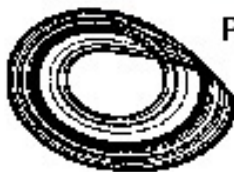


# Nonlinear Dynamics, Psychology, and Life Sciences



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## SPECIAL ISSUE: CLINICAL PSYCHOLOGY AND PSYCHOTHERAPY

David Pincus, Guest Editor

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*pp. 1-15.*

### Clinical Psychology at the Crossroads: An Introduction to the Special Issue on Nonlinear Dynamical Systems

David Pincus, Chapman University, Orange CA

**Abstract:** This introduction to a special issue of Nonlinear Dynamics, Psychology and Life Sciences discusses the contributing articles within the issue from a variety of perspectives. This analysis examines each article's contribution to understanding the self, and to exploring the application of innovative nonlinear methods to clinical questions. Moving beyond the special issue, the analysis examines the role of nonlinear science in clinical psychology from the perspective of Aristotle's four types of cause: material, efficient, formal and teleological. It is suggested that nonlinear science is particularly well-suited to empirical science aimed at understanding formal (i.e., systemic), and teleological (dynamical) causes. The strength of nonlinear dynamical systems methods in addressing formal and teleological cause could help bridge the gaps in understanding clinical phenomena using the medical model, which focuses primarily on material and efficient causes. Finally, a list of the top ten nonlinear dynamical systems concepts is presented with the goal of direct applications that may be useful for clinicians.

*pp. 17-56.*

### Nonlinear Indices with Applications to Schizophrenia and Bipolar Disorder

Colleen D. Cutler and Richard W. J. Neufeld, Western University, London, ON, Canada

**Abstract:** In this article we study the application of nonlinear indices (sometimes called complexity indices) to univariate time series data arising from studies of schizophrenia and bipolar disorder. Specifically, we consider time series arising from EEG studies, ECG studies, and self-report mood data. As part of our analysis, we empirically examine the claim in the literature that complexity tends to be higher in the EEG of schizophrenia patients than controls and that this tendency is dampened or even inverted by medication, increasing age, and reduced symptomatology. Our conclusion is that this claim is only partially supported and propose that symptomatology, specifically the presence or absence of schizophrenia "deficit syndrome," may be the most important factor. Results are more consistent in ECG studies in which reduced heart rate complexity is observed in both schizophrenia and bipolar disorder. The applications of nonlinear indices to the effects of antipsychotic medication and the discrimination of mood states are also examined. It is concluded that the monitoring of nonlinear indices may be useful in predicting response to medication and predicting onset of specific mood states.

pp. 57-78.

## Fractal Self-Structure and Psychological Resilience

**David Pincus**, Chapman University, Orange, CA, **Oto Cadsky**, University of Alberta, Edmonton, AL, Canada, **Vincent Berardi**, **Catherine M. Asuncion**, and **Katheryn Wann**, Chapman University, Orange, CA

**Abstract:** Since the mid 1980's, mainstream social psychology investigations of self-complexity and psychopathology have produced contradictory results. These results are likely the result of a lack of theoretical and methodological grounding in complexity theory. The current study proposes that the self has an interconnected fractal structure, and that this structure may be reflected within inverse-power law (IPL) distributions of response times to self-related questions. MMPI-2 item response sets ( $N = 300$ ) were selected from a larger pool of 1,881 forensic administrations. Self-complexity was operationalized as the inverse of the shape parameter ( $\beta$ ) of the frequency distribution of reaction times to MMPI-2 items ( $n = 567$ ) for each participant. It was predicted that: (a) these distributions would generally have strong fits with IPL distributions; and (b) that  $\beta$  would tend to be correlated with pathology among the MMPI-2 scale scores. The results confirmed that the response-time distributions tended to fit IPLs (mean  $R^2 = .94$ ; range: .64 to .99). Furthermore, 18 of 45 correlations between  $\beta$  and MMPI-2 scale scores associated with pathology were statistically significant, suggesting that rigidity in fractal self-structure is associated with broadband psychopathology. A follow up principal components analysis of the 45 individual scale scores across the participants confirmed this conclusion, producing three latent components, each of which was significantly correlated with  $\beta$ , and each of which had a broad variety of scales with factor loadings  $> |.5|$ . These results may provide a first step toward a practical complexity-science approach to measuring the structural resilience of the self, and viewing the self as a complex self-organizing system.

pp. 79-112

## A Nonlinear Dynamic Systems Model of Psychotherapy: First Steps Toward Validation and the Role of External Input

**Helmut Schöller**, **Kathrin Viol**, **Hannes Goditsch**, **Wolfgang Aichhorn**, Paracelsus Medical University, Salzburg, Austria, **Marc-Thorsten Hütt**, Jacobs University Bremen, Germany, and **Günter Schiepek**, Paracelsus Medical University, Salzburg, Austria

**Abstract:** Mathematical modeling and computer simulations are important means to understand the mechanisms of psychotherapy. The challenge is to design models which not only predict outcome, but simulate the nonlinear trajectories of change. Another challenge is to validate them with empirical data. We proposed a model on change dynamics which integrates five variables (order parameters) (therapeutic progress or success, motivation for change, problem severity, emotions, and insight) and four control parameters (capacity to enter a trustful cooperation and working alliance, cognitive competencies and mindfulness, hopefulness, behavioral resources). The control parameters modulate the nonlinear functions interrelating the variables. The evolution dynamics of the system is determined by a set of nine nonlinear difference

equations, one for each variable and parameter. Here we outline how the model can be tested and validated by empirical time series data of the variables, by time series of the therapeutic alliance, and by assessing the input onto the system as it is perceived by the client. The parameters are measured by questionnaires at the beginning and at the end of the treatment. A key element of the validation algorithm is the adjustment of the parameter values as assessed by the questionnaires to model-specific parameter values by which the dynamics can be reproduced (calibration). The validation steps are illustrated by the data of a client who used an internet-based tool for high-frequency therapy monitoring (daily self-ratings). Especially after applying the input vector (interventions as experienced by the client) the similarity between the empirical and the model dynamics becomes evident. The averaged correlation between the empirical and the simulated dynamics across all variables is .41, after applying a short averaging mean window and eliminating an initial transient period, it is .62, varying between .47 and .81, depending on the variable. The discussion opens perspectives on the combination of mathematical modeling with real-time monitoring in order to realize data-driven simulations for short-term predictions and to estimate the effects of interventions before real interventions are applied.

pp. 113-135.

## Monitoring Nonlinear Dynamics of Change in a Single Case of Psychodynamic Play Therapy

**Sibel Halfon**, **Alev Çavdar**, Istanbul Bilgi University, Istanbul, Turkey, **Giulia Paolini**, **Silvia Andreassi**, Sapienza University of Rome, Italy, **Alessandro Giuliani**, Italian National Institute of Health, Rome, Italy, **Franco F. Orsucci**, University College of London and NCU Italian, University, London, UK, and **Giulio de Felice**, Sapienza University of Rome, Italy and NCU Italian University, London, UK

**Abstract:** A systematic single case study with a mixed quantitative and qualitative methodology was conducted to investigate the nonlinear dynamics of change in play profiles of a child in psychodynamic play therapy. The first aim of the study was to cluster the different features of play characteristics (i.e., descriptive, cognitive, affective, and social characteristics of play, and the defensive strategies used in play) in order to construct the different play profiles of this child, and secondly to assess the transitions between profiles over the course of treatment. It was expected that there would be an increase in critical fluctuations during the transitions between the profiles and an increase in the variability of play profiles. Results showed that the child's play characteristics clustered into eight states and three attractors. The Markov Transition Matrix showed how play profiles evolved over time. Entropy analyses comparing the first and the second half of therapy showed an increase in variability. Qualitative analyses indicated the importance of expression of the child's underlying fear, and its integration with overt anger in the generation of the new play profiles. The results indicate an increase in variability, and a destabilization of old play profiles that were used towards generating new play profiles.

pp. 137-171.

## The Temporal Dimension in Maternal Sensitivity Predicting Organized Attachment in Children

**M. Angeles Cerezo, Gemma Pons-Salvador, Rosa M. Trenado**, University of Valencia, Spain, and **Purificación Sierra-García**, National Distance Education University, Madrid, Spain

**Abstract:** This study analyzed Maternal Sensitivity in the interaction of mother-infant dyads to distinguish different dynamics associated with their attachment group membership – Insecure-Avoidant (A), Secure (B), or Insecure-Resistant (C), with no Disorganized traits – that they developed at 15 months. Participants were 26 eight-month old infants interacting with their mothers in a free-play setting. The analyses used sequential streams of infant actions and maternal responses, and state-space grids to study the temporal organization of the sequences. We examined appropriateness and promptness of the maternal response to infant behavior and a dynamic analysis of the interactive process. In Group B, when the antecedent behavior was infant social approach, the appropriateness of the maternal profile (sensitive vs. intrusive responses) was related to their children’s subsequent security. However, how promptly mothers responded was not predictive. Conversely, when the antecedent behavior was infant play, how promptly the mothers responded was associated with securely attached children while mothers’ profile of appropriate responses did not distinguish the subsequent quality of attachment. The indices derived from state-space grids were associated with attachment type and distinguished Group C from Groups B and A. However, results from analysis of a specific region of states, “maternal interfering response to infant social approach,” showed significant discriminant function that correctly classified 78% of Group B, 73% of Group A, and 83% of Group C. Group B infants received less intrusive behavior than their counterparts, and when they did, it involved positive affection or playfulness. Finally, regarding attractors, although more Group B dyads showed multi-stability of coexisting attractors, than Groups A or C, the differences were not statistically significant.

pp. 173-176.

## Nature’s Fractal Similarities: Integrating Art and Science

**Richard P. Taylor**, University of Oregon, Eugene OR

**Abstract:** This year’s cover artist, Clinton Marstall, creates fractal imagery by photographing natural patterns. He then uses a pen to highlight the patterns and projects them on to a canvas for painting. Using this precision technique, he integrates a number of biomorphic images into a unique amalgam of multi-scaled complexity.

