Symposium in Honour of
Prof. Dr. Dr. h.c. mult. Hermann Haken
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Synergetics in Psychology
Phase Transitions and Critical Instabilities in Human Change Processes

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Synergetics has been arrived in psychology

- and transforms it
Synergetics has successfully applied to many topics in psychology

<table>
<thead>
<tr>
<th>General psychology</th>
<th>Developmental Psychology</th>
<th>Social psychology</th>
<th>Clinical psychology</th>
<th>Management / organizational psychology</th>
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<tbody>
<tr>
<td>• Motoric coordination</td>
<td>• Child development</td>
<td>• Dyadic interaction (client-therapist, mother-child)</td>
<td>• Etiology of mental disorders</td>
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<td>• Perception</td>
<td>• Assimilation and accommodation of schemata</td>
<td>• Attitude change</td>
<td>• Mental disorders as dynamical diseases</td>
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<td>• Decision making</td>
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<td>• Group dynamics</td>
<td>• Psychotherapy (definition, process-outcome-research, feedback and monitoring)</td>
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<td>• Memory</td>
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<td>• Stability and instability of collective behavior</td>
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<td>• Learning</td>
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<td>• Creativity and innovation</td>
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<td>• Individual and collective speech aquisition</td>
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<td>• Dynamics of emotions</td>
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<td>• The emergence of phenomenal consciousness</td>
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<td>• The dynamics of the „self“</td>
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Most of psychological phenomena are characterized by specific synergetic features

Order / order parameters
Pattern formation
Enslaving of system components
Critical instabilities
Order transitions (non-equilibrium phase transitions) and quasi-attractors
Hierarchies of order parameters
Symmetry breaking
Circular causality
Hysteresis
Coordination (competition or cooperation) of order parameters
Multistability
What psychology has got from synergetics

- Psychology got back its own history
- The concept of „time“ and dynamics
- Thinking in complexity
- A fruitful theory and research paradigm
- A specific „imago hominis“ accentuating autonomy as well as synchronization and cooperation
Nonlinear coupled neural networks and their plasticity create learning and development.
Rayleigh-Bénard-Instability
Symmetry breaking or bifurcation diagram

Bifurcation diagram and corresponding potential landscapes
V: potential
q: dynamic state of the system (order parameter)
R: control parameter

*Kelso (1995)*
Order transition in the motoric system with hysteresis
The Haken-Kelso-Bunz-Model
Activated areas in motoric order transitions

Target areas for the Transcranial magnetic stimulation (TMS)
1 premotoric cortex
2 supplementary motoric area
3 primary sensumotoric cortex

Method: H215O-PET
rCBF

Red/yellow: Areas with significant interaction between motoric pattern transitions and movement frequency (control parameter)

Green: no such interaction, but brain activation correlates with movement frequency

Order transition in motoric coordination – from parallel to antiparallel movement

Only in a destabilized state order transitions can be triggered (in this case by TMS-pulses), but not in each trial.

Hypothetical relations between degree of stability, change of control parameter(s), and intensity of external stimulation triggering change: explaining the effect of minimal or no interventions
Nonlinear and nonstationary dynamics in time series from daily ratings on the Therapy Process Questionnaire by an Internet-based device (Synergetic Navigation System)

grief  anger/rage  self-esteem  joy
Complexity Resonance Diagrams

significance test
- not significant
- significant on 5% level
- significant on 1% level

complexity value

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time
Therapy process of an OCD-patient in a day treatment center

Dynamic Complexity

Flooding

Crit. Instability

Complexity-Resonance-Diagram

Y-BOCS (two times per week)
The contribution of the ward atmosphere (stability of the boundary conditions) and local dynamic complexity (critical instability) to the therapy effect

**Interaction between ward atmosphere (stable boundary conditions) and local complexity (degree of critical instability).**

**Y-axis: reduction of Y-BOCS-score**

**Interaction between ward atmosphere (stable boundary conditions) and local complexity (degree of critical instability).**

**Y-axis: reduction of symptom severity (TPQ-scale)**
SNS-based feedback in a psychotherapy session
identification of patterns without the quality of qualia

adaptive indikation: data-driven decisions on interventions

certainty

theory-based reconstruction of ongoing processes

confirmation of the therapeutic progress

valid feedback

enhanced motivation

experience of self-efficacy

enhanced self-regulation of behavior and emotions

differentiated self-awareness of mental states

perception of emotions, emotional learning

the classic interactional and self-referential loops
**Design of the OCD-Study on Order Transitions**  
*The Dynamics of Change Processes During the Psychotherapy of Obsessive Compulsive Disorder*

N = 9 patients, 5 female, 4 male, AM age 31.9, with one exception dug naive OCD (F42.2), 8 out of 9 washing/contamination fear, with one exception no comorbidity (1 subject F34.1)

N = 9 healthy controls, 5 female, 4 male, AM age 30.9, similar education level

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<thead>
<tr>
<th>Pre</th>
<th>During treatment</th>
<th>Post</th>
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<tbody>
<tr>
<td>Y-BOCS</td>
<td>SNS-based TPB-OCD ratings (once per day) mean 55 days (range: 37-65)</td>
<td>Y-BOCS</td>
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<tr>
<td>BDI</td>
<td>Once per week: Y-BOCS</td>
<td>BDI</td>
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<tr>
<td>SCL-90-R</td>
<td>Number of fMRT-Scans Patients: 7 : 3 scans, 2 : 4 scans Controls: 5 : 3, 1 : 4, 3 : 2</td>
<td>SCL-90-R</td>
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<td>Inkongruenz-FB</td>
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<td>TPB-basiertes Symptomrating</td>
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2 Center-Study: Psychosomatische Klinik Windach, AKH Wien  
MRT-Messungen: Institut für Radiologie, Klinikum Großhadern, Excellenzzentrum für Hochfeld-MR, MedUni Wien
The diagram illustrates the neuronal pathways involved in executive functions and emotional processing. The "cognitive" dorsolateral prefrontal-striatal loop, which includes regions such as the DLPFC, OFC anterior/lateral, putamen, caudate nucleus, and subthalamic nucleus, is shown to decrease during executive functions. Conversely, the "affective" ventral orbitofrontal-striatal loop, involving areas like the OFC anterior/lateral, Striatum, Amygdala basolateral, and mediodorsal Thalamus, increases during emotional processing. The posterior parietal cortex, hippocampus, cerebellum, and superior temporal gyrus (STG) are also highlighted as crucial components of these circuits.
Single case:
dynamics of the Y-BOCS, dynamic complexity and brain activity
ISPP > Neutral
Patients Windach/Munich

Y-BOCS 13
SCL 1.16
TPB-S 4.8

59 Tage

Y-BOCS 9
SCL 0.51
TPB-S +0.65

58 Tage

Y-BOCS 12
SCL 0.20
TPB-S +0.08

47 Tage

Y-BOCS 16
SCL +0.06
TPB-S 0.98

63 Tage

fMRT 1.5 T p<0.005

fMRT 1.5 T p<0.005

fMRT 1.5 T p<0.005

fMRT 1.5 T p<0.005
Neuromodulation by noninvasive brain stimulation using principles from synergetics and synaptic plasticity

Psychotherapy with feedback and support by the Synergetic Navigation System

Neuro-Feedback by Real-Time functional MRI

The future of synergetics in an integrated neuro-psychological systems medicine