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Dave Pincus 2011
Conference Chair

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Alphabetical List of Authors & Conference Abstracts*

Gaetano L. Aiello, Universita di Palermo, Italy

Sleep Stages as Bifurcations at the Edge of Chaos

It has been shown (Aiello, 2011) that a sparsely connected random network can support a variety of behaviors (modes), from periodic oscillations to chaos, depending on the choice of the degree of connectivity. Numerical results show that the transitions between modes is discrete, corresponding to bifurcations. In particular, near-chaos bifurcations closely mimic the transition from low-conscious to fully conscious brain states, typical of sleep stages, thus enforcing the cognitive content of chaos in neuronal assemblies.

Loretta Bolyard, David Schuldberg, Jordan Pauli, Michael Kavanaugh, University of Montana

Search strategies and trajectory dynamics in the maze swimming of cannabinoid knockout and control mice

This paper describes research using two approaches to characterizing learning and search strategies in the maze swimming behaviors of two groups of mice. Control mice and mice genetically altered to lack the cannabinoid-1 receptor (CB1R-/-) were tested in the Morris Water Maze (MWM). The CB1R receptor, which is activated by the exogenous cannabinoid THC, is likely the most abundant G protein-coupled receptor in the mammalian brain. Several lines of evidence support its role in cognition. CB1R agonists disrupt learning and memory in a variety of paradigms, including the MWM. Conversely, mice treated with an antagonist, and CB1R-/- mice, exhibit enhanced learning and memory in other tasks. Interestingly, several authors demonstrate that CB1R-/- mice do not have facilitated learning in a MWM spatial acquisition task. To characterize further the role of CB1R in acquiring the location of a hidden platform, we analyzed search strategies and path dynamics of CB1R-/- and control mice. Similar to previous findings, CB1R blockade does not alter variables commonly associated with spatial acquisition. Analyses of search strategies indicate that CB1R-/- mice employ fewer spatial strategies when locating the platform (instead using more non-spatial systematic and repetitive looping strategies) over time, with significant differences on days five through seven. Follow-up analyses characterized the variability and wobbliness of swim paths during the post-acquisition trials with a variety of traditional and nonlinear indices. Initial results suggest that CB1R-/- mice employ suboptimal search strategies, which may not be directly related to learning and memory processes.

Lucia Ceja, IESE Business School, University of Navarra**, Jose Navarro,** Social Psychology Department, University of Barcelona

Understanding the dynamics of employee well-being: a comparison of linear versus nonlinear models of flow during work and non-work activities

The present study examines the application of a cusp catastrophe model to modeling flow during work and non-work activities by comparing it to a more traditional linear approach (i.e., hierarchical linear modeling) on a sample of 60 workers. Employees perceptions of challenge and skill regarding work and non-work activities and their subjective experience in terms of enjoyment, interest and absorption were assessed using the experience sampling method obtaining a total of 6981 observations. According to the R2, AIC and BIC indexes, the cusp model doubled the predictive capacity

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compared to its linear counterpart (e.g., in terms of R2 the cusp model explained 42% of the variance versus 19% explained by the linear model during non-work activities; likewise at work, the cusp model accounted for 44% of the variance versus 33% explained by its linear counterpart). Our results demonstrate that in both work and non-work contexts, flow presents nonlinear dynamics that combine gradual and abrupt changes. Moreover, research and intervention efforts interested in the process of flow should focus on the variable of challenge (i.e., the bifurcation parameter), which according to our study, is key to understand the complex dynamics of flow.

Francesco Ceresia, Department of European Studies, University of Palermo

The psychosocial and economic consequences of the online poker phenomenon in Italy. A system dynamics approach

This paper is focused on the psychosocial and economic consequences - at a community level of analysis - of the online poker phenomenon in Italy, adopting the system dynamics approach. The cause and effect structure that determine the dynamic of the considered system is depicted. The main goal of this study is to show that: (1) the online poker phenomenon can be represented by a causal loop diagram (CLD), where the cause and effect links between the main variables of this phenomenon are characterized by nonlinear and delayed relationships; (2) the structure of the online poker phenomenon causes some counterintuitive behaviors that are able to remove the positive economic effects expected by national government; (3) the national government could use a system dynamics model as an interactive learning environment to better understand the complexity of the online poker as a social system and to adopt public policy to effectively counteract its undesired consequences. One of the main conclusion of this research is that, despite the policy statements set by the governmental authorities, the online poker national regulation set by gambling public commissions are quite far from keeping these game fair and operators honest, whereas they are stressed on the exponential growth of the online poker national system, to achieve short-term economic goals.

Xinguang Chen, Wayne State University

Substance-Dependence as a self-organization system in a population Data from National Survey on Drug Use and Health

Self-organization is the process by which a structure or pattern develops in a system without an external or central force imposing it through purposeful planning. Self-organization as a systems theory has been used in describing many processes, but no reported study has examined if substance dependence in a population also manifest certain characteristics of self-organization. Using data from the National Survey on Drug Use and Health (NSDUH, a national representative sample), we assessed if addiction to multi-drugs in a population reveals any characteristics of self-organization. Data included in the analysis contained 43884 subjects, 47% were male, 37% youth (<18 years of age), and 67% were whites. Among the total sample, 43884 (81.2%) were not addicted to any substance. As the number of addicted substances increased from 0 to 2, the frequency dropped rapidly. The frequency progressively declined as the number of addicted substances further increased. Only one person in the sample was addicted to all substances. The same pattern for the total sample was observed for subgroups by age, gender and race. All the curves fitted exponential model well (R2 varied 0.91 to 0.98). Findings of this study suggest that the development of substance addiction in population show some characteristics of self-organization, forming a dissipative system. The existence of exponential distribution of the number of substances to which a person is addicted implies that addictive behaviors in a population tend to follow the small world model. Further research is needed to examine mechanisms behind this phenomenon to support evidence-based policies for more effective substance use prevention.

Arianna Dal Forno, Ugo Merlone, Statistics and Applied Mathematics Department, University of Torino

Basic Assumptions in Small Groups: A Mathematical Model

According to several authors Bion's contribution has been a landmark in thought and conceptualization of the unconscious functioning of human beings in groups. In this paper we provide a mathematical model of group behavior in which the different members of the group, depending on individual parameters, may behave sharing to different degrees what is in Bion"s theory a common basic assumption. We discuss a formalization which combines both individual characteristics and group dynamics. The state of each individual depends on both the group state and each individual"s valency for the basic assumption. By this formalization it is possible to analyze the group dynamics as the result of the individual dynamics of the members and prove that, under some conditions, each individual dynamics reproduces the group dynamics. In particular, the chaotic behavior that the group may exhibit is reflected in each member of the group. In this cases we are able

to provide conditions under which the nonlinear dynamics of the group becomes chaotic.

Arianna Dal Forno, Ugo Merlone, Statistics and Applied Mathematics Department, University of Torino

Effort dynamics in supervised work groups with envious subordinates

In the recent literature the dynamics of effort allocation in supervised work groups has been examined. In particular the consequences of the perception of inequity has been analyzed in terms of efficiency. In this paper we consider a model of supervised work group and introduce an incentive scheme in which subordinates are compensated according to their capacity and therefore their monetary compensation may be different. In the economic literature some authors model envy assuming that agents exhibit aversion towards disadvantageous inequity in monetary payoffs. As a consequence, the result of this incentive scheme is that the lower capacity subordinate may perceive envy towards the other subordinate. We analyze the effort allocation dynamics when the lower compensation subordinate alters his effort allocation as the result of envy. Our results show that, while on one side envy makes the dynamics less complex, on the other side it may decrease the allocation efficiency. Furthermore, when envy is excessive it may drive the efficiency to zero since the group production becomes null.

Steve Davidson, Private Practice

Is the mind subject to causality? A chaos-based answer.

With regard to the mind, science faces a paradox. The brain is a neurochemical system, and, at the molecular level clearly conforms to the concept of causality . However, phenomenologically, the mind does not seem subject to causal forces . People experience their minds as decision processes which evaluate outside influences and arrive at personal choices. This talk will attempt to resolve this causal-non-causal paradox via the concept of chaos. The following points will be touched upon: 1) the brain is the neurochemical platform that supports the experience of mind. 2) The brain/mind is infinitely complex. 3) That infiniteness introduces the element of chaos into considerations of the brain/mind. 4) As a chaotic phenomenon, the brain/mind is only minimally subject to the twin operational polestars of science prediction and control. 5) Therefore it can be proposed that causality, in the conventional sense of predictable and controllable point-for-point impact and response, is largely irrelevant in regard to the brain/mind, since the brain/mind is chaotic, versus mechanistic. 6) Clinically, that degree of nonlinear complexity renders partially inapplicable conventional notions of diagnosis, treatment, and problem-solving, since these concepts largely rest on finite, mechanical, non-chaotic premises.

Cedric Dawkins, California Polytechnical Institute Pomona.

Issue Management as a Nonlinear Dynamic Process

How are businesses to construe the maelstrom of events surrounding access to HIV/AIDS drugs in Africa that resulted in the pharmaceutical industry being assailed as morally bankrupt? The study of issue management an anticipatory, strategic process that helps firms detect and respond appropriately to gaps in stakeholder expectations and corporate practices is often premised on linear, Newtonian notions of institutional theory. Issue management is, however, nonlinear and the stages of institutional change are largely artifactual. That is, NDS principles generate the social artifacts described by institutional theory. Hence, I employ a case study of the pharmaceutical industry response to HIV/AIDS in Africa to propose an NDS-based model of issue management: (a) stakeholder pressure causes internal dissonance (i.e., turbulence), (b) issue attractor provides an alternative structuration to a bifurcated industry, (c) as firms gravitate toward the issue attractor, symmetry-breaking events evince the emergent consensus, and (d) coalescence around new structuration. A key implication is that issue trajectory can be determined by sensemaking centered on the fractal structure of the issue narrative (i.e., stakeholder statements, actions). In fractal analysis issue trajectory is not indicated solely by the influence of a single stakeholder or even the number of stakeholders, but by iteration, the reproduction of themes at different levels (i.e., grass roots, group, societal) or dimensions (i.e., political, social, moral) of the issue narrative. Because issue response attractors operate at the edge of chaos, they are less institutionalized, favorably predisposed toward innovations that disrupt the prevailing structuration, and unwitting purveyors of fractal analysis.

James Devine, Loyola Marymount University.

The Great Moderation and "Falling Off a Cliff": neo-Kaldorian dynamics

Following the broad outlines of Kaldor (1940), we develop a simple non-convex Keynesian macroeconomic model. This "catastrophe theory" model has two stable short-run equilibria, achieved by expectations adjustment; shifting curves in the medium run can cause a jump from high employment equilibrium to stagnation.

Such a fall can arise from endogenous declines in the demand/debt ratio occurring after persistent periods of high employment (cf. Minsky, 1982; Kalecki, 1933). We thus provide an explanation of the U.S. economy falling off a cliff perhaps as seen during 2007-9 as being due to the Great Moderation of 1985 2006; this interpretation is made more plausible by reference to empirical data. The model also allows for milder fluctuations. The model s asymmetries suggest the need for pump-priming by policy-makers to allow recovery after a steep recession. To understand the process of equilibration, we use a synthesis of the rational and adaptive theories of expectation determination.

A Steven Dietz, Texas State University

Developing Sustainability in a Fractured Society: A Systems look at Afghanistan in 2011

For hundreds maybe thousands or years Afghanistan has been the land ruled by the Strongman. The story (myth) of the strongman underlies much of the conflict, ambiguity and misunderstanding that is being experienced in Afghanistan today. This presentation will discuss the challenges associated with the development of a central government and economy in a country that is divided by warring groups, ethnic prejudice, and criminal activity a country in search of a strongman and stability. To better understand these challenges, several aspects of the current state of Afghanistan will be described including the past and current economic state, infrastructure, and government. Principles from complexity theory will be used to begin to try and identify friction and dissonance between groups, including international groups and how these relate to conflict and the inability of Afghans to find their strongman.

Caroline Fielden, Psychology, University of Sydney

Gray's Reinforcement Sensitivity Theory: A Dynamic Systems Perspective

Gray s Reinforcement Sensitivity Theory (RST) has been described as a biological theory of personality (Jackson, 2003). However, while taking biological mechanisms as its foci, Gray and McNaughton (2000) ultimately discuss personality in terms of complex and dynamic relationships between both biological and situational variables. Personality is thus defined in terms of individual differences in the way that biological elements respond to situational factors across time (Bijttbier, Beck, Claes & Vandereycken, 2009). This theory, therefore, could be taken to imply a dynamic systems perspective. To this point, however, the theory has not been explicitly modelled in accordance with such an approach. Moreover, an examination of the theory from this perspective reveals a coherent and testable model. It is anticipated that when tested, this model will support the redefinition of traits as complex systems of biological and situational factors that develop across time. This presentation demonstrates both a theoretical framework, and empirical plan for the testing of RST from a dynamic systems perspective.

Barbara Bruhns Frey, independent Consultant,
Salt Lake City UT

Examining nonlinear dynamical measures across training, stimulus interval and task difficulty

As individuals receive training, response times hasten and accuracy typically improves. This has led to the assumption that training can reduce processing demands. This presentation examines the use of nonlinear dynamical measures to detect trial-to-trial structure reflected in the reduction of processing demands via training. Additionally, the assumption of trial timing and its potential impact on nonlinear dynamical analysis is examined. Each participant"s response times on simple two-choice tasks are treated as a time series and submitted along with two comparisons to nonlinear dynamical measures. Across two experiments, three experimental variables are manipulated: training, stimulus interval and task difficulty. Estimated dimensionalities and maximal Lyapunov exponents are significantly lower in the observed in contrast to the comparison time series. Both measures reduce with increasing practice. Of the two methods for controlling stimulus rate, response-stimulus-interval and inter-stimulus-interval, the latter resulted in more significant differences across the nonlinear dynamical measures.

Victoria Gaetan, University of Central Oklahoma

Dynamical Systems Model of Social Power

Social psychological research on social power is plagued by theoretical fragmentation. Theories on social power differ in focus on level of analysis, varying from intrapersonal, interpersonal, and intergroup (ranging in group size from the dyad to society). Studies investigating social power focus on the differences in the powerful and powerless in one of three areas: perception, cognition, or action. Focus areas are driven by different theoretical views. These differences produce a lack of cohesion in scientific findings. Dynamical systems theory (DS) provides a theoretical framework to unify social power research. The complexity surrounding the organism and context in the study of social power is daunting to a scientist using linear models. The best explanatory and predictive behavior comes from a model that fits the issue. Dynamical systems provide a dual coupling model with the organism and the environment

interacting as a single system that fits the complexity of social power. The purpose of the current study is to establish DS model of social power where the dynamic variable (person performance) differs based on the level of perceived social power afforded by the person-environment interaction system. The current study established an action-scaled ratio of social power, where perceived affordance and subsequent performance is constrained by the perceived sense of power of the individual. Cognition and action are not separate, but a continuous, simultaneous feedback loop that reinforces itself to follow an attracted trajectory. Individual behavior differed over time at similar values of sense of power and ascending or descending difficulty.

Robert Galatzer-Levy, University of Chicago.

The nonlinear clinician

An ever enlarging body of NLDS studies addresses issues of psychoanalysis and psychodynamic psychotherapy. These conceptual contributions tend to interdigitate with and be supported by clinical developments in these fields, such as the emphasis on emergent qualities, appreciation of the patient-therapist dyad as a natural system for study, and the importance of sensitivity to initial conditions in the evolution of psychological processes. Existing practice is thus theorized in terms of NLDS concepts. However, the impact of NLDS thinking for clinical practice (i.e., how clinical practice might be changed by virtue of nonlinear thinking) has only been described to a limited extent, and the means by which this practice is influenced by NLDS concepts is itself complex. In this paper, I briefly outline the continued pervasive influence of late 19th century concepts of scientific explanation on clinical practice to the present day and outline clinical developments that transcend that tradition, despite lacking an adequate conceptual underpinning. I then show, through a variety of examples, how an NLDS conceptualization changes traditional psychodynamic psychotherapy practice in such areas as the analyst s activity, the selection of interpretation and the analyst s focus. I then demonstrate how immersion in NLDS concepts leads the analyst to think differently and distinctively from the manner in which he might proceed based on traditional psychoanalytic formulations and discuss how the (often implicit) integration of concepts into analysts thinking has the potential to transform the clinical practice of psychodynamic psychotherapy and psychoanalysis.

Stephen J. Guastello, Anthony F. Peressini, Robert W. Bond, Jr., Marquette University

Orbital Decomposition for Ill-Behaved Event Sequences: Transients and Superordinate Structures

Time series analysis is often challenged by the presence of transient functions. We examined some types of transients found in time series of events that lend themselves to symbolic dynamics analysis through the method of orbital decomposition, which is based on the principle that chaotic series arise from coupled oscillators. Synthetic data sets were constructed to study the impact of intrusive events, intrusive series, merged functions, non-coupled oscillators, and driving oscillations on the patterns of final statistics obtained from orbital decomposition analysis. Two real-world data sets a logbook of the ritual behaviors of a patient with obsessive compulsive disorder and a time series of kill dates from an infamous serial murderer were examined for non-ergodic properties similar to those found in the synthetic data.

Stephen J. Guastello, Henry Boeh, Michael Schimmels, Hillary Gorin, Samuel Huschen, Erin Mathys, Natalie Peters, Meghan Fabisch, Kirsten Poston, Marquette University

Cusp Catastrophe Models for Cognitive Workload and Fatigue in a Verbally-cued Pictorial Memory Task

The effects of cognitive workload and fatigue on performance are well-recognized in the human factors and ergonomics literature, but separating their effects remains a challenge. A viable theoretical framework for doing so involves the use of two cusp catastrophe models one for fatigue and one for workload. They have similar structures, but derive from different underlying dynamics. Contributing variables play different roles in each model. The research program is centered on the search for variables that contribute to flexibility with respect to load and identifying the compensatory variables associated with fatigue in different types of tasks. In this experiment 129 undergraduates performed a series of tasks involving spelling, arithmetic, episodic memory, and verbally-cued pictorial memory. Results supported the fatigue cusp for the main memory tasks with the quantity of work performed acting as the bifurcation parameter and performance on episodic memory acting as the asymmetry parameter. The load manipulations that were applied to the pictorial memory task were competition with another participant for rewards and time pressure. Results supported the cusp model for work load; the bifurcation variables was trait anxiety, and the asymmetry variable that corresponded to increased load was an incentive manipulation.

Eric Hessler, University of Minnesota Duluth

Visual feedback influences relative phase dynamics in motor-respiratory coordination

Coordination between movement and breathing during exercise can be described using relative phase, a measure of the location in the movement cycle relative to the location in the breathing cycle. Stability in that relative phase relation has been identified as being important for aerobic efficiency. The purpose of this experiment was to explore perceptual constraints on relative phase performance using feedback displays. Two balls oscillated upward and downward in a projected image, controlled directly by participants movement and breathing. There were three feedback conditions: control (no visual feedback), inphase feedback (balls moved upward and downward together), and antiphase feedback (balls moved opposite each other). A dynamical procedure called cross recurrence quantification analysis was used to reveal similarities in the structure of reconstructed attractors for movement and breathing. Measures of the amount of shared activity (%REC) and how long parallel trajectories could be maintained (MAXLINE) were calculated. Both measures were lower in the inphase feedback condition than the other feedback conditions. While that dynamical evidence might normally indicate that inphase feedback was a disadvantage, the variable error of relative phase performance was lower in the inphase feedback condition than the other feedback conditions. Inphase feedback provided coherent visual information that made mismatches between movement and breathing perceptually salient. When mismatches were seen, participants used small, within-cycle trajectory changes (e.g., quick jerks in movement) to achieve more stable relative phase performance overall.

Jher, University of Oregon

Metaphi (2010)

This multimedia presentation includes a light-sound intermedia encounter, and dialogues with UO philosopher Colin Koopman and artist Scott Draves. Draves received his Ph.D. from Carnegie Mellon in computer science, and is inventor of critically acclaimed fractal software art. His work is part of the permanent collection at the New York Museum of Modern Art (MOMA). Augmenting this presentation will be an definitional, artifactual (medium), and institutional (Stanford and MIT) overview of metamedia.

DA Katerndahl, SK Burge, RL Ferrer, R Wood, J Becho, Family & Community Medicine, University of Texas Health Science Center, San Antonio, TX. **R Perez,** Family Justice Center, San Antonio, TX. **M Talamantes,** Audie Murphy VA Hospital, San Antonio, TX.

Complementary Nature Of Measures Of Nonlinearity In Describing Intimate Partner Violence

Three theories attempt to explain the dynamics of intimate partner violence, suggesting different dynamic patterns of violence. Yet, few studies assess violence and its potential predictors in realtime, permitting dynamics assessment. The purpose was to estimate the degree of nonlinearity of the violence, determine the pattern of associations between them and measures of violence severity, and assess whether they provide complementary contributions when predicting violence severity. This -month time series study was conducted among adult women in violent relationships. Women completed daily telephone assessments of household environment and marital relationship using Interactive Verbal Response; missing husband-to-wife violence data was imputed using TISEAN software to maintain its nonlinear characteristics. LZ complexity, approximate entropy (ApEn), and largest Lyapunov exponents were used as measures of nonlinearity. Descriptors of household environment included measures of argument frequency, hassles, stress, sense of closeness and upset, and alcohol intake of both partners. Results showed that most relationships varied nonlinearly (based on mean LZ complexity, mean ApEn, and mean Lyapunov exponents). While ApEn was positive correlated with violence frequency and burden, and Lyapunov exponent was inversely related to violence, LZ complexity was only associated with wife-perpetrated violence. Regression analysis found that only ApEn predicted episode severity for men and women, but accounted for little variance. However, all three measures of nonlinearity independently predicted frequency of husband-to-wife abuse. In conclusion, while all three measures of nonlinearity suggested nonlinear dynamics in husband-to-wife violence, each correlated differently with measures of violence severity and independently contributed to frequency of husband-to-wife violence.

Gus Koehler, Time Structures, Inc., and USC Sacramento Center

Disaster Response: Emergent Space-Time Kluges

Disaster Response: Emergent Space-Time Kluges This paper investigates the proposition that disaster response involves creating kluges or patch work combinations of hardware and software to mend local, nested and extended community time-ecology failures. Response kluges produce their own intended and unintended short and long-term consequences. For my purposes, hardware is inclusive, extending to social and physical evolving artifacts; software includes the definition, organization, evolution, and manipulation of information be it digital or not. A disaster time-ecology is presented that seeks to show how the hardware and software of the disaster management process and a disaster are dynamically co-embedded. This includes how each is situated relative to the depth of the disappearing past, the crowded and confused present, and a vague chaotic future. Unexpected bifurcations, cusp catastrophes, and

other complex system events and characteristics throughout the time-ecology drive suddenly unexpected emergent reorganizations of the evolving disaster, including response interventions, with immediate and long-term consequences. It is due to these continuous disruptions that the disaster response produces kluges and not definitive answers. The presentation has implications for disaster research, responder training, and recovery. Illustrative pictures, maps, and graphs are drawn from the Japan and Sumatra Indonesia Tsunamis, the Sacramento River Metamsodium Spill, and the Los Angeles Civil Disturbance.

Aaron Likens, Arizona State University
Mickie Vanhoy, University of Central Oklahoma

Multifractal Eye Movements in Visual Search

Multifractals indicate a level of complexity that may manifest as apparent randomness despite having come from a deterministic process. Untransformed data from eye movement studies of visual search can produce random-looking plots but further analysis may reveal fractal microstructure. If eye movements in visual search are non-random, then some detectable pattern should emerge from the computation of their fractal dimensions and attractor strengths, whether that result is non-fractal (an integer dimension), a monofractal (a constant fractional dimension), or a multifractal (multiple fractional dimensions). We chose a well-known nonlinear time series method to search for multifractals in visual search data. Wavelet transform modulus maxima (WTMM) is an algorithm for detecting multifractals in time series data by tracking fractal dimensions in a waveform. WTMM transforms a discrete time series into a continuous one, computes similarity coefficients between successively larger sections of the waveform and an expected shape over many scales, and flags local maxima at each scale. The local maxima (also called singularities or attractors) and their Hurst exponents index the strength of the attractor at that scale. The output of WTMM is the dimensionality of each attractor (Hausdorff's D) and h, the attractor's strength or persistence (Hurst exponent). Monofractal data produce one data point but multifractals produce a spectrum. Although monofractals have appeared in eye movements before, visual search may be more complex still. Multifractal eye movements appeared in all participants across three experiments, i.e., the fractal dimension by attractor strength plots revealed the characteristic multifractal spectral arc for every participant.

Magnus Magnusson, University of Iceland, Reykjevik
Curt Sandman, University of California Irvine
Aaron Kemp, University of California Irvine
Judee Burgoon, U. of Arizona & U. Oklahoma
Amy Dix, University of Chicago
Susan Duncan, University of Chicago
Daniel Loher, The MITRE, Corporation
Alister Nico, University of Cambridge
Anne Segonds-Pichon, Babraham Institute, University of Cambridge
David Pincus, Chapman University

Symposium: **Temporal Statistical Pseudo-Fractals, Translation Symmetry and Syntax: The T-system and the Detection of Hidden Temporal Structure in Behavior and Interactions**

Magnus Magnusson presents the T-system, a set of related concepts for the description and detection of often hidden patterns within continuous real-time streams of numerous kinds of behavioral and/or environmental events. A special interval relationship, relating a pair of (time) point series underlies the definition and detection of the central t-pattern type (apparently a particular statistical pseudo-fractal). T-patterns are often invisible even to trained observers under ideal conditions, but the especially developed Theme software (Magnusson, 1996, 2000) has allowed the detection and analysis of complex t-patterns in many kinds of human, animal, and even neuronal behavior (Nicol et al, 2005) and on DNA molecules. Syntactic structure and symmetry come increasingly into focus. While centered on the repeated, temporally and sequentially constrained self-similar t-patterns, the T-system also involves non-sequential (T-packets) and non-repeating (T-composition) time patterns, which are also defined and illustrated, while the applications presented concern self-injurious behavior or SIB (C. Sandman, A. Kemp, M. Magnusson & D. Pincus), the structure and evolution of strategic human interactions (A. Dix, S. Duncan, D. Loehr, & J. Burgoon), and structure and function in neuronal interactions (A. Nicol, M. S. Magnusson, Anne Segonds-Pichon). Curt Sandman presents the paper on self-injuring acts, which are among the most dramatic behaviors exhibited by human beings, but have no known cause and no agreed upon treatment. Behavioral T-pattern detection with Theme has provided alternative descriptions of the initiation and maintenance of self-injury. The data was time stamped occurrences of twenty behavioral and environmental event-types recorded during forty hours of observations of 32 subjects within a two-week period. Many behavioral/environmental patterns were associated with self-injurious events contributing to more patterns and to more complex patterns. Moreover, self-injury left its imprint on the organization of behavior even when its occurrences were removed from the data. Self-injuring acts may function as singular points, increasing

coherence within self-organizing patterns of behavior. Amy Dix presents a Theme t-pattern analysis comparing early and late, six-minute-long intervals in a corpus of three-person, game-playing interactions requiring cooperative decision-making. Each team member had different information about the game scenario; one was instructed to mislead, one was told that one of the others would mislead, and the third was naïve to these manipulations. A variety of verbal and nonverbal behaviors were coded from videotapes. Higher numbers of patterns of verbal and nonverbal behaviors were detected in the later game intervals including more multi-party interactive patterns. Patterns are discussed that characterized the deceptive, suspicious, and naïve game participants, respectively, and interpersonal communication and deception as dynamically evolving processes. Alister Nicol s presentation suggests that coordinated activity amongst multiple neurons may encode sensory information much more effectively than single neuron activity measurements as spike-timing in neuronal networks underpins numerous theories of neuron function. While the detection of such patterns in large populations of highly interconnected neurons has proved elusive, T-Pattern analysis of microelectrode data from the rat olfactory bulb reveals considerable order and conveys information on internal state and sensory environment. - *David Pincus is a discussant at the symposium.*

Terry Marks-Tarlow, Private Practice,

Cracked Orlando: *Dramma per musica e frattali*

Perhaps because fractals are the geometry of nature as Mandelbrot so boldly declared, they also abound in art. Along with photographs of nature, self-similar structures in architecture, and the drip paintings of Jackson Pollack, I announce a new opera added to the list of art inspired by fractal geometry. The composer is a Julliard teacher named Jonathan Dawe who puts fractals in his music. I am the librettist who put fractals in the words using the Fibonacci series to. The result was a new genre of opera, accessible to a broader, more contemporary audience. In this presentation I will explain how I incorporated fractals into the libretto of Cracked Orlando. In addition I will show highlights from the opera s premiere, which included a ballet, as performed mid-October, 2010 at Columbia University s Italian Academy.

Carmel Martin, Atieh Zarabzadeh, **Deirdre Grady**, National Digital Research Centre, Dublin
Yvette Graham, Computer Science, Trinity College, Dublin
Enda Madden, Groupnos Technologies, Dublin
Lucy Hederman, Computer Science,Trinity College, Dublin
Kevin Smith, National Digital Research Centre, Dublin
Carl Vogel, Computer Science,Trinity College, Dublin

Using patient trajectories to develop clinical support systems for repeat hospitalizations.

Objective: To support clinical decision making in order to identify and categorize health and social deteriorations preceding repeated hospitalizations. Methods: A case study. Semi-structured telephone interviews 2-5 times per week provide longitudinal patient (or caregiver) narratives about everyday health and socio-environmental concerns and health service use. Interview data assessed by the clinical team provides information to classify patient journeys as stable or unstable using the Cynefin organizational framework. The clinical team detected and acted upon deterioration risks identified as red flags for unstable trajectories. Participants: 58 patients identified as being at risk of avoidable hospitalization consecutively identified from a regional primary care database, monitored for an average of 20 times over 30 days in intervention and control cohorts. Findings: Assessment of 1200 patients brief phone interviews by the clinical team detected red flags, when acted upon were associated with reduced hospitalizations by 35% in the intervention cohort. However recurrent poor health, hospitalization and death were noted in 5% of cases despite interventions, apparently exhibiting complex or chaotic dynamics. Methods will be developed to enable the prediction of unstable trajectories significantly above chance and to develop adaptive clinical intrventions.

Stephen Merrill, Marquette University,

Cost of failure to treat autoimmune thyroiditis in thyroid cancer initiation and growth

In the most common cause of hypothyroidism, autoimmune thyroiditis, low thyroid hormone (T4) results in high levels of the controlling hormone TSH. This hormone acts to both encourage thyroid nodule development and drive their growth. In this talk, using a nonlinear deterministic model of the production of the T4 and TSH in the presence of autoimmune thyroiditis (Hashimoto s disease), a stochastic model of the initiation and the growth of follicular cancer in the thyroid is developed. The question here is to examine the difference in the development of this cancer and

growth with and without treatment of the underlying hypothyroidism.

Kent D. Palmer, Orange, CA

The Robustness of Special Systems Theory and Emergent Meta-Systems Metatheories

A new advanced systems theory concerning the emergent nature of the Social, Consciousness and Life based on Mathematics and Physical Analogies is presented. This meta-theory concerns the distance between the emergent levels of these phenomena and their ultra-efficacious nature. The theory is based on the distinction between Systems and Meta-systems (Openscape Environments). We first realize that we can understand the difference between the System and the Meta-system in terms of the relation between a Whole greater than the sum of the parts and a Whole less than the sum of its parts, i.e. a whole full of holes (like a sponge). Once we understand this duality and clarify the nature of the organization of the Meta-system then it is possible to understand that there is a third possibility which is a whole exactly equal to the sum of its parts like perfect numbers. In fact there are three kinds of Special System corresponding to the perfect, amicable and sociable numbers. These are all equal to the sum of their parts but with different degrees of differing and deferring. All other numbers are either excessive or deficient in this regard. The Special Systems are based on various mathematical analogies and some physical analogies. But the most important of the Mathematical analogies is with the hypercomplex algebras which include the Complex Numbers, Quaternions and Octonions, with the Sedenions corresponding to the Emergent Meta-system. The Emergent Meta-system is a higher order global structure that includes the System with the three Special Systems as a cycle. There is an additive relation between the System and the Special Systems that produces the Meta-system which appears as this cycle. The Special Systems are a meta-model for the relation between the emergent levels of Consciousness (Dissipative Ordering), Autopoietic Symbiotic (Living), Social (Reflexive).

David Pincus, Chapman University

Complexity Science in the Future of Behavioral Medicine

Complexity science offers a new, broader paradigm for understanding complex medical conditions, characterized by the nonlinear and dynamical interactions of a variety of biopsychosocial factors. Examples of such conditions include type-II diabetes (DT2), overweight, pain, and anxiety-depression spectrum (ADS) disorders, each of which have proved difficult to manage in traditional models of care, and difficult to understand through the lenses of reductionism and materialism. By contrast, complexity science offers a variety of models and methods that are better suited to handling such situations involving formal (e.g., patterned) causal processes, and even in some cases teleological causes, defined most simply as trajectory effects. A few specific research models from nonlinear dynamics (e.g., time-series, network, and catastrophes) will be presented as a roadmap toward a more integrated understanding biopsychosocial resilience, illness, and recovery from complex conditions. Finally, the merging of the field of behavioral informatics with complexity will be suggested for the development of novel interventions in behavioral interventions, such as the use of smart phones for tracking health behaviors and delivering strategic, real time, information-based interventions.

David Pincus, Chapman University

Experiential Balancing Therapy

Experiential Balancing Therapy (EBT) is an integrative approach to psychotherapy based on complex adaptive systems (CAS) theory. The approach combines theoretical constructs and techniques from cognitive-behavioral (including third wave behavior therapies), client-centered, and the vast array of psychodynamic approaches under the more general rubric of experiential therapy. As the name suggests, EBT aims directly at assisting clients to obtaining optimal experiential balance structural integration and flexibility. In simple terms, the role of the therapist is to assist clients in the search for novel information within stagnant, restricted, or disintegrated areas of consciousness. In broader terms, the explanatory emphasis for psychopathology, assessment, and treatment lies primarily with the structural aspects of sensory images underlying: (a) here and now perception, (b) key developmental memories, and (c) teleological content. In addition, treatment outcomes are aimed at building optimal balance (i.e., integrity and flexibility) within and among impacted behavioral, emotional, cognitive or social dynamics. Using CAS, experiential balance rests upon several empirically verifiable assumptions: (1) Biopsychosocial processes are organized as nested hierarchical systems, with fractal (or quasi-fractal) network connections and outputs over time. (2) Adaptive responses within these systems occur through shifts toward rigidity or flexibility, primarily through the biopsychosocial integration function of the hypothalamic-pituitary-adrenal (HPA) axis. (3) Rigidity increases short-term robustness against threats to systemic integrity. (4) Flexibility allows for new growth, connectivity, and systemic integration. (5) Systemic evolution occurs via bifurcation, chaotic transitions, or changes to coupling relations (i.e., connection or linkage) among system elements.

Douglas Preddy, Mickie Vanhoy, University of Central Oklahoma

Haptic Control of Eye Movements

Eye-hand coordination is crucial to many important tasks. A NLDS framework assumes that eyes and hands are interacting facets of one complex oculo-motor system in which physiological and task constraints interact to shape overall system behavior. Participants (N=13) in this study played a first-person video game with either a traditional GameCube controller or a motion-sensing Wiimote controller. Eye movement and hand movement time series data were analyzed with nonlinear statistical methods in the search for evidence of multifractal structure. Multiple Hurst exponents were obtained for both conditions, indicating that eye and hand movements were multifractal. Hand movement data in both conditions contained brown noise indicative of short-term correlations in the time series. Eye movements in both conditions contained pink noise indicative of long-term correlations although the signal in the Wiimote condition was pinker, suggesting perhaps more orderly eye movements. Mean eye movement Hurst exponents in the Wiimote condition were pinker than in the GameCube condition. Eye movements change depending on the constraints of the hand.

Janice Ryan, University of Tennessee Health Science, Center Applications of Dynamical Systems

Analysis to Describe the Role of Intentionality in Meaning-Making Behavior

Conceptual modeling is used to analyze and describe patterns of self-motivated behavior change as emerging from context sensitive, self-organized shifts in intentionality. Two thematically coded data sets of meaning-making behavior were developed from interrelated exploratory research projects. The first was from reflective journal entries of eight young adult learners in the context of self-regulated learning. The second was from videotapes of eight withdrawn clients with advanced dementia in the context of self-directed occupational engagement during a treatment to support meaning-making behavior. The subjective intentionality experience is conceptualized as a plane of possibility on a neural profile (Siegel, D., 2010). Landscape diagrams (Eoyang, G., 2004) are used to clarify practice theory. Both cognitive interventions are applications of a nonlinear neuro-dynamical model of intention, meaning, and perception (Lazzarini, I., 2004). Future uses are proposed as a therapeutic facilitator of more flexible and self-directed adaptive behavior.

Mark Shelhamer, Aaron Wong, Johns Hopkins

Long-term correlations and 1/f noise in amplitudes of predictive eye movements

Eye-movement tracking of periodically-paced targets produces predictive behavior (saccadic eye movements), with low latencies. Previously, we found that consecutive saccades exhibit short- and long-term correlations in timing (latency). Long-term correlations are seen in slow decay of the autocorrelation. The extent of the correlations (width of the central autocorrelation peak) decreases as stimulus-timing variability increases, reflecting decreased confidence in the stimulus; conversely extended tracking expands the correlations. Simultaneously, error corrections occur on a trial-by-trial basis. Both timing and amplitude of predictive movements must be controlled. Thus, we wanted to determine if amplitude control exhibits properties similar to timing control. We found that predictive amplitude errors are corrected on a trial-by-trial basis in a direction-specific manner (the next saccade made in the same direction reflects a correction for errors made on the current saccade). We also find a process with long memory: performance information (inter-trial correlations) is retained across many saccades (~100). This is demonstrated by a 1/f-form of power spectrum, Hurst rescaled range analysis, and simulation with a fractional-integration operator to mimic a long-memory process (ARFIMA). These long-term correlations are modulated with stimulus reliability as for timing, although not as strongly. The dynamics of predictive control, a form of motor learning, exhibit complexities that are not fully described with current models.

E.H. (Dineke) Smit, PhD student, Radboud University Nijmegen

Nonlinear-minded professionals in a linear organized environment

We live in a complex society. Our society is a dynamic system which most people can hardly comprehend. There are so many complex social issues which interact with each other. There are many - sometimes conflicting - sources of knowledge. Right or wrong is no longer clear; the truth is in the eye of the beholder. Politicians also struggle with this complexity. Unfortunately they tend to formulate a linear model: reducing complex social problems to solvable problems with predictable outcomes. Professionals however, experience a feeling of bewilderment when they are confronted with this kind of political reductionism, such as a maze of rules and protocols towards unrealistic solutions. This can culminate in a loss of professional autonomy. For professionals in health care reality is dynamic, nonlinear,

contingent and oftentimes unpredictable. The model of linearity used by the government, contradicts with the nonlinear model of society experienced by professionals. This can create great tension. What can we do? First, we must accept there is and always will be a great deal of uncertainty. The pursuit of order and predictability does not have to be problematic in itself, but the denial of uncertainty may however prove disastrous. Understanding the complexity of our social existence is a step towards understanding the cycle of self-constitution, self organization and self production of professional activities and a professional attitude. Ultimately, uncertainty and chaos also offers the possibility for creative solutions!

E.H. (Dineke) Smit, Philosopher of Science and PhD student Faculty of Social Sciences of the RadboudUniversity Nijmegen

Understanding the complexity of primary care psychologists

Primary care psychology is complex. It is not about protocol or statistical truth; it is about the dynamical systems that form health care and is given shape in the interactions with individual clients. This includes the impact of scientifically based interventions, normative choices and unpredictable outcomes, influenced by social economic conditions. Social circumstances, economical conditions, psychological problems, epis-temological issues and ontological questions are mostly studied in isolation, by separate scientific disciplines. But primary care psychologists experience the interactions and dynamical relationships of these issues and want to, and need to connect (with) them. But how? The experi-enced complexity could become clear to primary care psychologists by using Edgar Morin's principle of distinction and conjunction, rather than the principles of reduction and disjunction of classical science. This offers a means to grasp the connectedness, and provides an opportunity to develop skills needed to make professional normative choices in complex situations. "I would say that complexity does not put us only in the distress of the uncertain, it allows us to see besides the probable, in the possibilities of the improbable, because of those which have been in the past and those that can be found in the future." (Morin, 2005)

Roulette Wm. Smith, Institute for Postgraduate Interdisciplinary Studies

Genetic Transcription and Translation Errors (Gerrs) - Implications for Preliophics, Nonlinear Dynamics and Logistic Reasoning

In 1949, Pauling, Itano, Singer and Wells used electrophoresis to reveal important structural differences in normal hemoglobin and sickle hemoglobin. Their discovery of this mutational difference gave birth to molecular medicine and the current basis for understanding normal and disease conditions. Somewhat surprisingly, researchers overlooked a need to elucidate and explicate molecular function. To respond to this unmet need, a preliophic moleculator (i.e., protonic-electronic-ionic-photonic molecular calculator) was recently patented. The device and its processes mimic features of inferred interactions of molecules in cellular structures and processes. In this report, preliophics is used to examine a category of genetic transcription and translation epigenetic and epigenomic errors (gerrs). Stress-activated Epstein-Barr virus [EBV] secondary small RNAs (i.e., EBER-1 and EBER-2) and some adenovirus secondary small RNAs (i.e., VA-I and VA-II) may be transmissible and infectious. They effectively can change the genetic code by interfering with host transfer RNAs. Their epigenetic context-specific byproducts then can give rise to molecular mimicry, autoimmune disorders, de novo mutations, cancers, tri-nucleotide repeat disorders, neuropsychiatric conditions, congenital conditions, etc. Logistic reasoning and preliophics reveal novel approaches to the study of etiology and causality. Cascading consequences of gerrs provide explanations for the foregoing phenomena. More importantly, gerrs provide novel perspectives on epigenetics, epigenomics and nonlinear dynamics. Insofar as stress may provide the underlying basis for many gerrs, this report underscores a need for stress management in virtually all clinical, institutional and catastrophic settings. Significantly, our findings also reveal ways common viruses may cause diverse and uncommon outcomes.

William Sulis, McMaster University/University of Waterloo

Causal Tapestries for Physics and Psychology

Archetypal dynamics is a formal approach to the modeling of information flow in complex systems used to study emergence. It is grounded in the Fundamental Triad of realisation (system), interpretation (archetype) and representation (formal model). Tapestries play a fundamental role as a formal representational system in this framework. They represent information flow by means of multi layered, recursive, interlinked graphical

structures that express both geometry (form or sign) and logic (semantics). This paper presents a detailed mathematical description of a specific tapestry model, the causal tapestry, selected for use in describing behaving systems such as appear in psychology and physics from the standpoint of Process Theory. Causal tapestries express an explicit Lorentz invariant transient now generated by means of a reality game. Observables are represented by tapestry informons while subjective or hidden components (for example intellectual and emotional processes) are incorporated into the reality game that determines the tapestry dynamics.

Whitney Tabor, University of Connecticut and Haskins Laboratories

A Dynamical Systems Model of Grammatical Innovation

Studying self-organization in the context of historical language change may shed light on how systems create new form. Generative Grammar and the theory of Turing computation characterize structural patterns at each time point, clarifying when a language community has innovated. Data on grammaticalization, the gradual emergence of new syntax over tens to hundreds of years, reveal: (i) systematic quantitative changes in word distributions precede structural innovations; (ii) words successively go down channels of grammatic-alization within the same language; (iii) grammatic-alization channels sometimes trace nonlinear arcs, visiting a series of structurally distinct regions. Point (iii) suggests that the channels cannot be explained as simple extensions of cultural differentials (e.g. My parents say I m all more than my grandparents, so I ll say it more than my parents.) We report on the Exploratory Recurrent Network (ERN), inspired by Elman s Simple Recurrent Network (SRN), an iterated function system that learns syntactic structure. The ERN, like the SRN, generates distributions over successor words when trained on a word sequence, but its dynamics are simpler to analyze. We first train the ERN to model a finite-state language. Then, the model trains itself by drawing its input events from its output distributions. The self-training network sometimes creates new grammatical systems. These innovation processes exhibit versions of the grammaticalization properties above. Analysis of the ERNs may shed light on the question, Given that the system works on a rich-get-richer principle, how is it that low-frequency, novel structures sometimes come up within, and overtake the dominant paradigm?

Claudio Tebaldi, Mathematics, Politecnico di Torino, Italy

Synchronization in Logistic Networks with Adaptative Competition

A general N-node network is considered for which, in absence of interactions, each node is governed by a logistic equation. Interactions among the nodes take place in the form of competition, which also includes adaptive abilities through a (short term) memory effect. As a consequence the dynamics of the network is governed by a system of NxN nonlinear ordinary differential equations depending on the strength of competition, the adaptation characteristic time and the size of the network. Existence and stability of the equilibria are discussed analytically in full generality. Time-dependent regimes exhibit remarkable properties of synchronization both in the case of periodic oscillations and chaotic behavior, related to the existence of attractive invariant subspaces. Depending on the network size, the loss of synchronization may happen when, increasing the adaptation time, the invariant subspaces loose attractiveness.

Marcus Thygeson, President, Center for Healthcare Innovation, Allina Hospitals & Clinics
Nisheeth Srivastava, Computer Science Department, University of Minnesota
Jaideep Srivastava, Professor, Computer Science,University of Minnesota

Medical Office Visit Frequency Fits a Power Law Distribution Modified by Exponential Censoring

Healthcare service utilization often generates additional utilization, and morbidity often generates additional morbidity. Such preferential attachment mechanisms are associated with inverse power law (IPL) distributions. However, unlike processes traditionally modeled using IPLs like wealth and city size, human populations experience censoring (e.g., death) as a function of morbidity. Mortality can be modeled with an exponential function M = ecX, where X is a risk factor like age. The greater the age or morbidity, the more likely people are to leave the population. We hypothesize that healthcare utilization data will manifest an IPL distribution modified by an exponential censoring function. We use previously published data on UK general practice office visit frequency to test our hypothesis using nonlinear regression. Patients with very low visit frequency (0-9 office visits in 41 months) were discarded from the analysis because they are likely to be healthy people receiving only preventive or minor acute care. Our results show that the log-log plot of the frequency distribution of medical office visits is concave downwards and fits an exponentially censored power law distribution extremely well (adjusted r2 = 0.982). This provides some preliminary evidence for our hypothesis. Factors

that may contribute to censoring include mortality, shifting of services to other providers, and physical or temporal limitations on utilization. Censored IPL distributions have been observed in other social and biological data sets. IPLs are indicators for sequentially interdependent processes and complex system dynamics. These findings may have important theoretical and practical implications for health services research and policy.

Irina Trofimova, McMaster University, Hailton, Ontario

Evolutionary phenomena of functional differentiation (FD) and fractal functionality (FF)

The phenomena of vertical and horizontal emergence are analysed in terms of functional differentiation (FD), a concept of fractal functionality (FF), a concept of the zone of proximate development and an application to iterative map techniques. These theoretical components are used to trace an evolution of structures at various levels of organization and to derive several universal evolutionary principles. The implications of these principles are: (1) building blocks of natural systems are performed uniquely and only once, they emerge, change and disappear, and therefore cannot be considered as Lego-like bricks of these systems; (2) building blocks develop not prior to, but simultaneously with the emergence of a macro-system, to which they are associated, and may continue to change even after the macro-system is established; (3) the existence of functional groups on the diagonal affects the subdivisions of horizontal distributions; (4) soft associations of elements to functional systems of several levels of complexity speaks against a vertical division of complexity levels and against a horizontal division of building blocks. Several examples will be presented if time permits.

Jeannine Turner, Ralph Waugh, Florida State University

A Quantitative Descriptive Analysis of Students Motivation, Emotions, and Self-Regulation Processes Using Dynamical Systems Framework

Sustained learning is a complex phenomenon involving adaptive processes of perceptual-cognitive appraisals, affective responses, and striving for future goals. Additionally, students must have complex skills of self-regulation, reading, problem-solving, and learning strategies. Using multiple data points of students motivations, emotions, self-regulation, and actual course-feedback, we describe 12 students in-depth dynamical processes across one semester. Subjects were recruited from an upper-division course in psychopharmacology. Of 54 possible subjects, 12 students completed all questionnaires (or almost all) necessary for analyses. Although the data were quantitative, we report a qualitative interpretation of how students ratings throughout the course explain attractors (future goals and self-efficacy). We also describe emergent processes and trajectories based on students on-ongoing appraisals of personal-control and personal-values. When looking across the semester, unique intra-individual patterns of students motivation, emotions, behavior, and achievement are detected. The data analyses support dynamical systems processes, suggesting that students initial conditions were on-going influences throughout the semester. A major source of students motivation and emotions were related to their perceptions of control, i.e., perceptions of competence and self-efficacy as well as their values associated with the course, i.e., their future goals and ways the course outcome or information was instrumentally linked to their future goals. Results suggested that receiving exam-feedback creates powerful academic events that dynamically evoke feelings from instantaneous appraisals of what the grade means to students. These powerful events reflect intrinsically-dynamic feedback processes that initiate intraindividual feedback that further influence formulation of motivational goals, expectations of self-efficacy, and effort-regulation processes.

Dankert Vedeler, Dept. of Psychology, NTNU

Epigenesis and the time dimension in Developmental Science

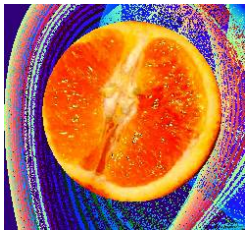
My central theoretical interest is the combination of Dynamic Systems Theory and an Epigenetic view to account for the time dimension in development. Advantages and difficulties of the two approaches are discussed, in view of combining them to have a complete understanding of development in the Life Sciences. The development of a living organism is illustrated through a version of Waddington s epigenetic landscape metaphor, where the concept of constraint is illustrated as denoting the ever-changing web of time dependent influences on a developmental trajectory. Thus, the time dimension becomes a central issue for understanding development. While having powerful concepts to account for both stability and change in developmental processes, dynamic systems theory has no theoretical models to account for stability and change over a life course. Therefore I try to combine thinking in terms of nonlinear dynamical system theory with probabilistic epigenesis, as proposed by Gottfried Gottlieb. Epigenetic theory includes an account for the successive changes an organism goes through in terms of a succession of states where any state in the life course depends on the present circumstances, for sure, but also on earlier states, that is, on the previous history of the individual organism. The point is that stability and

change may be depicted as attractor states that are cemented or destabilized through the accumulation of a history of events, possibly ending up in phase shifts.

Ken Ware, Department of Neurotricional Sciences, Emerald, Australia

Observing the Emergence of and the Control of Chaos in the Human Nervous System

This presentation will introduce exciting novel exercise techniques which quite visibly expose chaos in the human nervous system. Studies spanning 25 years have involved tens of thousands of subjects. An unpredictable chaotic tremor is observed in 100% of subjects while performing exercises that provide a very mild stimulus (afferent) to their system. The subject is encouraged to relax; the more the subject relaxes the more chaotic the tremor becomes. There shows to be a connection between the randomness and velocity of the neural turbulence and any degrees of physical/emotional disorders a subject may have. I.e. the chaotic tremor always increases in intensity and randomness, relevant to the degree of disorder in the subjects system, as does the surprising level of emotional anxiety or sensations of fear. However by the subject persisting with the movements in a more and more relaxed mode the nervous system, within a very short time frame, self organizes and recalibrates the system back to an orderly state (bifurcations spreading through neural landscapes/nonlinear synaptic interventions). Subjects always report dramatic positive recoveries and stabilities of disorders. A chaotic tremor will appear in every human being under these conditions which can either signify the homeostatic stability of their system (health and wellbeing) or instabilities that that could be of detriment. Neurobiological, chaos and nonlinear dynamics explanations relating to the above statements will be put forward. The reliability of the phenomena - which is a manifestation and magnification of underlying nonlinear kinetics/conformations, may also encourage other researches to use these techniques to study such things for e.g. as - particle turbulence and transitions that coincide with these events. There is an incredible amount of data able to be collected. At a basic level, we are observing the interaction of the human nervous system with its environment at micro, meso and macro scales i.e. where the two systems boundaries intersect (a subjects system is extremely sensitive to and dependant on these initial conditions). http://www.youtube.com/watch?v=EHfgmK6fx0Y -One example only of the techniques in practice.



Ken Ware, Experimental Therapy, Department of Neurotricional Sciences, Generations Healthy Life Centre, Emerald, QLD, Australia

Chaotic Protean Evasion

PROTEAN EVASION If you were being chased by a lion, you would not run in a straight line to get away. During fearful evasion of an attacker intrinsic mechanisms (central pattern generators) - not requiring thought or planning - initiate sudden swerve like unpredictable movements to assist in out maneuvering our attacker/s. We witness same evasive tactics when physically and or emotionally stressed subjects are stimulated with a mild, totally non threatening environmental stress. The mild afferent stimulus initiated by the subjects - perturbs sensitive regions of the subjects system. Central pattern generators become chaotic as their systems slowly roam through various and random regions of phase space verifying extreme sensitivity to initial conditions . Subjects systems will often try a variety of strategies - as seen in the accompanying footage - in random sequences to out maneuver what is unjustifiably perceived as a major threat. It is noted that the subject is quite capable of talking coherently as their system beneath the neck is behaving as if it is being electrocuted (this is not a joke). Using the afferent stimulus as a reference - intrinsic self organizing properties of system recalibrates the systems sensory motor integration domains. The phenomena enable us to study in real time - all aspects of the human nervous system as it interacts with its environment where these boundaries intersect. Projections of chaotic underlying kinetics and stochastic ion channel behavior is observed at a macro level - suggesting that mathematical modeling of macro transitions would apply to these other states.

Rita M. Weinberg, National Louis University

Chaos Theory and Energy Therapies

This paper explores the question of how principles of Chaos Theory explain and clarify a group of psychological treatments called energy therapies. There are variations. Thought Field Therapy is one I will use for discussion. Energy psychology is a set of physical and cognitive procedures designed to bring about therapeutic shifts in emotions, cognitions and behaviors which are targeted. It derives from energy medicine and postulates that mental disorders are related to disturbances in the body s electrical energy fields. Chaos Theory and energy therapies share many assumptions about energy and change. We discuss several principles of Chaos Theory, including initial conditions, bifurcations, attractors and self-organization and

examine how they relate to and parallel aspects of energy therapies. Both Chaos Theory and energy psychotherapies postulate that energy flow is basic for operating systems. Problems occur when there are blocks or interferences with the free flow of energy. Energy psychology therapies use patterns of tapping algorithms on meridians (high energy points)on the body to open energy pathways. The idea of bifurcation or change of direction appears in Chaos Theory and in energy therapy. Some changes are subtle. We need to notice sublties, unexpected relationships and connections. A small change (opening energy pathways) can yield large outcomes in therapy. The therapy itself can be an attractor which leads to self re-organization. From general systems theory, the basic feature is the same in energy therapies as in non linear theory: open energy flow dynamics result in energy exchanges which allow a system to maintain its integrity. Energy psychology therapy operates on a different paradigm from more traditional therapies. It is based on acupuncture, a treatment which has been used for thousands of years. It too postulates various energy points within the body. In my clinical experience with Thought Field Therapy, I found it was rapid and successful in treating a wide range of issues. Because Thought Field Therapy and other energy therapies match many rules of non-liner theory they provide a higher and faster rate of success. This may account for the ability of these therapies to be so successful. Closely following Chaos theory rules makes treatment easier. Re-arrangement of energy flow facilitates movement and change occur more readily since it obviates the necessity of installing new parts or processes into our mental processes.

Bruce West, Army Research Office
Paolo Grigolini, University of North Texas

Habituation and Leaky Faucets

The sting of a stream s icy water disappears to be replaced with a warm sensation on the swimmer s skin; the strong odors that command attention upon entering a delicatessen soon fade leaving a barely detectable residue; the background din of a party is muted by settling into an interesting conversation with one other person. All these stimuli start clearly in consciousness, but quickly fade. This is habituation in which a simple stimulus first attracts attention and then relinquishes that attention over time. Consequently we doze in front of the television, or in the middle of reading a paper. However more complex stimuli such as classical music can hold our attention for very long periods and we are kept awake by the thunder of a dripping faucet. Herein we discuss the results of new research establishing that it is the complexity of the brain compared with the complexity of an external stimulus that determines how we respond, that is, whether a person is vigilant or comatose in the presence of stimuli. To understand habituation we first recognize that there exists a connection between neural organization and information theory, the empirical laws of perception and the production of 1/f signals, with the remarkable property that 1/f signals, the signature of complex networks, are encoded and transmitted by sensory neurons more efficiently than are white noise signals.

Gail Williams, Corrections Corporation of America

Implications of Chaos Theory for Suicide Prevention

In the 19th century physicians started the present-day obsession with preventing suicides. Yet all of the "evidence-based" suicide prevention strategies are based on traditional linear, deterministic principles. What tiny blip in initial conditions would cause a mother to load her children into her van and drive into the Hudson River? What strange attractor would cause a man to take flying lessons so that on his first solo flight he could crash into the ground? Detailed analysis (called "psychological autopsies") of thousands of suicides have identified myriad risk factors for suicide. Deterministic risk factor analysis is then woven into the fabric of suicide prevention and every completed suicide is regarded as a failure of someone--family, spouse, therapist, employer, military commander--to exercise preventative action. Suicide rates continue to increase. It is time to think of suicide in terms of its nonlinear dynamics. The presentor brings a rich experience in prison and psychodynamic psychiatry to this discussion and hopes that experts in nonlinear dynamics from many fields can deepen our understanding of why people kill themselves.

Anthony Wright, Philosophy and Religion, Asian and Comparative Studies, California Institute of Integral Studies (CIIS) San Francisco, CA
Complexity theory and Confucius's Great Learning

Confucius's seminal work *The Great Learning* (Dà Xúe, 大學) has had great impact in the development of principles of harmony and morality in the social structures and government of China for nearly eight hundred years. In this work, Confucius shows how the Cosmos is reflected in the individual identities or selves of people, and the self is reflected in the Cosmos—fractal geometry offers a similar understanding through the concept of self-similarity. The structures of Chinese philosophy in *The Great Learning* can, for the non-

mathematician, illuminate ideas about self-similar patterns that repeat across different scales. The parallels between Chinese philosophy and fractal geometry have been explored (Jones and Culliney, 1998, 1999) but this paper will focus specifically on a re-translation of a phrase at the core of the self-similar structure in Confucius's *The Great Learning.* The conventional translation of this phrase in *The Great Learning* is, "The extension of knowledge (of the self and the Cosmos) lies in the investigation of things." My alternate translation is "The completion of wisdom lies in the *patterning* of things." The implications of this alternate translation for both philosophers and complexity scientists are explored through selected passages from *The Great Learning.*

Shane Wurdeman, Nebraska Biomechanics Core Facility, University of Nebraska at Omaha; College of Public Health, University of Nebraska Medical Center
Sara Myers, Neil Huben, Nebraska Biomechanics Core Facility,University of Nebraska at Omaha
Nicholas Stergiou, Nebraska Biomechanics Core Facility,University of Nebraska at Omaha; College of Public Health, University of Nebraska Medical Center

Direction of Gait Affects Attractor Divergence

It has been proposed that the fore-aft control of gait is largely a passive action based on reflexive neural mechanisms of the spinal cord whereas lateral stabilization requires more upper motor neuron activation for control. However, motor control studies comparing fore-aft to lateral stabilization have only tested walking in the fore-aft direction. Attractor divergence has been utilized to explore questions in motor control of gait. The purpose of this study was to examine the amount of attractor divergence in the lateral direction compared to the fore-aft direction during lateral step gait at two speeds. It was hypothesized that subjects would have greater attractor divergence in the fore-aft direction and an increase in speed would result in a further increase in attractor divergence. Eleven subjects performed the lateral step gait at a preferred speed and a fast comfortable speed. The largest Lyapunov exponent was calculated for right and left foot position in the fore-aft and lateral directions. Paired t-tests were used for comparisons. Results supported the hypotheses. The fore-aft direction had significantly greater attractor divergence. Furthermore, an increase in speed led to an attractor divergence increase only in the fore-aft direction, revealing greater sensitivity to task in this direction. These results would seem to indicate that directional control of gait is not partitioned within the neuromuscular system as believed before.

Yuji Yamamoto, Nagoya Univeristy, Japan
Motoki Okumura, Shizuoka University, Japan
Akifumi Kijima, Yamanashi University, Japan
Keiko Yokoyama, Hokkaido Univesity/JSPS Research Fellow, Japan
Hiroo Suzuki, Nagoya University, Japan
Koji Kadota, Osaka University, Japan

The Dynamics of Interpersonal Competition during Sports

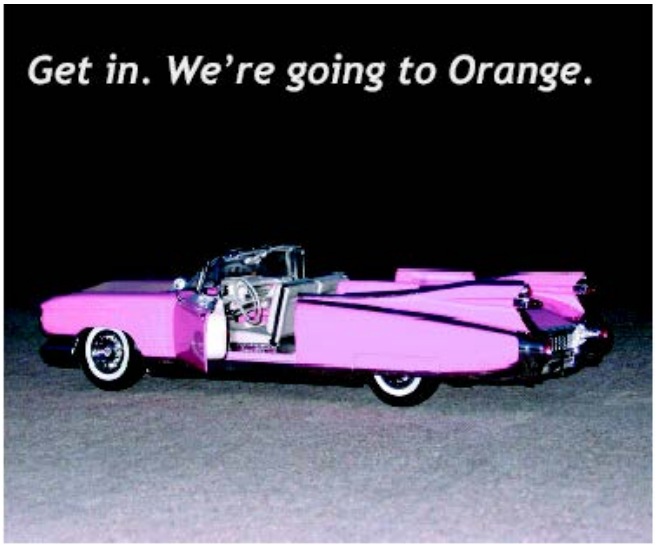
We examined the dynamics underlying interpersonal competition during tennis games and Japanese fencing (kendo) in terms of the processes underlying complex systems. Both activities included interpersonal interactions that were designed by each player to best the other. The positional data for the two players in the games were recorded and analyzed; the polar coordinates and the relative distances between two players were calculated during the tennis and kendo games, respectively. Using the point at which the ball was struck and the peaks of interpersonal distances, we created return maps as plots depicting a time series as a function of current and previous positions, and derived the characteristics of the phase space of the systems from the return map. This analysis showed both common and unique characteristics in the two activities. Both tennis and kendo were characterized by the similar vector fields, but tennis demonstrated two attractors, whereas kendo demonstrated one attractor and one repeller. These results suggest that the interpersonal competition in tennis and kendo both involve a coupling dynamics between two players via transitions between two attractors or between an attractor and a repeller.

Keiko Yokoyama, Hokkaido Univesity/JSPS Research Fellow, Japan
Yuji Yamamoto, Human movement science, Nagoya University, Japan

Three People Can Synchronize as Coupled Oscillators during Sports Activities

We experimentally investigated the synchronized patterns of three people during sports activities and found that the activity corresponded to spatiotemporal patterns in rings of coupled biological oscillators derived from symmetric Hopf bifurcation theory, which is based on group theory. This theory can provide catalogs of possible generic spatiotemporal patterns irrespective of their internal models. Instead, they are simply based on the geometrical symmetries of the systems. We predicted the synchronization patterns of rings of three coupled oscillators as trajectories on the phase plane. The interactions among three people during a 3 vs 1 ball possession task were plotted on the phase plane. We then demonstrated that two patterns conformed to two of the three patterns predicted by the theory. One of

these patterns was a rotation pattern (R) in which phase differences between adjacent oscillators were almost 2pi/3. The other was a partial anti-phase pattern (PA) in which the two oscillators were anti-phase and the third oscillator frequency was dead. These results suggested that symmetric Hopf bifurcation theory could be used to understand synchronization phenomena among three people who communicate via perceptual information, not just physically connected systems such as slime molds, chemical reactions, and animal gaits. In addition, the skill level in human synchronization may play the role of the bifurcation parameter.



Anatoly Zhirkov, Saint Petersburg State University
Olga Zhirkova, Saint Petersburg University Medical College
Viktor Kostenko, Saint Petersburg Institute for Emergency medical Care

From Chaos Theory to Psychosomatic Harmonization Concept. Ten Years with SCTPLS

The aim of report is to present authors experience of using chaos theory for interdisciplinary clinical research. We used Myocardial Infarction, Bone mechanical trauma and AIDS as models to research psychosomatic interaction. Helsinki Declaration principles were used in the study algorithm. Patients were researched and treated in specialized medical clinics. More than 400 patients were included in the database. One hundred signs of different functional systems were included in research form for every patient. Traditional and specialized statistical tools were used to look through main signs correlations. The results showed that the statistical relationships between signs were very complex and might be described in the terms of the chaos theory for all used clinical models. Main groups of signs were identified after the procedure of simplification. Signs were divided into four pools according to the corresponding psychosomatic systems: psychological, immune, infection and regenerative. Geometrically they may be represented as four sides pyramid (tetrahedron). The role of this concept for clinical medicine is discussed. In conclusion authors stressed the role of SCTPLS for interdisciplinary scientific research.

Workshop on Nonlinear Methods

Methodologies provide a doorway to new information, the advancement of theory, and development of new applications. The Society for Chaos Theory in Psychology and Life Sciences (SCTPLS) is pleased to announce a full day pre-conference workshop covering a range of nonlinear methodologies that are well suited to broad and interdisciplinary applications across psychology, social sciences, and life sciences.

The workshop is scheduled from **8:30 AM to 5:00 PM, Thursday, August 4, 2011** – kicking off the 21st Annual International Conference. **For Beginners:** This workshop is ideal for individuals who want to move forward to design and conduct a research project involving nonlinear dynamics, and also have a better understanding of the works of others using related methodologies. We recommend that participants should have a basic familiarity with concepts of attractors, bifurcations, chaos, complexity, and related nonlinear concepts. This is an excellent training opportunity for graduate students, especially those who plan to do a dissertation with impact. **For Experts**: Each workshop module will provide up to date developments on fast-moving topics and software options. Advanced researchers will gain: a deeper understanding of the theoretical coherence among the various approaches along with detailed information regarding empirical design and interpretation of results.

The workshop begins with a brief introduction followed by five one-hour modules covering: Phase space diagrams & correlation dimensions; Recurrence analysis; Power laws; Nonlinear regression; and Symbolic dynamics/orbital decomposition. The day will conclude with an open group discussion with the training panel.

Topics and Presenters

Phase-space diagrams and correlation dimensions
Mark Shelhammer, Sc.D., Associate Professor, Department of Otolaryngology – Head & Neck Surgery and Associate Professor, Department of Biomedical Engineering, The Johns Hopkins University, School of Medicine

The main topic will be time-delay reconstruction of trajectories in the state space: how to do it correctly, basics of the underlying topology, and applications. One application is determination of the dimension of the reconstructed attractor, and use of the correlation dimension for this will be discussed, including computational procedures and interpretation of dimension estimates.

Recurrence Analysis
Deborah J. Aks, Ph.D., Research Professor, Center for Cognitive Science, Rutgers University.

This module will describe how Recurrence Quantification Analysis (RQA) can be utilized to understand temporal dynamics of behavioral sequences. Using eye movement behavior from different object tracking tasks, I will show how RQA quantifies dynamics such as general recurrence, and the extent to which a string of behaviors recurs over time, and is stable. I will further describe how tracking dynamics can be represented more simply in a 3D state space. Finally, I will show how recurrences in eye-position sequences can account for the memory required to sustain effective tracking over time and when tracking undergoes intermittent but natural interruptions.

Power-laws
Bruce J. West, Ph.D., Chief Scientist Mathematics (ST), Information Science Directorate, US Army Research Office, Research Triangle Park, NC 27709.

This talk will explain why the normal distribution is irrelevant for the description of data from complex phenomena and why the inverse power-law distribution is ubiquitous in the physical, life and social sciences. We will discuss a number of simple data processing procedures for determining the scaling properties of data with examples drawn from fractal physiology, habituation and decision making. If time permits we will also discuss why some of the more popular methods for determining scaling are misleading if not just wrong.

Nonlinear Regression
Stephen J. Guastello, Ph.D., Professor of Industrial Organizational Psychology, Marquette University.

Nonlinear regression is a statistical procedure that allows the user to test hypotheses concerning any nonlinear structure for degree of fit and to estimate model parameters for a sample or a time series. This section of the workshop covers how to use nonlinear regression on SPSS software, how it contrasts with multiple linear regression, and a series of structural equations that capture attractors, bifurcations, chaos, Lyapunov exponents, and compound dynamics.

Markov Chains
Stephen J. Merrill, Ph.D., Professor of Mathematics and computational science, Marquette University.

This talk involves building and using Markov chains and their cousins, hidden Markov models (HMM), to describe

and explore time series data. Topics include simulating models constructed from data, using the definition of "state" to extend applicability of the models, and developing tools to describe the dynamical nature of these models (and thus the original data).

Symbolic Dynamics and Orbital Decomposition
David Pincus, Ph.D., Associate Professor of Clinical Psychology, Crean School of Health and Life Sciences, Chapman University

Categorical time-series data are produced by many phenomena in social, behavioral and life sciences, in any situation involving the unfolding of a series of unique events. Using an example data set of therapeutic conversation patterns, this section of the workshop will demonstrate how patterns may be identified in such data sets and how one may derive a variety of quantitative indices characterizing complexity, stationarity, and part-to-whole relations underlying emergence.

Keynote Speakers

Polemnia G. Amazeen
Arizona State University

Crossing Boundaries with Dynamics

Dynamical systems analysis offers a cohesive, interdisciplinary approach to science. This powerful tool comes from theoretical physics and engineering, but it can be used to analyze patterns of change in psychology and other social sciences. In this talk, I will present a strategy for dynamical application that centers on the idea of dynamical similitude: the same behaviors are observed across very different systems. That concept allows us to adopt dynamical models from outside of psychology to study the phenomena that interest us in psychology. I will show how this strategy has been used successfully in such diverse fields as motor coordination and clinical psychology. In some cases, there is no apparent model fit. I will illustrate how (social) team dynamics can be extracted using more exploratory techniques. As the dynamical literature in the social sciences grows, so do the possibilities for application and collaboration.

Biography. Polemnia G. Amazeen is an Associate Professor in the Department of Psychology at Arizona State University. She received her Ph.D. from the Center for the Ecological Study of Perception and Action at the University of Connecticut in 1996 and completed a three-year postdoctoral fellowship in the Faculty of Human Movement Sciences at the Vrije Universiteit, Amsterdam before joining the faculty at ASU in 1999.

Dr. Amazeen's research is concerned with the treatment of coordination as a complex, dynamical system. She looks for general principles in coordination patterns across people (social interactions) and within people (bimanual and motor-respiratory coordination) using the tools of dynamical systems analysis. Dr. Amazeen's research is naturally collaborative. Recent projects include: the detection of team coordination patterns in real time; oscillations in pain prediction accuracy in rheumatoid arthritis patients; and dynamical analysis of dyadic interactions in elementary schoolchildren.

Dr. Amazeen's work appears in over 50 articles, chapters, and published abstracts and has been presented at numerous workshops, conferences, and invited colloquia. She is a currently an Associate Editor for *Research Quarterly for Exercise and Sport* and a Consulting Editor for *Ecological Psychology*. Dr. Amazeen's research has been funded by the National Science Foundation and the Office of Naval Research.

Thomas J. Dishion
Child and Family Center, University of Oregon,
and Department of Psychology, Arizona State University

Applying Dynamic Systems Analyses to Understanding Adolescent Psychopathology and Health

Abstract: For the past two decades considerable progress has been made in studying relationship dynamics of families and peers in understanding the development of antisocial behavior, and then in turn, applying that understanding to the design of effective intervention programs. The emergence of dynamic systems analyses has buttressed this progress by deepening our understanding of rigidity, flexibility, attractors and entropy within relationship interactions. This presentation will provide four illustrations of the application of dynamic systems analyses to friendship and family interactions of adolescents, considering the joint focus on the process dynamic as well as the content of the interaction in predicting future adjustment. Implications of this work for the design of interventions that prevent psychopathology and promote health will be discussed.

Biography: Tom Dishion is currently a professor in psychology and school psychology at the University of Oregon, and soon to be a professor in psychology at Arizona State University. He founded the Child and Family Center at the University of ORegon, and was the director until recently. He conducts research in developmental psychopathology and prevention science. Dr. Dishion is interested in understanding how children's relationship dynamics with parents and peers influence the development of problem behavior and depression in children and adolescents. More recently, he is interested in exploring the basic socialization process and mechanisms from a dynamic systems perspective, and translating developmental findings to the design of new prevention and intervention strategies for children and families. He and colleagues use the Family Check Up model as a preventive and treatment strategy, and as a venue for translating developmental findings into improved services for children and families. He collaborates on several developmental and intervention research studies funded by NIH and IES.