

# Modeling Psychopathology: From Data Models to Formal Theories

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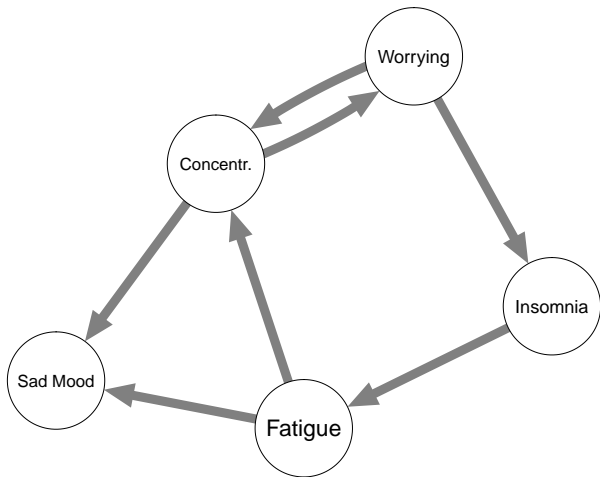
Donald Robinaugh\*  
*Harvard University*

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*University of Amsterdam*

*\*Joint first authors*

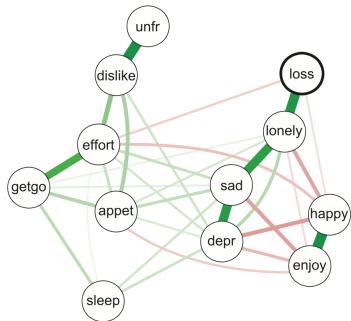
EAM 2021

# Network Approach to Psychopathology



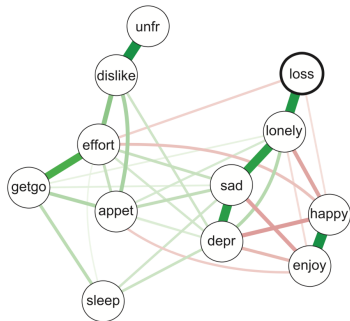
(Cramer et al, 2010; Borsboom et al. 2013; Schmittman et al, 2013; Borsboom, 2017)

# Statistical Network Analysis

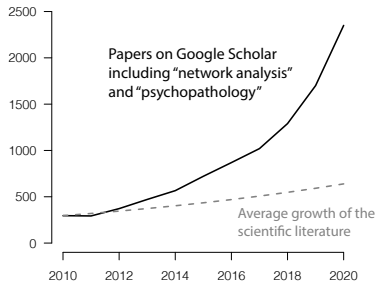


(Figure from Fried et al., 2015)

# Statistical Network Analysis

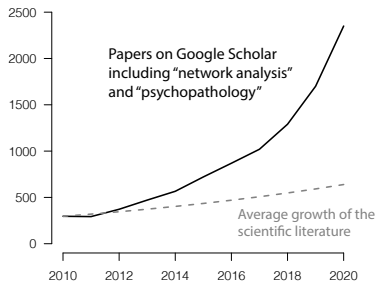


(Figure from Fried et al., 2015)



# Statistical Network Analysis

Theories?



# Statistical Network Models as Theories?

# Statistical Network Models as Theories?

Feedback  
Loops



Asymmetric  
Relationships



Different  
Time Scales



Higher-order  
Interactions



Multiple  
Stable States



# Statistical Network Models as Theories?

Feedback  
Loops



Asymmetric  
Relationships



Different  
Time Scales



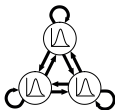
Higher-order  
Interactions



Multiple  
Stable States



VAR  
Model



GGM






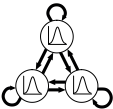



Ising  
Model





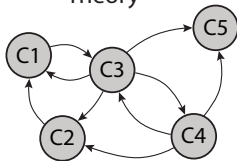
# Statistical Network Models as Theories?

	Feedback Loops	Asymmetric Relationships	Different Time Scales	Higher-order Interactions	Multiple Stable States
VAR Model					
VAR Model	✓	✓	✗	✗	✗
GGM					
GGM	✓	✗	✗	✗	✗
Ising Model					
Ising Model	✓	✗	✗	✗	✓

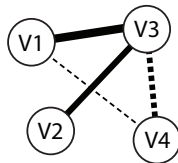
(Haslbeck\*, Ryan\*, Robinaugh\*, et al., 2021)

# Target systems, Theories, Data and Data Models

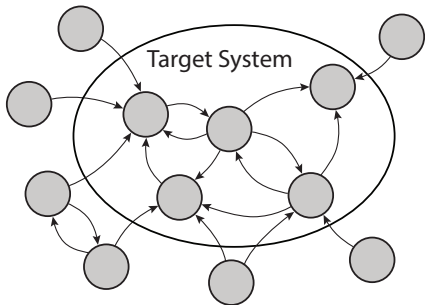
Theory



Data Model



Target System

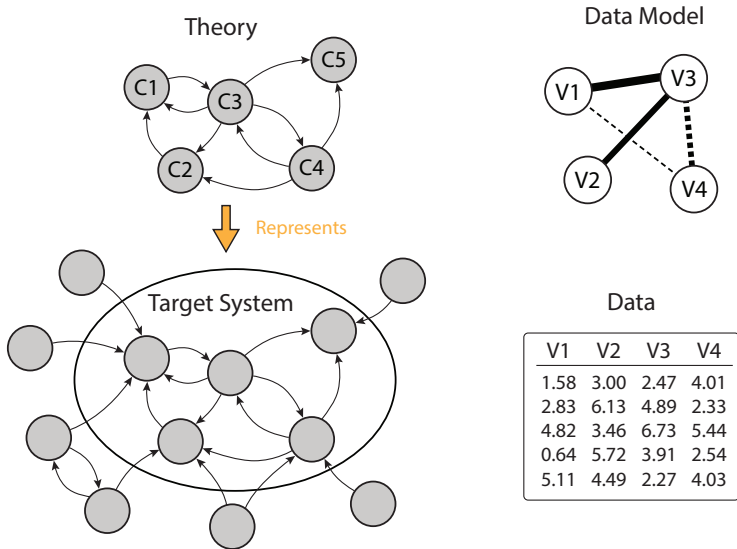


Data

V1	V2	V3	V4
1.58	3.00	2.47	4.01
2.83	6.13	4.89	2.33
4.82	3.46	6.73	5.44
0.64	5.72	3.91	2.54
5.11	4.49	2.27	4.03

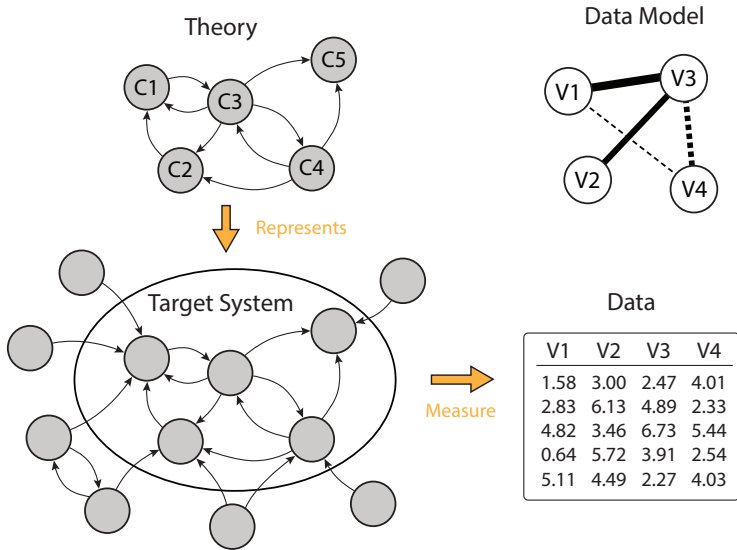
(Suárez & Pero, 2019; Haslbeck\*, Ryan\*, Robinaugh\*, et al., 2021)

# Target systems, Theories, Data and Data Models



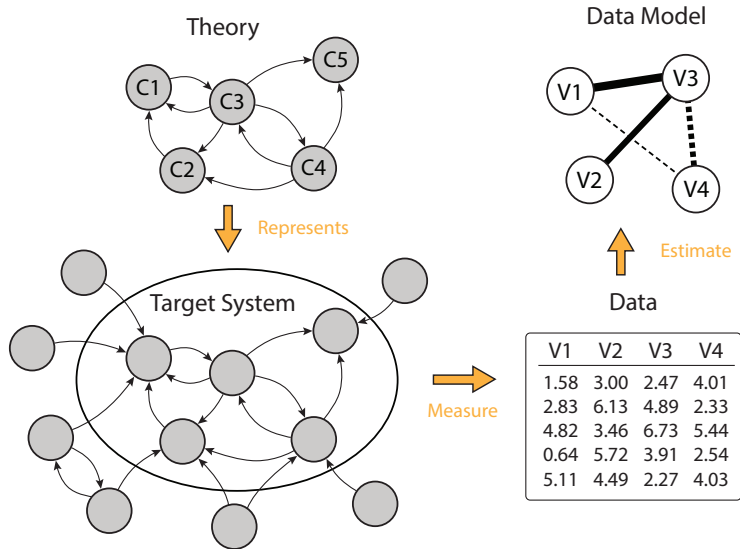
(Suárez & Pero, 2019; Haslbeck\* ,Ryan\* ,Robinaugh\* , et al., 2021)

# Target systems, Theories, Data and Data Models



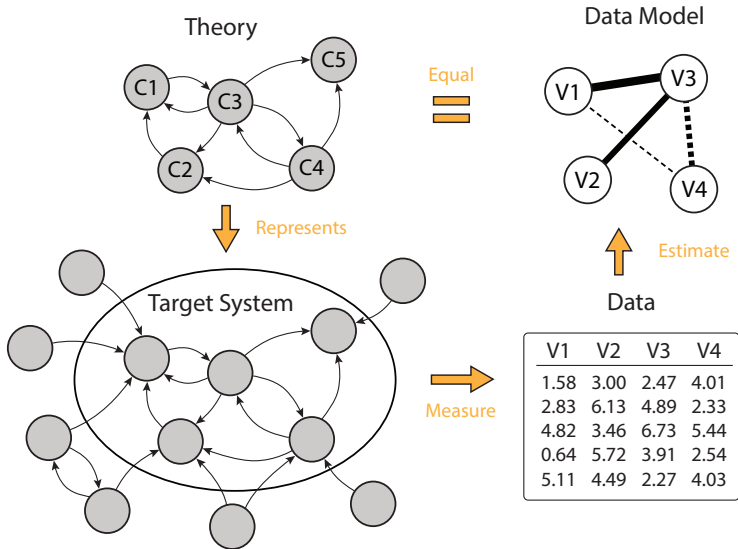
(Suárez & Pero, 2019; Haslbeck\*, Ryan\*, Robinaugh\*, et al., 2021)

# Target systems, Theories, Data and Data Models



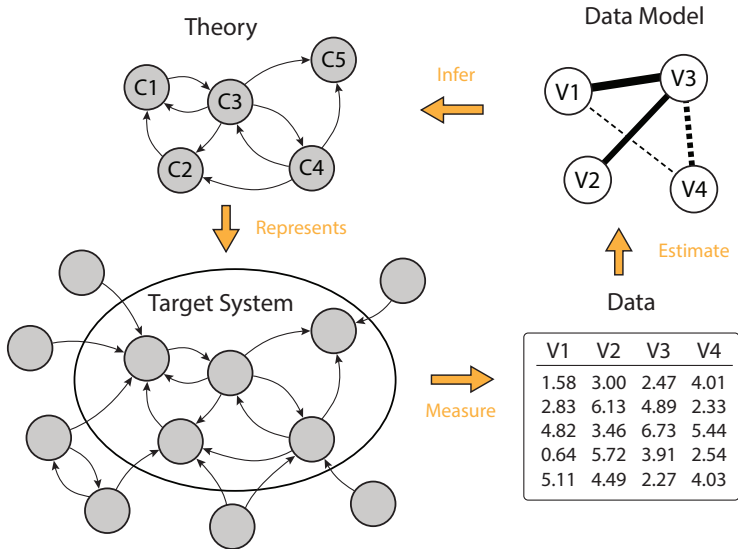
(Suárez & Pero, 2019; Haslbeck\*, Ryan\*, Robinaugh\*, et al., 2021)

# Target systems, Theories, Data and Data Models



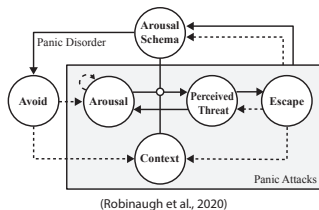
(Suárez & Pero, 2019; Haslbeck\*, Ryan\*, Robinaugh\*, et al., 2021)

# Target systems, Theories, Data and Data Models

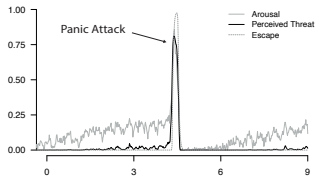


(Suárez & Pero, 2019; Haslbeck\*, Ryan\*, Robinaugh\*, et al., 2021)

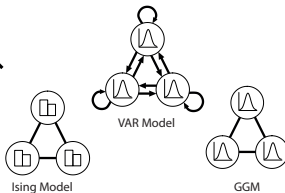
# Infer Theories from Data Models?



Generate



Try to infer  
true formal theory



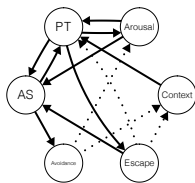
Estimate

(Robinaugh et al., 2020; Haslbeck\*, Ryan\*, Robinaugh\*, et al., 2021)



# Infer Theories from Data Models?

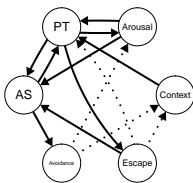
(a) True Local Dependence



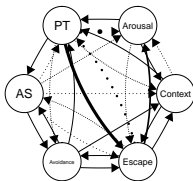
(Haslbeck\*, Ryan\*, Robinaugh\*, et al., 2021; Ryan, Bringmann, Schuurman, 2020)

# Infer Theories from Data Models?

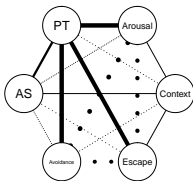
(a) True Local Dependence



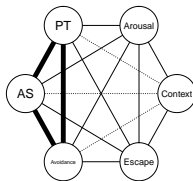
(b) VAR Model



(c) Gaussian Graphical Model



(d) Ising Model

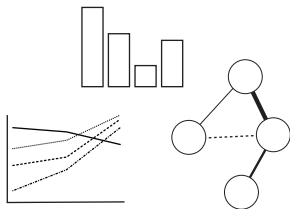


(Haslbeck\*, Ryan\*, Robinaugh\*, et al., 2021; Ryan, Bringmann, Schuurman, 2020)

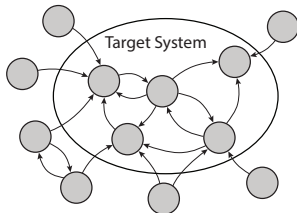


# How to generate an initial theory?

**Step 1:** Specify phenomenon to be explained



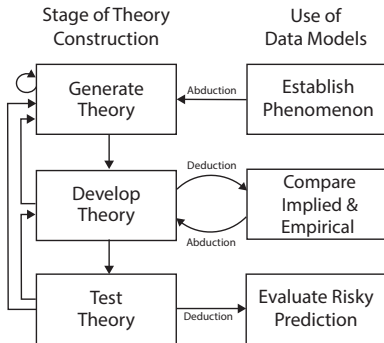
**Step 2:** Specify components and relations of target system



(Wimsat, 1987; Smaldino, 2017; Haslbeck\*, Ryan\*, Robinaugh\*, et al., 2021)

# From Data Models to Formal Theories

- ▶ Data models are unlikely to be good theories
- ▶ Naive inferences from data models to theories are highly problematic
- ▶ Abductive theory construction may be a powerful way forward



Haslbeck J. M. B.\*, Ryan O.\*, Robinaugh D. J.\*, Waldorp L. J., & Borsboom D. (accepted, 2021). Modeling Psychopathology: From Data Models to Formal Theories. *Psychological Methods*. PsyArXiv: <https://psyarxiv.com/jgm7f>

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