

Complexity Methods for Behavioural Science

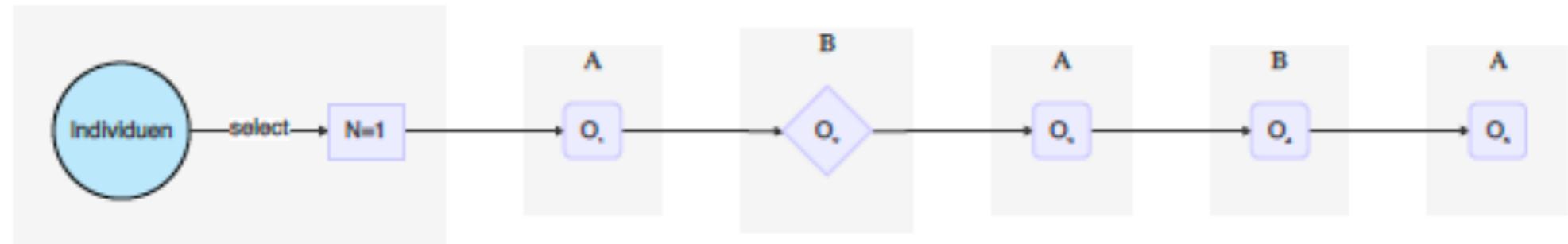
Idiographic science

Fred Hasselman



Idiographic methods

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



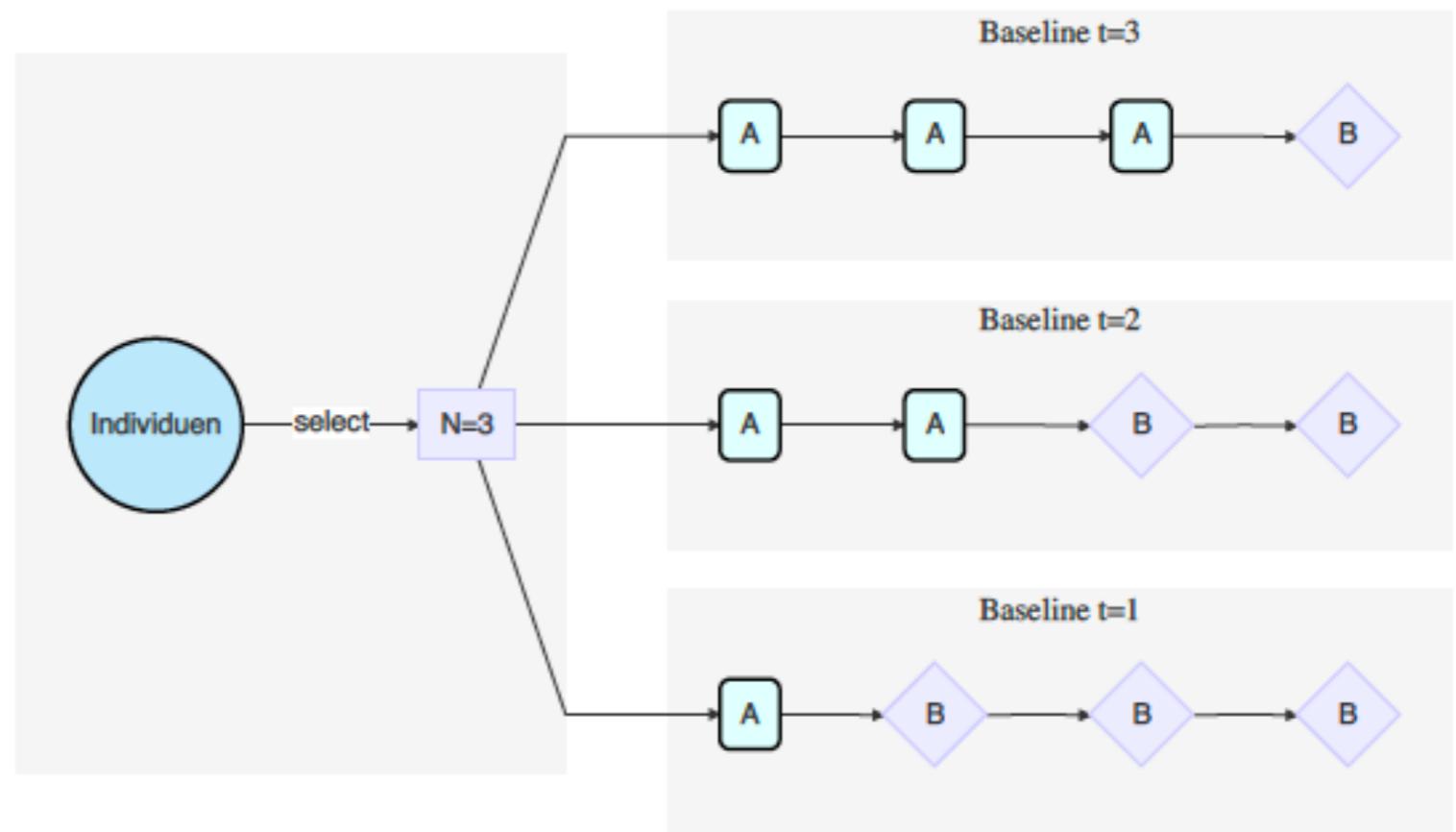
ABA
Within case,
across contexts



Idiographic methods

ABA

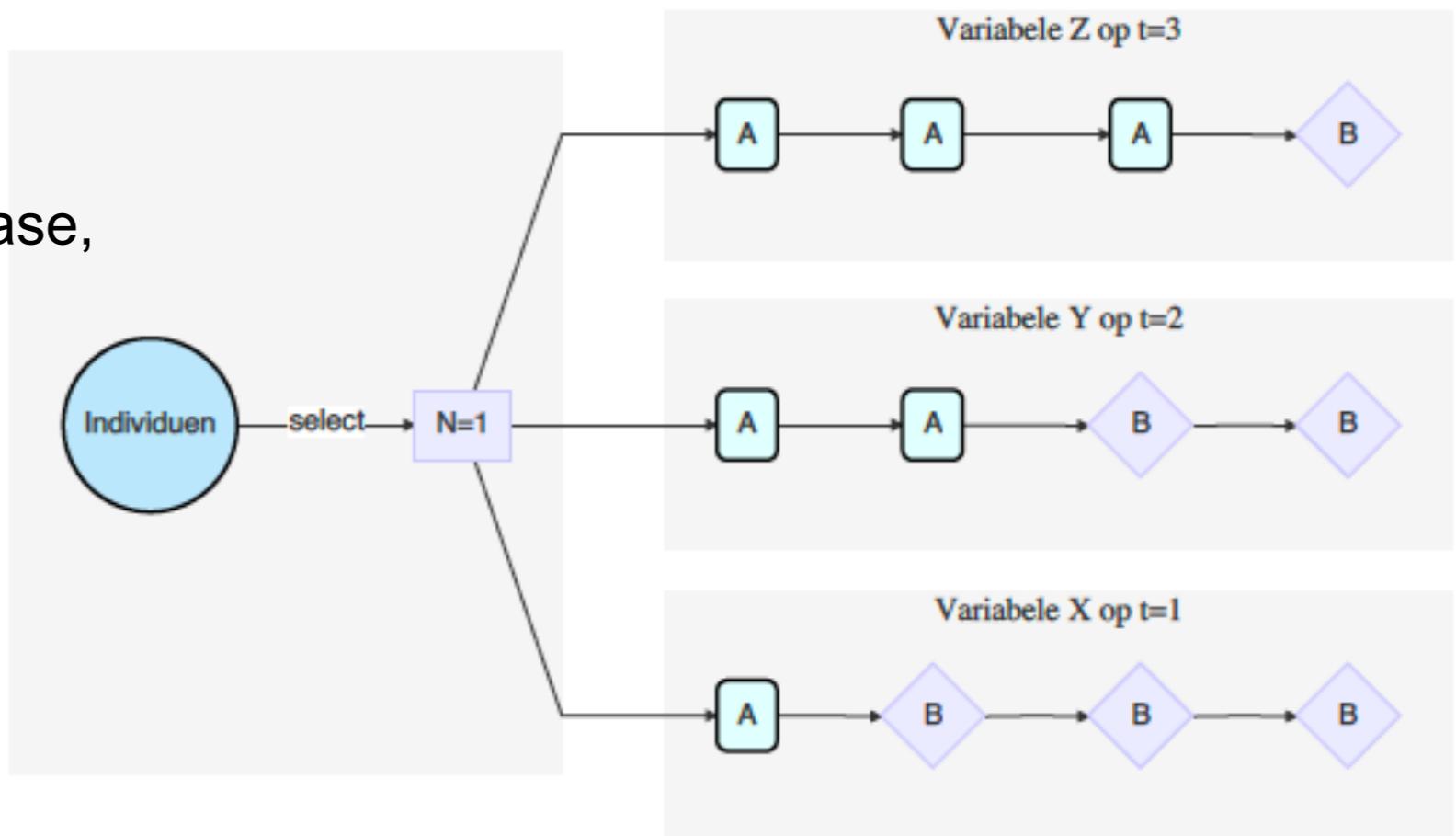
Multiple baselines across



Idiographic methods

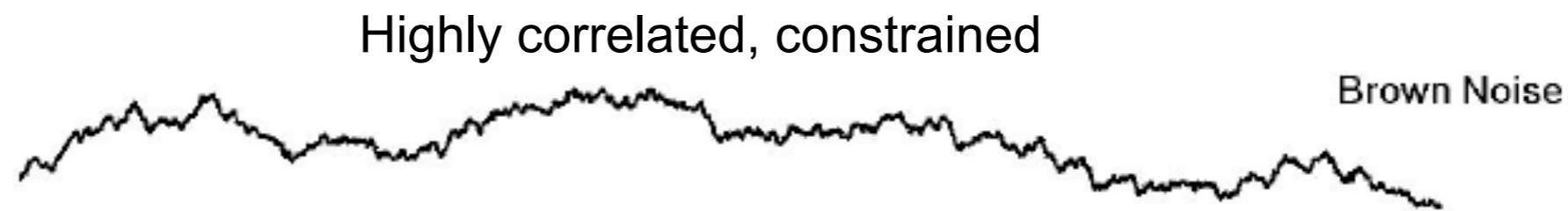
ABA

Multiple baselines within case,
across variables

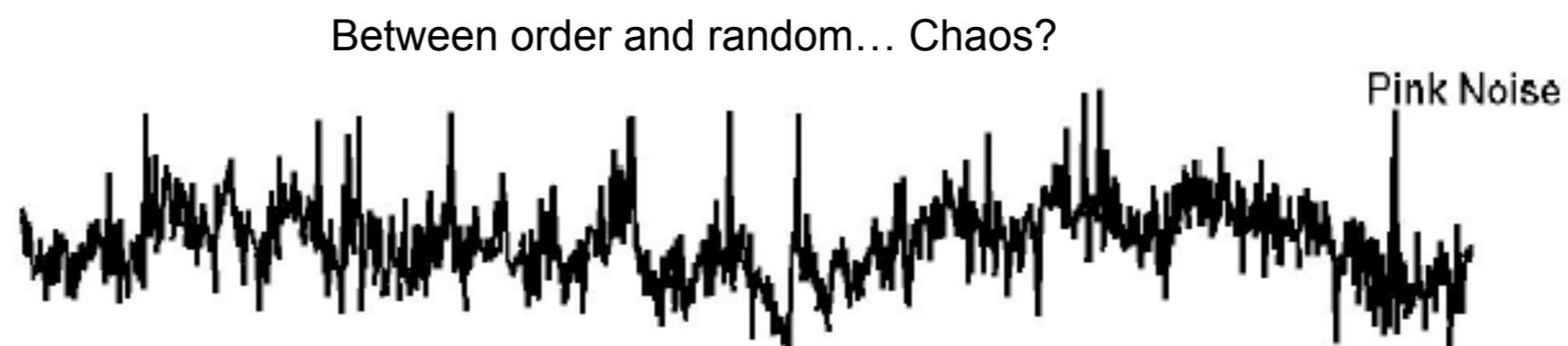


Idiographic Science

**Brownian motion,
or random walk
processes**



*Associated with Self
Organizing Complex Systems*



**Gaussian, random
processes**



22

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

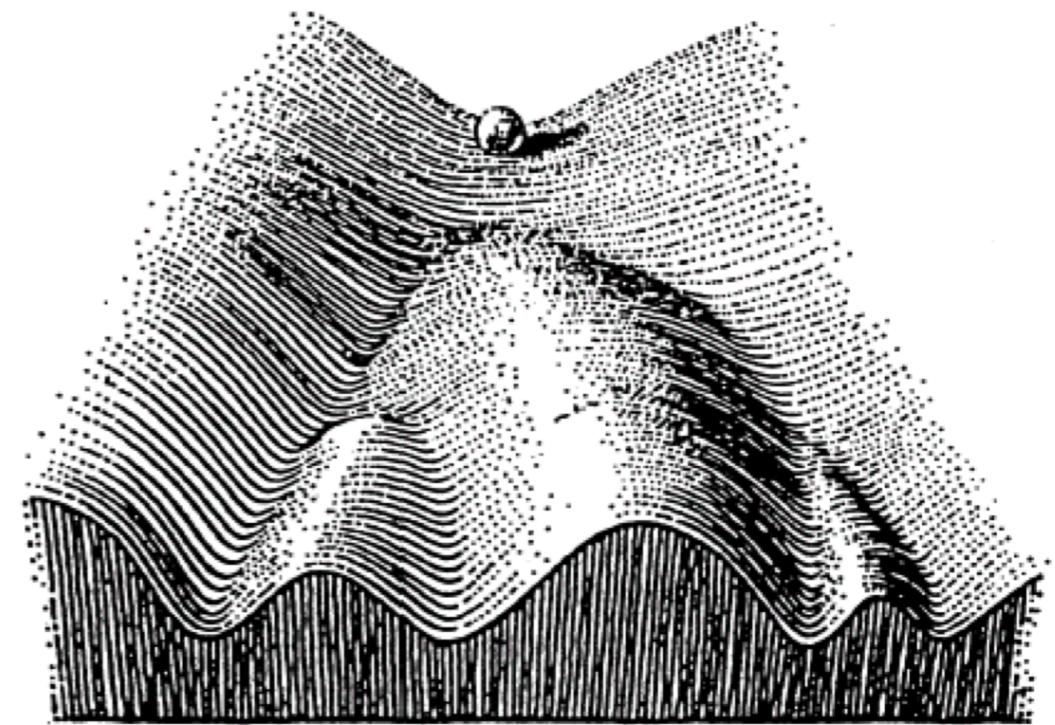
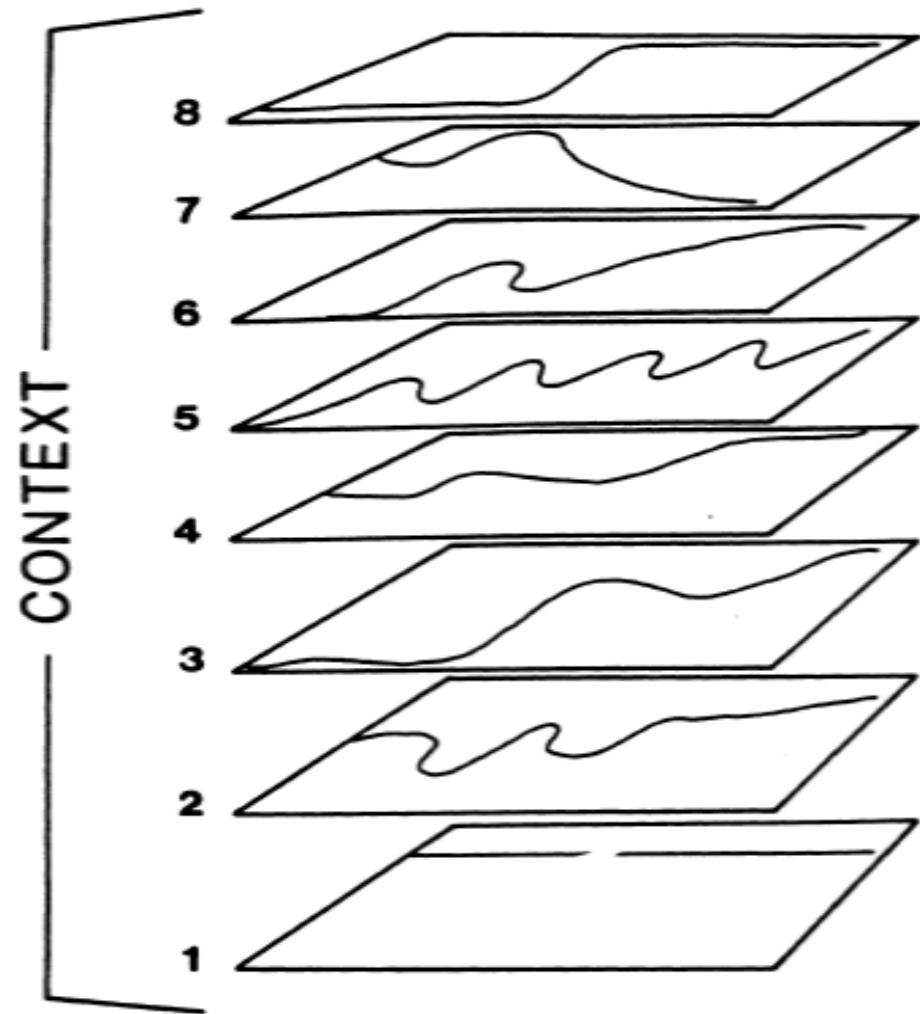
A Manifesto on Psychology
as Idiographic Science: Bringing the
Person Back Into Scientific Psychology,
This Time Forever

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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

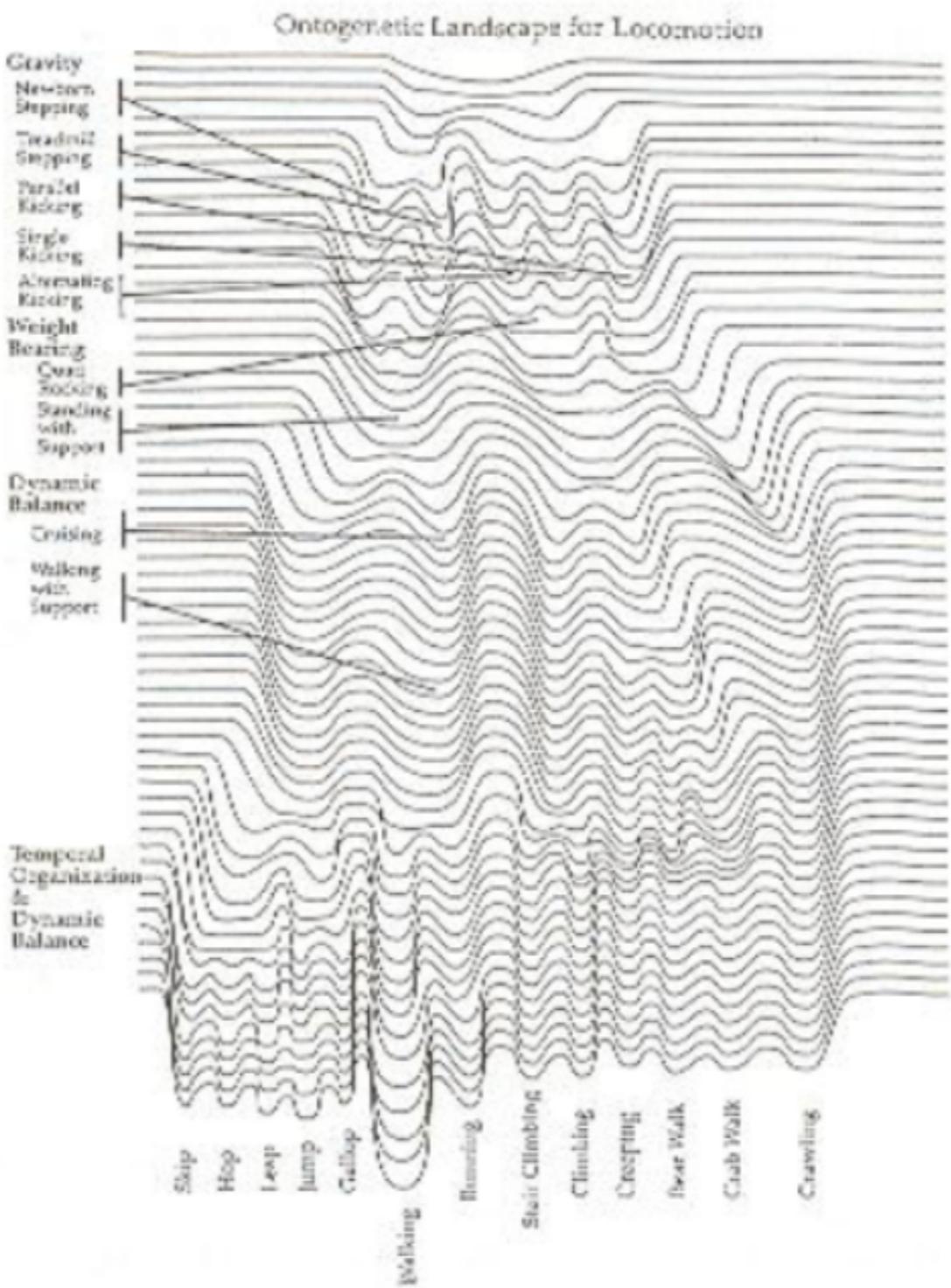
A (hypothetical) dynamical landscape for the different phases of locomotion. →

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

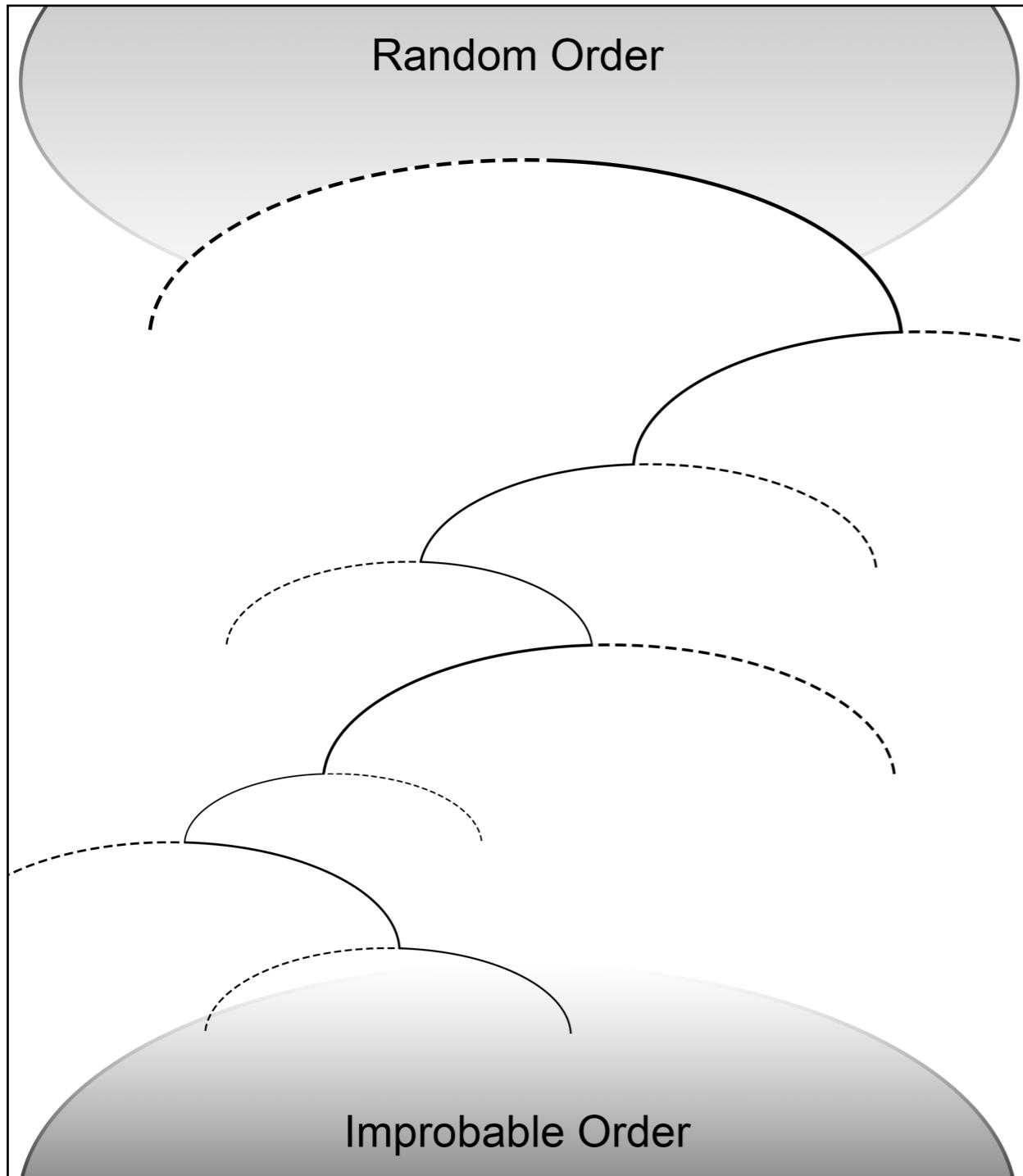
Y-axis: Age (time)

X-axis: Forms of locomotion

Z-axis: Measure of stability



Idiographic Science



Ordered mass

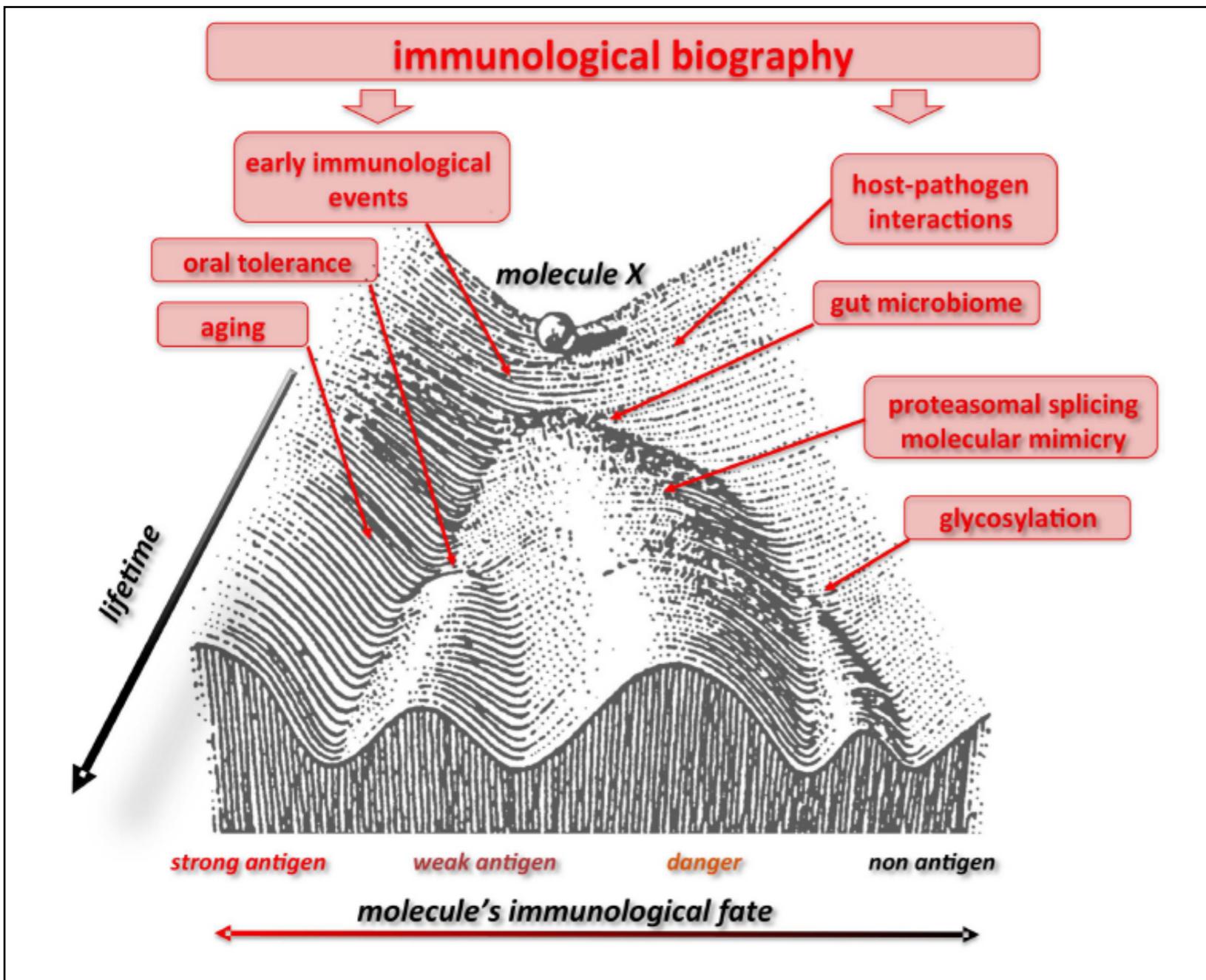
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Thermodynamically
Improbable Structure

“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

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



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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

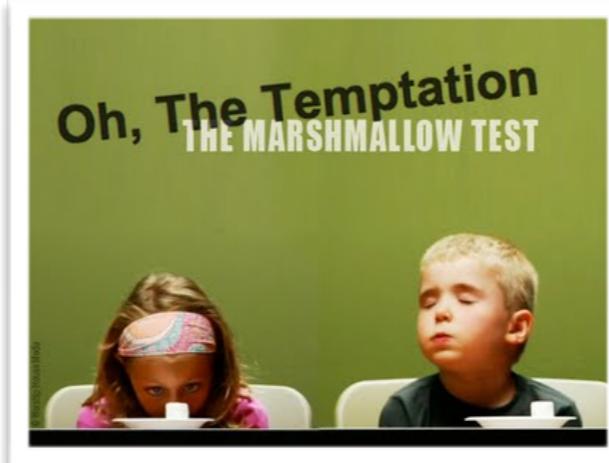
Principle of jaggedness

no individual corresponds to average



Principle of context

no behaviour is context independent



THE FAILERS...

struggled more in stressful situations

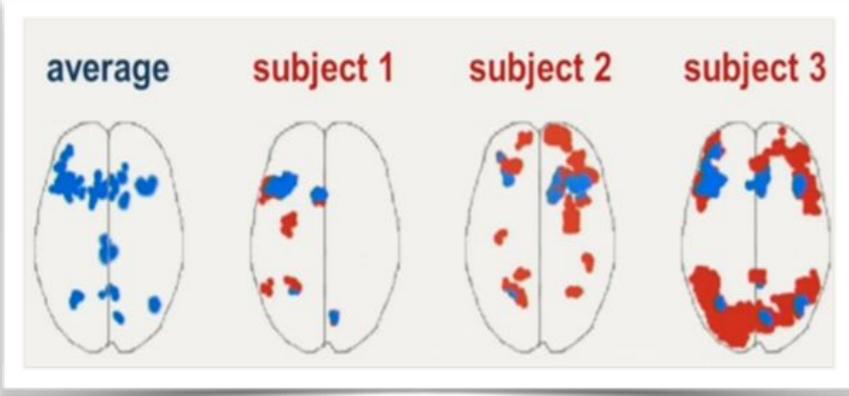
had more trouble paying attention

had greater difficulty maintaining friendships

scored lower on the S.A.T. (by over 200 points)

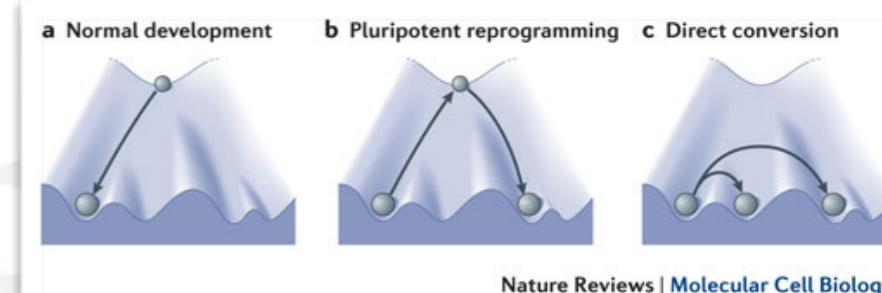
prone to a much higher higher body-mass index

were more likely to have drug addictions

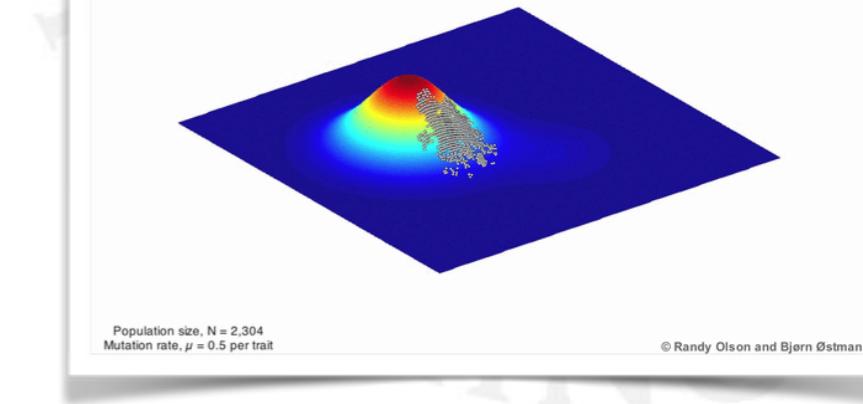


Principle of pathways

multiple trajectories to 'success'



Dynamic fitness landscape



Behavioural Science Institute

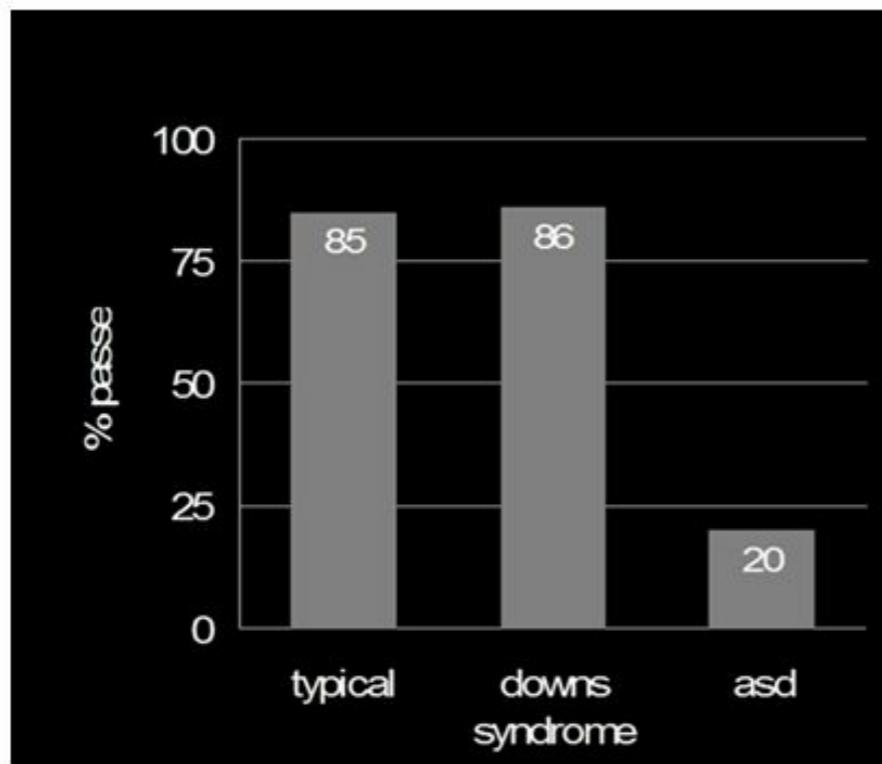
Radboud University Nijmegen



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}*

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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).

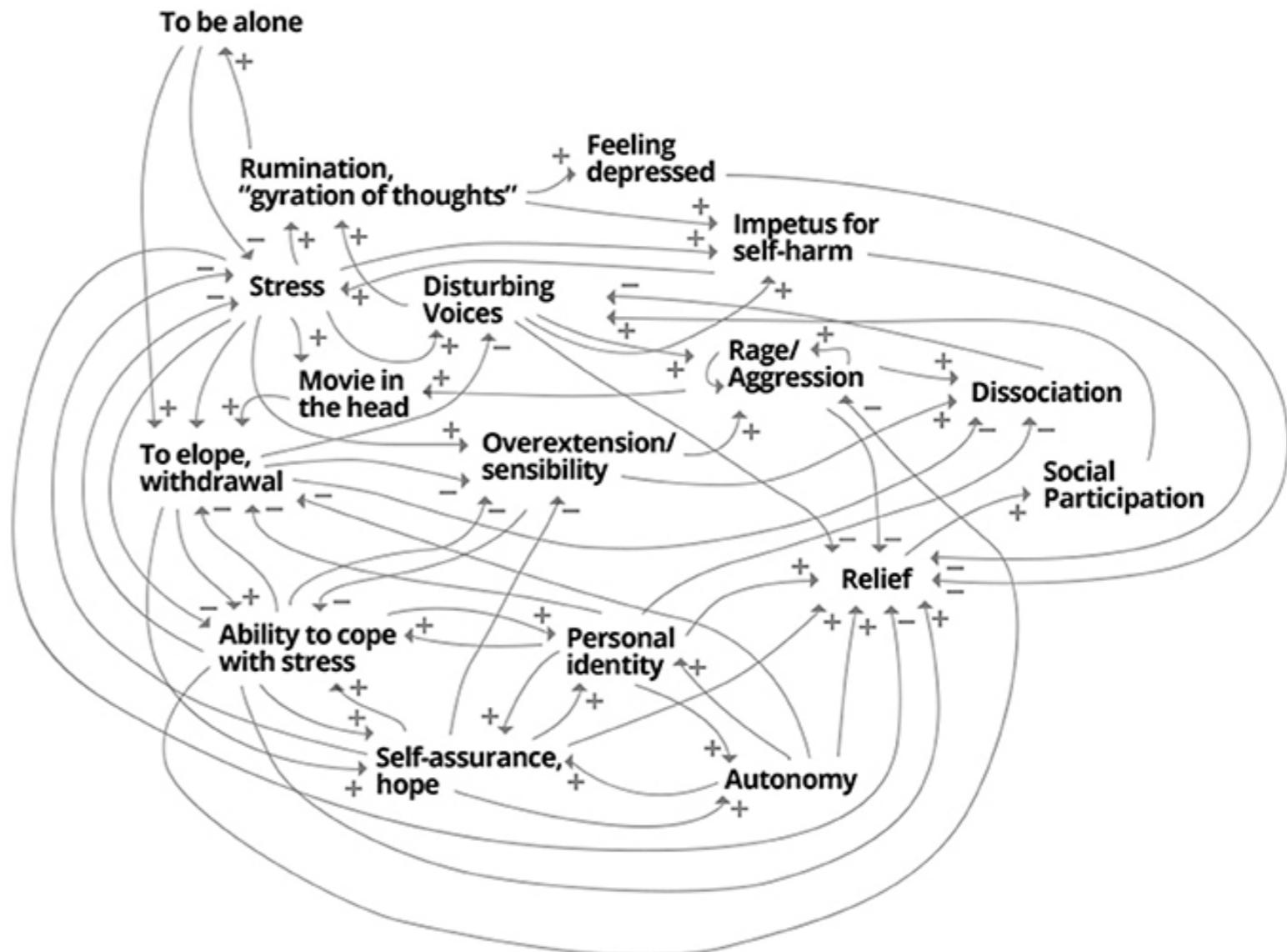


Table I.1
Goals for a Developmental Theory

-
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.
-

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



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).

