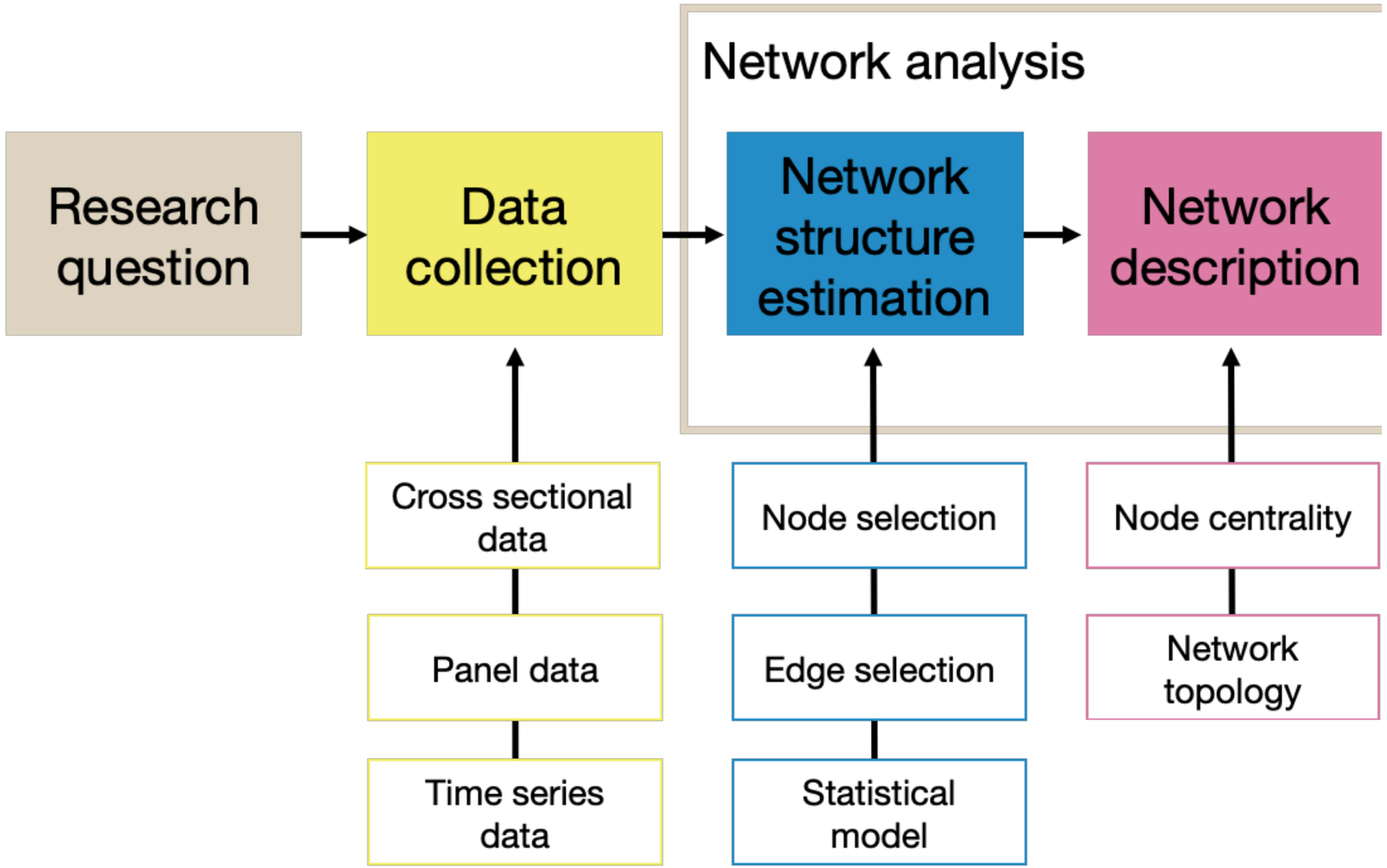
The network analysis landscape



Work flow in the network approach



Work flow in the network approach—In today's lecture

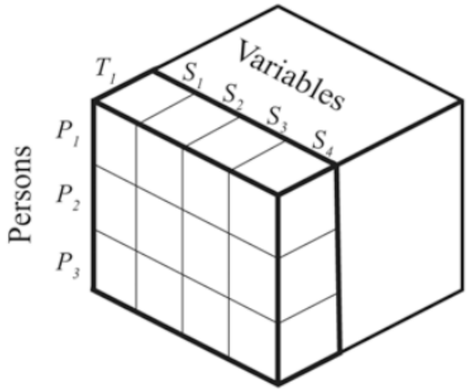


Research questions

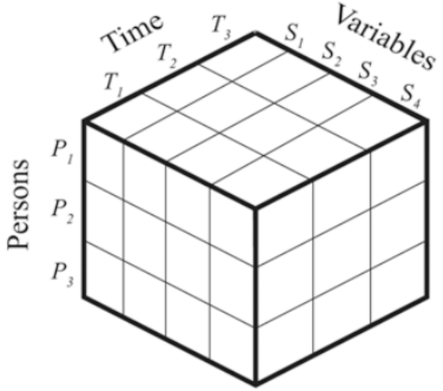
What kind of research questions do you think are suited to answer using a network approach?

Data structures

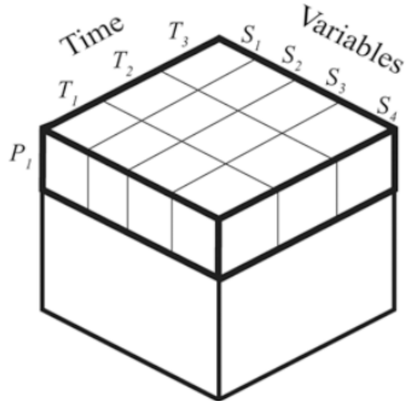
cross-sectional data
(N = large, T = 1)

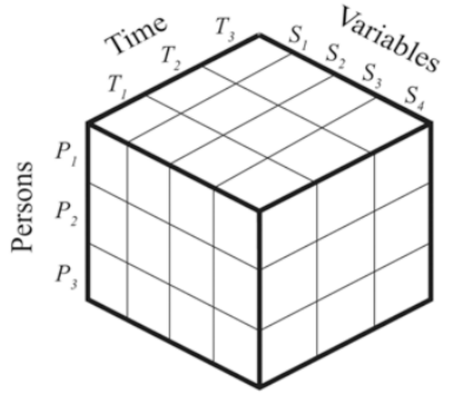


panel data
(N>>T)



time series data
(N >1, T = large)





Statistical procedures

cross-sectional data (N = large, T = 1)

- Ising model
  - College 3
- Gaussian Graphical Model (GGM)
  - College 3
- Mixed Graphical Model (MGM)
  - See online tutorials and symposium

panel data (N>>1)

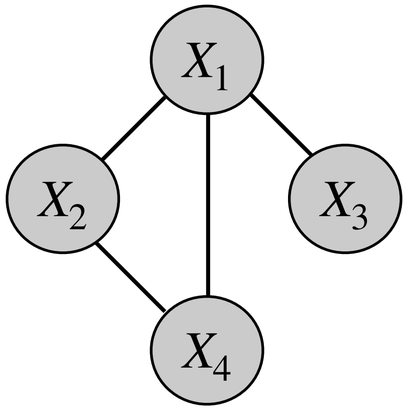
- Multilevel graphical Vector Autoregression (VAR)
  - College 4

time series data (N >1, T = large)

- Graphical Vector autoregression
  - College 4
- Multilevel graphical Vector Autoregression (VAR)
  - College 4

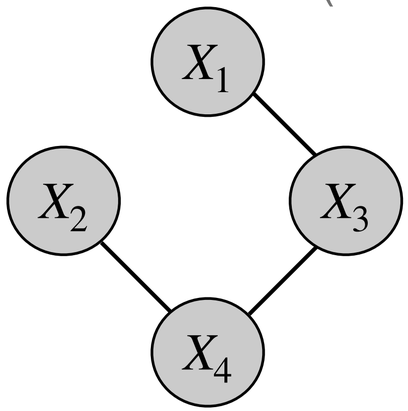
Network types

cross-sectional data
(N = large, T = 1)

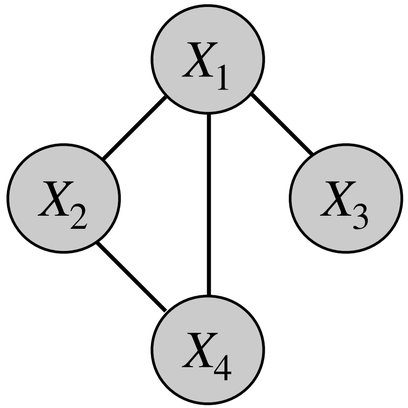


Between-person

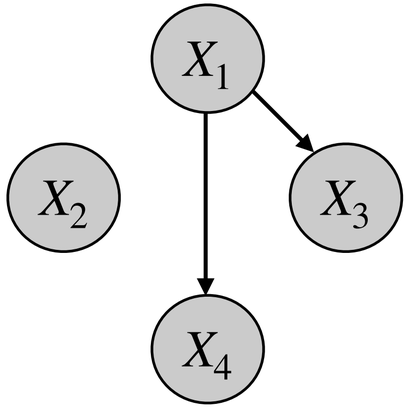
panel data
(N>>1)



Within-person
comtemporaneous

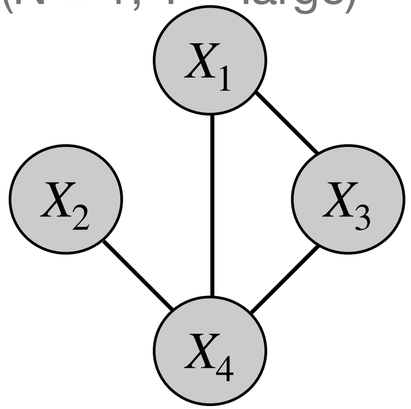


Between-person

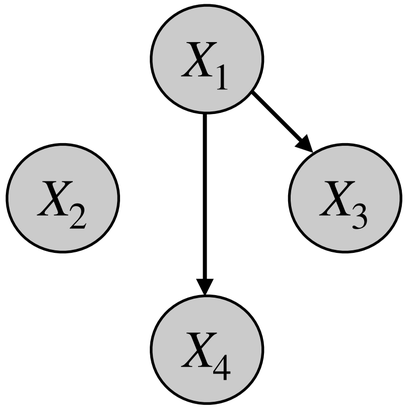


Within-person temporal

time series data
(N = 1, T = large)



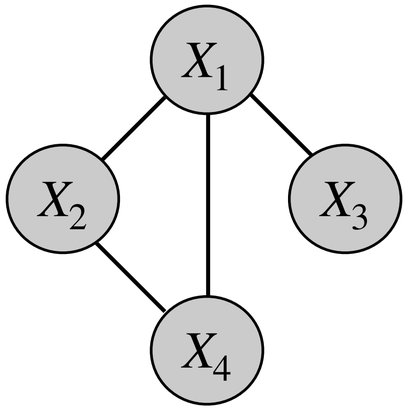
Within-person
comtemporaneous



Within-person temporal

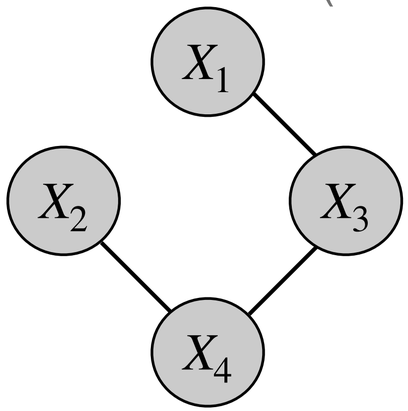
Network types

cross-sectional data
(N = large, T = 1)

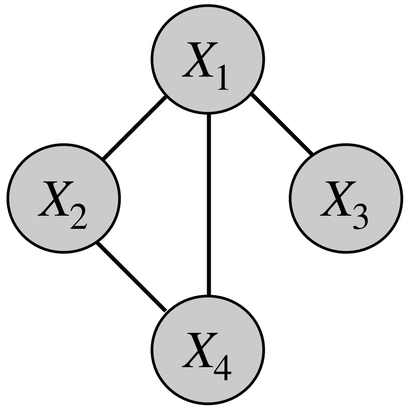


Between-person

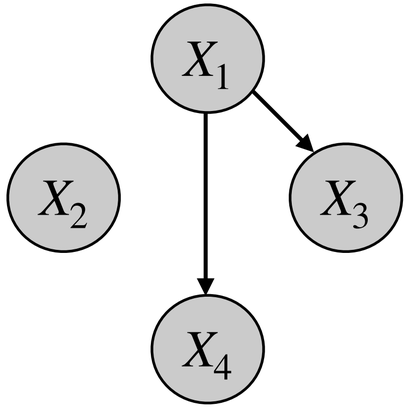
panel data
(N>>1)



Within-person
comtemporaneous

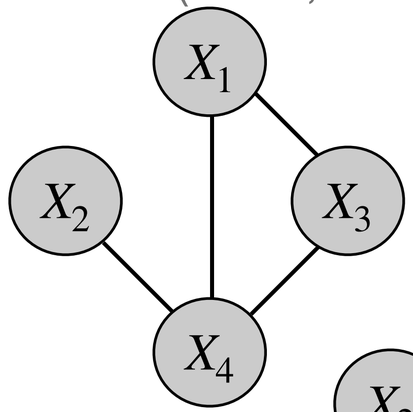


Between-person

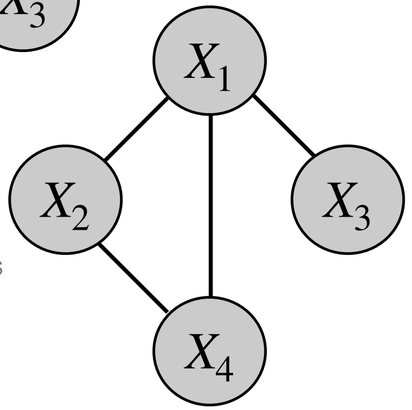


Within-person temporal

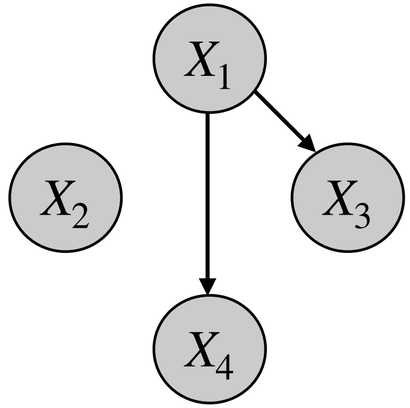
time series data
(N > 1, T = large)



Within-person
comtemporaneous



Between-person



Within-person temporal

Network description

Local network properties

RQ: The role of specific nodes in the network

- Centrality
  - Direct connectivity
    - node degree, node strength, one-step expected influence
  - Indirect connectivity
    - closeness, betweenness, two-step expected influence
  - Bridge centrality
    - Strength, bridge expected influence, closeness, betweenness
- Clustering

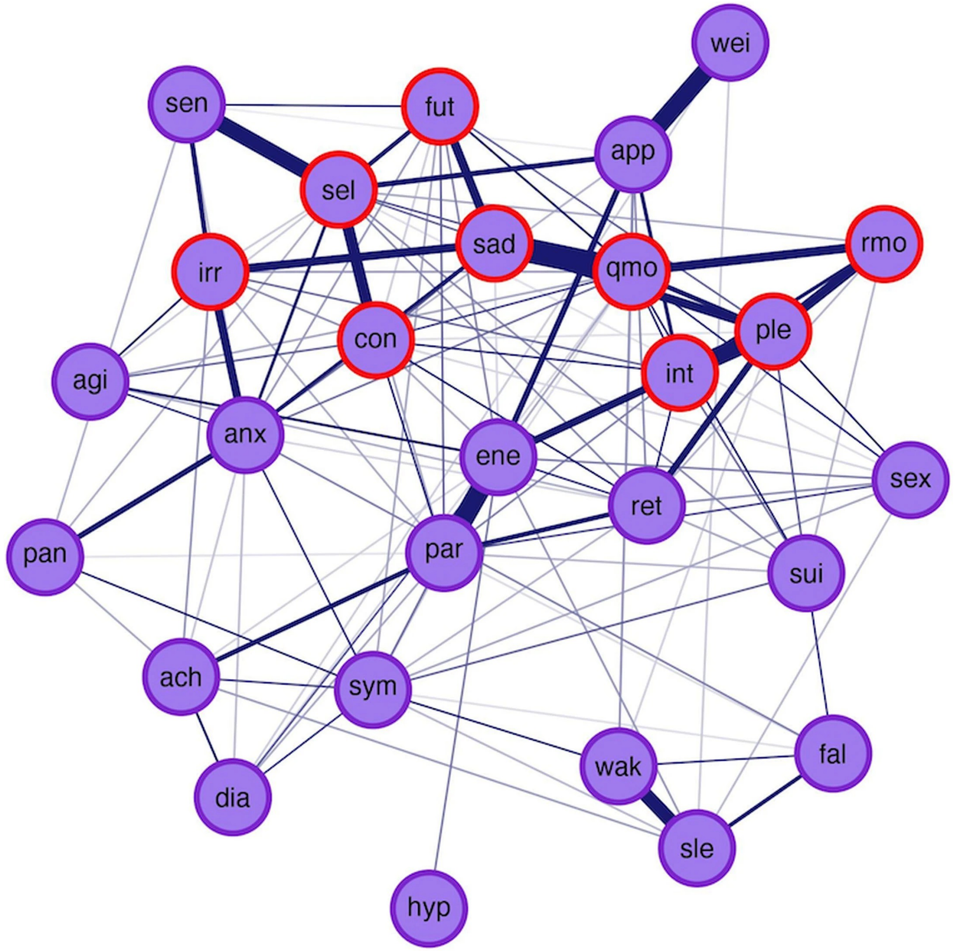
Global network properties

RQ: The role of the whole network structure

- Degree distributions
- Connectivity
  - Density/sparsity of a network
- Clustering
  - Global clustering coefficient, transitivy
- Community detection

Cross-sectional network techniques — Ising model

- RQ1: How are individual depression symptoms related?
- RQ2: Which symptoms are important in the depression network?
- Data:
  - N = 1108
  - Binary data on 27 items from the Inventory of depressive Symptomatology
- Network model:
  - Ising model
- Network description:
  - Community structure
  - node strength, betweenness, local clustering
- Inference:
  - Most cognitive depressive symptoms cluster together and these symptoms are high on at lest two out of three centrality measures



ach: aches and pains
agi: psychomotor agitation
anx: feeling anxious
app: change of appetite
con: concentration problems
dia: diarrhea/constipation
ene: energy level
fal: falling asleep
fut: view of myself
hyp: hypersomnia
int: general interest
irr: feeling irritable
pan: panic/phobic symptoms
par: leaden paralysis
ple: capacity for pleasure (not sex)
qmo: quality of mood
ret: psychomotor retardation
rmo: respons of mood
sad: feeling sad
sel: view of oneself
sen: interpersonal sensitivity
sex: interest in sex
sle: sleep during the night
sui: suicidal thoughts
sym: other bodily symptoms
wak: waking up too early
wei: change of weight

Figure 3 in Van Borkulo, C. D., Borsboom, D., Epskamp, S., Blanken, T. F., Boschloo, L., Schoevers, R. A., & Waldorp, L. J. (2014). A new method for constructing networks from binary data. *Scientific reports*, *4*(1), 1-10.

Cross-sectional network techniques — GGM

- RQ1: Identify pathways that may be involved in the relationship between childhood trauma and psychosis
- Data:
  - N = 552
  - Symptoms of psychosis, general psychopathology and childhood trauma
- Network model:
  - Gaussian Graphical Model
- Network description:
  - Node strength, betweenness and closeness
  - Inspected shortest paths between trauma scale and the positive and negative symptoms of the PANSS
- Network inference:
  - Childhood trauma subscales are not directly associated with any positive or negatieve symptoms, only via general psychopathology symptoms, i.e., general psychopathology could function as a mediator

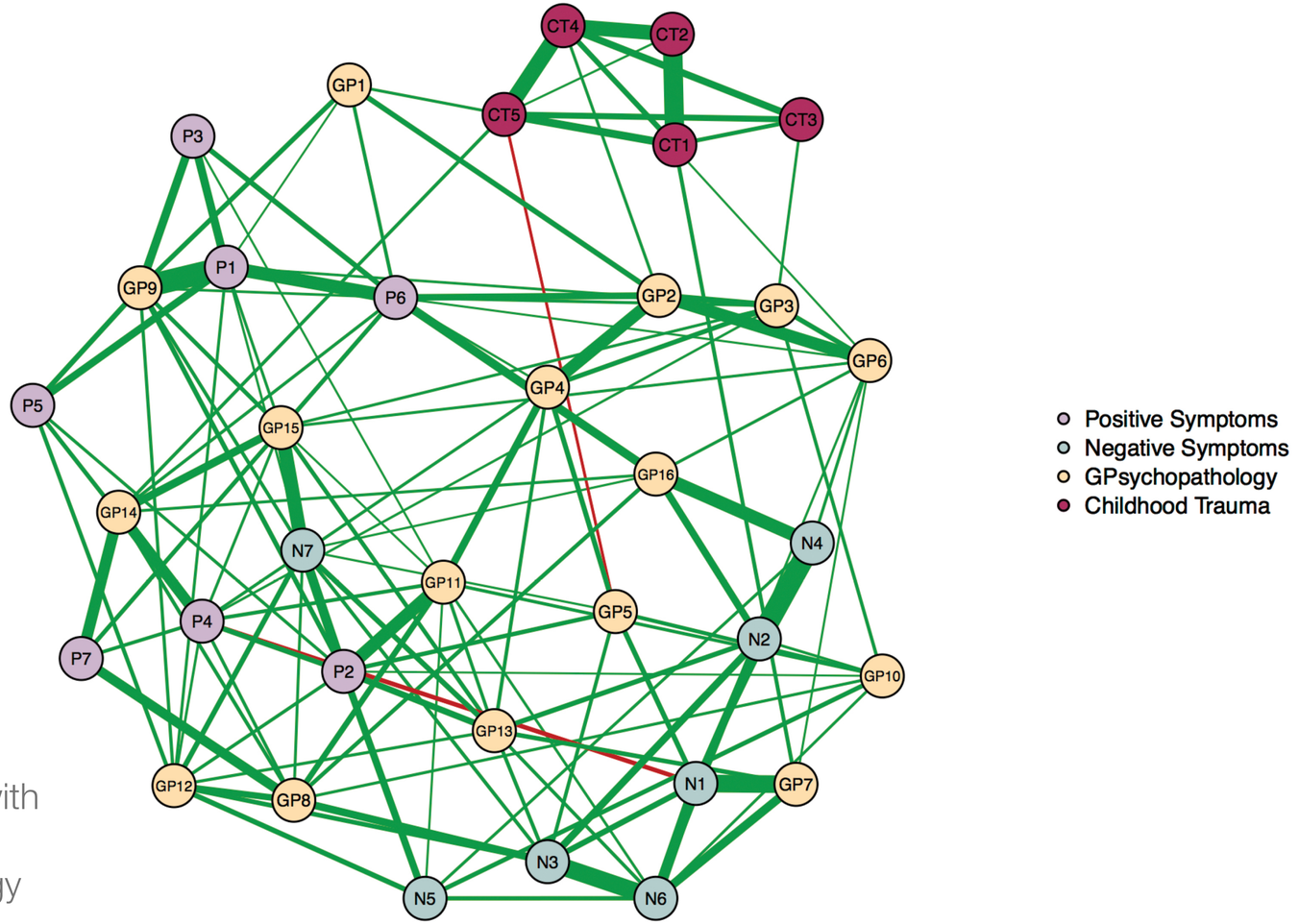


Figure 1 in Isvoranu, A. M., van Borkulo, C. D., Boyette, L. L., Wigman, J. T., Vinkers, C. H., Borsboom, D., & Group Investigators. (2017). A network approach to psychosis: pathways between childhood trauma and psychotic symptoms. *Schizophrenia bulletin*, *43*(1), 187-196.

Cross-sectional network techniques — MGM

- RQ1: What is the sequential development and order of CBTI-induced effects on symptoms of insomnia and depression throughout the course of treatment?
- Data:
  - N = 104
  - Symptoms of insomnia and depression
- Network model:
  - MGM for each week of treatment combined with Network Intervention Analysis (NIA)
- Network description:
  - Influence of treatment variable
- Network inference:
  - Treatment had a primary effect on insomnia symptoms. Sequential development indicated that treatment first improved sleep problems and later on dissatisfaction with sleep

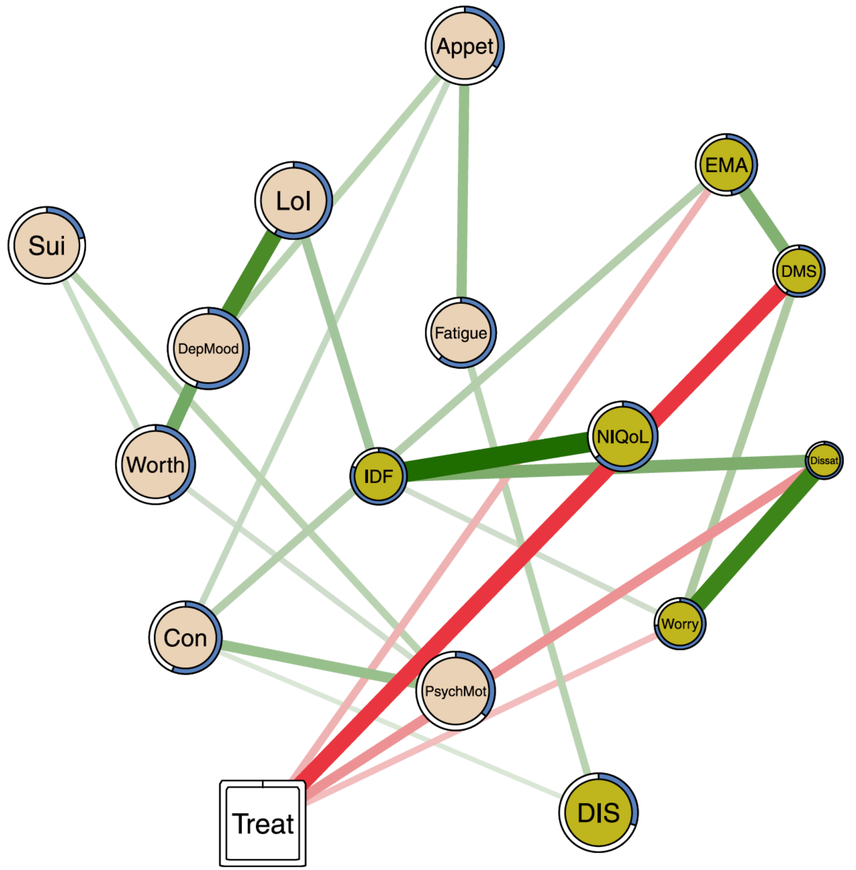


Figure 1 in Blanken, T. F., Van Der Zweerde, T., Van Straten, A., Van Someren, E. J., Borsboom, D., & Lancee, J. (2019). Introducing network intervention analysis to investigate sequential, symptom-specific treatment effects: a demonstration in co-occurring insomnia and depression. *Psychotherapy and Psychosomatics*, *88*(1), 52-54.

Time series network techniques — GVAR for panel data

- RQ: Evaluate the interconnections between work-related psychosocial risks and resources over 12 years
- Data:
  - N = 10.892 at baseline
  - T = 4 (spanning 12 years)
  - Psychosocial measures such as: job demands, team climate, job control
- Network model:
  - Panel VAR
- Network description:
  - Strength centrality
- Network inference:
  - Psychosocial factors show a clear pattern of clustering. Team climate and procedural and interactional justice were the most connected factors with other psychosocial factors.

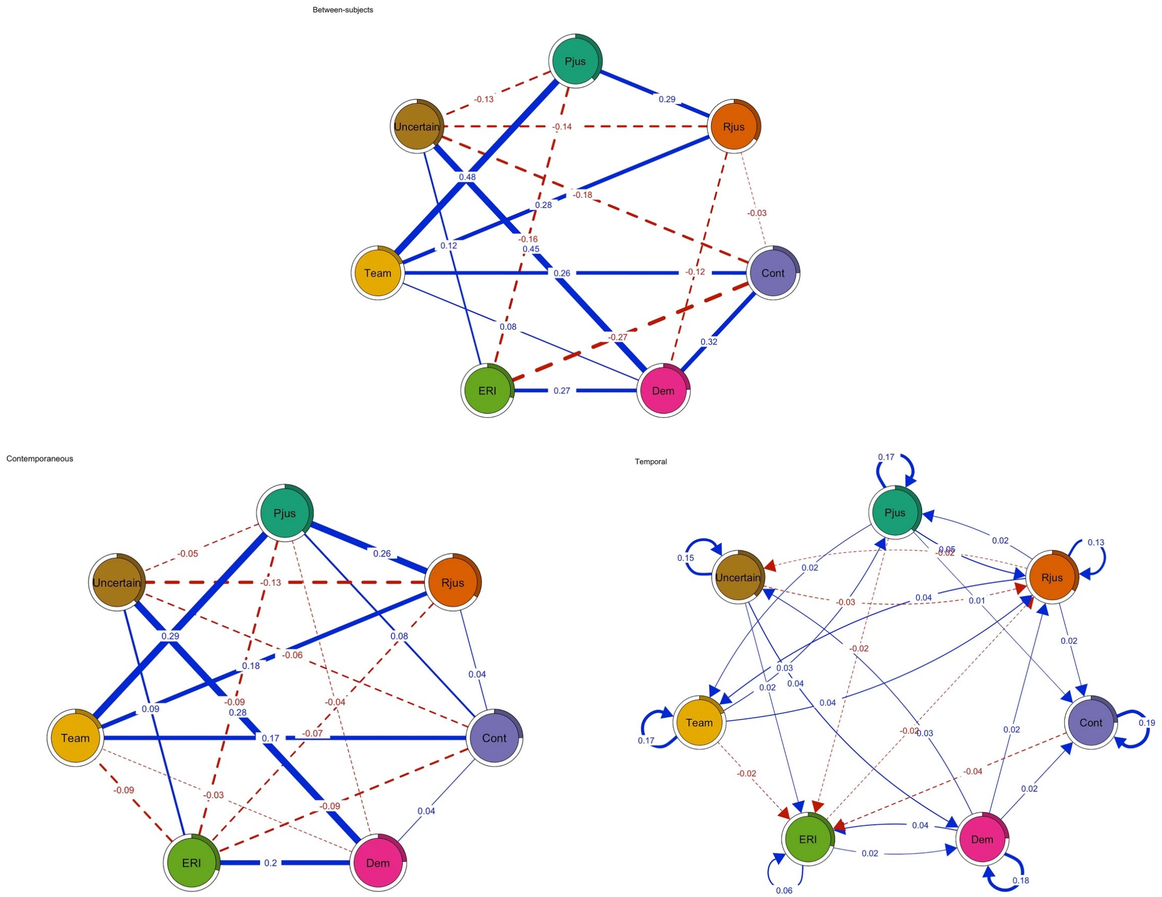


Figure 3, 4, and 5 in Elovainio, M., Hakulinen, C., Komulainen, K., Kivimäki, M., Virtanen, M., Ervasti, J., & Oksanen, T. (2022). Psychosocial work environment as a dynamic network: a multi-wave cohort study. *Scientific reports*, *12*(1), 1-11.

Time series network techniques — GVAR

- RQ 1: How do Eating Disorder (ED) symptoms in one person relate to other ED symptoms accounting for all other symptoms?
- RQ2: How do ED symptoms in one person differ from ED symptoms in another person with the same diagnoses?
- Data:
  - N = 200 (for individual networks)
  - T = 48
  - ED symptoms
- Network model:
  - Graphical VAR
- Network description:
  - Strength centrality
- Network inference:
  - While symptom connections vary greatly in individual networks, the most common symptoms that provide input to predict other symptoms were cognition focused such as fear of weight gain, and overvaluation of weight and shape.

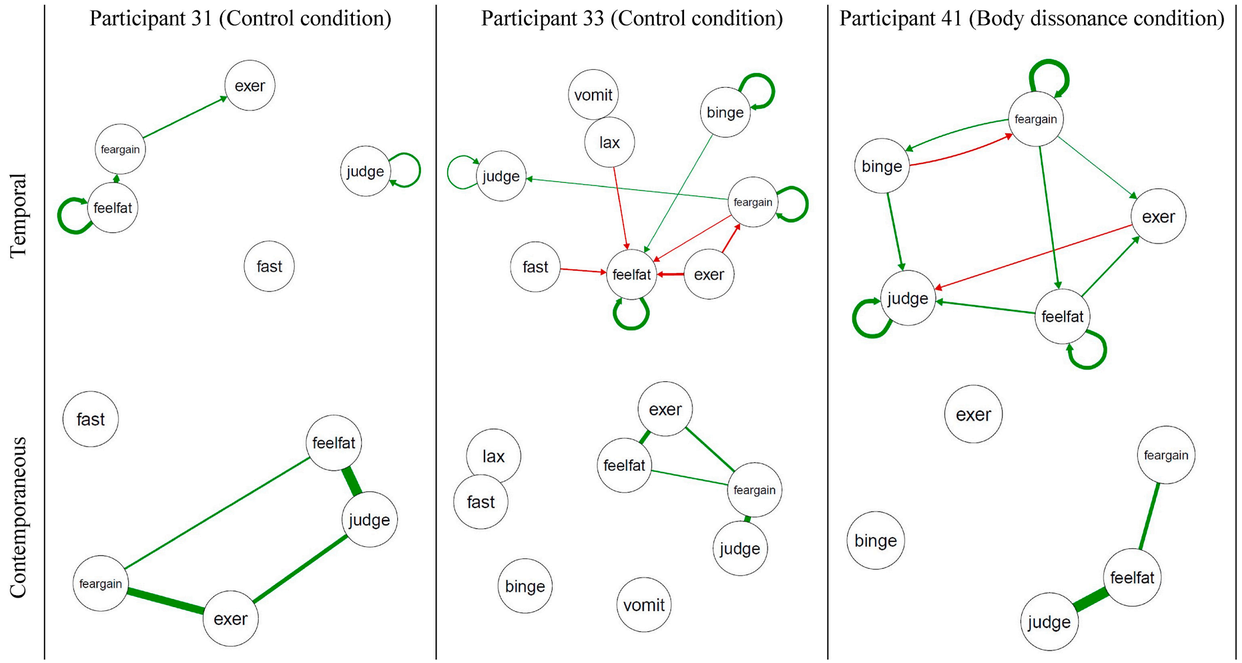


Figure 4 in Levinson, C. A., Vanzhula, I. A., Smith, T. W., & Stice, E. (2020). Group and longitudinal intra-individual networks of eating disorder symptoms in adolescents and young adults at-risk for an eating disorder. *Behaviour research and therapy*, *135*, 103731.

Time series network techniques — mlVAR

- RQ: What are the potential causal relations among mental health and covid-19 concerns (e.g., do COVID-19 concerns lead to higher levels of mental health problems at the next measurement point)?
- Data:
  - N = 80
  - T = 56
  - Mental health problems, social contact and isolation, and concerns about the COVID-19 pandemic
- Network model:
  - ml VAR
- Network inference:
  - Mental health items were interrelated, and indicated potential vicious cycles: e.g., loneliness was positively related to mental health problems and concerns about COVID-19 predicted mental health outcomes.

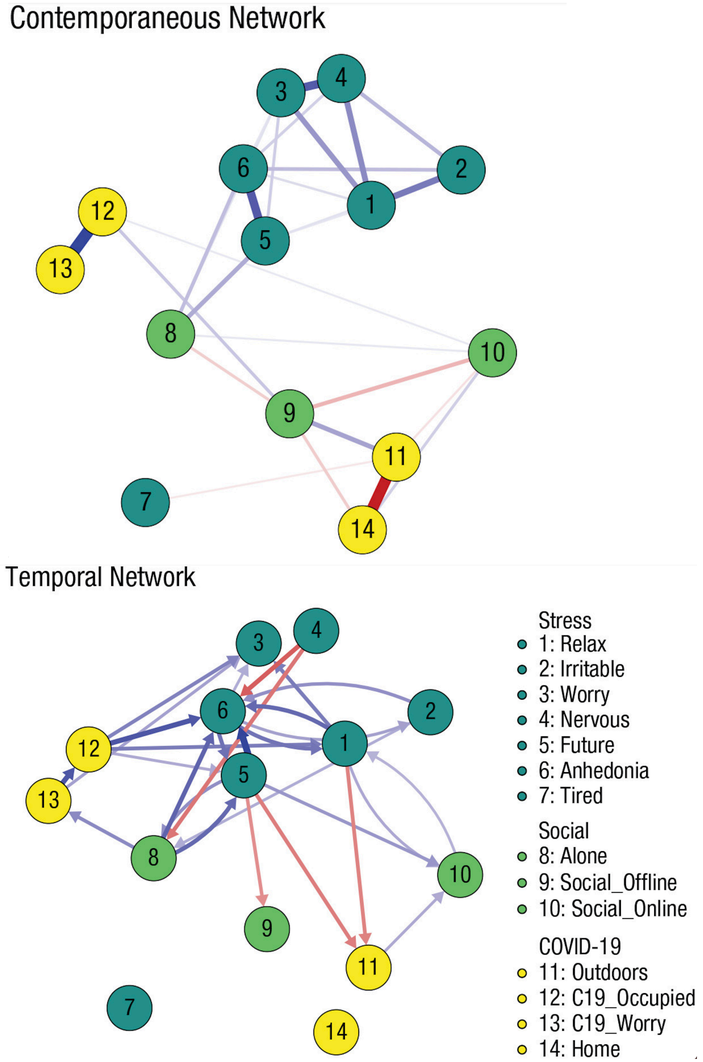
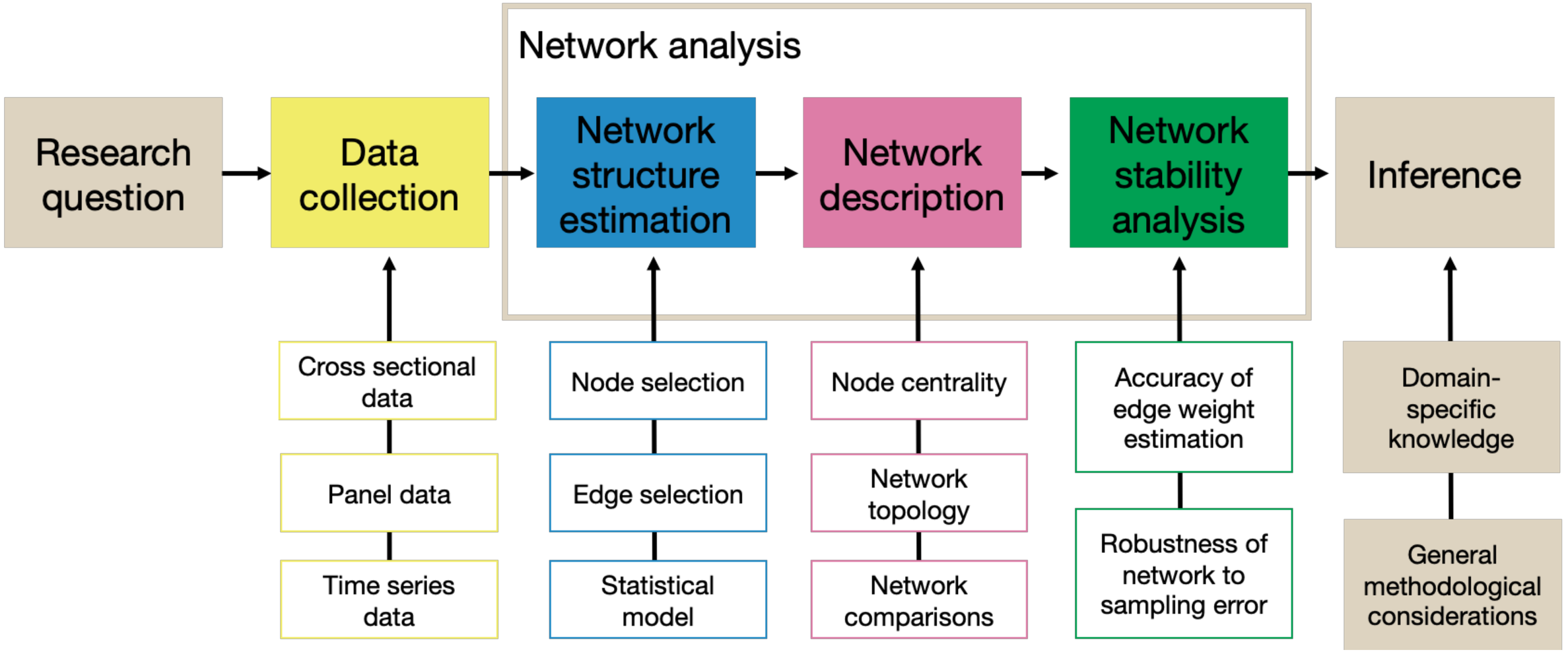


Figure 3 in Fried, E. I., Papanikolaou, F., & Epskamp, S. (2022). Mental health and social contact during the COVID-19 pandemic: an ecological momentary assessment study. *Clinical Psychological Science*, *10*(2), 340-354.

What to expect



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