Society for Chaos Theory in Psychology & Life Sciences

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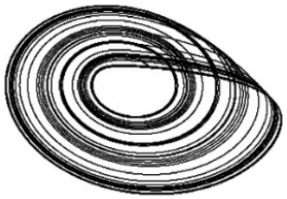
Abstracts to the 26th Annual International Conference, Salt Lake City, UT 2016



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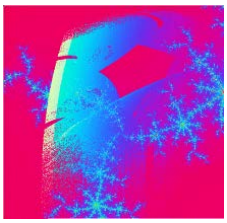

ABSTRACTS

26th Annual International Conference

Salt Lake City, Utah, July 30-31, 2016

In alphabetical order by Author or Presenter

Symposium: **Dynamic Issues in Children's Play**

Doris Fromberg, Hofstra University (retired)
Doris Bergen, Miami University

This symposium has two presenters on issues related to dynamic qualities of children"s play. The first presenter will discuss The Dynamics of Play, Meaning, and Learning: Principles of nonlinear dynamic systems underlie the predictably unpredictable nature of play. The nonlinear dynamical relationship between play, meaning, and learning, as well as the confluence of play with characteristics of self-regulation that support early education will be discussed. The second speaker will discuss Dynamic Effects of Technology-Augmented Toys and Virtual Media on Children's Brain Development and the Future of Play. Because brain development and play development are interactive dynamic systems, the pervasiveness of technology-augmented toys and virtual media will influence these systems in multiple ways. This presentation will address chaotic issues such as self-organization, openness, stability, soft assembly, phase shifts, fractals, and attractor states in relation to potential dynamic effects on brain development and the future of children's play. Discussion with audience will follow.

Dynamics of Embodied Bistable Perception of the Necker Cube

Thomas Brooks University of Connecticut

Bistable images present a problem to traditional theories of perception that rely on the integration of primitives. In these theories, perceptual elements are combined through an inferential process and an executive system assigns meaning to the sensory information. However, participants viewing a Necker cube experience spontaneous reorientations of the figure even though none of the primitives have changed and even though the switch happens after the assignment of meaning. An alternative theory is that percepts are determined by the action opportunities (or affordances) offered by an object. Since any single object offers multiple affordances, a perceiver can become aware of additional object affordances throughout the perception process. However, as an affordance is specific to a single action, perception of affordances is somewhat constrained by the perceiver's current action state. For a Necker cube, this means that we can expect the action states of the perceiver to influence which affordances of the cube are perceived, which will be apparent in which orientation of the cube the perceiver reports. In this experiment, participants showed a more persistent symmetry in orientation preference when their method of reporting was congruent with perceived orientation. Additionally, Detrended Fluctuation Analysis showed that the time series of switching had a significantly higher Hurst exponent in the incongruent condition, indicating that perceptual switching was more dependent on previous states. We believe this is because the perceptual-motor system assembled for the incongruent task requires a greater degree of retuning, and so relies more heavily on the process's prior states.

Examining a Cusp Catastrophe Model for Public Health Planning and Management

Barbara Bruhns Frey Potential Connections, Inc.

Recessions and other fiscal crises can have detrimental impacts on mental health needs. Careful fiscal planning could minimize the adverse consequence for high-risk individuals. State mental health agencies (SMHAs) are on the frontline of federal and state-level budget cuts. Utilizing publically available health measures and indicators, this presentation will discuss some initial work focused on modeling the impact of government expenditures on mental health outcomes via cusp catastrophe model. The data from multiple years of SMHA controlled mental health expenditures are examined and clustered into three groups using changes

in annual expenditures: (1) minimal change in annual expenditures, (2) increase in annual expenditures and (3) decrease in annual expenditures. An initial cusp model called, Health Wellness Model, explores the impact on well-being/health from changes in resources (a) and population need (b). A model predicting instability in health management can aid budget and program development to target individuals at-risk for greater instability and reduced wellness (e.g., increasing case management or home care to off-set declines in overall budgets).

Preliminary Results of an Explanatory Sequential Mixed Methods Study of the School Leaders Role in Students Mathematics Achievement through the Lens of Chaos and Complexity Theory

Emma Bullock Utah State University

Student achievement in the K-12 mathematics classroom is of concern to parents, teachers, and community leaders as complex modern technological innovations call for higher proficiency in problem solving and mathematically creative minds are necessary to fill the vital, higher-paying jobs of today and the future. As societies recognize this need, more pressure is placed on schools to adequately prepare students for success in mathematical fields. As such, school leaders are expected to make decisions that will measurably and, in some cases dramatically, improve student achievement in mathematics. However, one of the difficulties for school leaders has been the limited amount of research concerning content-specific school leadership and its effects on student achievement. In addition, school leaders do not make decisions in isolation; rather, they make decisions as part of a complex adaptive system (CAS). Educational institutions, such as schools, represent CASs made of individual stakeholders whose everyday decisions influence all other stakeholders in meaningful ways. As such, a school leader will be influenced by the agency, or interactions, among different stakeholders and, in turn, the school leader will directly and indirectly influence others. This study focuses on the relationships between students' mathematics achievement and the characteristics of school leaders, looks at the influences affecting the decisions and actions being made by school leaders, and then seeks to understand how a school leaders decisions and actions are associated with students mathematics achievement. By viewing the school as a CAS, the purpose of this study is to pragmatically examine the school leaders role in students mathematics achievement in the context of complexity theory. This paper will focus on the preliminary results of this study.

The Onflow of the Mind as an Autocatalytic Process

Leslie Combs California Institute of Integral Studies
Zachary Stein Education, Meridian University

Current theorizing from a number of quarters illustrates the existence and indeed the importance of widespread autocatalytic processes throughout the cosmos. These range from self-assembling autocatalytic circuits of organic protein and DNA molecules as described by Stuart Kauffman and others, to analogous or very similar processes that seem to operate at large in the cosmos on astronomical scales, in each instance forming what Kauffman terms a Kantian Whole. In this presentation the author proposes similar self-organizing dynamics said to undergird the human mind; dynamics that are reflected in the onflow of conscious experience. Drawing together the ideas from his own past publications and combining them with current complexity theory, the presenter attempts to give a partial answer to James query stated at the very beginning of "The Principles of Psychology" (1890): "This multitude of ideas, existing absolutely, yet clinging together, and weaving an endless carpet of themselves whence do they get their fantastic laws of clinging, and why do they cling in just the shapes they do?"

Using Chua's Circuit to Test Novel Nonlinear Analysis Methodologies

Gregory Derry Physics Department, Loyola University

Because problems in chaos and nonlinear dynamics are frequently complex and difficult, novel methodological approaches often need to be developed to make the analyses tractable. Adequate amounts of good-quality data are also difficult to obtain in many of the problems of interest. For these same reasons, however, it is difficult to test and validate these novel methodologies. One of the simplest examples of a nonlinear system in a chaotic state is the so-called Chua's circuit, which consists merely of two capacitors, one resistor, one inductor, and a single active component that acts as a nonlinear negative resistance. The mathematics of Chua's circuit are comparatively simple (three first-order differential equations in three variables), have been extensively analyzed, and are well understood. Chua's circuit is also very simple to build. Once built, this circuit can generate vast amounts of high-quality data extremely quickly. These features make possible the testing of novel methodological approaches in a problem where data is easily available and the behavior of the system is already known well. In this presentation we will examine some examples of this testing and validation protocol for methodological approaches that the author has developed to study considerably less tractable problems in the nonlinear dynamics of endocrine physiology. We are particularly interested in the question of whether time intervals between intermittent events can be used as a substitute for actual time series data, because the validity of that assumption has been crucial in these previous studies.

Giving Top-Down Thinking Its Due

Paula Derry Paula Derry Enterprises

Two perspectives on understanding nonlinear dynamical systems are bottom up--self-organization emerges from the interaction of elements of the system--and top down --the system influences, constrains, or makes intelligible, the patterning of its elements. Bottom-up analyses often focus on relatively simple interactions among autonomous units that interact according to specifiable rules. Important as these analyses are, there are questions they do not answer. By definition a complex system is a whole that transcends its elements; systems influence, constrain, or makes intelligible the patterning and dynamics of elements. Drawing on the work of the physiologists Ragnar Granit and Walter Cannon, this presentation examines questions and observations pertaining to understanding systems from a top-down perspective. Topics include: (a) Units that are not autonomous atoms; instead, they are defined by or change with the state of the system; (b) When more than one set of rules is possible for interaction among units, why one set of rules rather than another get called into play transcends rules of interaction among autonomous elements; (c) Describing the larger system involves a different kind of explanation from describing the interactions among its elements; (d) Often, purpose/teleology or nonmaterial constructs are unavoidable. Specific examples will be given of each point from scientific research and clinical practice.

Using Eoyang's Container-Difference-Exchange Model to Explain Complex Change: The Case of The Sustainability Consortium

Kevin Dooley Arizona State University

Glenda Eoyang's Container-Difference-Exchange (CDE) Model is a broadly used framework for practitioners engaging in organizational change efforts. The CDE model draws from the thermodynamic roots of complexity science, in particular, Prigogine's theories on self-organizing systems. The basic premise of the CDE Model is that a system has a handful of fundamental ways to drive change in its patterns of behavior (i.e. attractor) to expand or contract its boundaries (container), to change the information that agents attend to (difference), or to change the interconnections and interactions between agents and other system elements (exchange). The CDE Model succeeds in being true to its underlying science but simple enough for non-scientists to grasp and use effectively. In order to demonstrate the power of the CDE Model I shall use it to analyze the case of The Sustainability Consortium (TSC). TSC was created in 2008 as a multi-stakeholder initiative to create more sustainable consumer products through standardizing the measurement and reporting of environmental and socially responsible performance. Today TSC consists of over 100 organizations and has a global staff of over 50, and TSC's supplier sustainability surveys are the basis for the Walmart Sustainability Index. I shall review various challenges within TSC's life and discuss the interventions we used to drive change, from the perspective of the CDE Model.

Poster: **Dynamic EEG Desynchronization in Response to Vicarious Pain**

Justin Durham, **Chanda Rooney**, **Mickie Vanhoy**, **Robert Mather**, University of Central Oklahoma

The psychological construct of empathy is to understand a person's cognitive perspective and experience the other person's emotional state (Guastello, 2016). Deciphering emotional states is conducive for interpret-ing vicarious pain. Observing others physical pain activates neural networks related to the actual experience of pain itself. The study addresses empathy as a nonlinear dynamic process of simulation for individuals to understand the mental states of others and experience vicarious pain through self-organized criticality. Such criticality follows from a combination of neural networks with an excitatory feedback loop generating bistability to resonate permutated empathy. Cortical networks exhibit diverse patterns of activity, including oscillations, synchrony and waves. However, the temporal dynamics of neurophysiological activities underlying empathic processes remain poorly under-stood. The current study recorded subjective empathy-psychopathy ratings and EEG signals from 12 undergraduates who observed a pre-post baseline and a video of consecutive sports injuries. EEG electrodes measured the presence and absence of mu rhythms in each condition. Mu rhythm is an EEG oscillation with dominant frequencies of 8-13 Hz when the sensorimotor cortex is idling. Overall mu rhythm desynchronization or blocking due to motor preparation was expected during the pain condition. A Fast Fourier Transformation (FFT) converting a time series domain into a frequency domain was implemented to identify EEG mu rhythms. Participants displayed mixed desynchronization results in each condition, suggesting a complex explanation. Further analysis will contain dynamical systems techniques such as multifractal time series analysis to produce nested patterns of variability in each condition.

Sunday Keynote: **There Be Dragons: The Future of Uncertainty**

Glenda H. Eoyang Human Systems Dynamics Institute

Our cultures are addicted to certainty. Business, government, education, healthcare, technology, even the arts and philanthropy are built on and judged by what they can predict and control. That is not a bad thing; in fact it is great when it works. The problem is that our most urgent and intractable challenges lie beyond the certainty horizon. Climate change, violent conflict, corruption, and fascism are all essentially unknowable because they are driven by conditions that are open, high dimension, and nonlinear.

Though facets of these problematic systems may be under control, the depth and the future of these issues draw us into an infinite game. In such a game, no one wins or loses, and the purpose is to keep the game going. Still, individuals and institutions must act with conscience and intention. We must prepare ourselves and each other to make principled decisions and take decisive action, even when we are certain that the outcomes will be uncertain. I will deploy insights from nonlinear dynamics to show how they can inform reasonable decision making in an uncertain future. Applicable in all domains of human endeavor, these will illuminate and disrupt some fundamental fallacies that our research designs, our teaching, our consulting, and our other professional and personal practices may be resting upon, including:

- Precision improves accuracy
- Causation is a vector
- Time is a line, and we are on it.
- Difference is a conserved quantity
- Everything begins and ends
- The most interesting thing about a problem is its solution

Each of these has profound implications for the infinite games of science and society. As complexity scholars and practitioners, we have the unique opportunity, even the responsibility, to use nonlinear understandings to challenge these beliefs in ourselves and others so we all engage as more reasonable actors in an irrational future.

Symposium: What Difference Does it Make: Applications and Implications of Complexity for Practice

Glenda H. Eoyang, Human Systems Dynamics Institute
Kevin Dooley, Arizona State University
Janice Ryan, University of Tennessee Chattanooga

For twenty-five years, SCTPLS has brought us together in scholarly dialogue to share research questions and emerging answers. As scholar-practitioners many of us stand at the intersection of theory and practice. We have taken lessons from nonlinear dynamics to inform decision making and action taking as practitioners in fields as diverse as occupational therapy and supply chain management. Our research and our practice have been closely aligned. We explored questions of theory through practice. Practical challenges informed our research programs.

Development of theory has been tracked reasonably well in the literature, not so for practical applications of complexity. There are many reasons why the evolution of complexity practice is not well documented. Our applications and contexts are incredibly diverse, so theory in practice has been largely a solitary journey. Time, resources, and compensation are not aligned to support practitioners who research and write. Traditional standards of rigor in research are not friendly to practitioners because practitioners are not prone to publish, perhaps because the standards of traditional research are not suited to the open, high dimension, nonlinear conditions of practice in complex systems. We have chosen to speak to our colleagues within our various disciples, so our discourse has been scattered and externally focused. For all these reasons and more, the evolution of the practice of chaos and complexity in human systems has not been well documented.

This session brings three expert practitioners and long-time SCTPLS members together in a panel discussion about the past, present, and future of the practice of nonlinear dynamics, chaos, and complexity. Janice Ryan, OTD, OTR/L, will share her experience in research and practice in the field of Occupational Therapy. She has used lessons from complexity to inform interventions to improve performance for isolated children and elders suffering with Alzheimers Disease. Kevin Dooley used his background in Mechanical Engineering, his interest in Total Quality, and his passion for time to inform a network-based project to capture and assess the carbon impacts of retail products. Glenda Eoyang leads a network of associates who use her theories, models, and methods to see, understand, and influence patterns in human systems at all scales.

These three will reflect on their own practices, compare and contrast their experiences, and engage in dialogue with the audience. The conversation will coalesce around the following questions: (1) What difference has this field (complexity and/or HSD) made for you? Personally? Professionally? For your organiza-tions and communities? For the world, as you see it? (2) So what are the current challenges of complexity-informed practice? (3) Now what can we hope for from future applications of nonlinear dynamics?

Honing Theory: Rationale and Evidence for a Complex Systems Framework for Creativity

Liane Gabora University of British Columbia

I will present a theory of creativity, referred to as honing theory, which posits that creativity fuels the process by which culture evolves through communal exchange amongst minds that are self-organizing, self-maintaining, and self-reproducing. According to honing theory, minds, like other self-organizing systems, modify their contents and adapt to their environments to minimize entropy. Creativity begins with detection of high psychological entropy material, which provokes uncertainty and is arousal-inducing. The creative process involves recursively considering this material from new contexts until it is sufficiently restructured that arousal dissipates. Restructuring involves neural synchrony and dynamic binding, and may be facilitated by temporarily shifting to a more associative mode of thought. A creative work may similarly induce restructuring in others, and thereby contribute to the cultural evolution of more nuanced worldviews. Since lines of cultural descent connecting creative outputs may exhibit little continuity, it is proposed

that cultural evolution occurs at the level of self-organizing minds; outputs reflect their evolutionary state. Honing theory addresses challenges not addressed by other theories of creativity, such as the factors that guide restructuring, and in what sense creative works evolve. Evidence comes from empirical studies, an agent-based computational model of cultural evolution, and a model of concept combination.

Performance and Participation Dynamics in Stag Hunt Games

Stephen J. Guastello, **David E. Marra**, **Julian Castro**, **Maribeth Gomez**, **Claire Perna**, Marquette University

This study examined relationships between participation and performance within a team and performance transfer effects between opponents in an Emergency Response (ER) game. Classical organizational theories have emphasized the importance of group participation for organizational performance, but there have been few or no attempts to investigate participation-performance relationships in short-interval time series. The exper-imental task was a Stag Hunt game, as defined in game theory; performance trends would be affected by levels of participation, which in turn should be affected by recent performance experiences that modulate the players self-efficacy for the task. Participants were 62 undergraduates who were organized into 11 teams of 3 or 4 members playing an ER board game against one attacker. Time series analyses were conducted through nonlinear regression with exponential structural equations and by linear analyses for comparison. Results showed that performance time series of one opponent did not affect the other for teams of this size. Teams showed higher levels of adaptability compared to attackers, as evidenced by higher Lyapunov exponents. Performance affected group participation levels more so than the other way around. There appeared to be emergent group dynamics occurring between two experimental sessions that moderated the validity of the core linear and nonlinear models. Emergent group properties are one of several possible directions for further investigation within this experimental paradigm. Nonlinear models were more accurate than linear models after correcting for correlated residuals.

Development and Validation of a Synchronization Coefficient for Biosocial Interactions in Groups and Teams

Stephen J. Guastello, **Anthony F. Peressini**, **David E. Marra**, **Julian Castro**, **Maribeth Gomez**, Marquette University

Body movements, autonomic arousal, and EEGs of group members are often coordinated or synchronized with those of other group members. Linear and nonlinear measures of synchronization have been developed for pairs of individuals, but little work has been done on measures of synchronization for groups. We define a new synchronization coefficient, SE, for a group based on pair-wise correlations in time series data and employing the notion of a group driver (an individual who most drives the group's responses) and empath (an individual who is most driven by the group's responses). A simulation study explores its properties and considers the balance between strong versus weak autocor-relational effects, transfer, group size, and direct versus oscillatory functions. Distributions of SE are not affected by group size up to 16 members. Norms for interpreting the coefficient are presented. The last segment of the presentation describes a real-time study in which 11 teams of 3 or 4 members played a series of six an emergency response games against a single opponent. Synchronization within the team was calculated from electrodermal time series. Results showed that physiological synchronization increased as the team won more games. The finding is consistent with the well-known finding that group cohesion improves as the group shares positive experiences.

Short Workshop: **Hands-on Modelling of Percep-tual Switching in Coupled Rotations of Four Ordered Oppositional Pairs: Chiral Quaternions**

Martin Hay, Independent, UK
Terry Marks-Tarlow Private practice, artist, teaching faculty, and research associate
Herb Klitzner Klitzner Connections

In this workshop presented by Martin Hay, we will explore a chiral quaternion system for processing relationships between economic agents that does not privilege any agent over any other. This is an experiential opportunity to "unpack" the abstractions and visual representations of chiralkine sytems discussed in our article *Quaternions, Chirality, Exchange Interactions: A New Tool for Neuroscience?* (*SCTPLS Newsletter, 23*(1), 8-14). It will be structured around the symbolism in an ancient Chinese panel that embodies pairwise relationships between figures of five immortals arranged in an exquisite, geometrically designed setting. This panel has guided the presenter through the creation of a novel entitled Resolution of Zero and the invention of a game to the coding of the system in

four ordered polarities. Through the use of models that participants can rotate using their left and right hands, the concepts of chirality (handedness), quaternions, symmetry, antisymmetry, ownership, rights and obligations, and coding of economic relationships (accounting and voting) will be explored. Participants will be introduced to a board game played with the left and right hands that might be adaptable to exploit brain plasticity in the treatment of stroke. There are also codes written for a system for the exchange of goods and services without using any form of currency and for a new kind of quaternion voting/iterative decision making system that can be accessed and played with online during the workshop. The workshop will aim to give the participants a sense of how the co-ordination of muscle antagonist pairs to effect movement of the body through physical space may be related through chiral quaternion rotations to navigation through social space.

Symposium: Co-Regulation Processes between Nonlinear Dynamical Systems: A Computational Approach to Study Dyadic Interactions

Peter Hilpert, University of Washington
Brian Baucom, **Craig Bryan**, **Zac Imel**,
Christina Soma, **Jasara Hogan**, **Jonathan Butner**,
University of Utah

Human interactions unfold over time and is highly complex to study. Understanding better how people systematically influence each other during interactions will help to fine-tune dyadic interventions (e.g., patient-therapist interventions) in the long-term. According to the polyvagal theory (Porges, 1995), people in social situations scan the behavior of the interaction partner. For example, if person A decodes a negative behavior from person B, it triggers unconsciously A's facial muscles, larynx, and pharynx via A's vagal nerve, which changes A's facial and vocal expression. Changes in A's facial and vocal expression, in turn, trigger B's behavior to change. Based on these theoretical assumptions, we can assume rapid co-regulation processes of nonlinear dynamical behaviors between persons during dyadic interactions, where changes in one person's behavior predict changes in the other person's behavior and vice versa. Although human interactions have been profitably examined with a range of methods, none appear well suited for capturing the dynamic, moment-to-moment processes outlined in the above model. For example, laboratory behavioral observation techniques can reveal how the frequency of specific behaviors during couple interactions predict future outcomes; yet this method generates sparse data, undermining analysis of dynamical processes between dyads during behavioral exchanges. Thus, the goal of the proposed symposium is to present novel methods to overcome the current limitations. We show in four projects how new engineering methods can be used to extract very intensive behavioral data, which in turn allow us to examine co-regulation processes of nonlinear behavioral expressions.

In the first paper, Craig Bryan used audio recordings of soldiers with suicidal ideation in crisis interventions to extract nonlinear vocal stress signals of both the therapist and the patient. Results indicated that clinician/patient synchrony in fundamental frequency and transactional processes of emotional regulation were associated with patient-rated emotional bond. In the second paper, Christina Soma and Zac Imel present an analysis of vocal encoded arousal in patient-therapist dyads. Utilizing dynamic systems modeling, they will explore the social regulation of emotion within 355 therapy dyads. In the third paper, Jasara Hogan und Brian Baucom test a biobehavioral model of closeness in romantic relationships. Drawing on Polyvagal Theory, associations between attractor dynamics of fundamental frequency, vagal withdrawal, and experienced closeness are examined during conflict discussions of 60 married couples. Finally, Peter Hilpert and Jonathan Butner use a variety of engineering techniques to extract intensive measurements of emotion from nonlinear dynamical facial and vocal expression and estimates co-regulation processes between partners during dyadic interactions in two samples (189 couples, 39 couples). Together, these four studies show how novel methodologies can be used to overcome current limitations and provide intensive behavioral data. Intensive data allows us then to examine how behavior occurs nonlinear over time and how dyads co-regulate their behavior during interactions.

Symposium: Innovative Nonlinear Analysis Methods for Uncovering Informative Physiological Transitions during Neurophysics Therapy: An Empirical Journey from Datapalooza to SCTPLS 2016

Adam Kiefer, Division of Sports Medicine, Cincinnati Children's Hospital Medical Center
Ken Ware, NeuroPhysics Therapy Institute

NeuroPhysics therapy is a therapeutic regime inspired by nonlinear dynamical properties of biological systems that leverages the natural chaotic rhythms of the human nervous system to catalyze physiological phase transitions to healthier, stable states. The first talk (Ware) in this symposium will provide an overview of NeuroPhysics therapy and discuss the uniform training methods that create catalytic initial conditions to evoke the same kind of natural processes, and benefits, across individuals (i.e., the body self-tailors these processes to meet its individual health needs). Hallmark characteristics of dynamic physiological transitions that have been subjectively observed by neurotricionists (i.e., clinicians) during NeuroPhysics therapy will be discussed in the context of a clinical case an individual suffering from long-term sequela associated with traumatic brain injury. These phase transitions, and the observable system-wide dynamics more generally, provide information to the neurotricionist that motivates further mediation by the neurotricionist during a

NeuroPhysics therapy session; however, they can be subtle and NeuroPhysics therapy would benefit from more objective identification of these phenomena. Thus, the first talk will conclude with a brief discussion of the challenges associated with the objective measurement of these nonlinear dynamical system characteristics and how such difficulties have inspired an evolution from electrophysiological measurement toward more noninvasive data collection tools (i.e., infrared thermography) to objectively identify and assess these nonlinear dynamical processes.

The second talk (Kiefer) will focus on a series of computational approaches used to quantify the nonlinear dynamical system characteristics associated with NeuroPhysics therapy. Specifically, nonlinear analyses of thermal imaging data will be presented. Thermal imaging provides a useful, non-invasive measurement tool for capturing characteristic changes in physiological processes that arise during NeuroPhysics therapy. Unfortunately, current methods for analyzing thermal imaging data are limited in their inability to quantify fine grained changes in temperature across a variety of time scales changes that are a hallmark of complex biological systems and may provide insight into the underlying processes that give rise to important physiological phase transitions during NeuroPhysics therapy. These data will be analyzed using novel, entropy-based analysis techniques derived from more classic nonlinear analysis tools such as recurrence quantification analysis. They will also be compared to similar measures of electrophysiological activity to understand thermographic changes at multiple time and biological scales. The second talk will conclude with a discussion of future applications of such methods to advance the understanding of system-wide synchronization and coordination in biological systems more generally, and will introduce a methodological framework for identifying transitions in system dynamics from pathological dysfunction to healthy, efficient function.

The Antifragile Athlete: A Preliminary Analysis of the Association between Neuromotor Dynamics and G-Force Impacts Sustained during Sport

Adam Kiefer, **Christopher DiCesare**, **Kim Barber Foss**, Division of Sports Medicine, Cincinnati Children's Hospital Medical Center
Patrick Nalepka, **Michael Riley**, Center for Cognition, Action & Perception, University of Cincinnati
Ken Ware, NeuroPhysics Therapy Institute
Paula Silva, Center for Cognition, Action & Perception, University of Cincinnati
Gregory Myer, Division of Sports Medicine, Cincinnati Children's Hospital Medical Center

The majority of the 3.5 million sports-related pediatric injuries result from falls and collisions with other athletes. To promote antifragility (i.e., increased intermittency in muscle tonus dynamics and lower injury risk), we have previously advocated new training principles to facilitate neuromotor adaptations—a necessary precursor to fluid, efficient transitions between various stable states of motor behavior. We proposed that lower values of the recurrence measure percent laminarity (%LAM) may index greater antifragility in the context of neuromotor dynamics. The present study examined the association between pre-season dynamics of neuromotor control and collision-based *g* forces during a competitive high school ice hockey season (N=12 male athletes). Prospective measures of center of pressure (CoP) dynamics prior to each athlete's motor response to an unpredictable movement stimulus and the eyes closed resting state electroencephalography (EEG) dynamics were assessed. Over the monitored season, the total experienced *g* forces were measured via helmet-mounted wireless accelerometers. A Kendall's tau-b correlation coefficient indicated a significant relation between preseason measures of CoP %LAM and in-season *g* forces experienced (τ_b = .527, p = .024): lower CoP %LAM (i.e., greater intermittency) was associated with fewer experienced *g* forces. Additionally, CoP %LAM was modestly correlated with resting-state EEG %LAM in the frontal region (τ_b = .422, p = .089) indicating potential system-wide coherence of intermittent dynamics. These results support the notion that athletes who exhibit greater impermanency of neuromotor dynamics (i.e., antifragile characteristics) may be better poised to avoid collisions, and potentially injury, during sport.

Banquet Keynote: The Temporal-Space Mysteries of a Complex System: Performance of an Instant in Time

Gus Koehler Time Structures, Inc.

Multiple time-space dimensions shape the ongoing dynamic performance that is a complex system. Complex systems from an everyday perspective contain the whole range of who we are: as performance at all scales; as embodied (cellular, etc.); as human shaping of somatic flow (how of the forming of action); as awareness-mind-consciousness (perception), cognitive, artistic poetic, moral, etc. Let's go where few have gone before; let's speculate and theorize about how analytical concepts like "time-ecology", "heterochrony", and "temporal signature" might reveal and even shape such a performance and what they might have to tell us about the life of complex systems.

First, we are time; it is uniquely known by living systems. The Time that *we* can only directly know, are and shape is lived, relational time in an instant with other sentient organisms embedded in five temporal realities at any one instant point or now. A complex system is a time-ecology of performed relational time across these temporalities, each temporality having its own unique causality and linked to biotemporal time by various fabrications like scientific instruments, dance, poetry, and

all the other elements of the poetic. Complex systems exhibit a propensity to unfold or grow in a particular way shaped by how these temporalities come together as instants. The performance of any node or link or their acting together as network is the convergence of past-present-future perspectives at an instant. This tentative direction is not strictly predictable from an understanding of causal relationships, but it can be partially intuited if the full range of reason is available and listened to.

Most of the rest of my presentation will focus on applications and implications. I will speculate on how these ideas might apply to some of the areas that I have thought about: disasters, computer simulations, the Feigenbaum diagram, public policy making, Dante-God space, virtual reality, traffic and communication technologies, and battlefields. I will also briefly explore the possible implications of a possible temporal category error for public policy and climate change. My hope is provide you with at least the beginnings of a new perspective to view your research and personal world from.

Complexity in Applied Educational Research: Conceptual and Methodological Issues

Matthijs Koopmans Department of Education, Mercy College

In education, there has been a proliferation of publications over the past decade and a half that discuss or promote complexity theory as an alternative to the traditional linear paradigm that still predominates in research and policy. The educational literature now contains references to complexity in the discussion of issues as diverse as educational reform, learning systems, curriculum, high school science, pedagogy, research methods, epistemology, classroom dynamics, English as a second language learning, spirituality, creativity and ethnics. As in other disciplines, the degree of transparency with which the idea of complexity is put forward varies considerably, and some clarification may therefore be beneficial. The purpose of this presentation is to define complexity as a construct for the field, focusing on two interrelated issues. 1) The historical roots of the term in information theory, cybernetics and general systems theory, as well as complexity at the edge of chaos. 2) The shifting priorities that materialize in educational theory and research reflecting the use of complexity theory as a paradigm. Is there a paradigm shift in the Kuhnian sense? It is proposed instead that to really understand educational processes, complexity theory needs to attain a status in the field equal to that of normal science by challenging its unquestioned assumptions, qualifying its findings and developing alternative questions and approaches. In the end, the two perspectives should work together to attain a deeper understanding of the mechanisms underlying stability and transformation in the educational process and its institutions.

Self-organization in the Dreaming Brain

Stanley Krippner, Saybrook University
Leslie Allen Combs, California Institute of Integral Studies

Self-organization in the Dreaming Brain Stanley Krippner and Leslie Allan Combs Chaos theory permits the reconciliation of brain-based and content-based attempts to understand the nature of dreaming. The brain can be understood as a complex self-organizing system that in dreaming responds to subtle influences such as residual feelings and memories. The hyper-responsiveness of the brain during dreaming is viewed in terms of complex chaotic-like systems to respond to small variations in initial conditions (the "butterfly effect") and to the amplification of subtle emotional and cognitive signals trough the mechanism of stochastic resonance, all in combination with psychophysiological changes in the brain during both slow wave sleep and REM (rapid eye movement) sleep. Such changes include the active inhibition of extroceptive stimulation and, especially in REM sleep, alterations in the brain's dominant neuromodulatory systems, bombardment of the visual cortex with burst of PRG activity, increased limbic system activity, and a reduction of activity in the brain's prefrontal regions.

An Exploration of Complexity Theory in Managing Difficult Projects

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Ashok K Pundir, National Institute of Industrial Engineering (NITIE)

The dominant discourse on managing projects is based on assumptions of linearity even while practitioners of project management continue to struggle with time and cost overruns. Although complexity is a recurrent theme in several project management studies, the theory is yet to be understood sufficiently, accepted and implemented in practice. The dichotomous postures implicit in the two worldviews suggest the need for a coherent framework and further research. This paper attempts to understand the project phenomenon so as to explore alternative courses for an appropriate project response of an organisation. We suggest that managing projects requires an acceptance of multiplicity of views and contexts and the underlying social life that drives various interactions. Studies in project behaviour indicate that complexity arises, in part, due to an assumption of order ignoring the dynamic organisational context. Coexistence of order and uncertainty in a project environment suggests that an understanding of the uniqueness is essential in critical decisions on the right leadership style and project team. We propose that complexity is not an attribute of a project per se, but rather of the capability of the project organisation vis-a-vis that project. This suggests that one cannot have a prede-

termined method to achieve the end results. Rather, the manager must be sensitive to the context, accept diversity of views and methods, and allow the method to emerge from the interactions between the project and the context. Thus, project managers might be better off if they strive to orient the progress towards desired outcomes.

Love Affair Dynamics with One Delay in Losing Memory or Gaining Affection

Akio Matsumoto, Chuo University
Ferenc Szidarovszky, University of Pécs

A dynamic model of a love affair between two people is examined under different conditions. First the two-dimensional model is analyzed without time delays in the interaction of the lovers. Conditions are derived for the existence of a unique as well as for multiple steady states. The nonzero steady states are always stable and the stability of the zero steady state depends on model parameters. Then a delay is assumed in the mutual-reaction process called the Gaining-affection process. Similarly to the no-delay case, the nonzero steady states are always stable. The zero steady state is either always stable or always unstable or it is stable for small delays and at a certain threshold stability is lost in which case the steady state bifurcates to a limit cycle. When delay is introduced to the self-reaction process called the Losing-memory process, then the asymptotic behavior of the steady state becomes more complex. The stability of the nonzero steady state is lost at a certain value of the delay and bifurcates to a limit cycle, while the stability of the zero steady state depends on model parameters and there is the possibility of multiple stability switches with stability losses and regains. All stability conditions and stability switches are derived analytically, which are also verified and illustrated by using computer simulation.

HRV Quantifies a Normal Corridor for Entropy Useful for Clinical Conditions

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Olinto Linares, Dept. of Pulmonology, Intermountain Medical Center, Murray, UT

Background. Heart-rate variability (HRV) is the variation in time interval between one heartbeat and the next. While linear analysis of HRV predicts structural heart disease-mortality risk, linear parameters do not address disease evolution. In comparison, HRV studied with nonlinear tools reveal system dynamics. Entropy of HRV quantifies changes in system complexity. Entropy analysis of patterns of heartbeats collected during sleep and wakefulness in healthy people has not been described. Aim: A normal corridor for entropy of HRV in healthy volunteers is described against which pathological conditions and treatments may be measured. We explain the usefulness of this corridor with examples from our research on clinical conditions. Methods. HRV was derived from 24-hour ambulatory ECG (Holter) from healthy male/females. Approximate entropy (ApEn) algorithm using 5-minute-moving window, without overlapping, quantified regularity or unpredictability. We correlated ApEn with Dynamic Poincare plots during various sleep stages and wakefulness. Results. For normals, entropy during sleep was smaller than during wakefulness. Within sleep the largest entropy occurred during dream sleep (REM) and transitions between sleep stages. Correlation of ApEn with Dynamic Poincare plots showed REM having the most widely distributed Poincare pattern, while deep sleep has the smallest, least distributed pattern. This information lead to definition of the normal corridor for ApEn HRV. We use this corridor to characterize Depression (before/after) treatment and to distinguish Traumatic Brain Injury (TBI) from TBI+PTSD. Conclusions: HRV complexity, measured by ApEn, describes a normal corridor in health. ApEn may be useful in early diagnosis and in quantifying healing in various clinical conditions.

Nonlinear Analysis of Heart-Rate Variability in U.S. Military Service Members with Post-Concussive Syndrome after Mild Traumatic Brain Injury

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Background: Post-Concussive Syndrome(PCS) after Mild Traumatic Brain Injury(mTBI), often with Posttraumatic Stress Disorder(PTSD), includes stress-intolerance, sleep disturbance, anger and impaired problem-solving. Heart-rate variability(HRV), a series of interbeat intervals, tracks response to environmental change. Linear analysis of HRV in PCS revealed associations between HRV and select vestibular, visual, neurological and neuropsychological abnormalities. Aims: Can nonlinear analysis of HRV distinguish categories of PCS? Methods: HRV from 24-hour ECG(Holter) in 61 male-active-duty/veteran U.S.Service Members with PCS/mTBI at baseline was processed(NevroKard,Matlab). Age-adjusted statistical models were examined for

associations between injury-type, mTBI and mTBI+PTSD as part of a Department of Defense*(DoD)double-blind clinical trial determining response to hyperbaric oxygen or sham. We present HRV results from nonlinear analysis of sleep. Results: Entropy increased with age for participants with recent blast injuries while it decreased for blunt force injuries (p=0.037). Short-term variability(SD1) from Dynamic Poincare decreased with age for blast and increased with age for blunt-force injuries (p=0.015). SD1 was smaller for blast (median=35, range=[11-152]) then for blunt-force injuries (median=54, range=[24-91]). Both SD1 and long-term variability (SD2) were larger for multiple injuries and for those injured 1-5 years previously.The smallest SD1 was found for mTBI+PTSD (median=31, range=[11-108]) vs. mTBI alone (median=50, range=[19-152]) with age a potential separator (p=0.11). Detrended fluctuation analysis slope discriminated between mTBI+PTSD and mTBI alone: (0.979 = median, range = [0.886-1.121]) vs. (0.945 = median, range = [0.815-1.081]; p = 0.016). Conclusions: Recent linear analysis of HRV measured proportional change in PCS compared with published normals. Nonlinear analysis, by maintaining both timing and sequence of heartbeats, reveals state changes, differentiating categories of PCS/TBI. **Opinions, interpretations, conclusion, and recommendations are those of the presenter and are not necessarily endorsed by the other members of the HBO2 research consortium, the U.S. Army Medical Research and Materiel Command, or the Department of Defense.*

Poster: **ERP Analysis: Using a Third Order Coupled Oscillator Model**

A. K. Munion, **Jon Butner**, **Matt Euler**, **Tyler McKinney**, Psychology, University of Utah

Traditional EEG analytic approaches for examining event related brain dynamics tend to be restricted to point estimates such as peak amplitude or latency. As an alternative to classical approaches of ERP analysis, we propose a differential structural equation model which captures the dynamics of the EEG signal over the course of the brain's response to a stimulus. Our model results in a description of the oscillatory properties, in terms of frequency, damping, and coupling. Participants were shown different slides indicating a sequence of movements they then had to perform, while the familiarity of any given slide was psuedo-randomized. The data was then collapsed across slides, into conditions of first through fourth exposure to a stimulus. We selected two electrodes near the posterior parietal cortex for this analysis, which captured visual perceptual processing. We estimated the third-order (position, velocity, acceleration and jerk) differential coupled oscillatory model to characterize the emergent patterns produced by two electrodes over stimulus responses. This model provides tests of if the ERP signal is attracted to, or moves away from a stable pattern over time. Further, we test to see if activity at the two different electrodes tends to create coupled patterns over time, also allowing for a test of node synchrony, which further clarifies the phasic behavior. The coupled damped oscillator is an acceptable description of this data. This model offer an alternative framework to describe ERP patterns emergent over task repetition, and thus an alternative way to conceptualize ERP data analysis.

Centering on Topology: Using Centering in the Dynamic Decomposition of GPS Tracks

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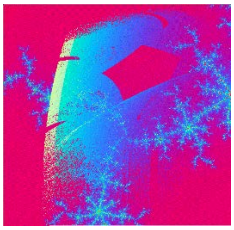
Ericka Rovira, Department of Behavioral Sciences & Leadership, U.S. Military Academy
Michael Hendricks, Department of Geography & Environmental Engineering, U. S. Military Academy

GPS data was collected from cadets at U.S. Military Academy at West Point during their annual land navigation assessment. Participants were asked to find 3 flags using only a map and compass, in a 6km2 heavily forested area. A subset of cadets was randomly selected for exploratory analyses, due to the large amount of data for each participant. An emphasis was placed on the interplay between the topological features of the real world environment, which contained hills, trees, lakes and valleys, and the way in which cadets moved within the space. The latitudes and longitudes were centered on the topological features - in this case the highest feature in the environment. Using latent change score SEM models, the spatiotemporal patterns of participants as they completed their navigation tasks were decomposed into their second order dynamic properties. With the use of the centering to different locations, the interpretations of the parameter estimates become the way in which the cadets are attracted or repelled from or oscillating around the topological feature. That is, the interpretation becomes the dynamics of how the person's movement over a physical space interacts with one particular piece of the environment, over time. These results give a theoretical implication of how centering can be used within dynamical systems, as well as a more interesting categorization of how cadets are moving through real world space during their navigation task.



From Nothing to Something: How Basketball Spread Across the Globe

Derek Paar, Department of Psychology, Springfield College
Dennis Gildea, Department of Sports Journalism and Communication, Springfield College

One hundred twenty five years ago in December, a few days before Christmas Vacation, in a class at the six year old International Young Men's Christian Association Training School (now Springfield College), a homework assignment aimed at calming unruly young men who felt cooped up in a gym gave birth to an activity that became a game that became a sport that is now played in every country on earth by over a half billion people. This presentation will explain how the unique cultural, personal, religious, and historical conditions of that time and place helped account for the invention of basketball. We will also argue that basketball grew in popularity so quickly because of the lack of a central organizing body and unpredictable large-scale events such as two world wars. In other words, basketball can be seen as a dynamic system that grew from nothing to something because of sensitive dependence on initial conditions and self organization.

A Patient-specific Model for Hyperthyroidism Treatment in Graves' Disease

Balamurugan Pandiyan University of Wisconsin

Graves disease is an autoimmune disorder of the thyroid gland caused by circulating anti-thyroid receptor antibodies (TRAb) in the serum. TRAb mimics the action of thyroid stimulating hormone (TSH) and stimulates the thyroid hormone receptor (TSHR), which results in hyperthyroidism (overactive thyroid gland) and goiter. Methimazole is a medicine used for hyperthyroidism treatment for patients with Graves disease. We have developed a patient-specific model for hyperthyroidism treatment using a system of ordinary differential equations. With a bifurcation parameter, we simulate the time-course of patients progression from hyperthyroidism to euthyroidism (normal condition). We validated the model predictions with a patient dataset.

Short Workshop: **Experiential Balancing Therapy (EBT): An Integrative Theory and Approach Grounded in Nonlinear Dynamical Systems Science**

David Pincus Chapman University

Experiential Balancing Therapy (EBT), which is based on principles from complex adaptive systems (CAS) theory, combines a broad variety of empirically validated approaches including: cognitive-behavioral, humanist-experiential, and psychodynamic approaches. The basis for integrating these seemingly disparate approaches rests in the understanding that all psychotherapies share two complementary structural goals: (a) expanding people's experiential flexibility and intentionality; and (b) maintaining or improving the systemic integrity of people's flow of experience. This talk will briefly introduce: the theoretical grounding for the approach; key concepts that are used in case formulation; rubrics for clinical assessment, and some mainstream techniques reconsidered from a structural perspective. Although the vast majority of techniques used within the approach have already been empirically validated for a variety of psychological problems, a plan for empirical testing will be described focusing on process, efficiency, and on structural resiliency-based outcomes.

Fractal Conflict Dynamics in Dating Relationships

David Pincus Chapman University

Previous research has demonstrated that interpersonal dynamics are fractal, and that conflict is a key control parameter for fractal complexity (Pincus, 2015). The present study aimed to extend this line of research to examine conflict dynamics over time in dating relationships. An experience sampling methodology was used to assess conflict, relationship satisfaction, and commitment levels three times daily for 30 days (n = 90) for 18 undergraduates self-identifying as being in a monogamous relationship. Hypotheses: (1) ratings of conflict will conform to a fractal distribution, with exponentially more small conflicts than large ones; (2) moderate levels of fractal dimension (i.e., flexibility) will be associated with higher levels of relationship satisfaction above and beyond mean conflict levels. Hypothesis 1 has initial support based on fit of the combined data across the 18 participants (N = 1620; R^2 = 0.949, fractal dimension = 1.783). In addition, both satisfaction (R^2 = .898, fractal dimension = 2.918) and commitment (R^2 = .926, fractal dimension = 4.254) appear to be fractal as well. Hypothesis 2 was not yet fully tested, pending more participants and a modification to the Likert scale to increase its sensitivity (i.e., too many individuals had conflict ratings with a maximum of three on the Likert scale).

"Being in Uncertainties:" A Perspective on Teaching and Chaos

Diane Rosen State University of New York

Contemporary pedagogy views education as a closed linear system, privileging outcome-driven methods that largely constrain critical and creative thinking. This presentation draws on a nonlinear dynamical systems

perspective to contest that approach. It is argued that the reading-writing-learning experience, a complex interactive process, is more effectively supported by means of flexible classroom practices such as inquiry. Discussion focuses on "Methods of Inquiry," the program I designed and taught as a Curriculum Consultant for Student Press Initiative at Columbia University in partnership with a NY City high school. Elements explored include: cultivating curiosity, challenging assumptions, embracing uncertainty, building on disruption and surprise. Because chaos theory emphasizes principles central to the emergent nature of meaning-production, it is a vital paradigm for authentic teaching and learning that values not only the unexpected, but those non-rational modalities (dis-order) that generate new ways of knowing (order). This fundamental paradox was famously described by English poet John Keats as: "NEGATIVE CAPABILITY, when man is capable of being in uncertainties, Mysteries, doubts, without any irritable reaching after fact & reason." Dynamic inquiry stimulates a similar kind of energized, productive disequilibrium. Examples of student work illustrate how such infusions of curricular chaos, complex yet coherent, foster open-ended conditions essential for intellectual and creative growth across disciplines.

The Measure of Fractal Action Complexity as a Cross-cutting Unit of Analysis for Fractal Physiological, Psychological, and Social Dynamics

Sara Nora Ross Neurotricional Sciences Education Pty. Ltd.

A common unit of analysis for efforts that study dynamic systems is both desirable and, as argued here, available. Such a unit enables measuring actions and series of actions—i.e., coordination dynamics—performed by entities at any scale. These may be more simple (e.g., sensory or motor; sensorimotor, e.g., a cellular protein channel; a heart) or more complex (e.g., human physiology; some adults' reasoning and decision making). The scope of an analysis is tailored to the need. The unit of analysis permits measuring action with coarse- or fine-grained attention, including phase transitions (as long as knowledge of an entity's components and environment is commensurate with the analytical interest). The variability and extent of action analysis and fractal transition detail available differs by three tiers of entity-capacity: structural constraints, existence of a nervous system, and brain structure. Dependent behavioral dynamics over time that are also discontinuous in time can be coded and tracked. An implication for exploiting this unit of analysis is the ability to code and re-analyze data. Its use may reveal coherence undetectable without it; dynamics previously interpreted as white or brown noise may not be so. Based on previous work by the author and others, a range of entity and behavioral examples apply the unit of analysis. Such a universal unit of analysis for entities that act may afford new next steps in many fields of study to further investigate *how* dynamic systems do what they do, and *why*.

Cortisol Synchronization in the Intentional Interpersonal Relationship

Janice Ryan Occupational Therapy Department, University of Tennessee, Chattanooga

A central conceptualization throughout the history of occupational therapy has been the therapeutic relationship and therapeutic use of self. By applying nonlinear models developed by Walter Freeman related to the Intention-Meaning-Perception circular causality and by Glenda Eoyang related to the adaptive action cycle, the intentional relationship that can lead to biopsychosocioemotional healing is being clarified for further study. The presenter will discuss her currently developing practice-based research strand related to the influences of cortisol in healthy as well as troubled interpersonal relationships. Her current research studies are on interventions believed to have the capacity to facilitate biopsychosocioemotional healing of mood disorders and post-traumatic stress reactions that negatively influence interpersonal relationships. Supportive research on mindfulness, mindful therapy and human-animal bonding will be reviewed. Potential enhancements of this cortisol synchronization process will be discussed when treatment occurs within personally preferred therapeutic environments of two types: multi-sensory environments and virtual contexts. Invited discussion will follow related to the promising use of convergent cross-mapping (CCM) of time series data for nonlinear causality using state space reconstruction to measure therapeutic outcomes.

Visions of Stability and Change in Physiological and Social Systems

David Schuldberg Department of Psychology, University of Montana, Missoula

The idea of a fundamental stability in physiological systems -- as well as in the body politic -- can be traced to ancient times, coexisting with parallel pictures of development and change. In physiological systems these ideas flowered in Claude Bernard's description of the milieu intèrieur and Walter Cannon's wisdom of the body or homeostasis. Homeostasis has also been generalized to social systems and was particularly well articulated in family systems theory. In a 1996 SCTPLS meeting I discussed how nonlinear dynamical models pointed beyond homeostasis for our thinking about living systems. This paper reviews historical precursors of

homeostasis, as well as summarizing Bernard's and Cannon's views. Next, it describes subsequent revisions of the idea, the motivations behind these changes, and the sometimes colorful terms given to its modifications, elaborations, and extensions, including hetero-stasis, allostasis, anhomeostasis, rheostasis, homeokinetics, homeodynamics, and morphostasis. These revisions have acknowledged variability in everyday and healthy functioning, the multifactorial and multivariate nature of biological systems, the fact that regulative set points can change, the wide range of possible computational approaches to regulation, the role of anticipatory, feed forward, deviation-amplifying and negative feedback, as well as change and emergence in self-regulative systems. The paper concludes by arguing for a broader formulation of physiological and social stability in terms of stationary states.

Complexity at the Root of Psychoanalysis: A Freudian Leap Revealed by Overdetermination

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Despite abundant research in psychology and social sciences integrating complexity and NDS, psychoanalysis has just started to see the tip of the iceberg. With some remarkable contributions around the world, NDS have already been proven of use to psychoanalytic thought. Nonetheless, there are still a number of challenges for its consolidation, and these approaches have yet to encounter widespread integration in most 21st century psychoanalytic circles. Why is this, and what new paths have yet to be forged? Due to epistemological misunderstanding, psychoanalysis is sometimes still considered as a linear and reductionist model. This misconception not only comes from some contemporary critics, but also unknowingly from some psychoanalysts themselves. My hypothesis is that by identifying the complex roots within psychoanalysis, as proven by the Freudian notion of Overdetermination, we might help to clear up this confusion, and thus catalyze further acceptance of NDS as a valid model for psychoanalysis. The particularity and usefulness of this procedure stems from working inside our own system, therefore avoiding certain resistances to change ensuing from its perception as an outside factor or fad. We will see how the notion of Overdetermination (also multiple determination), created alongside psychoanalysis, is both, a primordial key to appreciate its effort to cognize the human psyche, as well as proof of an epistemological transformation that we will call the Freudian Leap: the stemming away from a purely classical linear deterministic model, and the movement towards the realm of what we can now conceive as complexity and NDS.

NeuroPhysics Therapy as a Potential Approach for Prevention of Epileptic Seizure: A Preliminary Analysis

Tom Ware NeuroPhysics Therapy Institute
Adam Kiefer Div. of Sports Medicine, Cincinnati Children's Hospital Medical Center; Dept. of Pediatrics, College of Medicine, University of Cincinnati; Center for Cognition, Action & Perception, University of Cincinnati
Ken Ware NeuroPhysics Therapy Institute

Epilepsy affects approximately 65 million people globally, with 150,000 new cases diagnosed in the U.S. annually. Over 30% of these individuals suffer an unacceptable quantity of seizures despite reasonable treatment. At present, there is no reliable means of seizure prevention. Decades of conjecture about causes of seizures led to agreement that these events arise from a rigid orderliness (i.e., over-synchronization) of brain regions, reducing the body's healthy, rhythmic variability. It has been further hypothesized that the seizure is the body's way of disposing excess energy. If so, this is similar to the energy dissipated from the earth's crust during an earthquake, and, importantly, the distributions of seizure energy flows and recurrence times are similar to that of earthquakes. Data from the use of NeuroPhysics Therapy (NPT) consistently indicate increases in the nervous system's variability and complexity. Thus, it may be possible to use the increased complexity of the body's response to NPT to remove the system's build-up of orderliness by preventing the conditions giving rise to it. These effects may, ultimately, prevent a large seizure episode. In this talk, data will be presented from four cases of epileptic seizure to examine the physiological changes associated with NPT. Nonlinear measures of synchronization and entropy are explored. Results are discussed in the context of seizure dynamics, NPT techniques, and possible seizure prevention.

Synchronizing Family Science with Edward Lorenz to Build a More Culture-Friendly Household Chaos Theory

Corey Whitesell University of Rochester

Much like in chaos theory, in *household chaos theory*, the family system is unable to achieve individual and relational equilibrium producing unpredictable patterns. In family science, household chaos traditionally describes a disordered home environment, with patterns of activity and interactions that are more irregular than regular. Unpredictable patterns offer poor reinforcement for socialization strategies that caregivers need to convey to children through consistent messages that build in complexity. Household chaos strays by specifically defining parameters of positive and negative family patterns, rather than identifying disrupted

patterns as they exist in the family, and defines them with an implicit bias for dominant culture patterns. Standardizing patterns may produce orderly data, but in the study of human relationships, the antithesis of chaos is not order but instead patterns that promote wellbeing. These patterns are embedded in the family's culture, providing the structure for, not just how and when to socialize, but why socializing is important. It is this why that connects children to a deeper sense of internalized meaning. By marginalizing family practices that fall outside the dominant culture parameters, meaningful, stable family patterns are misidentified as chaotic. This paper offers a modified version of household chaos theory that requires first identifying household patterns meaningful to the family and as they exist in the family, then identifying patterns that have been disrupted. By synchronizing these two theories, future work could better identify truly chaotic family systems whose poor family regulation is independent of culture or other sources, as suggested in chaos theory.

Changes in Dimensionality and Fractal Scaling as Evidence for Softly-Assembled Dynamics in Human EEG

Travis J. Wiltshire, **Matthew J. Euler**, **Jonathan E. Butner**, **Ty L. McKinney**, **A. K. Munion**, University of Utah

Soft-assembled dynamical systems are comprised by components that are temporarily formed, task specific synergies. Rather than components of the human cognitive system being fixed, soft-assembly presumes a flexible dynamic where the system self-organizes to functionally, and often efficiently, meet the demands of a task or situation. In prior work, the primary evidence that a system is softly-assembled has taken the form of fractal scaling relations. We argue that the evidence for soft-assembly can be strengthened by demonstrating that a system exhibits: (a) changes in dimensionality under various conditions or tasks and (b) changes in the fractal scaling exponents. We conducted an experiment in which we recorded electroencephalography (EEG) from 18 participants completing the classic and inverted visual oddball tasks. Across the conditions, we compared pre- to post-stimulus event related potentials (ERP). For the ERPs prior to (pre) and following the stimulus (post), we estimated the correlation dimension and fractal scaling exponents. Overall, we found that the dimensionality significantly decreased from pre-to-post stimulus and the fractal scaling exponents significantly increased from pre-to-post stimulus. The change in dimensionality suggests that following the stimulus, cortical activity in the brain is more coordinated and requires a lower dimensional structure to process the stimuli. The fractal scaling changed from the pink to brown noise range, suggesting that prior to the stimulus the cortical structures exhibited long range temporal correlations that transitioned to a non-stationary process. We discuss our findings and suggest two additional metrics for future work to examine as evidence for soft-assembly.

Quantifying Stress Using mDFA: An Empirical Study for a Practical Method of Heartbeat Analysis

Toru Yazawa, Tokyo Metropolitan University

We recently made a method for analyzing the healthiness of the heart. Our method is: modified detrended fluctuation analysis (mDFA, Yazawa 2015 ASME Monograph Book). With mDFA, we looked at the cardio-vascular system as a whole. The true test of any technology is, how well it works in a real-life operational setting (Reginald Brothers, NASA, May7, 2015). We thus present empirical results of mDFA-tests, to quantify stress through the heartbeat (electrocardiograms, EKGs) recordings, including job-related stressful EKG, caregiver *fs* stressful EKG, as well as stress/fear EKG-response of model animals, lobsters and crabs. The method did not require sophisticated technical training or complicated mathematics. Our method is a kind of tailored medicine, that is, observing subjects one by one without big statistics. We present a single universal result: Healthy individuals may show a scaling exponent near 1.0 and unhealthy subjects show a decreased scaling exponent.

Officers' Club, Ft. Douglas, Univeristy of Utah, where the SCTPLS meetings were held.

Graphics credits: The Helping Fractal Hand, by J. C. Sprott. Cover fractal also by J. C. Sprott.