

Dynamics of Complex Systems

Scaling Summary

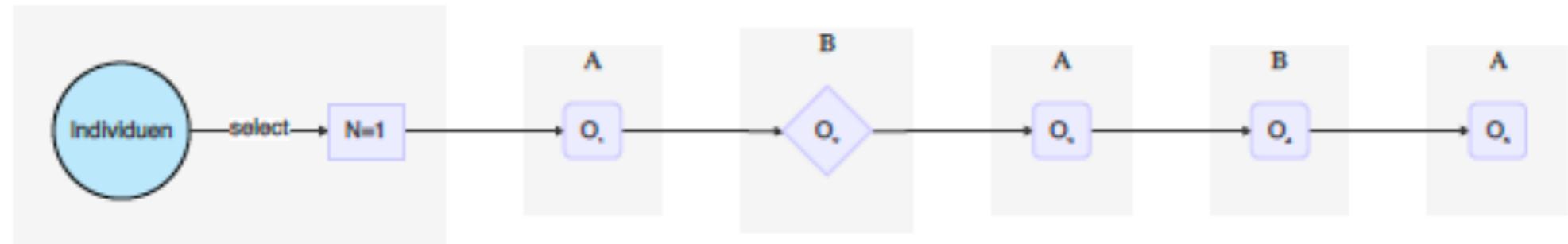
Fred Hasselman & Maarten Wijnants

Radboud University Nijmegen



Idiographic methods

ABA
ABAB
ABAB-BAB
BABA-ABA
... etc



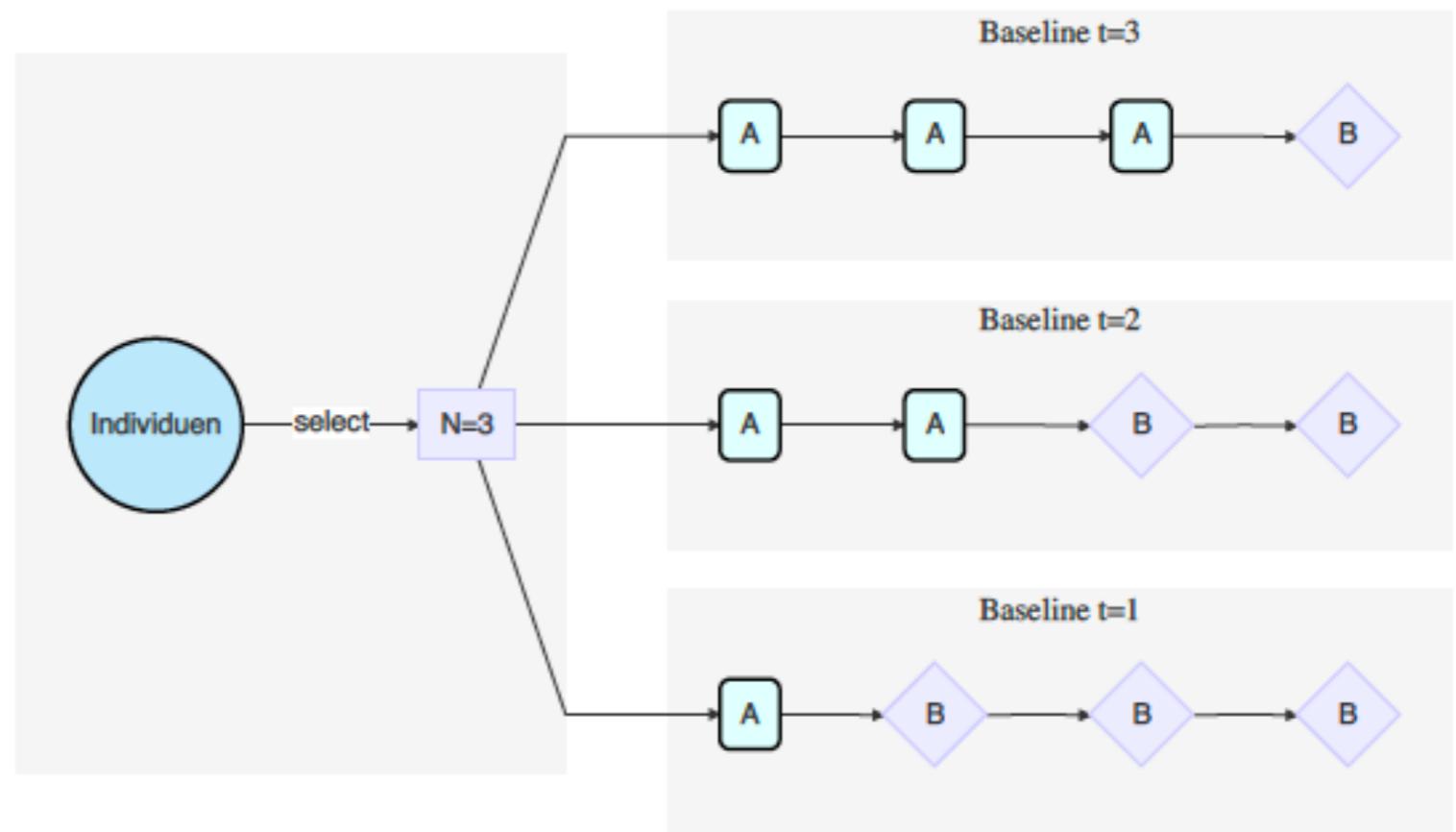
ABA
Within case,
across contexts



Idiographic methods

ABA

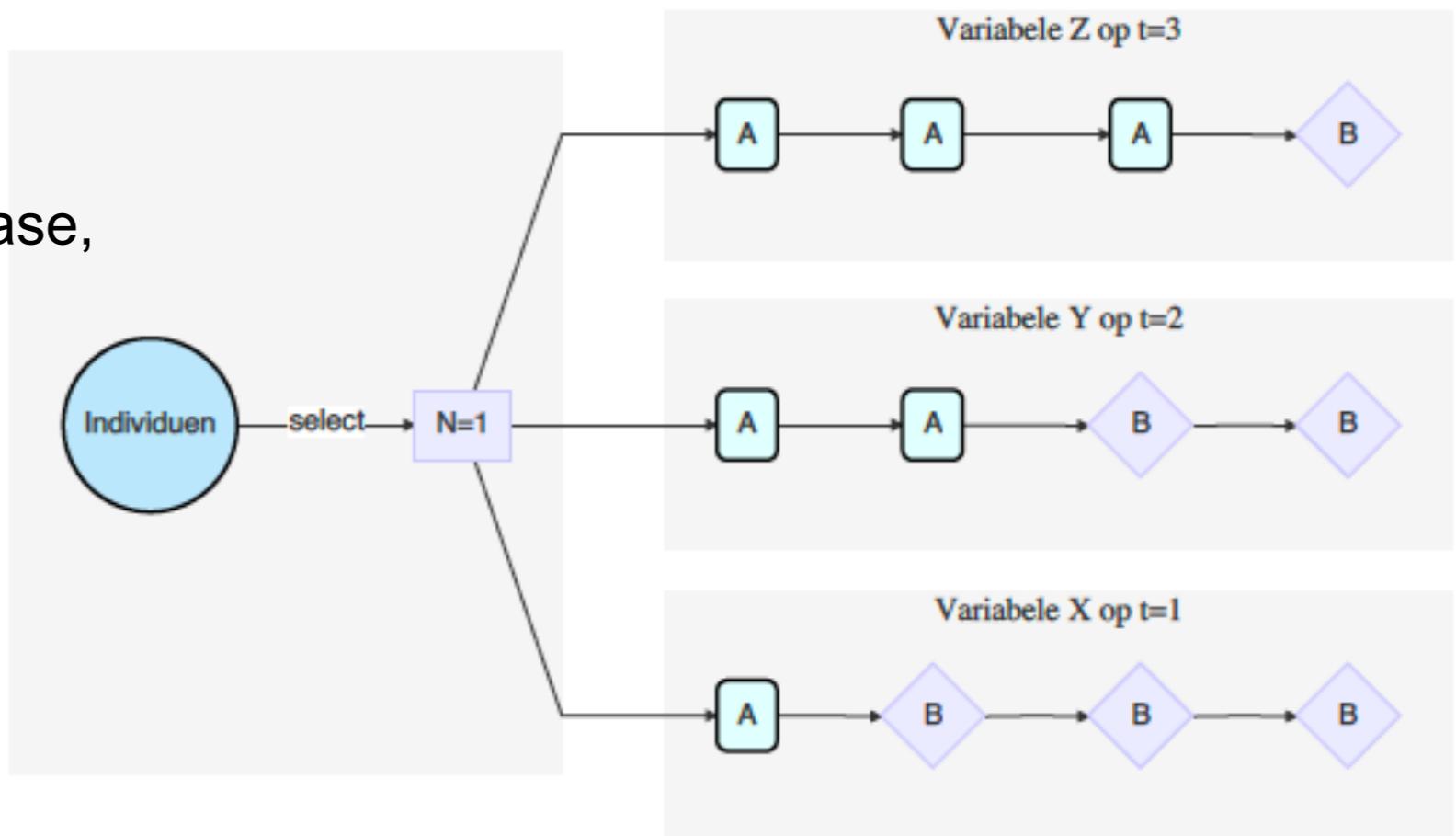
Multiple baselines across



Idiographic methods

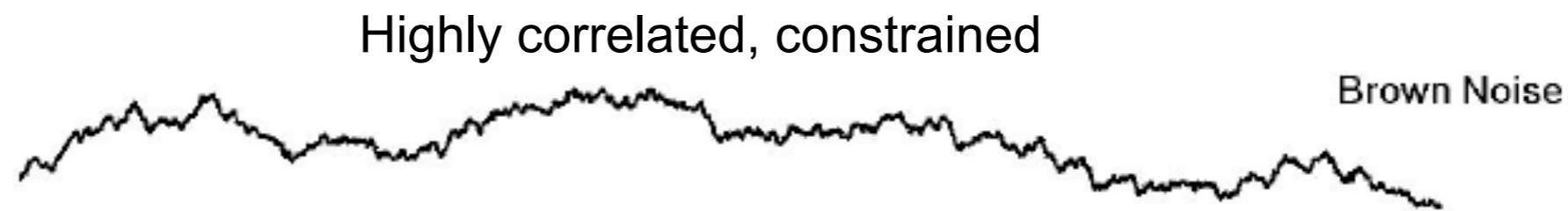
ABA

Multiple baselines within case,
across variables

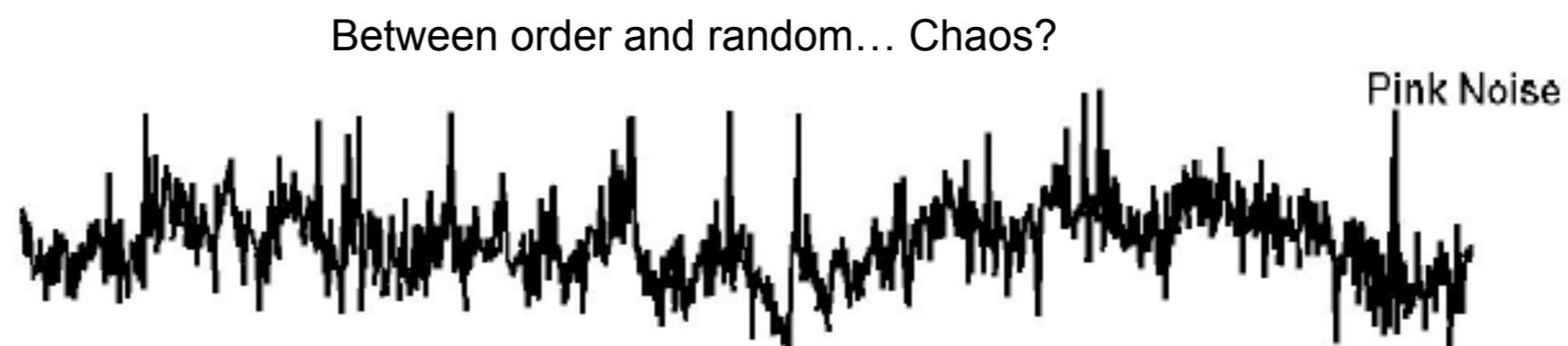


Idiographic Science

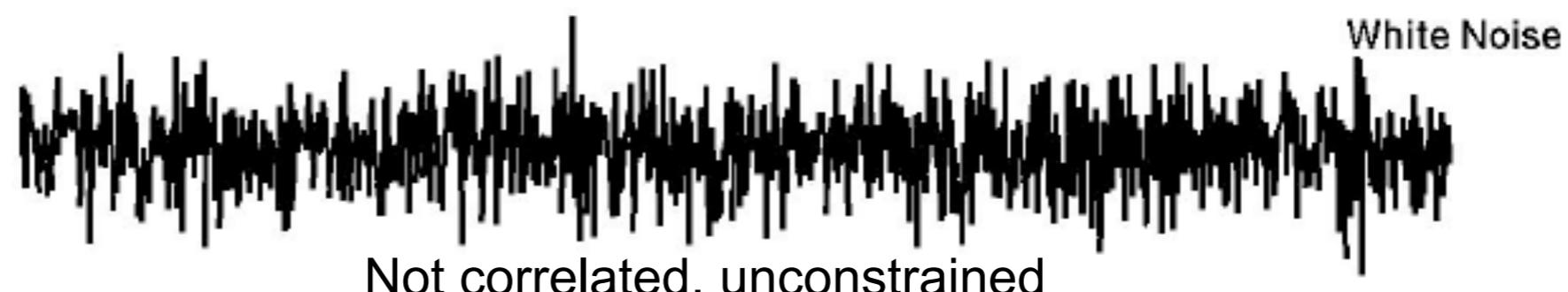
**Brownian motion,
or random walk
processes**



*Associated with Self
Organizing Complex Systems*



**Gaussian, random
processes**



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Fundamental problems for main-stream Social & Life Sciences

Time series of observables of living systems
(e.g. human physiology, performance and self-reports of well-being)

- Often no *stationarity* of central moments
- Often no characteristic scale of fluctuation (*homogeneity*)
- No *memoryless-ness* property (nontrivial after-effects of interactions)
- *Anomalous diffusion* rather than typical diffusion
- *Ageing* (losing identity over time)
- *Scaling* (1/f noise, multifractal spectrum, multiplicative cascades)

>> *non-ergodic, non-equilibrium, non-linear phenomena*

Most common model in Social Sciences: General Linear Model

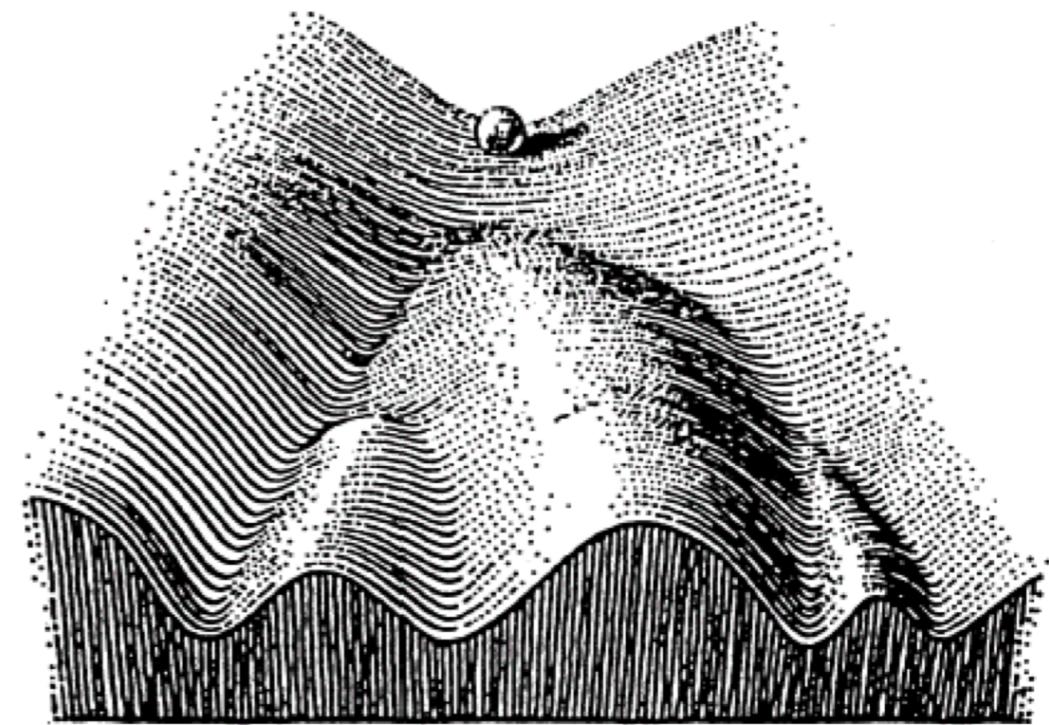
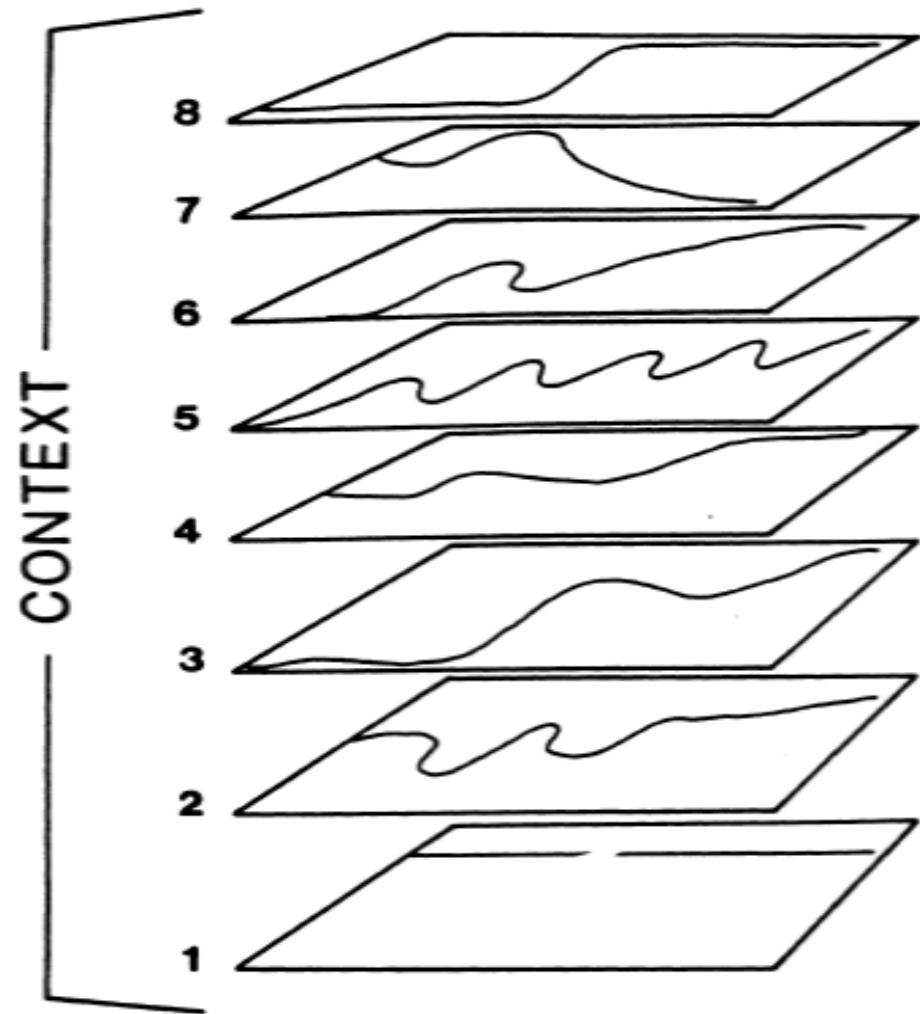
A Manifesto on Psychology
as Idiographic Science: Bringing the
Person Back Into Scientific Psychology,
This Time Forever

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Special Section On A Biological
Window on Psychological
Development. Edited by Clancy Blair
& Jean-Louise Gariepy

On the Implications of the
Classical Ergodic Theorems:
Analysis of Developmental
Processes has to Focus on
Intra-Individual Variation



ONTOGENETIC LANDSCAPE

Development:

Continuous

Occurs across and within multiple nested temporal and spatial scales

The result of interactions with the internal and external environment

The Ontogenesis of a Competence

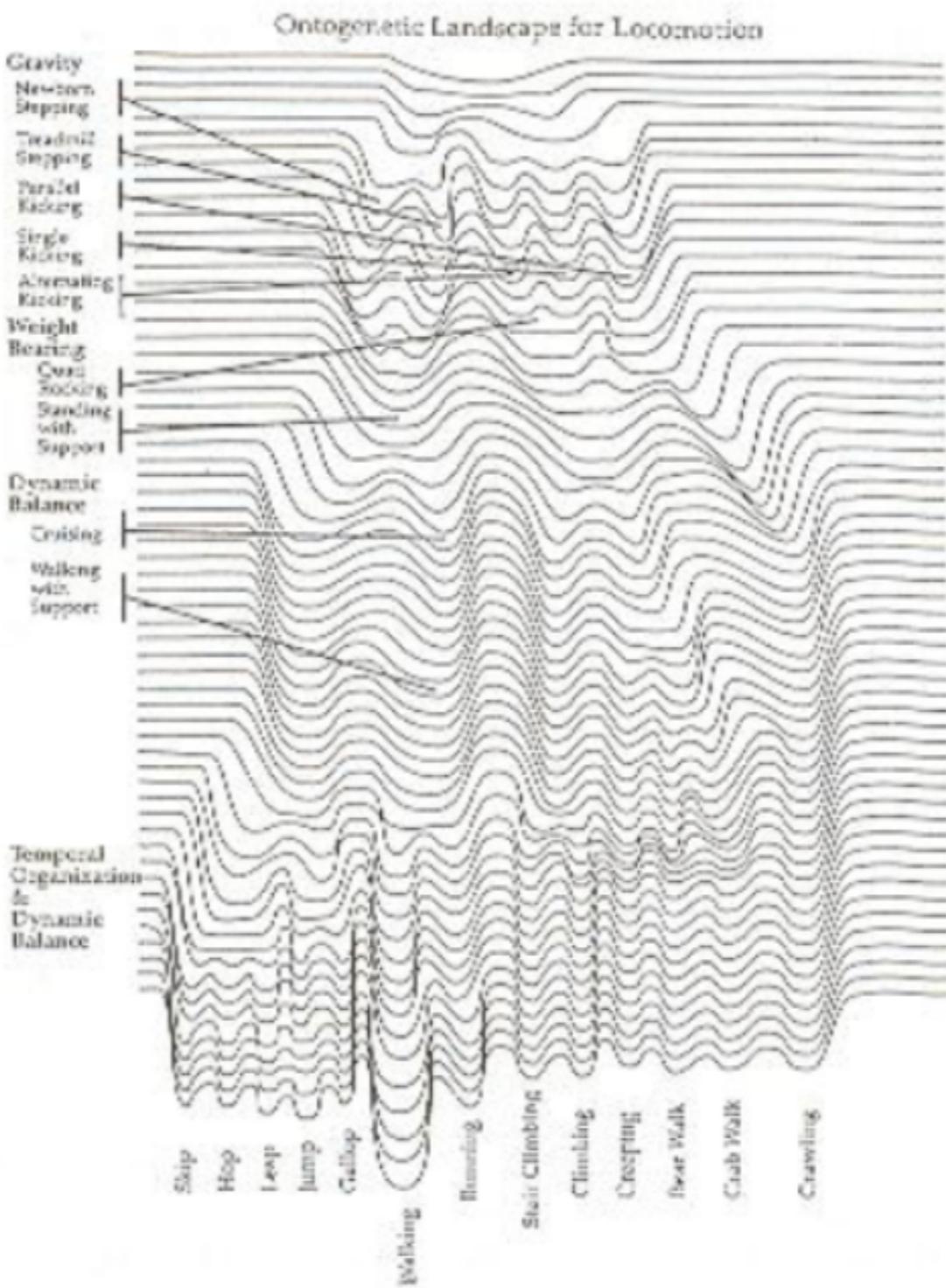
A (hypothetical) dynamical landscape for the different phases of locomotion. →

The groves mark the stable locomotor organizations that are possible at a certain age (lines).

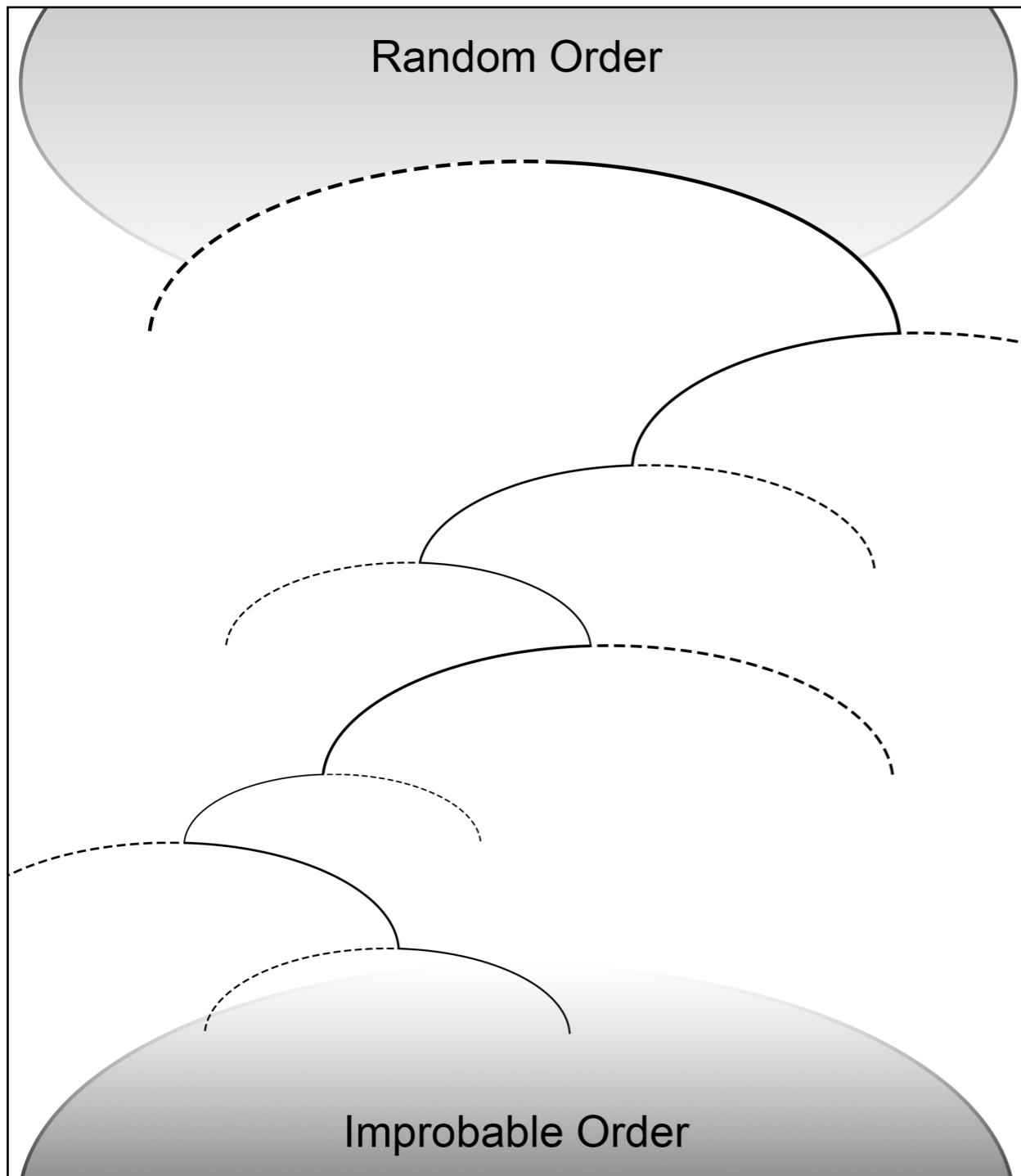
Y-axis: Age (time)

X-axis: Forms of locomotion

Z-axis: Measure of stability



Idiographic Science



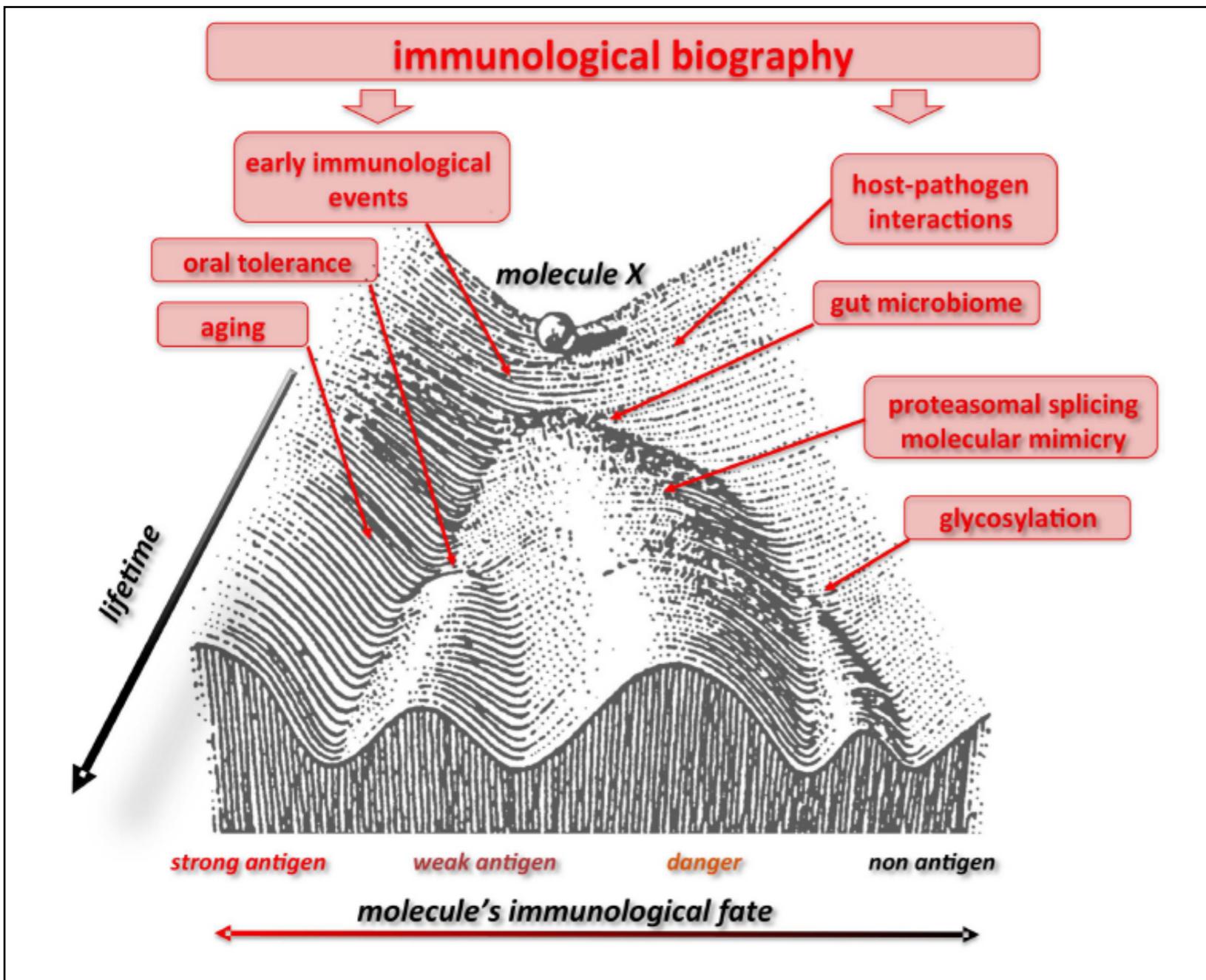
Ordered mass
=

Thermodynamically
Improbable Structure

“Life is an accumulation of broken
symmetries of the past”
(Hopfield, 1994)

thermodynamic
information

Idiographic Science



interaction biography

=

unique history
of interactions

lifeless systems:
biography is irrelevant

living systems:
biography is crucial

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**On the Implications of the
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ageing and metamorphism

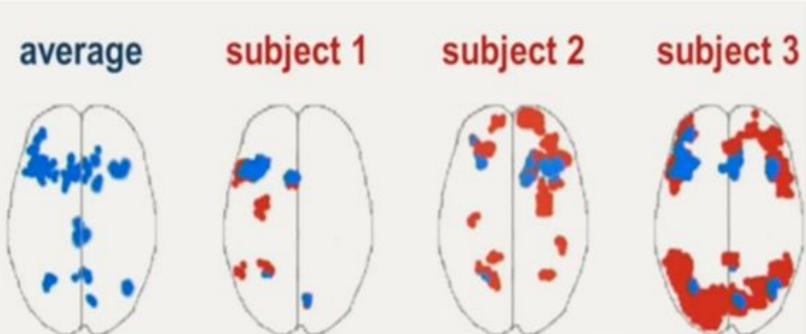
- There are after-effects of interactions with the internal and external environment. Coordination of behaviour based on previously experienced events.
- Loss of it-entity over time which leads to increase of individuality (need to know about the unique history of the system to predict where it is going)
- Loss of individuality (= becoming ‘dividual’) when interacting with tools, other agents, without loss of identity

Idiographic Science

- Complexity Science - Science of the Individual - Systems Biology
- **Idiographic** versus **Nomothetic** goal of scientific explanation

Principle of jaggedness

no individual corresponds to average



Principle of context

no behaviour is context independent

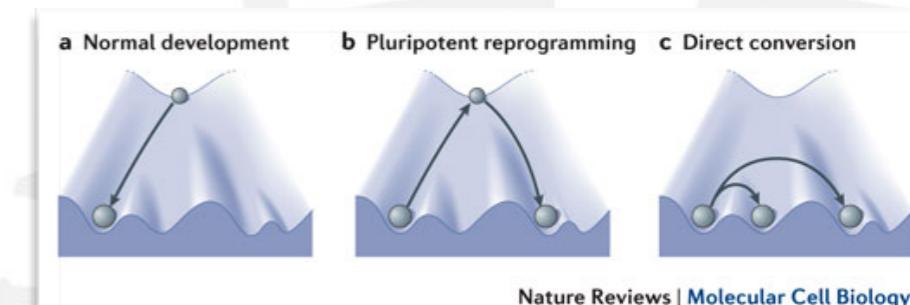


THE FAILERS...

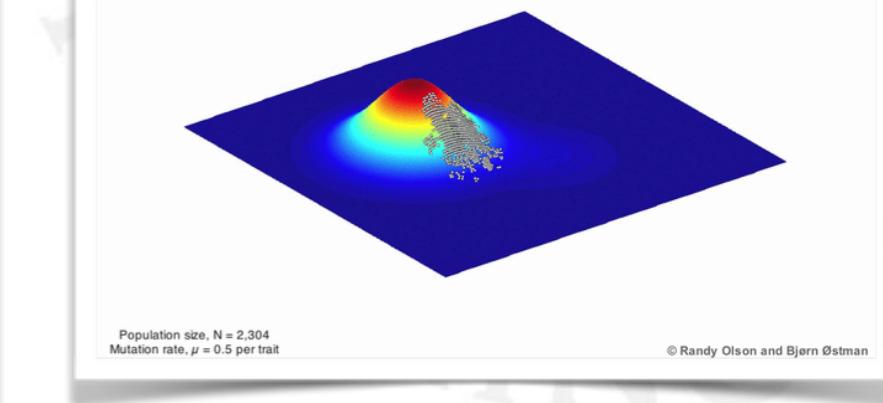
struggled more in stressful situations
had more trouble paying attention
had greater difficulty maintaining friendships
scored lower on the S.A.T. (by over 200 points)
prone to a much higher higher body-mass index
were more likely to have drug addictions

Principle of pathways

multiple trajectories to 'success'



Dynamic fitness landscape



Thread 1:

At age 27-32, those who had waited longest during the Marshmallow Test in preschool had a lower BMI, a better sense of self-worth, pursued their goals more effectively, and coped better with stress and frustration.



(pg. 5)

Thread 6:

The more we learn about nature and nurture, the more it is clear that they inseparably shape each other. "A pre-disposition does not a pre-determination make."



(pg. 91-93)

Thread 7:

Each child who waited successfully had a distinctive methodology for self-control. First, they had to remember and actively keep in mind their chosen goal.



(pg. 107)

long range correlations attractor / repellor resistance to change context sensitivity

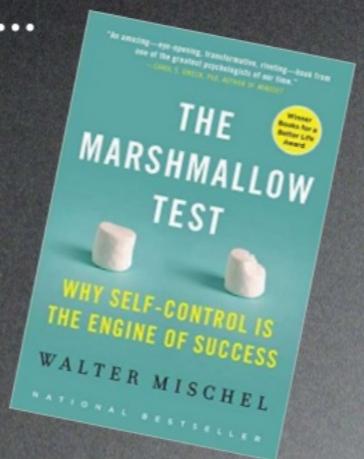
Thread 2:

Resisting temptation is difficult because the brain's "hot system" is heavily biased towards the present: it takes full account of immediate rewards, but discounts rewards that are delayed.

(pg. 255)



Teasing 10 threads from Walter Mischel's...



Thread 4:

Prolonged stress impairs the prefrontal cortex, essential for things like surviving high school, holding down a job, avoiding depression and refraining from decisions that seem intuitively right but turn out to be really stupid.



(pg. 49)

complex dynamics different paths (multi-realibility)

metaphors from thermodynamics

Thread 10:

The Fundamental Marshmallow Principle: "Cool the now; heat the later!"

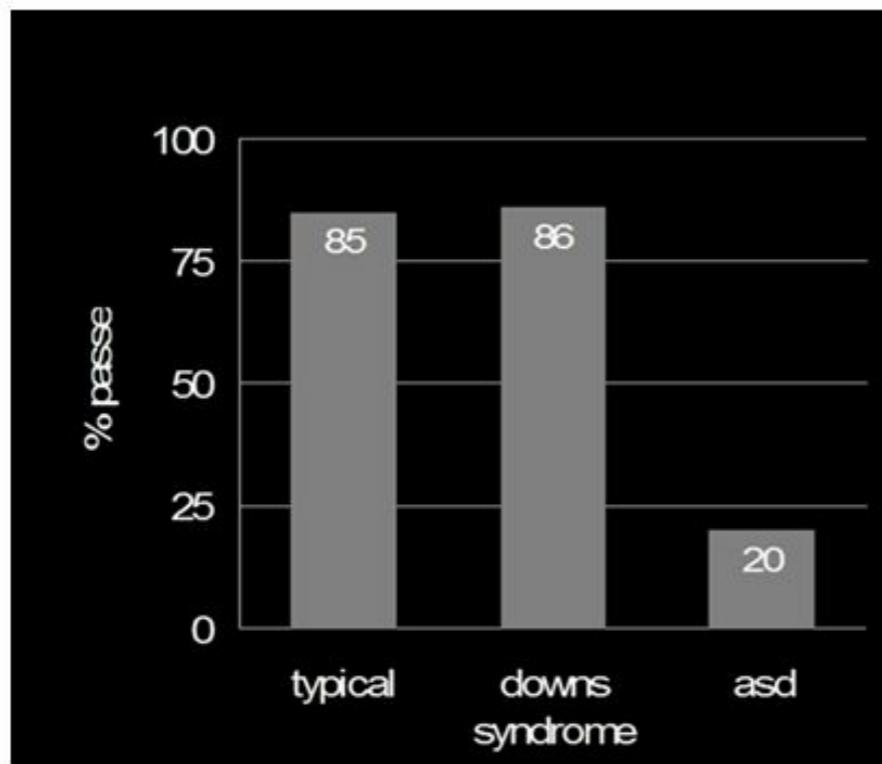


(pg. 256)

theory of mind?

only four of the 20 autistic children (20%) answered correctly

Sally-Anne problem



Baron-Cohen, Leslie, and Frith (1985)
Social and emotional problems secondary
to cognitive problem

Instruct to keep the chocolate.... no problem!



Idiographic methods

Systemic Case Formulation, Individualized Process Monitoring, and State Dynamics in a Case of Dissociative Identity Disorder

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Helmut Schöller^{1,2} and Benjamin Aas^{1,2}*

¹ Institute of Synergetics and Psychotherapy Research, Paracelsus Medical University, Salzburg, Austria, ² Department of Psychology and Pedagogics, Ludwig Maximilians University, Munich, Germany, ³ Department of Psychosomatics and Inpatient Psychotherapy, Paracelsus Medical University, Christian Doppler University Hospital, Salzburg, Austria

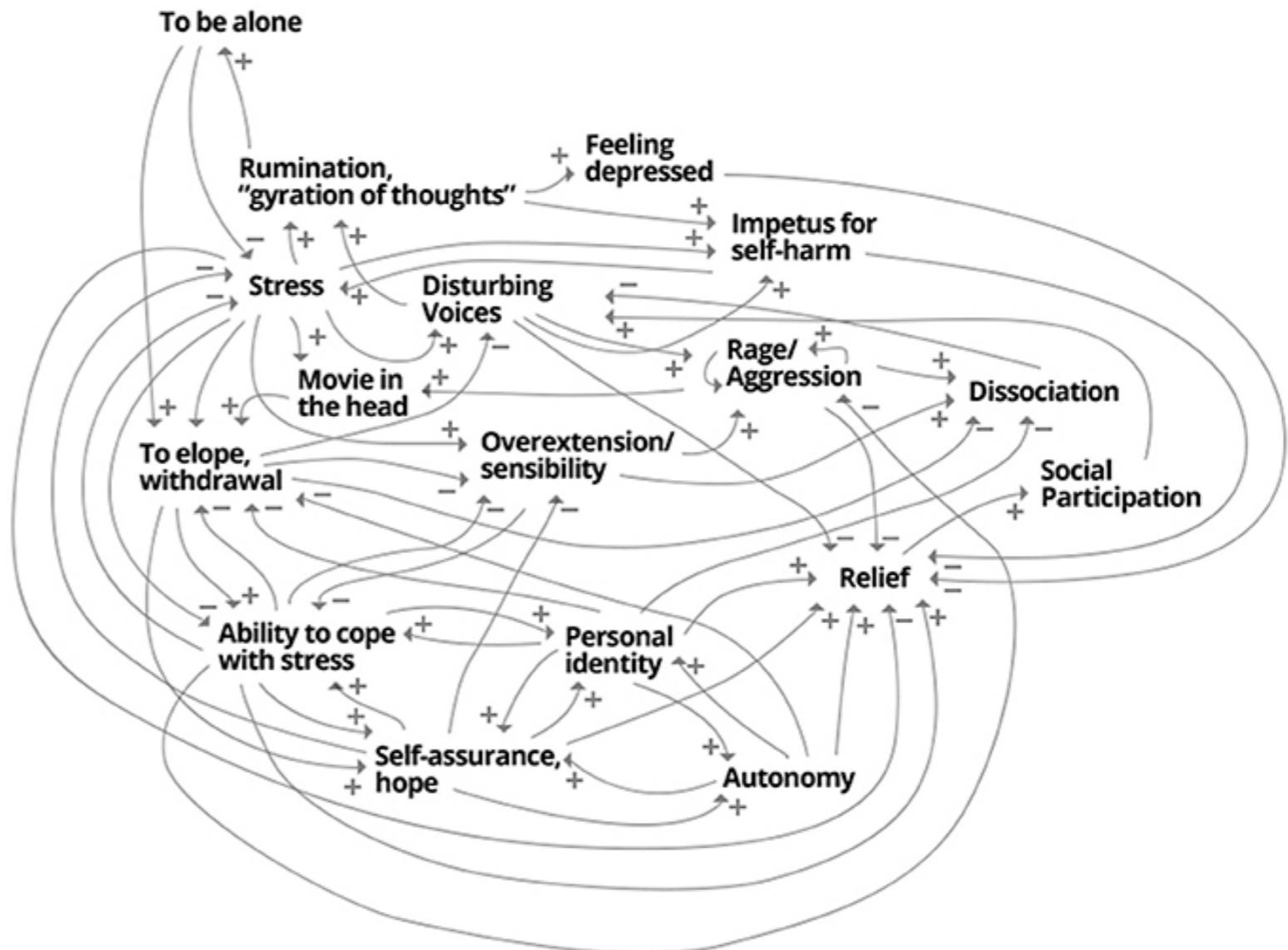
I Stress and Coping (state-cluster "child", EP, corresponds to factor I of the individual questionnaire)

1. Today, I experienced stress ...
2. Today, I had to activate my "head-cinema" ("movie in the head") ...
3. Today, I zoomed out - dissociated ...
4. Today, it was important to me to be alone ...
5. Today, the depression carried me away ...
6. The impulse to hurt myself was today ...
7. Today, I ruminated ...
8. The intrusive voices were today ...
9. My level of aggression was today ...
10. My level of anger was today ...
11. Today, I felt overwhelmed ...
12. My need for distancing myself from others was today ...

II Positive goals and development of identity (state-cluster "adult", ANP, corresponds to factor II of the individual questionnaire)

13. Today, I felt resilient and able to cope with stress ...
14. My feelings of inner security were today ...
15. My feelings of independence were today ...
16. The sense of my own inner identity was today ...
17. Today I had a sense of relief ...
18. Today, I took part in social life ...

Match the 18 variables of her ISM, as shown in **Figure 1**, separated into two factors. The client answered these items daily via the online monitoring system SNS. Each question is scored by a visual analog slider (VAS), ranging from 0 to 100 and extrema of "not at all" to "very much" (where applicable).



Three degrees of theory separation

A. Scientific claim, either by construction, or by raising conjectures to principles:

- I. Type of entity postulated (substance, structure, event, state, disposition, field)
- II. Compositional, developmental, or efficient-causal connections between the entities in I

being
formal

B. Tests of associations between entities

- III. Signs of first derivatives of functional dynamic laws of connections in II
- IV. Signs of second derivatives of functional dynamic laws of connections in II
- V. Signs of mixed second order partial derivatives (Fisher "interactions") of connections in II
- VI. Ordering relationships among the derivatives in III, IV, V

(linear) statistical
models

C. Prediction of functional form and parameter values, tests of universality:

- VII. Function forms (e. g., linear? logarithmic? exponential?) of connections in II
- VIII. Trans-situationality (Context relativity) of parameters in VII
- IX. Quantitative relations among parameters in VII
- X. Numerical values of parameters in VII

mathematical model formal
calculus



Also necessary and sufficient conditions to describe an agent-environment system?

Table 10.1: Discrimination criteria for SOC and non-SOC systems.

Process	Criterion 1: Statistical independence of events	Criterion 2: Nonlinear growth phase	Criterion 3: Random rise times	Occurrence frequency distribution of energy	Waiting time distribution
Stationary SOC	Yes	Yes	Yes	Powerlaw	Exponential
Nonstationary SOC	Yes	Yes	Yes	Powerlaw	Powerlaw
Hierarchical SOC					
–Coupled	No	Yes	Yes	Powerlaw	Powerlaw
–Filtered	Yes	Yes	Yes	Powerlaw	Powerlaw
Self-Organization	No	No	No	Powerlaw	...
Brownian Motion	No	No	No
MHD Turbulence	No	No	No	Powerlaw	Powerlaw
Forced Criticality	No	Yes	Yes	Powerlaw	...
Percolation	No	No	No	Exponential	...
Chaotic Systems	No	Yes	No	Exponential	Quasi-periodic



xviii **Introduction**

Table I.1
Goals for a Developmental Theory

1. To understand the origins of novelty.
 2. To reconcile global regularities with local variability, complexity, and context-specificity.
 3. To integrate developmental data at many levels of explanation.
 4. To provide a biologically plausible yet nonreductionist account of the development of behavior.
 5. To understand how local processes lead to global outcomes.
 6. To establish a theoretical basis for generating and interpreting empirical research.
-

Holism and Emergence

- **Composition principle:** How do parts of the system relate to wholes?

*“A physical theory is holistic if and only if it is **impossible in principle**, for a set of local agents each having access to a single subsystem only, to infer the global properties of a system as assigned in the theory (which can be inferred by global measurements), by using the resource basis available to the agents.”* (Epistemological criterion - Seevinck, 2004).

*“It was shown that all theories on a state space using a **Cartesian product** to combine sub- system state spaces, such as **classical physics and Bohmian mechanics**, are not holistic in both the supervenience and epistemological approach. The reason for this is that the Boolean algebra structure of the global properties is determined by the Boolean algebra structures of the local ones. **The orthodox interpretation of quantum mechanics, however, was found to instantiate holism.**”* (Seevinck, 2004).

