

# Early-Warning Signals and Phase Transitions in Psychotherapy

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Dynamics of Complex Systems 2019



# Outline

1. Introduction: weather prediction
2. Phase transitions in psychotherapy
  - a. Study 1: The relation between instability and treatment outcome
  - b. Study 2: Early-warning signals for sudden gains and losses
3. Weather prediction revisited

	gemiddelde maximum temperatuur (°C)	gemiddelde minimum temperatuur (°C)	gemiddeld aantal uren zon per dag	gemiddeld aantal dagen neerslag per maand	gemiddeld aantal mm neerslag per maand	gemiddelde water temperatuur (°C)
januari	5	-1	2	20	ddd	n.v.t.
februari	6	-1	3	16	dd	n.v.t.
maart	9	2	4	20	ddd	n.v.t.
april	13	3	5	17	dd	n.v.t.
mei	18	7	7	19	ddd	n.v.t.
juni	20	10	6	20	ddd	n.v.t.
juli	21	11	7	19	ddd	n.v.t.
augustus	22	12	7	18	ddd	n.v.t.
september	19	9	5	19	ddd	n.v.t.
oktober	14	6	4	20	ddd	n.v.t.
november	9	3	2	22	ddd	n.v.t.
december	6	1	2	22	ddd	n.v.t.
nihil = 0-5 mm • d = 6-30 mm • dd = 31-60 mm • ddd = 61-100 mm • ddd = 101-200 mm • dddd = meer dan 200 mm						

48 uur

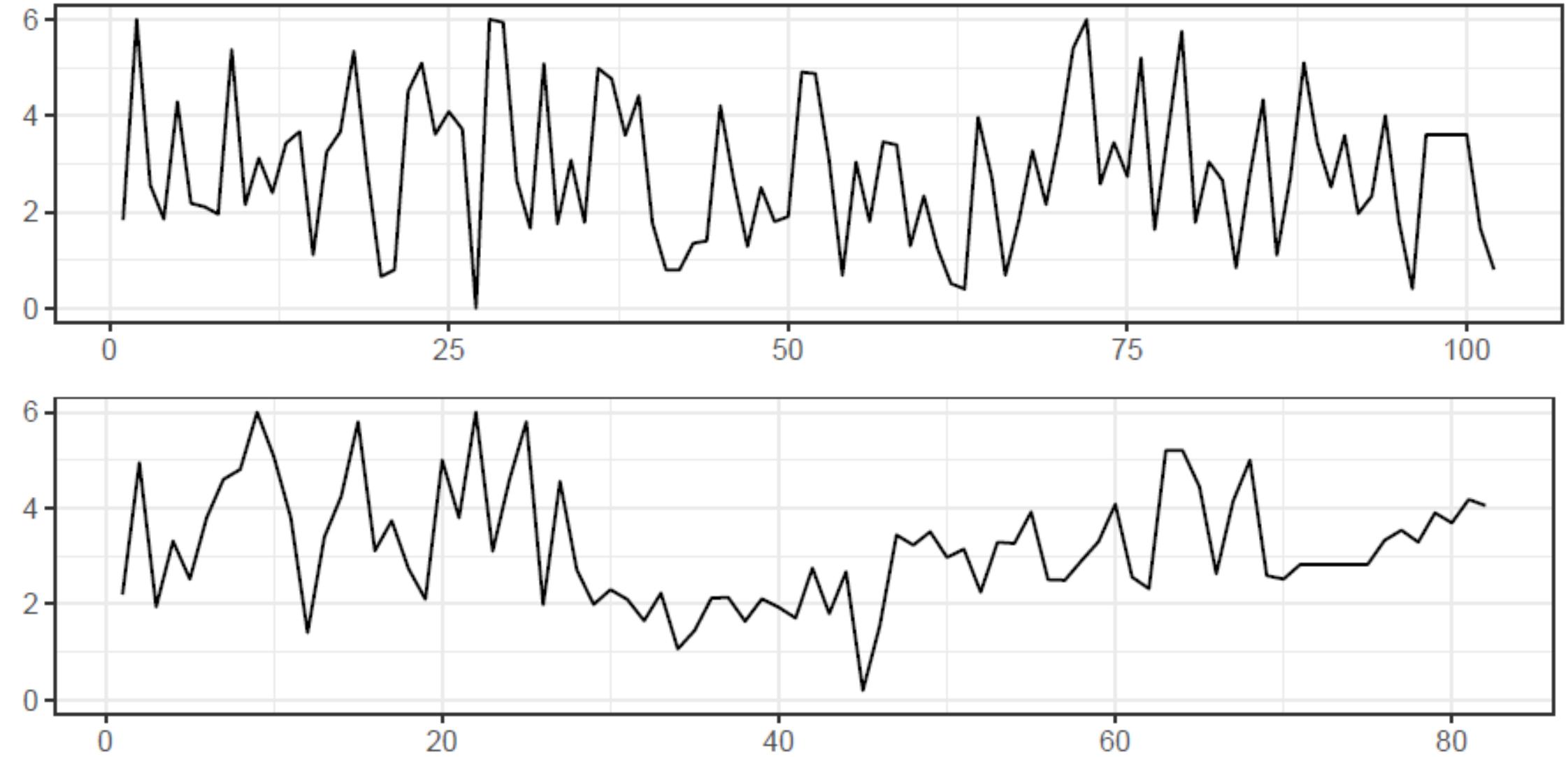
5 dagen

14 dagen

De weersverwachting voor Nijmegen voor de komende 5 dagen

	vandaag			morgen			vrijdag			zaterdag			zondag		
	ochtend	middag	avond	ochtend	middag	avond	ochtend	middag	avond	ochtend	middag	avond	ochtend	middag	avond
Min (°C)	2°			6°			4°			5°			1°		
Max (°C)	12°			15°			18°			13°			12°		
Wind Bft															
Neersl. (%)	70%			20%			5%			10%			20%		
Neersl. (mm)	0,0 mm			0,0 mm			0,0 mm			0,0 mm			0,0 mm		
Weercijfer															

# Process monitoring in psychotherapy



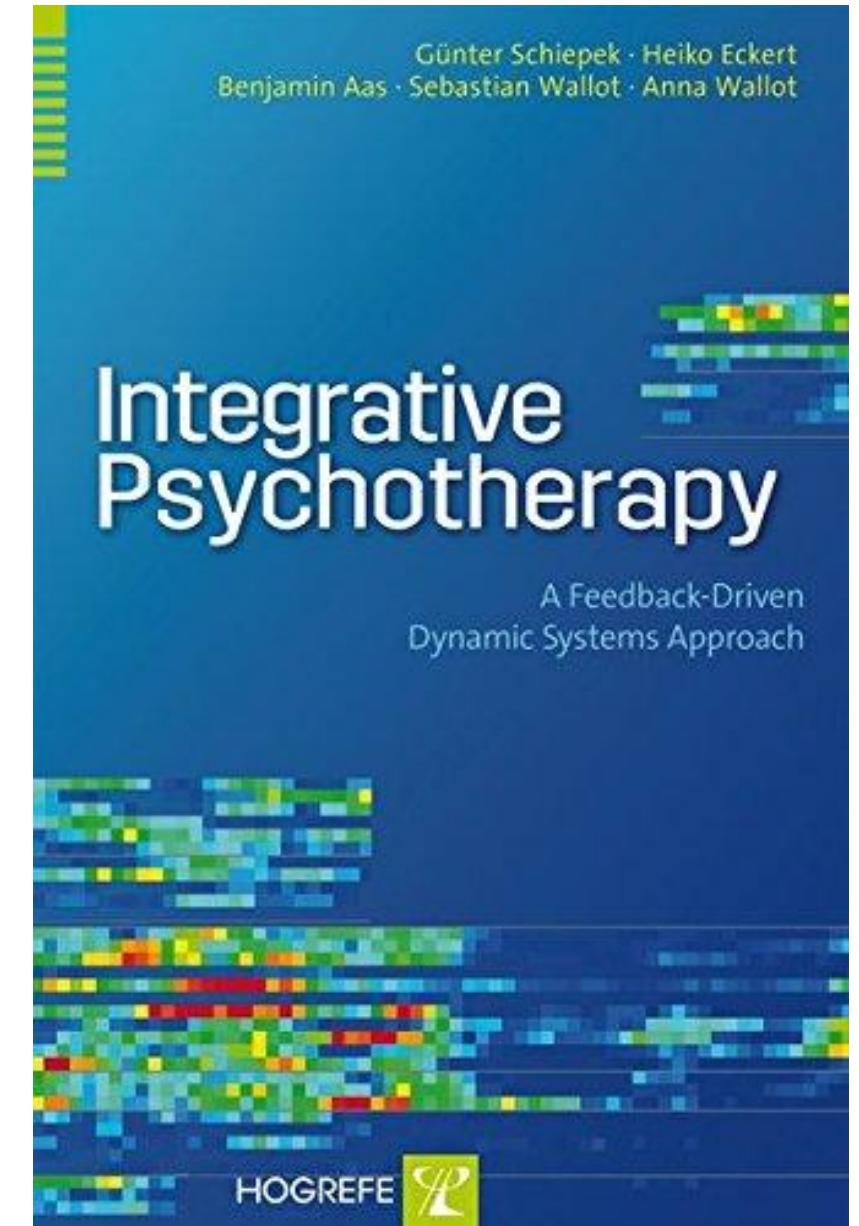
- Discontinuous changes
- Large and irregular fluctuations

Kowalik et al., 1997; Molenaar & Campbell, 2013; Schiepek et al., 2016; 2017

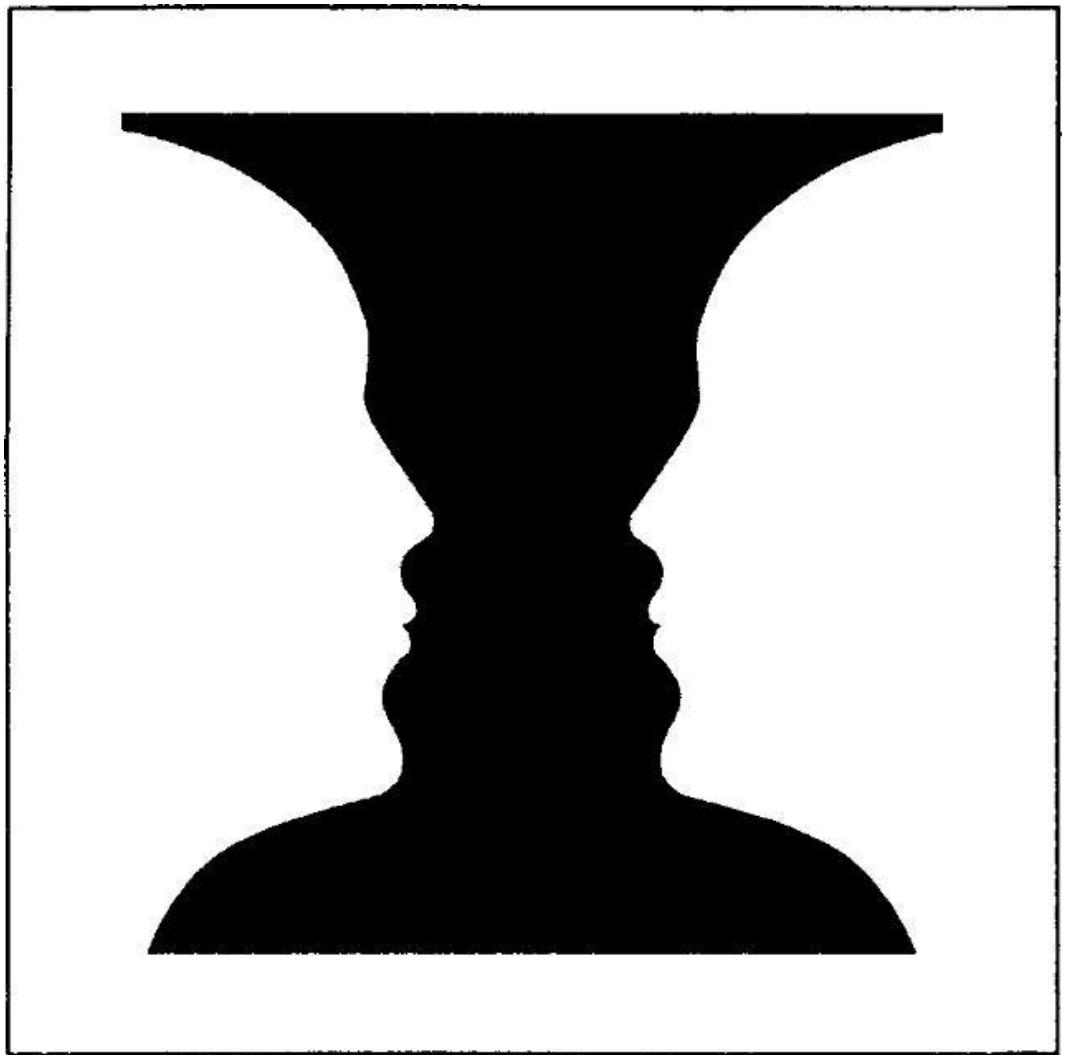


# Complex systems

- Weather (Lorenz, 1963)
- Laser Physics (Haken, 1978)
- Ecology (Scheffer et al., 2009)
- Movement (Kelso et al., 1986; Thelen & Ullrich, 1991)
- Visual Perception (Haken, 1997)
- Cognitive Development (Thelen & Smith, 1994; Van Geert, 1994)
- Emotion (Lewis & Granic, 2000)
- Psychotherapy (Schiepek et al., 2016)

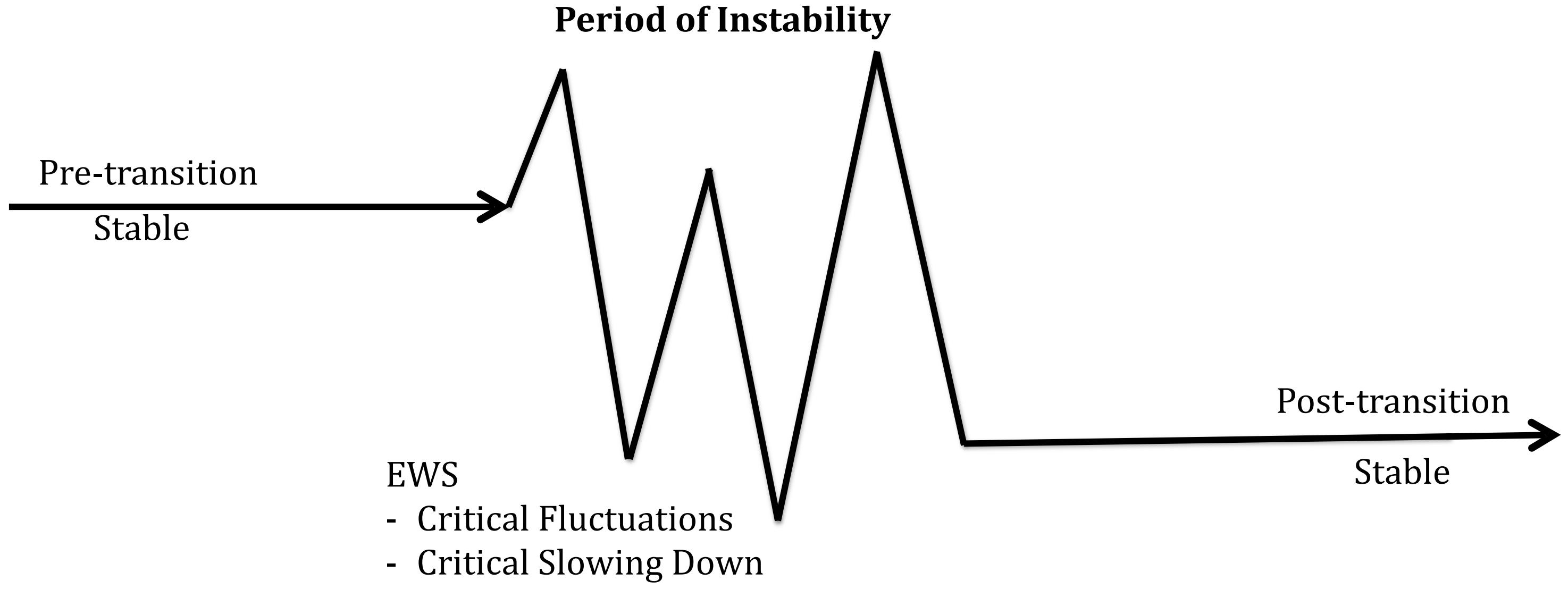


# Order formation in complex systems

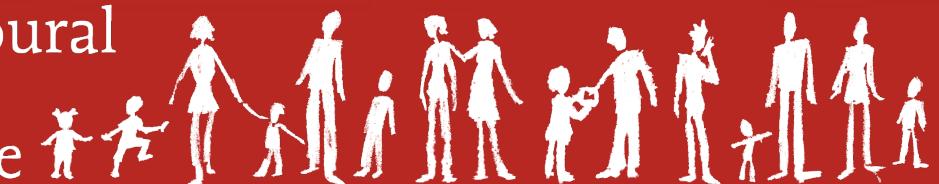


Haken, 1997; Schiepek et al., 2016

# Early-warning signals for phase transitions



Lichtwarck-Aschoff et al., 2012; Gelo & Salvatore, 2016; Scheffer et al., 2009



# Instability is related to clinical improvement

- Adults with mood disorders (Hayes & Strauss, 1998; Hayes & Yasinski, 2015; Van de Leemput et al., 2014; Schreuder et al. n.d.)
- Adults with obsessive-compulsive disorders (Schiepek, Tominschek & Heinzel, 2014)
- Adults with mixed diagnosis (Haken & Shiepek, 2006)
- Children with aggression problems (Lichtwarck-Aschoff, Hasselman, ... & Granic, 2012)
- Children with anxiety problems (Lichtwarck-Aschoff & Van Rooij, 2019)

Studies have small sample sizes or neglect possible destabilization periods during therapy.



# Study 1: The relation between destabilization and treatment outcome

Olthof, Hasselman, Strunk, Aas, Schiepek & Lichtwarck-Aschoff (2019) Destabilization in self-ratings of the psychotherapeutic process is associated with better treatment outcome in patients with mood disorders, Psychotherapy Research, DOI: 10.1080/10503307.2019.1633484

<https://osf.io/fhrw4/>



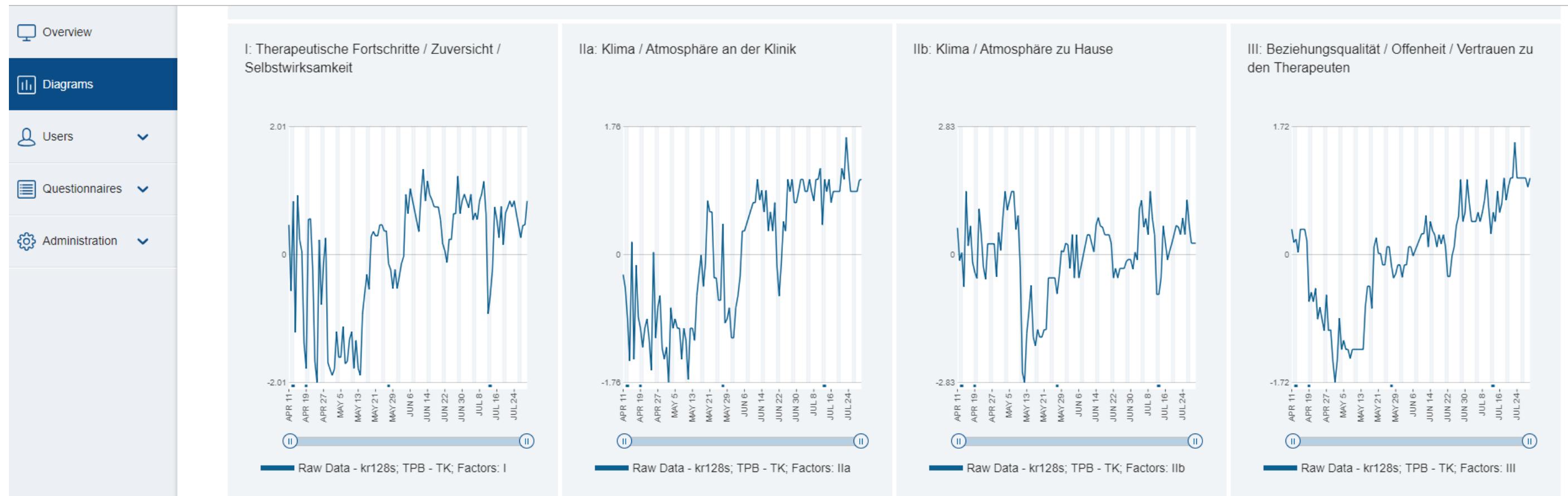
# Design

- Patients with mood disorders (N=328)
- Collected with the Synergetic Navigation System<sup>1</sup> between 2008-2014
- Therapy Process Questionnaire (TPQ<sup>2</sup>)
  - Factor I: Therapy progress
  - Factor II: Problem Intensity
  - Factor III: Relationship quality and trust in therapist
  - Factor IV: Dysphoric affect
  - Factor V: Relationship with fellow patients

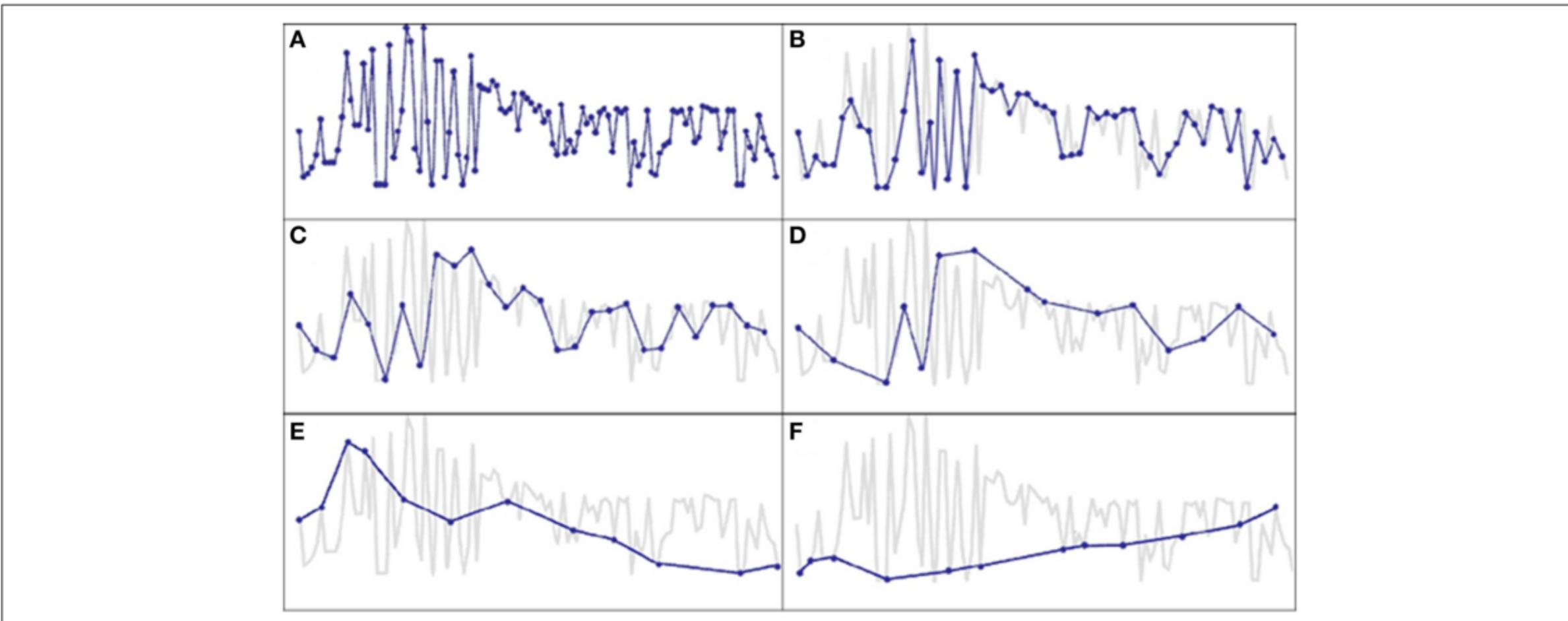
<sup>1</sup>Schiepek et al. (2016), <sup>2</sup>Haken & Schiepek (2010)

# Data Collection

- Collected in real-world psychiatric care setting with the SNS



# Why daily self-ratings?

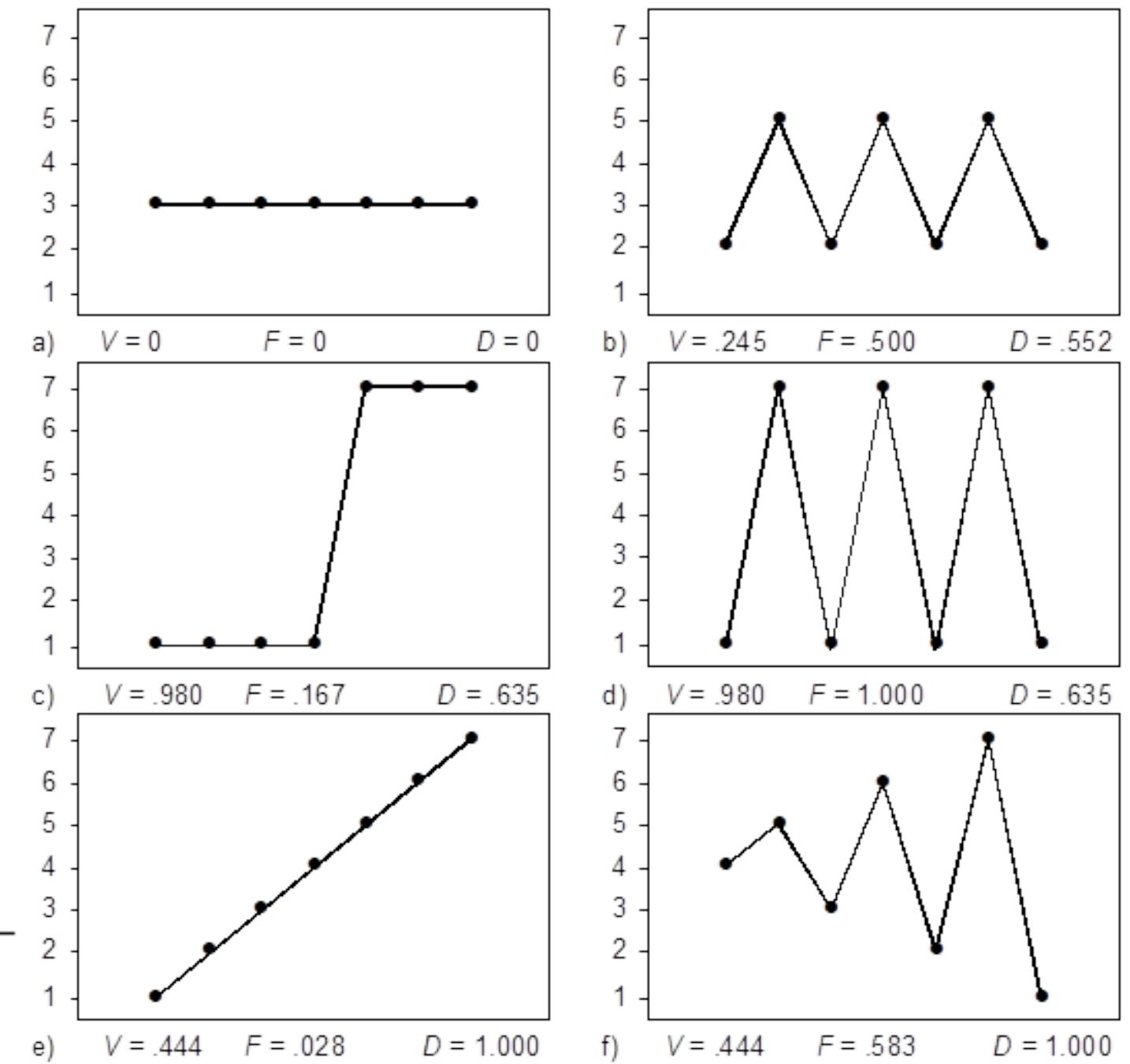
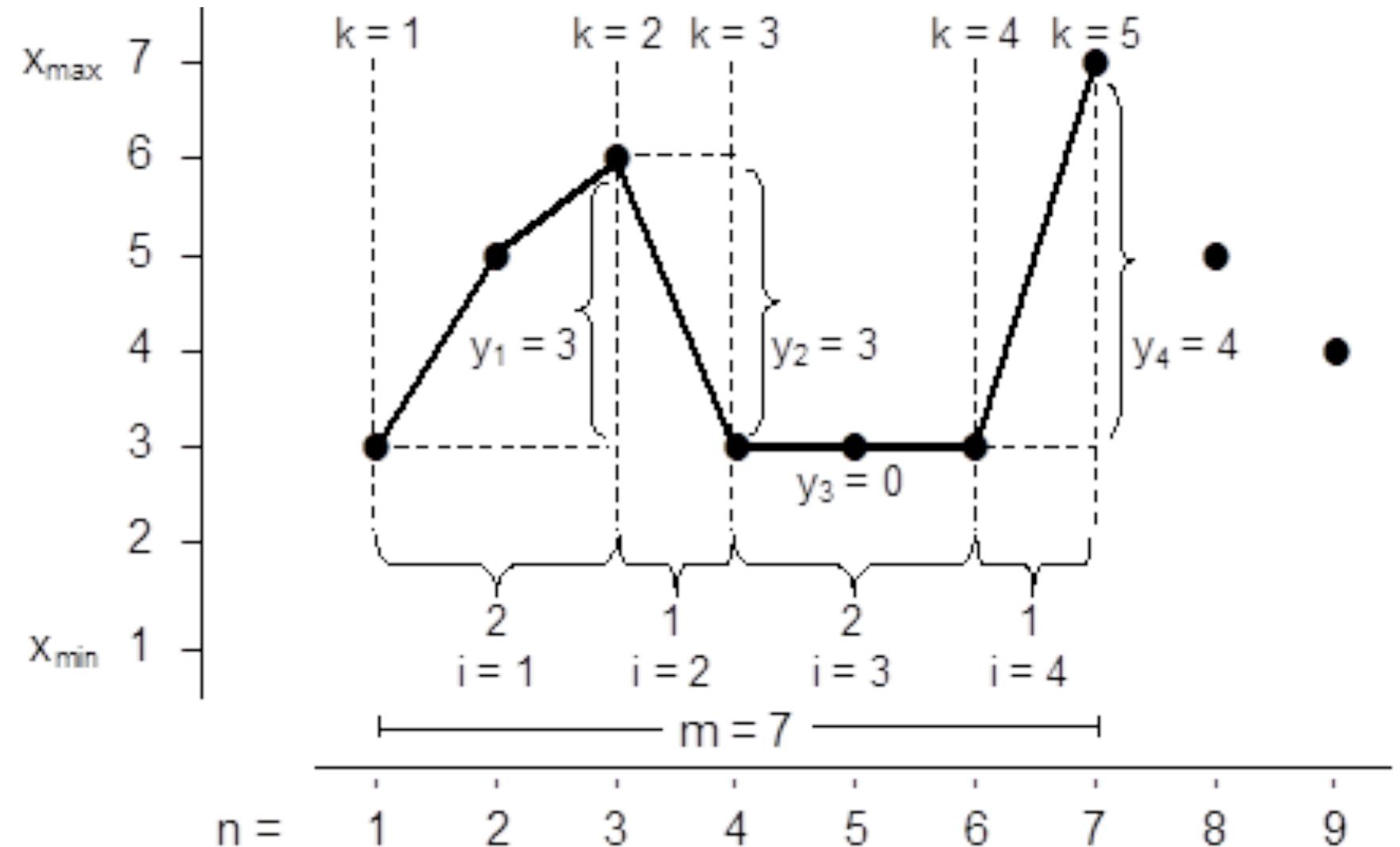


**FIGURE 1 | Distortion of the dynamics of a time series by omitting measurement points.** Depicted is a self-esteem time series of a single client (with borderline personality disorder diagnosis). **(A)** Shows the original time series with daily responses (opaque in **B–F**). In **(B)** only every second day is omitted as missing day. Fluctuations of the first weeks of the time series vanish, if ratings are only made on every fourth day **(C)** or weekly with some variation **(D)**. A major loss of information and possible source of therapeutic misjudgment occurs with the common practice of occasional weekly and fortnightly measurement intervals **(E,F)**.

Schiepek et al., 2016

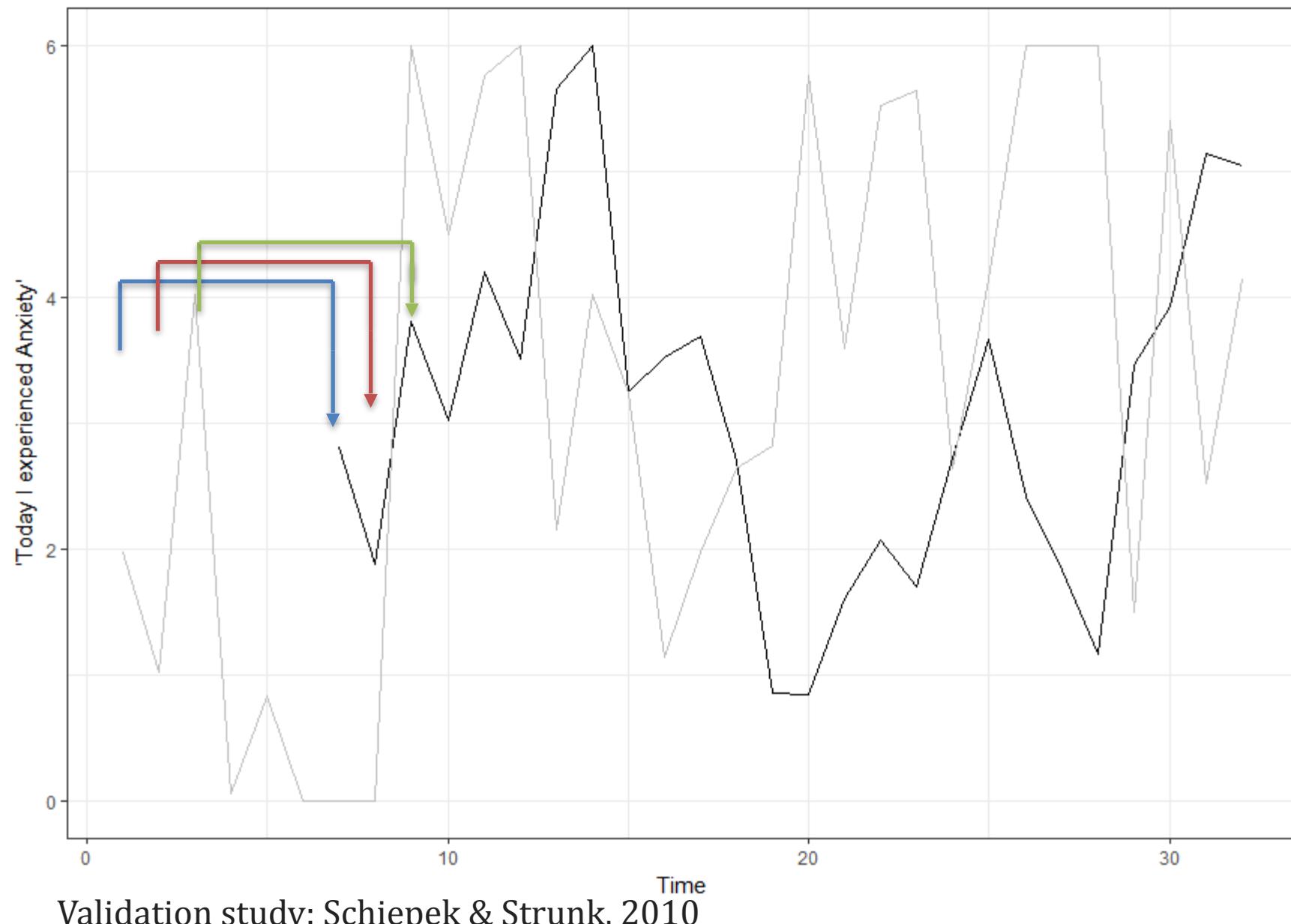


# Dynamic Complexity

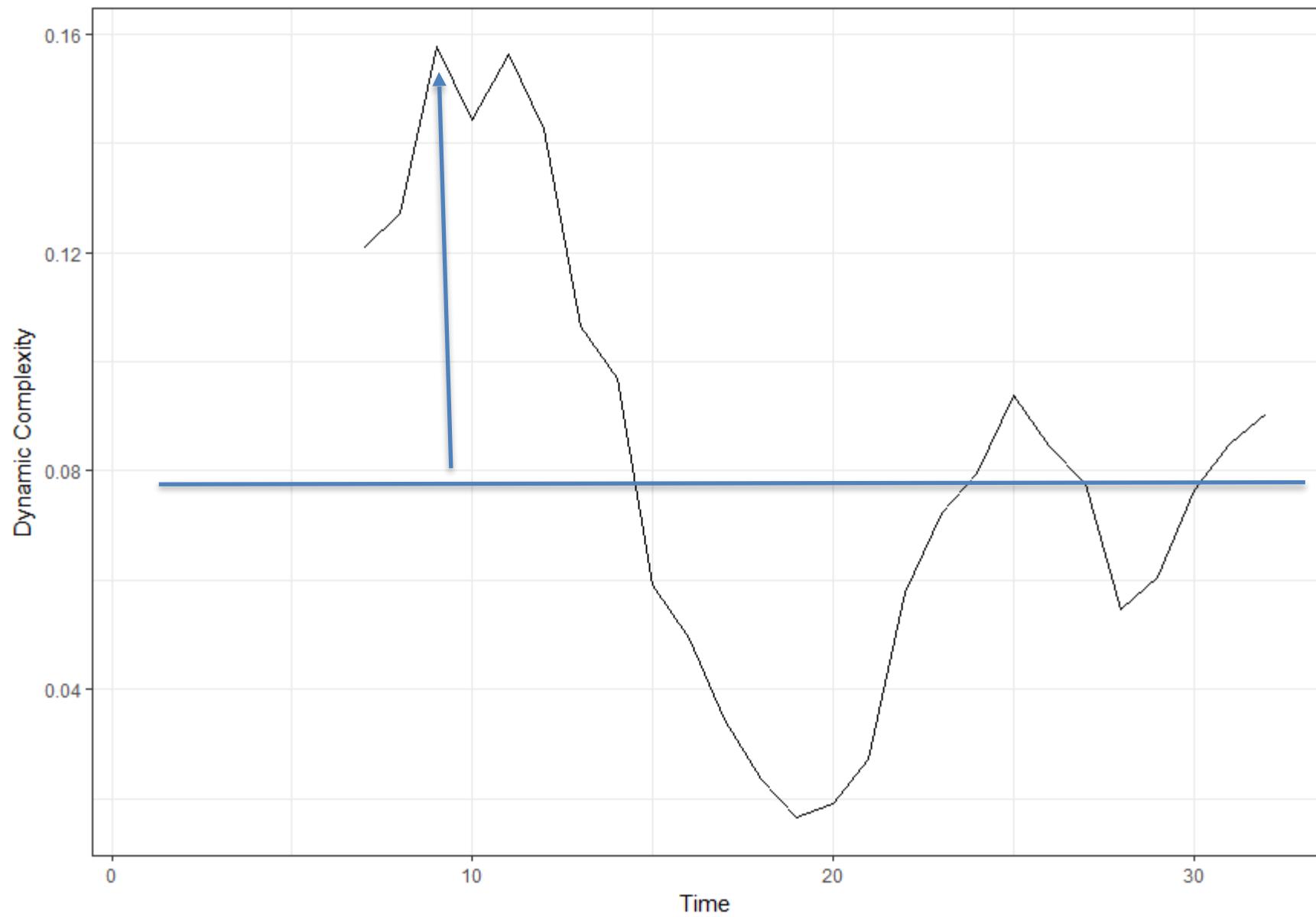


Schiepek & Strunk, 2010

# Dynamic Complexity in a moving window



Validation study: Schiepek & Strunk, 2010

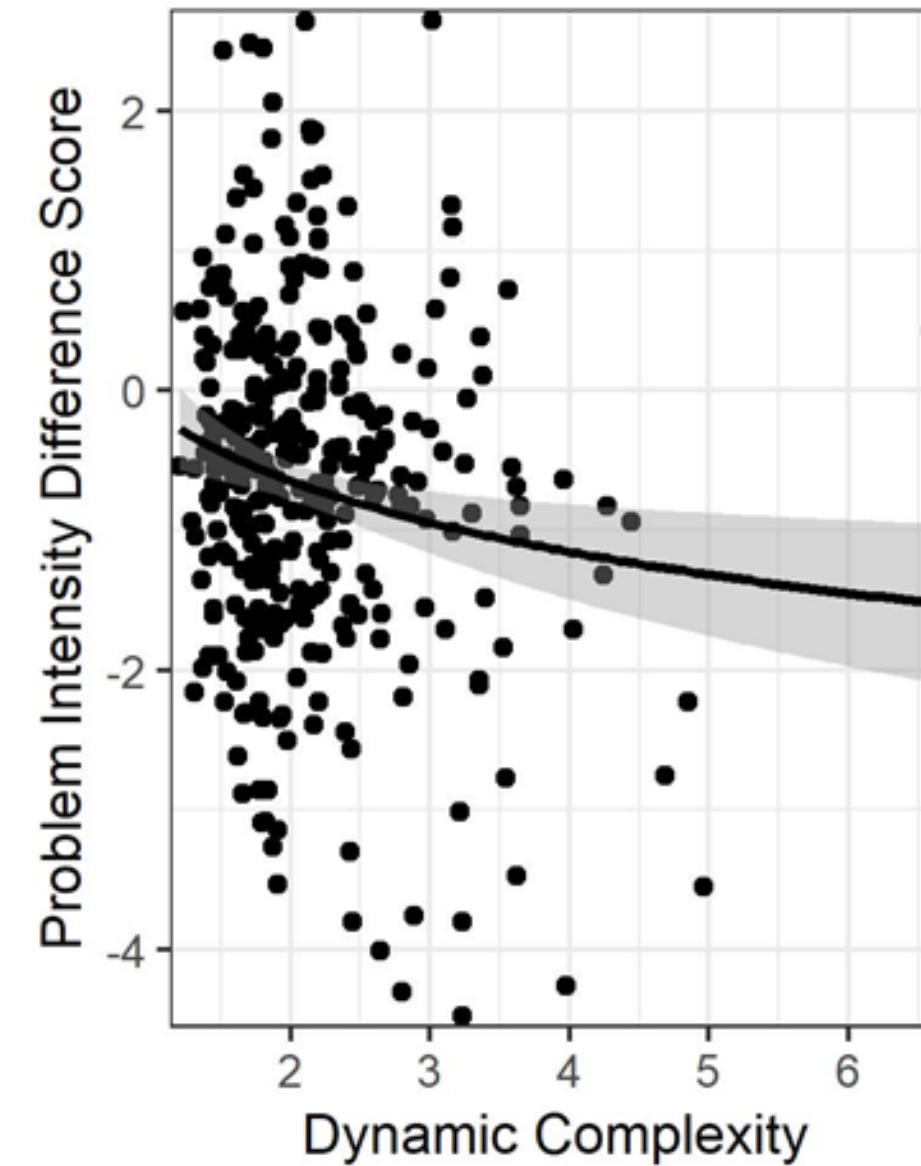
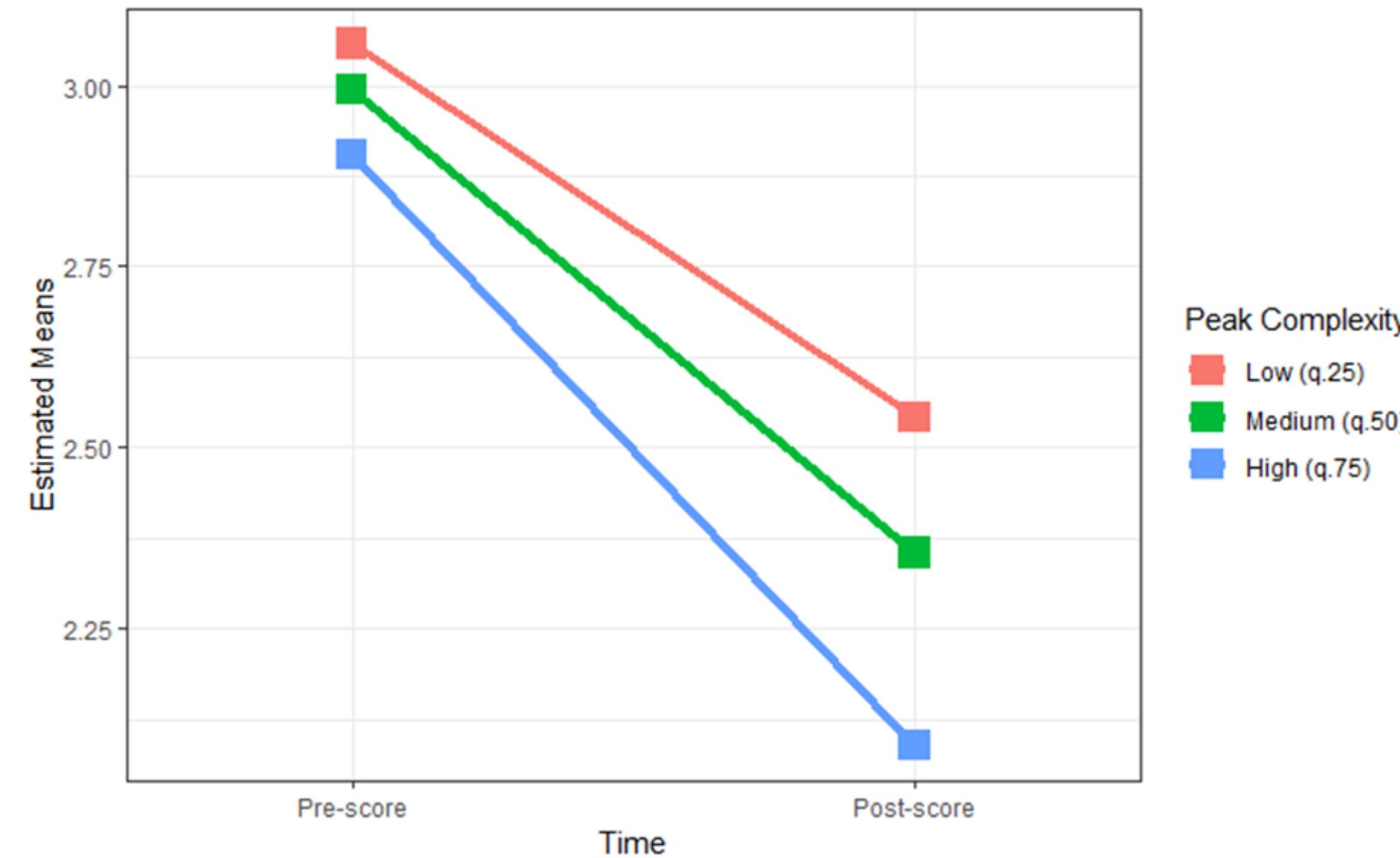


# Data Analysis

- Peak Complexity (previous slide)
- Treatment Duration
- Problem Intensity (factor 2 of the TPQ)
  - Prescore: first week
  - Postscore: last week
- Linear mixed-effects model

<sup>1</sup>Schiepek et al. (2016), <sup>2</sup>Haken & Schiepek (2010)

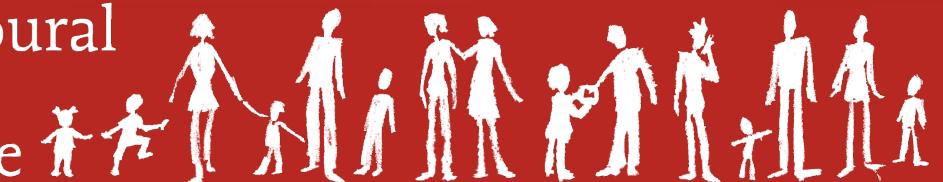
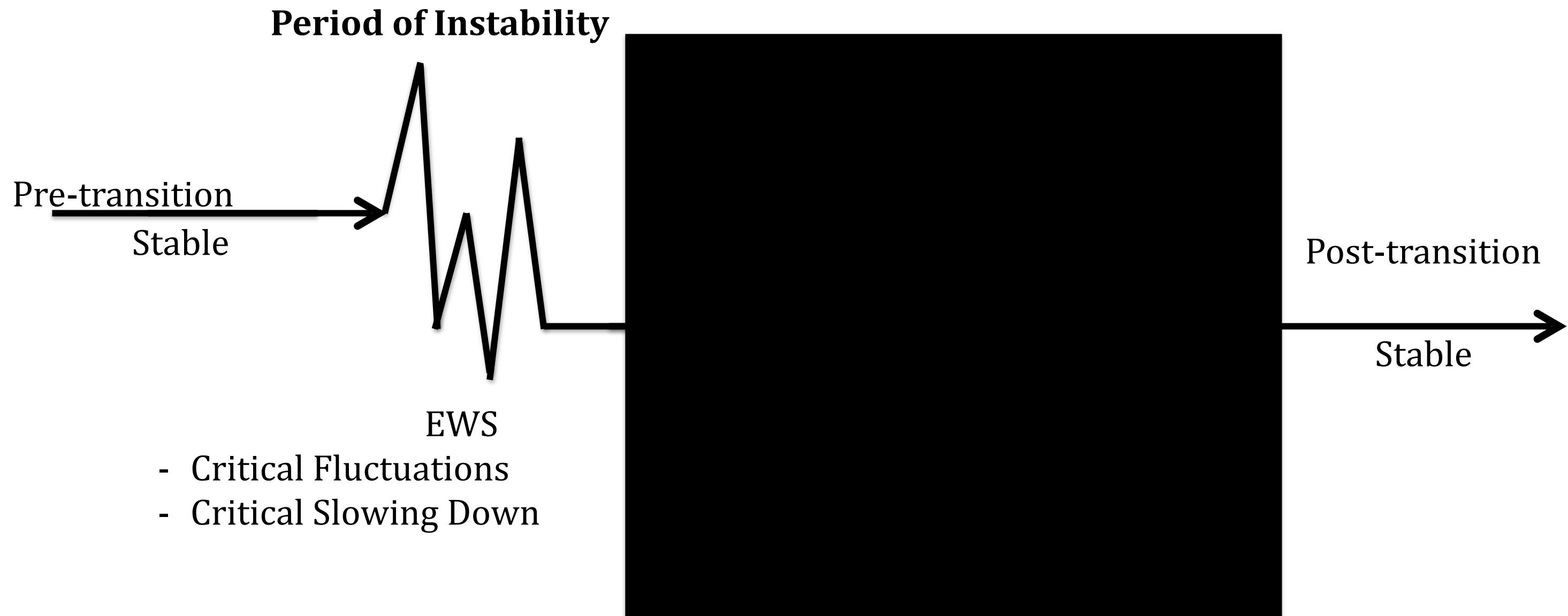
# Results



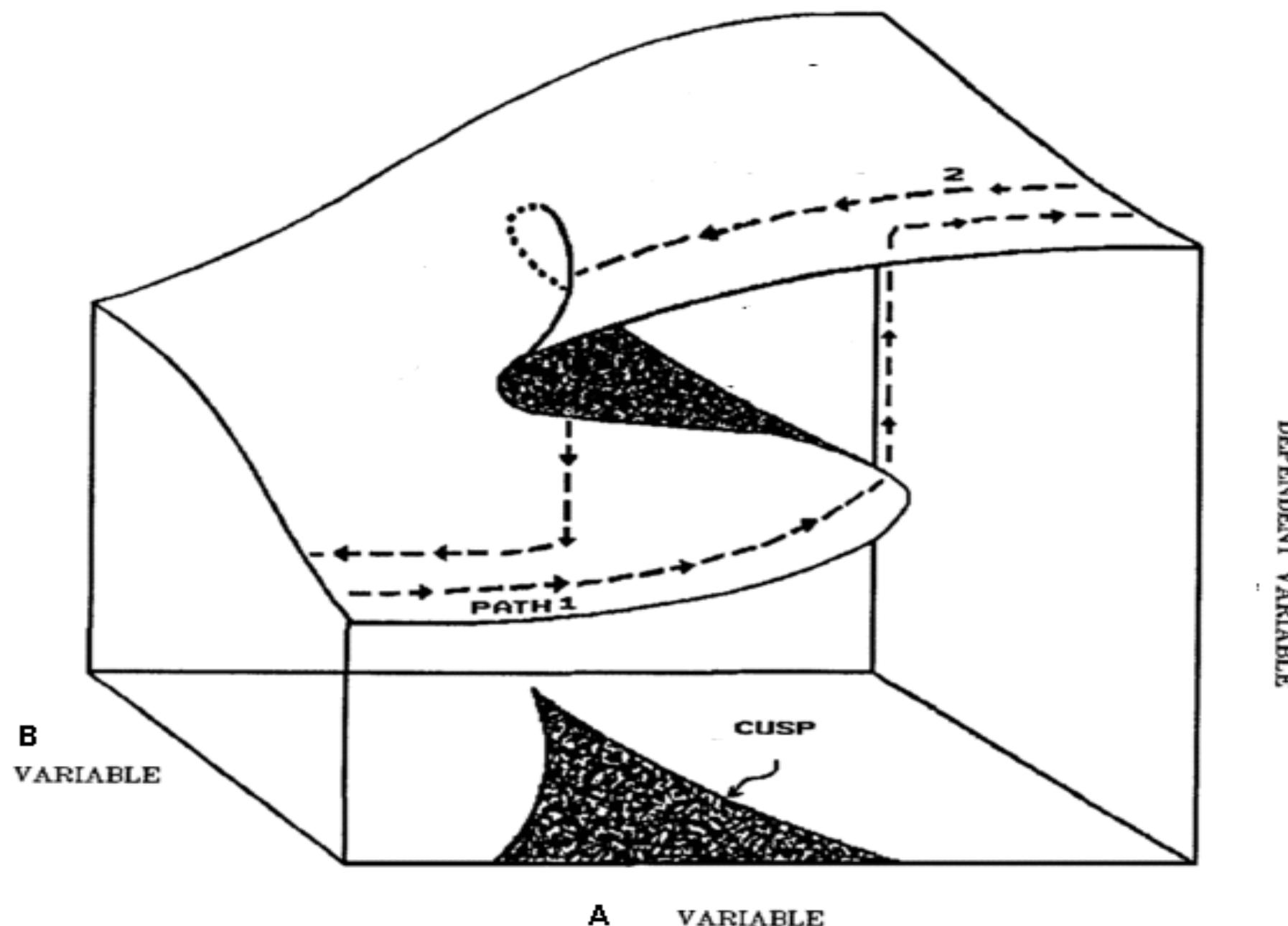
# Conclusions

- Patients with higher Peak Complexity have a stronger reduction in Problem Intensity
- Destabilization periods that might seem obstructive in clinical observation may actually be beneficial for the patients change process, as these destabilization periods can result in a Phase Transition towards clinical improvement
- But can we use this knowledge for short-term prediction?

# Instability and outcome: The black box



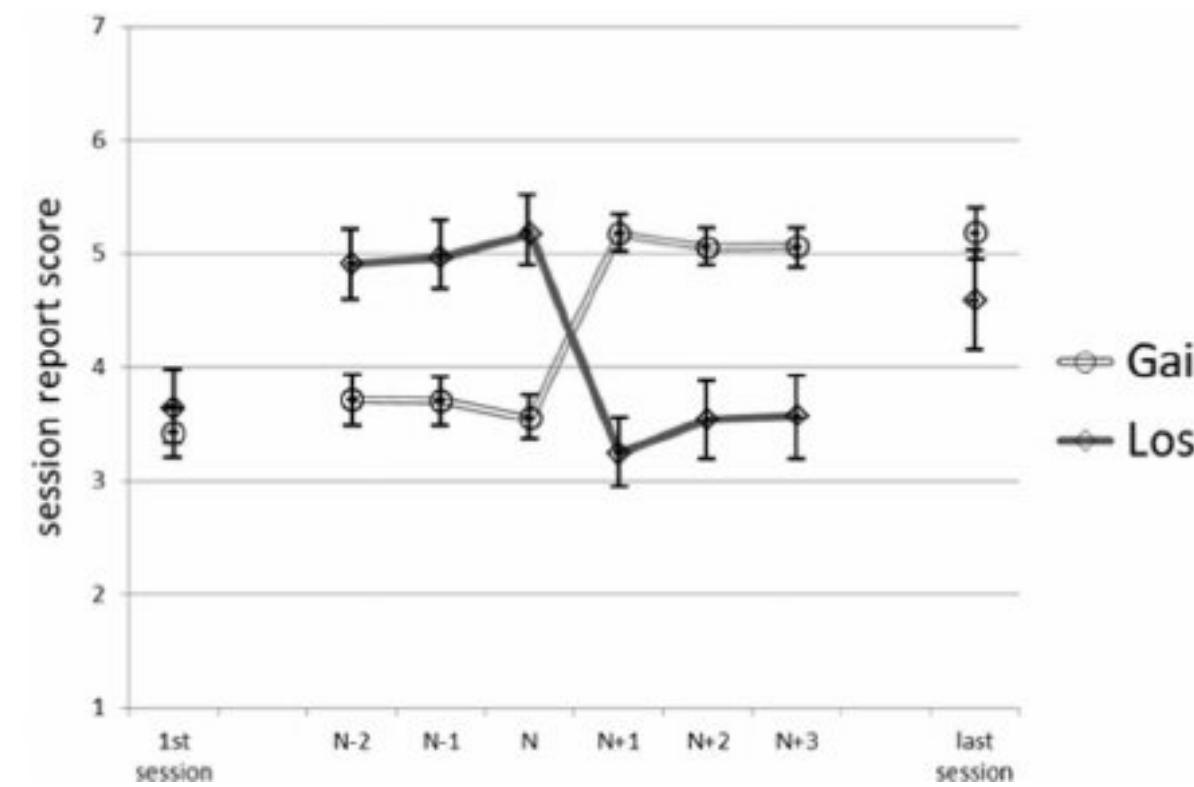
# Back to the theory: the phase transition



Haken, 1983; Gilmore, 1992

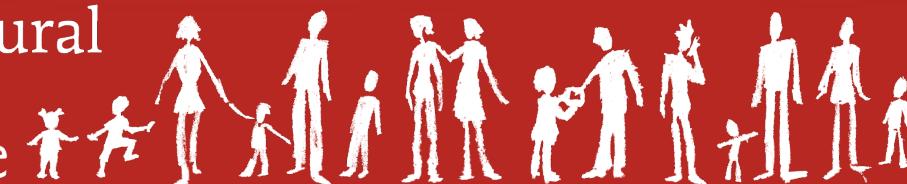


# Are there ‘phase transition like’ phenomena in clinical change?



- Sudden gains and losses are usually observed in 17% to 50% of patients receiving psychotherapy, but they also occur in pharmacological and placebo treatments
- Note the parallel with the learning literature in developmental (e.g. Piaget) and cognitive psychology (e.g. aha-effects)

Tang & DeRubeis, 1999; Hayes et al., 2007; figure from Lutz et al., 2015



# Study 2: Early-warning signals for sudden gains and losses

Olthof, Hasselman, Strunk, van Rooij, Aas, Helmich, Schiepek & Lichtwarck-Aschoff (in press). Critical Fluctuations as an Early-Warning Signal for Sudden Gains and Losses in Patients receiving Psychotherapy for Mood Disorders. *Clinical Psychological Science*.

<https://osf.io/fhrw4/>



# Analyses

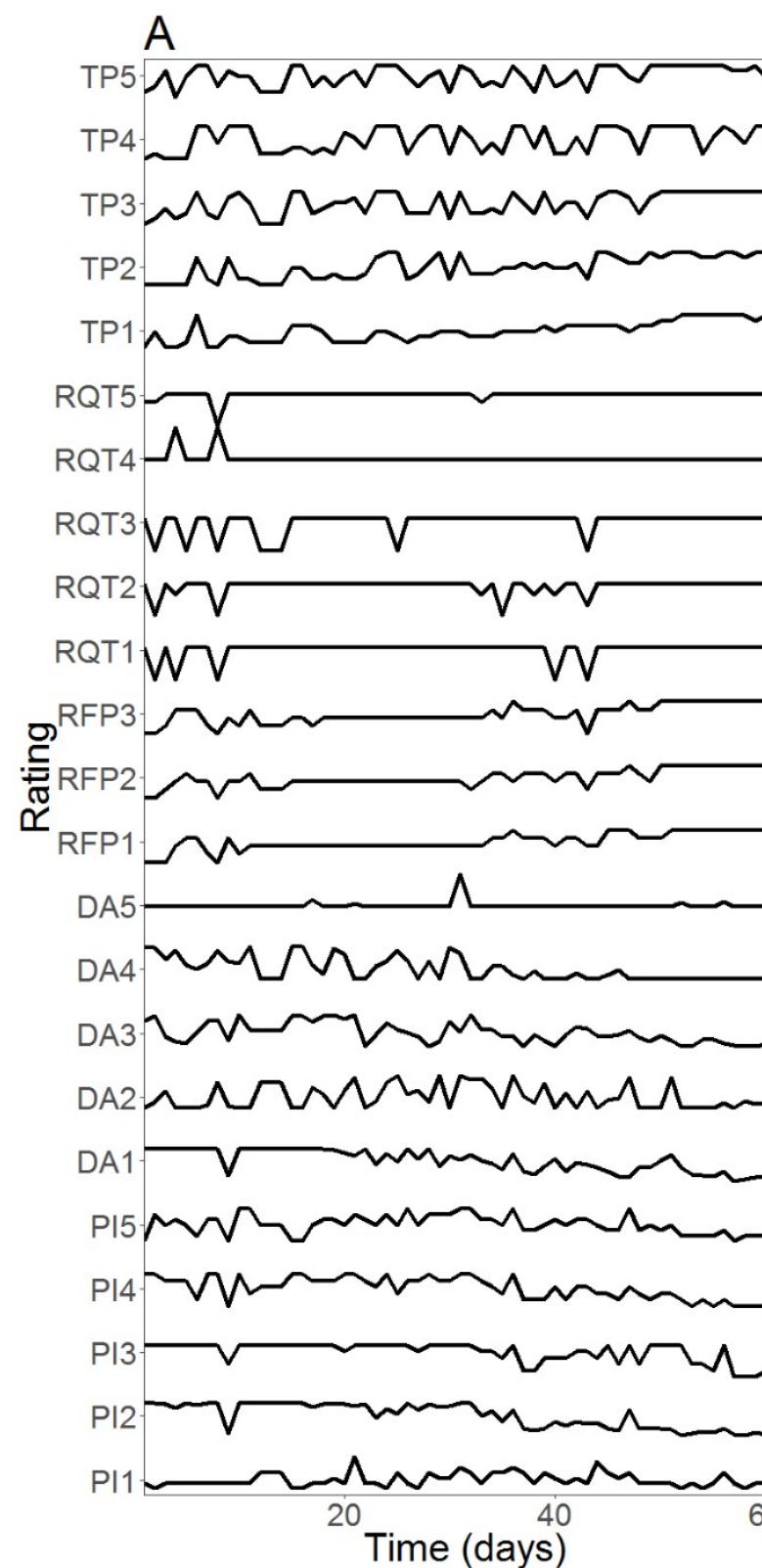
Individual level:

- Sudden gains / losses\*
- Dynamic complexity

Multi-level:

- Survival analysis

\*Google scholar: ‘Ceulemans, change point analysis’ for an alternative approach, or ask Marieke!



# Results and conclusions

- A 1 standard deviation increase in dynamic complexity is related to a 55% increased change for a sudden gain or loss in the upcoming 4 days
- Early-warning signals have a real-time predictive value for sudden gains and losses
- Sudden gains and losses are likely to represent order transitions within a patient
- Predictive early-warning signals can be used in clinical practice to identify periods of instability within a patient's change process

Thank you for your attention!

# Getting started with complexity in clinical psychology

Borsboom et al. (2011): the small world of psychopathology

Gelo & Salvatore (2016)

Hayes & Strauss (1998)

Hayes et al. (2007): change is not always linear...

Hayes et al. (2015): network destabilization and transition...

Schiepek et al. (2006): real-time monitoring of psychotherapy...

Schiepek et al. (2016): case-study dissociative-identity disorder

Wichers, Groot, et al. (2016): critical slowing down as a personalized...

General:

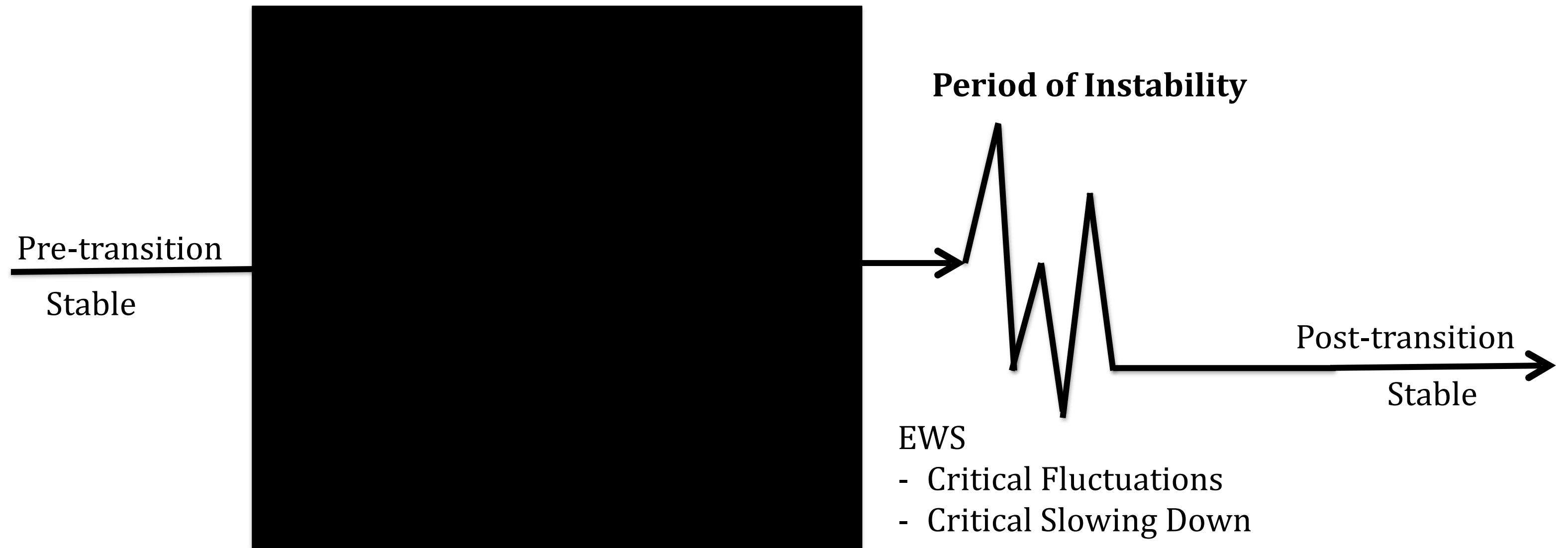
Thelen & Ullrich (1991) / Thelen & Smith (1994)

Stephen, Dixon & Isenhower (2009): dynamics of representational change

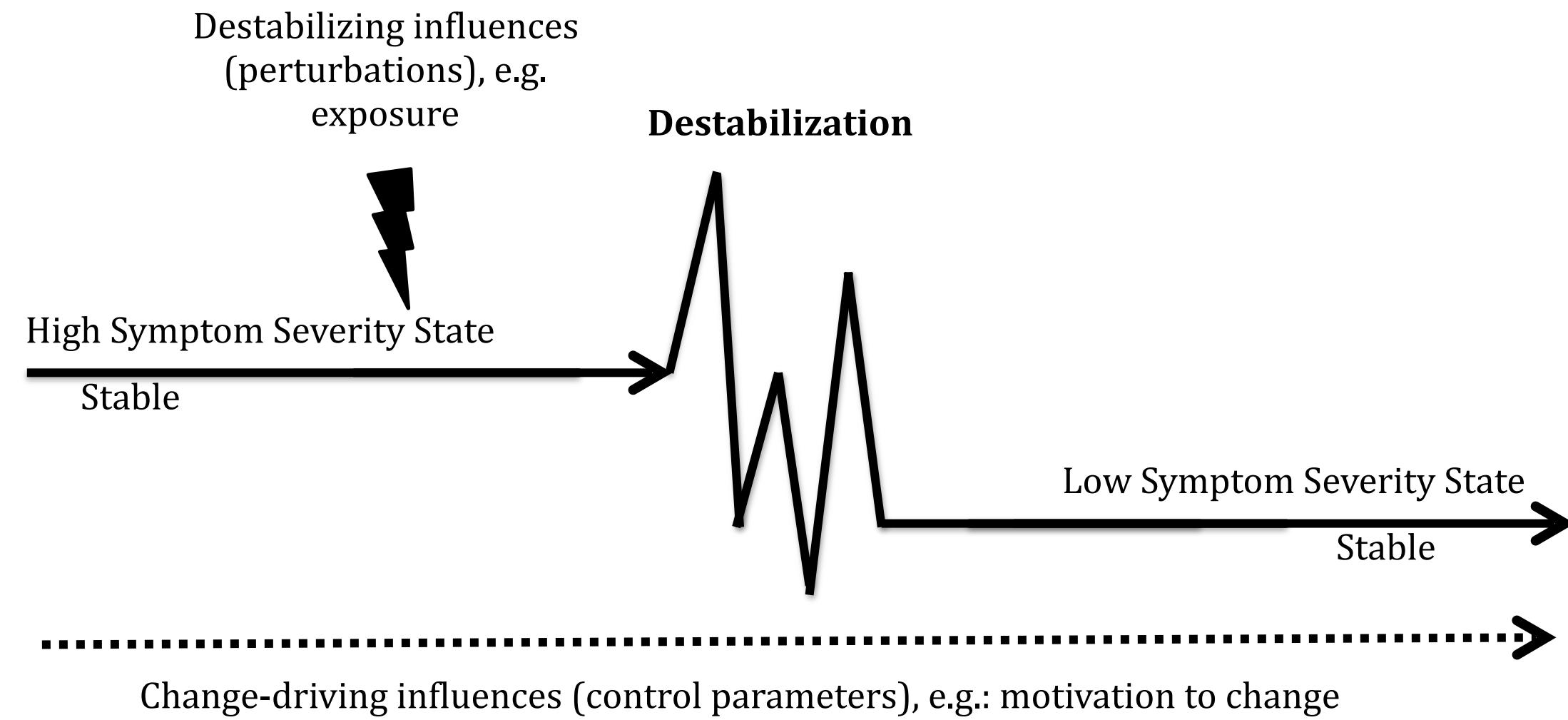
Turvey (1990): coordination

Kelso

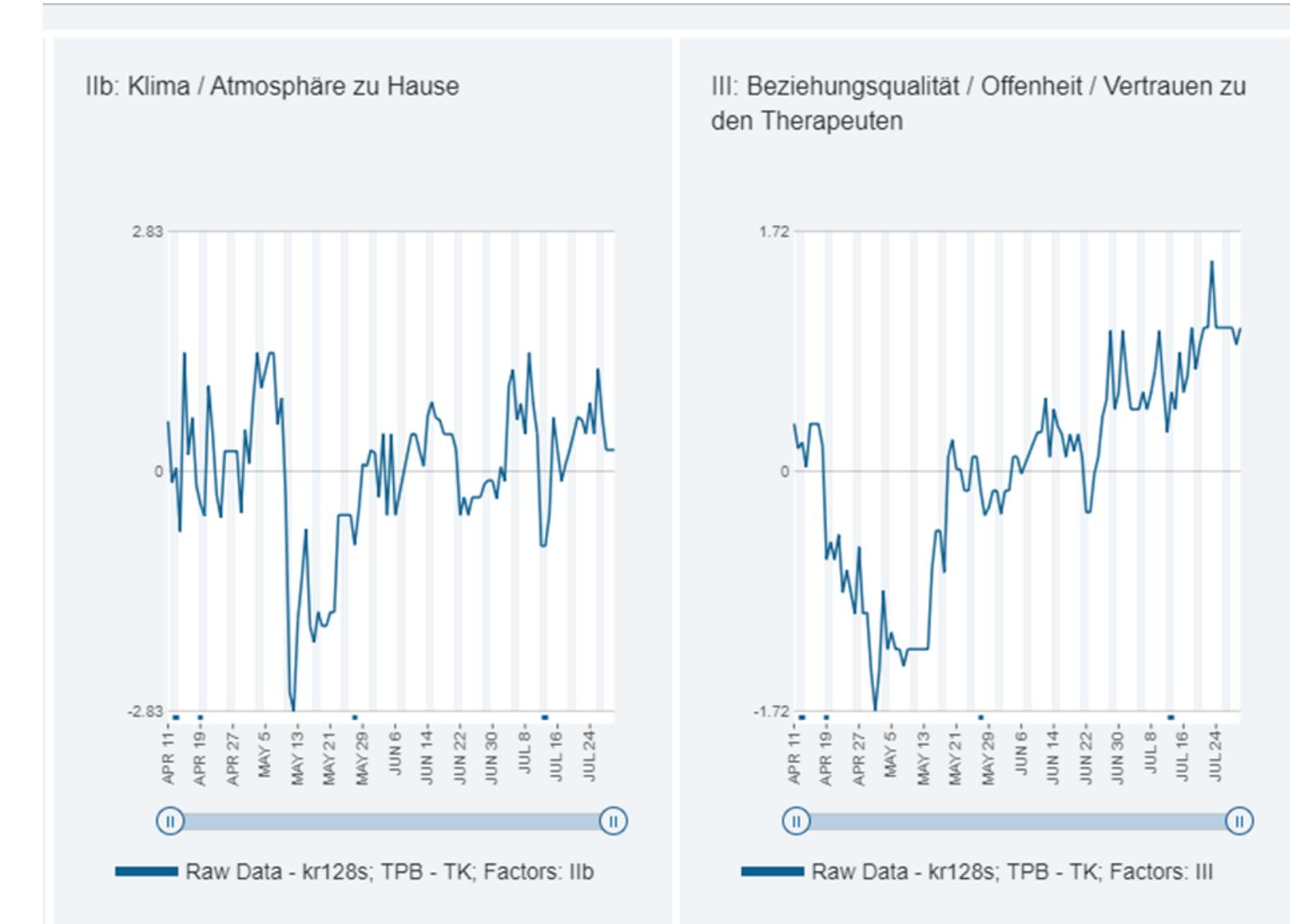
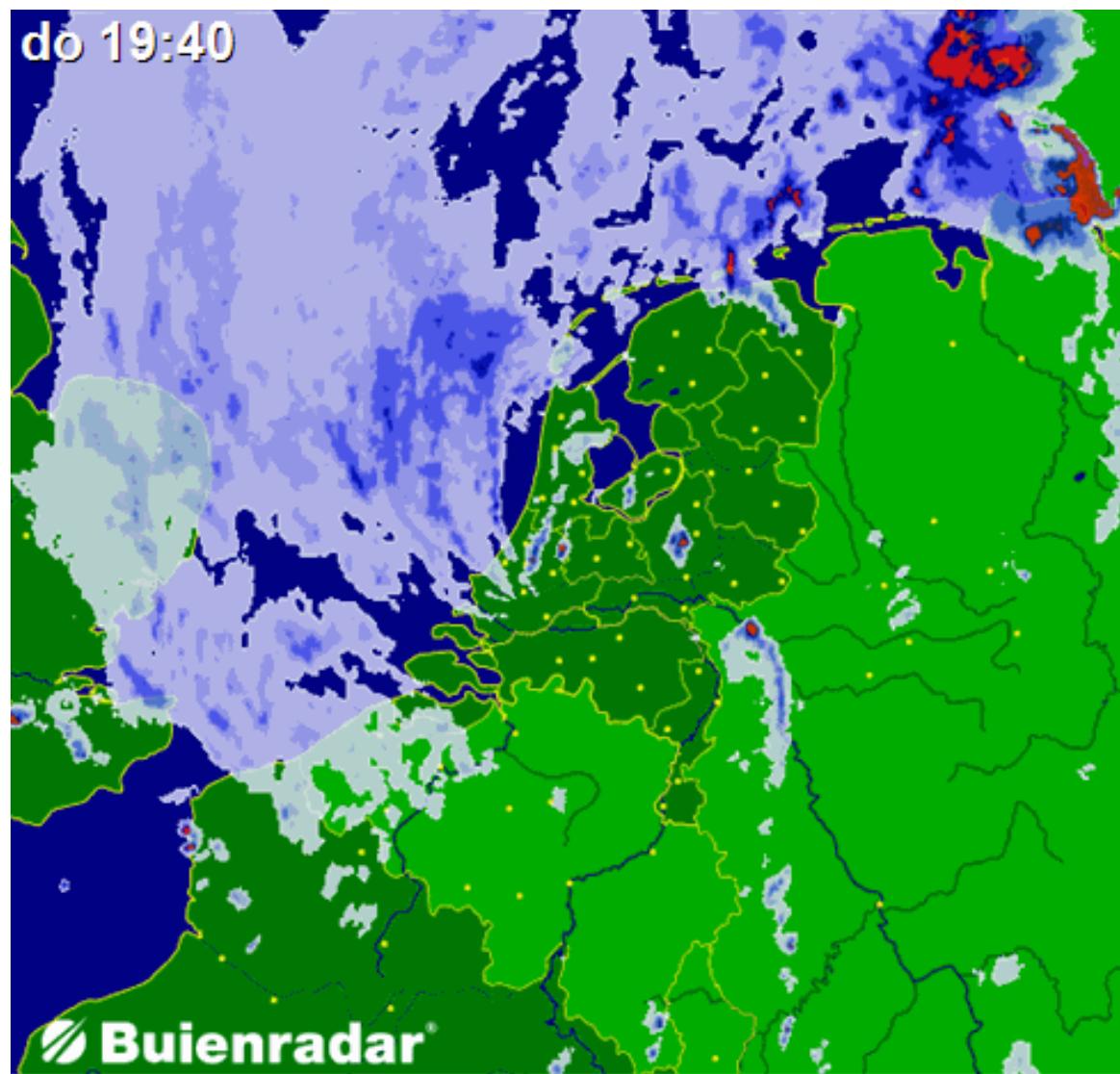
# Instability and outcome: the other black box



# The Phase Transition in Psychotherapy



# The future: predicting individual clinical change processes like the weather?

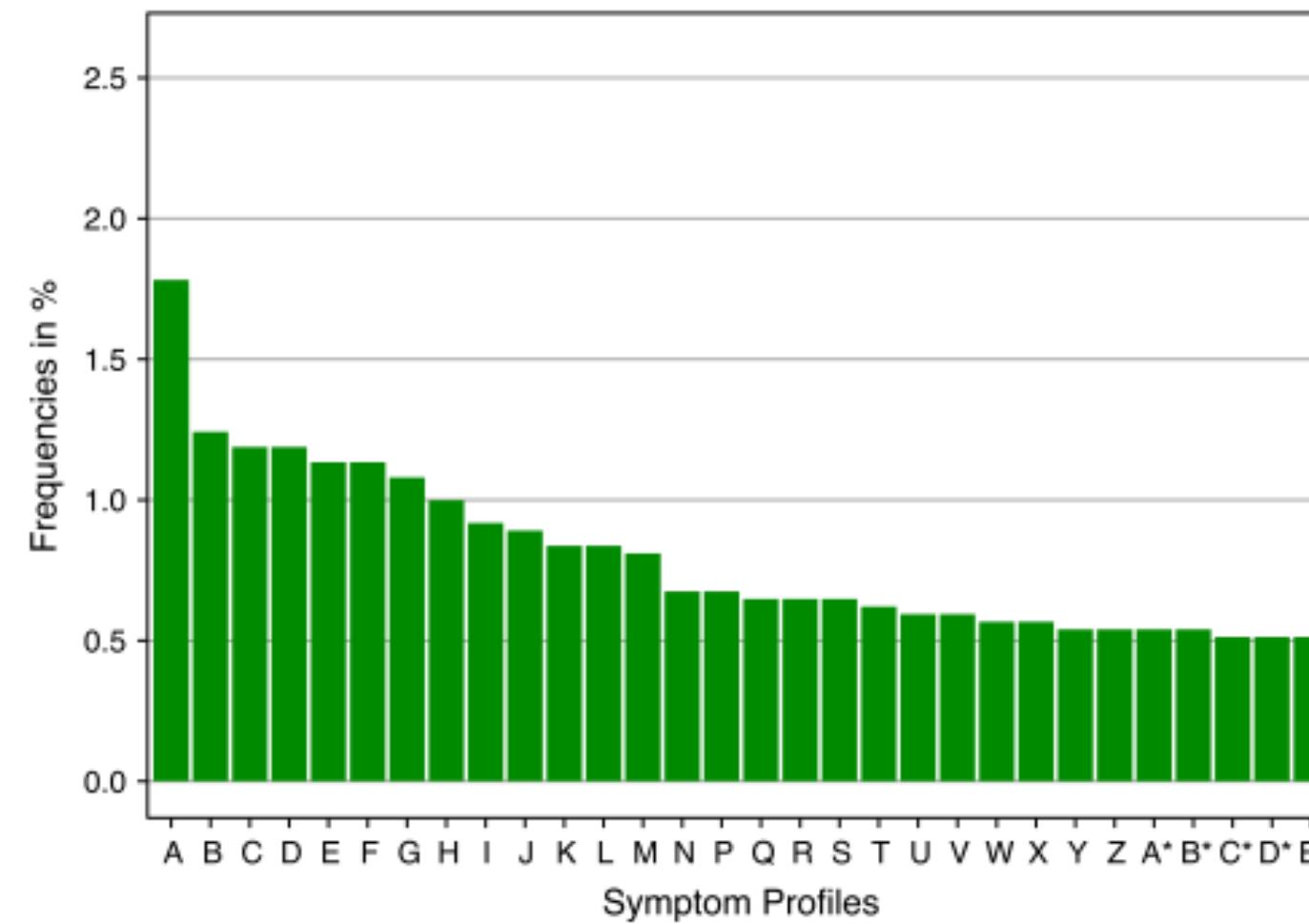


Schöller et al., 2019; <http://www.societyforchaostheory.org/ndpls/askFILE.cgi?vol=23&iss=01&art=04&desc=PDF>

Thank you for your attention!

# Extra slide: individual differences in symptom profiles

1 disorder → 3703 patients → 1031 unique symptoms profiles → 501 reported by only 1 individual



Fried & Nesse, 2015

Fig. 1. Frequencies of the 30 most common depression symptom profiles during the beginning of the first treatment stage of the STAR\*D study ( $n=3703$ ).

