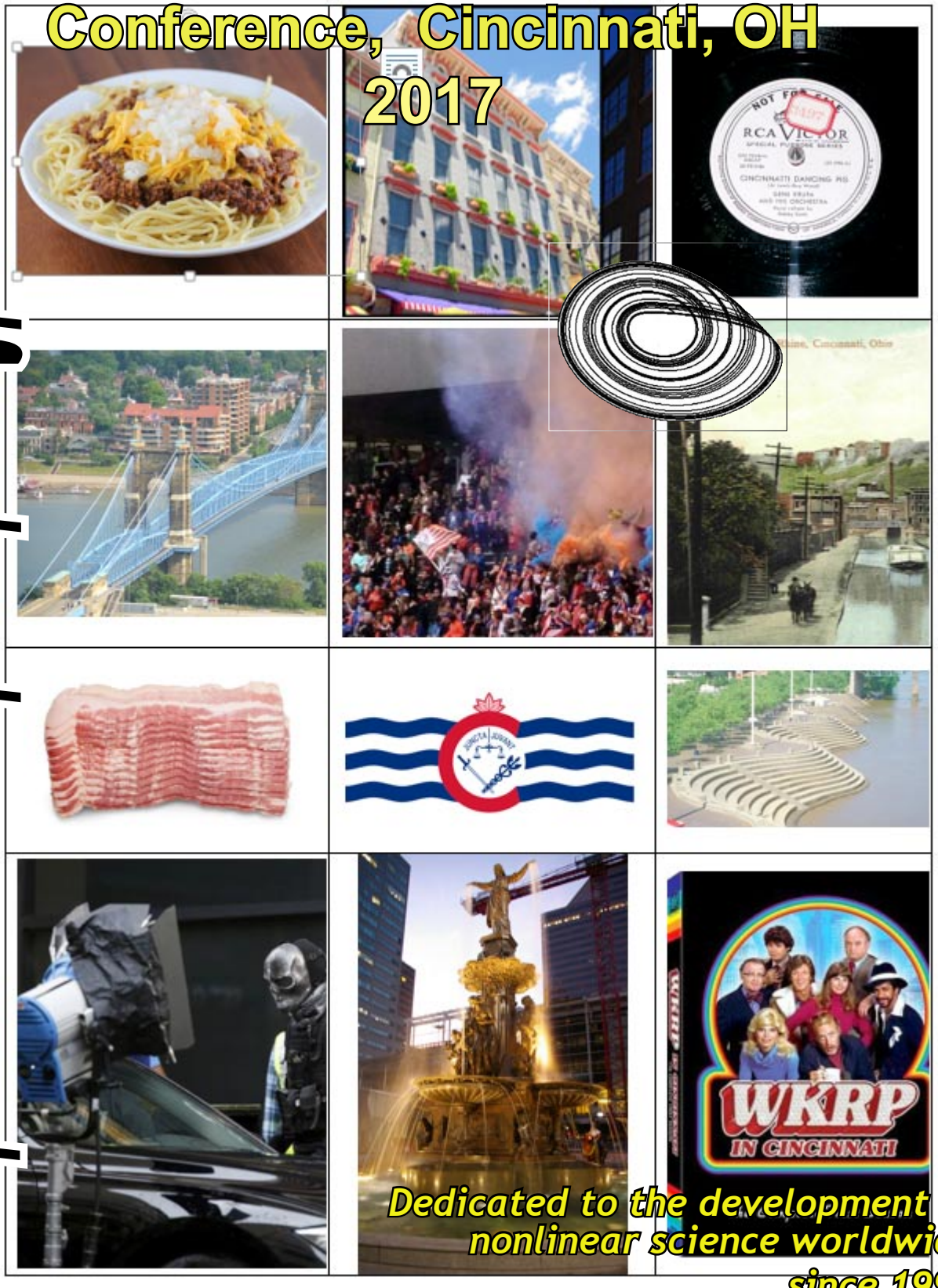
Society for Chaos Theory in Psychology & Life Sciences

Abstracts to the 27th Annual International Conference, Cincinnati, OH 2017



Dedicated to the development of nonlinear science worldwide since 1991

27th Annual International Conference
of the Society for Chaos Theory in Psychology & Life Sciences

Cincinnati, Ohio, August 11-13, 2017

Keynotes Speakers' Abstracts

Warren W. Burggren, Developmental Integrative Biology
University of North Texas, Denton, TX, USA

DEVELOPMENTAL PLASTICITY, EPIGENETICS AND EVOLUTION: NONLINEAR THINKING IN TRADITIONALLY LINEAR BIOLOGICAL FIELDS

Oft quoted is Theodosius Dobzhansky's 1973 statement that "Nothing in biology makes sense except in the light of evolution." While that statement continues to be timeless and ever-relevant, what *is* changing is our understanding of the mechanisms that underlie evolution and the evolutionary process. Long-viewed as a constant, inexorable process (*phyletic gradualism*), Stephen Gould and others since have promoted the idea of evolution as a *saltatory* or *punctuated equilibrium* process, in which long periods of stability in a species are suddenly interrupted by rapid changes that lead to the formation of new species.

Against this backdrop, the "new kid on the evolutionary block" is the burgeoning field of *epigenetics.* A major sub-component of this field is epigenetic inheritance, in which traits of the parents are passed on to offspring – that is, inherited - *without changes in gene sequence*. Importantly, epigenetic inheritance can occur suddenly in response to an environmental stressor (temperature, low oxygen, oil pollution), can affect large proportions of a population, but – and this distinguishes epigenetic inheritance from genetic inheritance – can subsequently be sunsetted as the environmental stressor wanes.

Yet, to paraphrase Dobzhansky, nothing in epigenetic inheritance makes sense except in the light of phenotypic plasticity. Long recognized but not well understood, *phenotypic plasticity* describes how multiple phenotypes (physical forms) can derive from a single genotype (DNA template). These phenotypes are sometimes unpredictable and are especially plastic during development, which can be driven by environment stressors along one of a multitude of nonlinear pathways. Using both theoretical and actual examples from developmental, environmental, and evolutionary biology, this presentation will describe how very small changes in environment can potentially lead to large, nonlinear changes in an organism's phenotype, which may then persist across generations and ultimately lead to speciation.

Heidi Kloos, Ph.D., Department of Psychology
University of Cincinnati, Cincinnati, OH 45229

STEM LEARNING AND NETWORK THEORY: PROMISE OR FAD?

While advances in complexity science and network theory have improved our understanding of physical, chemical, biological, and social systems, these advances have only sparingly reached the field of education. This is surprising, given that education is lamented widely as needing an overhaul. In the current talk, I will trace ways in which network theory can inform effective pedagogy, focusing on elementary school math and science education. These two STEM areas have enjoyed attention in the last decade, with a sharp increase in funding to support educational initiatives. Yet the learning trajectory of students has remained flat, even showing some decline. It is time to step back and take a closer look at the mind's activities when asked to learn content outside of what it has evolved to learn spontaneously. What can network theory offer to change the stagnant trajectory of children's STEM learning?

To understand the learning mind, we use insights from the theory of *adaptive evolving networks*, characterized by (1) a drive towards balancing network sensitivity to external fluctuations, and (2) a drive towards balancing internal cohesion among network elements. Using the ecosystem as an example, I will show how these both are necessary and sufficient to capture the dynamics of adaptive evolving networks. They are also grounded in basic processes of synchrony and thermodynamics, carrying low theoretical costs. My claim is that knowledge is best thought of as such an adaptive evolving network, one that continuously balances external sensitivity and internal cohesion. This deviates sharply from traditional claims about the mind, shedding new light on processes of attention and memory.

In the last part, I will apply the theory of mental networks to STEM education. The claim is that an ideal learning context strengthens network sensitivity and network cohesion. Each aspect constitutes its own challenge; examples are provided in science and math education. To avoid negative outcomes, the learning context needs to be calibrated carefully to ensure a balance of sensitivity and cohesion.

Alphabetical List of Authors & Abstracts

Frederick David Abraham, Blueberry Brain Institute, Waterbury Center, VT

The Entanglement of Semiotics and Dynamics

The Blueberry Brain Institute and the Niccolo Cusano Italian University London Epistemology, ontology, objectivity, phenomenology, semiotics, complexity/nonlinear systems, cognitive neuroscience, and the Philosophy of Science. We will start with a network-type view of the 5,000 year evolution of Mesopotamian divination, in short its semiotics and implicative and empirical nature, likening it to the basic semiotic triangle, including a system s view of the triangle and cultural evolution as *mu*-bifurcational (cascade like). Hardy covered some of this in her Networks of Meaning. Then we will go into the analytical views of operationalism and the logical positivistic crisis in the Philosophy of Science, and Bridgman s recovery and his passion and his angst. We will then end with the attempt to reconcile objectivity and phenomenology in contemporary cognitive neuroscience and neo-pragmatism. An interesting feature of this process is its reliance on cultural and technological changes.

Faina Berezovskaya, Mathematics Department Howard University, Washington DC
George Karev, NIH, Bethesda, MD

Model of Greek Ornamental Design

In this work, we propose and study a simple model of a specific ornamental design which one can see in historical museums of Crete and Athens. The designs contain bands of different but fixed numbers of flowers (centers or spirals), spider webs and stars. Boundaries of the bands may be smooth curves or may have be star-shaped; the bands are connected by lines. The proposed model represents a complex differential equation describing weak resonance [Arnold, 1977]. It depends on integer parameter *n*, a rotation number of a phase curve, that can be odd and even, and complex parameters A and B. We pay the close attention to the analysis of roles of parameters B and A in giving rise to different peculiarities of the repeated designs, in particular, the dynamical indeterminacy of corresponding model trajectories at different n. The model allows to trace the change and reconstruction of the design under variation of the parameters, and to animate and to construct some new ornamental designs.

Doris Bergen, **Mostafa Modir Rousta**
Miami University, OH

Creativity, Humor, and Play: A Dynamic Systems Neuro-Developmental Perspective

A number of theorists and researchers have discussed why many human development processes are best understood from dynamic systems perspectives (e. g., Fogel, 2011; Lewis, 2011; Spencer et al., 2011; van Geert, 1998). Three developmental phenomenon creativity, humor, and play-- have characteristics of dynamic systems with multiple interacting components involving brain neurological networks and body system changes. All three of these phenomena can be observed in initial forms in the developmental trajectories of very young children and they continue to have interacting trajectories through childhood, adolescence, and adulthood. This presentation will discuss aspects of their complementary synchrony, soft assembly, plasticity, disequilibrium, control parameters, attractors, and self-organizing features. The complexity of biological, genetic, social, and cultural influences on these developmental phenomena will be outlined and dynamics influencing sensitive dependence on initial conditions that may involve both microlevel and macrolevel system changes in their synchronous development throughout life will be suggested.

Ramon Castillo, Universidad de Talca, Chile
Heidi Kloos, University of Cincinnati, OH

Sticky Knowledge: The Role of Uncertainty in the Cohesion of Flow Network of Beliefs

Knowledge acquisition can be described as the emergence of flow networks networks of interconnected experiences that change locally to improve global network cohesion. The strength of this conceptualization lies in explaining the stability of mistaken beliefs when confronted with challenging evidence. Such resistance to perturbation cannot be explained by traditional computational models of learning. In the current paper, we expand on this idea and look for flags that predict the emergence of flow networks. The experimental set-up was a predictive-learning task. Trials were manipulated such that a simplistic strategy led to success in a subset of the trials, while a more advanced strategy led to success in all trials. Two patterns of performance were of specific interest: (1) start off well but then get worse over time (vs. continue to perform well), and (2) follow a simplistic strategy and then change to another simplistic strategy (vs. either get better over time or continue with the simplistic

strategy). These two patterns (to get worse despite training) were observed across three experiments, independently of our manipulation of task instructions, distribution of trials, and whether adults were explicitly told what to look for. Thus, getting worse in the face of training constitute an integral part of spontaneous mental activity. A flag of such unexpected patterns of performance is the degree of uncertainty in a group of adjacent trials. To test this hypothesis, we determined the change of uncertainty in non-overlapping epochs. Results partially confirm the hypothesis that uncertainty leads to increased network cohesion.

Shawn Daley , Biomechanics, University of Nebraska at Omaha, NE
Vivien Marmelat, Biomechanics, University of Nebraska at Omaha, NE

The Effects of Levodopa on Postural Complexity in Parkinson s Disease

Parkinson s Disease (PD) is associated with deleterious alterations to balance and postural control. Recent findings have evidenced that multifractal analysis of center of pressure (COP) displacement and velocity can provide insight into nonlinear control processes involved in quiet standing, i.e. postural complexity. Recent research investigating the effects of ON and OFF states of Levodopa an anti-parkinsonian medication - have demonstrated changes in postural strategies employed by PD patients. However, it remains to be determined how these changes in strategy relate to changes in postural complexity. The purpose of this study is to examine progressive changes of postural complexity in PD patients due to the onset of Levodopa. This will be achieved by measuring quiet standing (eyes open and eyes closed) in 15 PD patients before (OFF state), during (every 20 min after taking medication), and after full onset (ON state) of Levodopa. Principal Component Analysis (PCA) of kinematic marker data will be used to quantify principal movements in subjects' strategies, providing a fine-grained analysis of how subjects' postural strategies contribute to COP variance. We hypothesize that Levodopa will enhance postural complexity and this enhancement will be correlated to changes in postural control strategies displayed by PD patients.

Paula De Franco, **Stanley Krippner**, Saybrook University

The Dynamic Bridge Between Ego and Shadow

This essay elaborates on Jung's (1957) basic theoretical framework of the psyche of Self as a two-step mechanism involving ego/conscious and shadow/unconscious. These concepts set the groundwork in further support of Jung's concept of the bridge, a space where shadow and ego can be observed interacting and overlapping. Jung described this interaction as involving fluid, continuous, and random patterns of movement. Jung's framework is expanded upon by integrating Dynamic Systems Theory. The emerging model's framework also conceptualizes the latent construct of self-awareness, defined as the ability to become aware of one's Self. The result of this engineering is a new and dynamic psychological model from which the roots of behavior and the roles of factors such as economic inequality and poverty on human behavioral development can be examined. The bridge of self-awareness is a meme and blueprint which together map an individual's unique behavioral DNA while accommodating factors such as culture, ethnicity, religion, and gender. The Transaction Model of Self-Awareness is operation-alized by integrating Dynamic Systems Theory and its principles while expanding on Jungian theory (Thelen & Smith, 1994). This results in the novel discovery of the bridge where the psyche orders and unifies the ego and shadow. The term trigger is then introduced which expands on and is aligned with Jung's definition of a complex, a universal pattern of inter-related behaviors caused by internal conflicts. A key theoretical discovery introduced in this essay is that triggers occupy the role of a control parameter or gatekeeper in the first dimension of this dynamic new system of behavior referenced and envisioned throughout Jung's career (Jung & Hull, 1968; Thelen & Smith, 1994). Without question, this new theoretical framework challenges the most fundamental psychological assumptions we have about the metaphysical world. The Theory of Self-Awareness and the Transaction Model (De Franco, 2015) is supported by a bedrock of research and provides a measurable window where behavior can be observed for the first time which emerges from a few simple rules concerning the ego and shadow. The interaction between the two is observable in the overlap created between the new models' two dimensions (ego and shadow) and adheres to dynamic principles (Jacobi & Bash 1943; Jung & Hull, 1968; Thelen & Smith, 1994). The model's framework maps the entryway of external events from the environment that cause shifts in behavior when they are introduced into the system and unconsciously activate triggers. This creates an emergent new system that is made up of the external event, ego, and triggers (Thelen & Smith, 1994). A critical assumption underlying the Transaction Model's framework and the Theory of Self-awareness is the concept of the Self as the unit of analysis (Jung, 1957). The Transaction Model is a logical compliment to Jungian Theory and Dynamic Systems Theory. It is the bridge that closes the gap between matter and consciousness by demonstrating how material processes (external events) introduced into the system (behavior) affect consciousness and subsequent behavior patterns (Grof, 2012).

Daniel E. Dewey, VA Charleston, MUSC
David Schuldberg, **Allen D. Szalda-Petree**
University of Montana

Causality and Complexity in Negative Emotions and PTSD Symptoms

This paper extends work on the relationship between moment-to-moment fluctuations in the experience of negative emotions and the varying intensity of Posttraumatic Stress Disorder (PTSD) symptoms. Theory and past research suggest that negative emotions may influence both development and maintenance of PTSD. Yet, there is limited study of momentary interactions between emotions and the experience of PTSD symptoms. Time series data were gathered from 33 trauma-exposed participants using Ecological Momentary Assessment methods, 84 observations per participant. Previous work with this dataset broadly suggests that PTSD symptoms are dynamic and co-vary significantly with emotions. Evidence is evaluated here for causal links and their directionality among specific symptoms and emotions. In addition, possible complex deterministic processes are discussed potentially underlying the fluctuations themselves.

Austin Duncan, Vivien Marmelat, University of Nebraska at Omaha

Individual Relationships between Locomotor Dexterity and Stride to Stride Dynamics

Dexterity is the capacity to generate context-specific behaviors that align with the actor's goals; it is imperative for walking in a complex world. Individuals widely considered to be dexterous, i.e., young adults, also tend to display fractal stride-to-stride dynamics. Conversely, older adults present both lower walking dexterity and diminished fractal properties of their stride dynamics. Despite numerous studies finding that groups of older individuals exhibit changes in both fractal properties of walking dynamics and walking dexterity, the direct relationship between individual measures of walking dexterity and walking variability remains to be determined. We hypothesize that individuals displaying highly fractal stride-to-stride dynamics will perform better during a gait dexterity task than individuals with reduced fractal stride dynamics. 15 young adults and 15 elderly adults free of neurological disease will be recruited to participate in the study. Participants stride-to-stride walking dynamics we be analyzed during 15-minutes of treadmill walking at their self-selected speed. During a subsequent 15-minute bout of treadmill walking, participants will be unexpectedly tripped 10 times to induce a dexterous response. Participants' kinetic and kinematic response to the trips will be analyzed to determine their level of dexterity. Determining a strong relationship between these walking phenomena will both bridge the theoretical gap between walking dynamics and dexterity but also introduce walking dynamics measures as an integrated biomarker for gait dexterity allowing healthcare professionals a highly efficient means of measuring their patients' gait dexterity and risk for falls.

Austin Duncan, University of Nebraska at Omaha
Amy Hellman, University of Nebraska Medical Center
Vivien Marmelat, University of Nebraska at Omaha

Altering Stride Dynamics of Parkinson s Disease Patients utilizing Fractally Structured Auditory Stimulation

Healthy young individuals display fractal properties in their stride to stride dynamics, whereas individuals with Parkinson's disease (PD) display stride dynamics tending toward randomness. Fractal dynamics are theorized to manifest from highly adapted and dexterous individuals. Therefore, increasing the fractal stride dynamics of individuals with PD may indicate an increased dexterous capacity during locomotion. Auditory stimulation has been evidenced to alter walking in PD through increasing stride length and stride speed. However, traditional auditory stimulation is periodically structured, inducing a higher level of randomness in individuals stride dynamics. Therefore, we propose the use of a fractally structured metronome and fractally structured music with the hypothesis that these stimuli will induce similar increases in stride length and speed with concurrent increases in the fractal dynamics of stride to stride intervals, and that walking to the fractally structured music will be more enjoyable than to the fractal metronome. To test this hypothesis, we will recruit 15 PD individuals and 15 age-matched controls. Participants will walk around a 200m oval track with footswitches inserted in their shoes under three 15-minute conditions. The first condition will be utilized to assess baseline walking dynamics; participants will walk without auditory stimulation. The last two conditions will be randomized and will consist of walking to either a fractally structured metronome or fractally structured music. Five to ten minutes will be allowed between trials to minimize fatigue. If our hypothesized results are confirmed, fractally structured music could become a cost effective and highly beneficial therapy for individuals with PD.

Charlotte Fiskum, Norwegian University of Science and Technology

Cardiac Complexity Predicts Degree of Psychopathology in Children with Internalizing Difficulties

Objective: Psychopathology can be modeled as a dysregulated state space along the dimensions of affective valence and arousal resulting in overgeneralization of maladapted behavior. Sample entropy (SampEn) gives an estimate of non-linear signal complexity in cardiac time series and can give information beyond linear high frequency heart rate variability (HF-HRV). Therefore, this study investigates whether cardiac SampEn predicts psychopathology above an established linear HF- HRV measure that has shown relevance for psychopathology, the root mean square of successive differences (RMSSD). Method: Participants were 32 children (9-13 years) with internalizing difficulties. Parents filled out the Child Behavior Checklist, and an internalizing composite score based on symptoms of anxiety, depression and somatization was calculated. SampEn and root mean square of successive differences (RMSSD) were computed during a five minute baseline condition with open eyes. The study investigated the predictive power of SampEn and RMSSD on degree of psychopathology in a Generalized Linear Model. Results: The full model with SampEn and RMSSD as predictors of Total Problems, and age, mean heart rate, gender and BMI as controlling variables, was significant ($p \leq .019$). SampEn ($p \leq .001$) was the only significant predictor in the model. Conclusions: Lower cardiac complexity as indexed by SampEn can be used as a marker of dysregulation in the underlying dynamical processes contributing to psychopathology. This makes SampEn an important complementary measure to linear HRV, outperforming RMSSD as a predictor of psychopathology in this study.

Jayne Fleener, North Carolina State University

It's Really Not So Complicated, but it Requires Complexity: Challenges for 21st Century Democracy and Educational Research

This paper provides important tangible calls to action to complexity scientists to address some of education's most intractable problems. Society, as a whole, has reached a critical point in its collective understanding of the interdependencies and complexities of social systems, including education, and the need for social institutions to meet the challenges of a rapidly changing and technologically interconnected world. The 2016 U.S. elections are a harbinger of the challenges we face in finding relevancy for 21st century democracy and speak directly to the need to complexify our understandings of education as an important social function to meet the needs of an accelerated world. Beginning with a simple question -- What kind of research is important for supporting policies important for 21st century education and democracies? -- this presentation connects the challenges of educational research and policy to address the most intractable problems of education including student disengagement, achievement gaps, and failing schools, to offer important directions for research and policy solutions to these perennial and increasing problems. Often overlooked in theoretical and empirical studies of chaos and complexity applied to education are the underlying assumptions and policies that work against a complex understanding of education. The specific policy cases of school vouchers, widening achievement gaps, and low performing schools will ground the discussion of the challenges of contemporary democracies and needed complexity research to inform policies that contribute to educational opportunity, hopefulness, and capabilities to positively shape the future.

Ethan Fleuchaus, **Heidi Kloos**, **Paula Silva**, University of Cincinnati
Adam Kiefer, Cincinnati Children's Hospital Medical Center, Cincinnati, OH

The Antifragile Mind: Reconceptualizing Mistaken Belief in Early Science Learning

Behavior can be non-adaptive two ways: It is either too cohesive against perturbations (i.e., overly stable) or too sensitive to outside changes (overly flexible). Adaptive behavior, by contrast, retains a balance between stability and flexibility (also known as meta-stability, intermittency, fractality, or antifragility). This balance has been described extensively, notably in the context of perceptual-motor learning (PML) and its emphasis on calibration of behavior. In the current presentation we seek to apply the language of PML to capture patterns of children's exploratory behavior in a well-known balancing task. Children are asked to balance various beams on a fulcrum, some beams being symmetrical in regards to their weight distribution and others not. Various distinct patterns of behavior have been observed during children's spontaneous exploration of the domain. For example, children sometimes show a bias towards balancing a beam at its geometric middle rather than at its center of mass. The traditional explanation of this bias invokes representational terms: Children are said to have some mental entity, a representation, belief, or theory, about how to make things balance. With this conceptualization, children's failure to incorporate feedback can be explained away: The existing representation guides behavior, in effect drowning out feedback. However, such representation-based explanation cannot explain how it is that children eventually learn, i.e., abandon a mistaken pattern of performance, and adopt the correct one. This is

where the language from the PML literature proves more encompassing.

Jeffrey Goldstein, Adelphi University

Emergence and Bergson's Upspringing

Because of its place among contemporary constructs in the study of complex systems, emergence tends to be thought of as of contemporary vintage. Yet, the idea goes back to the mid-nineteenth-century in the philosophical ruminations and speculations of the celebrated English philosopher John Stuart Mill and the American/English man of letters George Henry Lewes. What is much less known is that the concept of emergence played a key role across the Channel in the evolutionary philosophy of the great French philosopher and Nobel Laureate Henri Bergson. In his very influential work, *Creative Evolution*, Bergson reinterpreted evolution in terms of his own process vitalist metaphysics. There Bergson had introduced his notion of an upspringing (Mitchell's awkward translation of the French, fait *jaillir*. The paper explores Bergson's understanding of emergence in terms of his notion of upspringing. Emphasis will be on how Bergson converted emergence into a main aspect of the subjective flow of consciousness. In the latter, upspringing happens when there are novel contents of consciousness. This subjective orientation will be contrasted with a combined subjective and objective perspective.

Stephen J. Guastello, **Anthony N. Correro II**, **David E. Marra,** Marquette University

Cusp Catastrophe Models for Cognitive Workload and Fatigue in Teams

The effects of cognitive workload and fatigue on performance have been difficult to separate analytically because they both depress performance simultaneously. Their effects are complicated further by momentum and practice effects and coping strategies, which have a positive impact on perform-ance. Coping strategies often involve a mental or physical reorganization of the task, task switching, or trade-offs between fatigue and workload effects. A relatively new problem is how to assess and isolate workload and fatigue effects on the performance of teams. A solution to the entangled problems involved the use of two catastrophe models, one for workload and one for fatigue, among individuals. The present study is the first to use the cusp models to assess cognitive workload and fatigue on team performance. In an experiment involving an emergency response simulation, 360 undergraduates were organized into 44 teams of various sizes, 65 opponents, and 43 observers. Workload was experimentally varied by team size, number of opponents, and time pressure. Individual differences across numerous individual differences in elasticity-rigidity and ratings of subjective workload at the group and individual levels were included in the procedure and assessed as control variables. Final cusp models for workload were more accurate for describing trends in one of two performance criteria compared to linear alternatives. The fatigue model was more accurate for both criteria. Individual differences in elasticity-rigidity were less important than subjective workload and experimental conditions as control variables in the workload model. Fluid intelligence was an important compensatory ability in the fatigue model.

Stephen J. Guastello, Anthony N. Correro II, David E. Marra, Marquette University

Do Emergent Leaders Experience Greater Workload? The Swallowtail Catastrophe Model and Changes in Leadership

Although positions of greater responsibility imply greater workloads and consequences for actions, the experience of emergent leaders could be a different story. People who gravitate toward leadership roles might have a better understanding and skill set for the task requirements, and thus reported lower workload, but they might also report greater workload because they do indeed recognize demands that other people do not fathom. Either way, the demands could impact a person's willingness to play a leadership role. This study examines these dynamics within the framework of the swallowtail catastrophe model for leadership emergence. The study also offered an opportunity to examine changes in leadership. The experiment involved an emergency response simulation in two sessions that were scheduled one week apart; 360 undergraduates were organized into 44 teams of various sizes, 65 opponents, and 43 observers. Workload was experimentally varied by team size, number of opponents, and time pressure. Subjective experience was measured by standardized ratings of individual and group-level sources of workload. The core model verified previously published results in which a broad spectrum of contributions to the team discussions corresponded to the asymmetry parameter, group size corresponded to the bifurcation parameter, and team performance corresponded to the bias parameter. Individual ratings of effort required and frustration also contributed to the bias parameter. Group-level ratings of coordination demands corresponded to the asymmetry parameter. Changes in leadership between sessions were explained by the same dynamics as the emergence of leaders within a single session.

Shan Guisinger, University of Montana

Attractors, Catastrophes and Archetypes: Evidence for Humans Nature

Human nature is characterized by universal patterns of behaviors with unpredictable moment-by-moment behaviors, cognitions and emotions. The past five million years of our evolution has produced a deeply social species of cooperative hunters and gatherers with strong family and tribal loyalties behaviorally distinct from any of our primate cousins. Utilizing aspects of deterministic chaos and catastrophe theory with recent work in human behavioral genetics and neuroscience, this presentation provides a theoretical framework for the sudden emergence of emotionally-fraught ideas like falling in love, mothering, and cooperative fighting and hunting.

Joshua Haworth, Kinesiology, Whittier College, Whittier, CA,
Eric Slattery, **Mark Walsh**, Kinesiology, Miami University, Oxford, OH,

Task Specificity Constrains Postural Sway Dynamics: a Study of Balance in Ice Hockey Players

Much research has gone into understanding the various qualities of standing posture. Generally, in motor learning and development, task specificity is known to serve as a guiding constraint on performance. We explored whether such a principle is true in the expression of sway dynamics amongst athletes in different sports. Particularly, we looked at pathlength and sample entropy of double and single leg stance of ice hockey (n=16) and American football (n=47) athletes and non-athletes (n=16). Due to the extremely narrow base of support (width of skate blade in ML direction) and the unique frictional characteristics (low friction allows gliding in AP direction), we hypothesized that hockey athletes would have developed unique balance characteristics from their peers. Athletes produced shorter path length, particularly true in the ML direction, with football athletes producing the shortest path length. Athletes demonstrated lower sample entropy compared to controls, with the ice hockey and football groups producing similar values for all ML measurements but significantly different values for all AP conditions. Sample entropy during double leg stance in AP was considerably lower for hockey athletes (0.09±0.04) than football athletes (0.22±0.04) or non-athletes (0.55±0.32). When on the ground, plantar and dorsiflexion help control postural sway. This is different when on ice, where AP balance can be regulated by gliding the foot fore-aft. This gliding is unique to ice sports and appears to have a carryover impact on stance in these athletes. This research provides one indication that balance training and diagnostics should be performed with consideration of sport-specific demands.

Joseph Jacobsen, Sustainable Economy, LLC and Concordia University of Wisconsin

Sudden Diffusion of Sustainable Technologies

This nonlinear sustainable technology deployment discussion will consider why clean technologies diffuse so slowly and will encourage participants not to bother waiting for a magic sustainable invention that powers up the economy because the answers are already here. The presentation will identify the solutions to the most pressing problem facing humanity, climate change. We will examine two nonlinear systems: the temperature/change of state continuum and the deployment of solution technologies and practices that slow climate change and may also avoid sudden extremes. Facilitative or obstructive factors mediating the deployment of sustainable technologies, such as distributed generation with combined heat and power, have direct climate consequences. We will review the diffusion of these technologies and how to accelerate their installation. As a final point, we will examine what we, as individuals, can do to avoid this looming energy/climate catastrophe.

Richard N. Knowles, Richard N. Knowles & Associates, Inc.

Insights about Self-Organizing Criticality and the Process Enneagram in Building Sustainable, High Performance Organizations

Per Bak proposed that systems like the moving tectonic plates and the pattern of earthquakes followed a very consistent pattern for the frequency and intensity of the earthquakes. He also found that sand piles whose height was gradually increased by slowly adding grains of sand also experienced a similar pattern between the size and frequency of the avalanches taking place. In these self-organizing systems, energy is gradually built up to the point of criticality where a release of energy occurred. These patterns followed power laws. Organizations are complex, adapting, self-organizing networks of people. Each conversation in an organization can be seen as if it were like a grain of sand in a sand pile, each adding potential energy to the system. As the energy builds, the organization moves towards the edge of chaos where a change can occur. When an organization experiences a crisis, many conversations erupt, and it quickly move towards criticality. People do amazing things to overcome the crisis. They often feel excited, creative and fulfilled, but they are not able to sustain this after the crisis passes. However, when the people in the organization are in

conversations building and co-creating their Process Enneagram, it serves as a strange attractor holding and sustaining the organization at the edge of chaos where energy and creativity emerge. Practical, real-life examples of these phenomena will be shared.

Gus Koehler, Pin Li, Time Structures
Diane Rosen, State University of New York
Fred Abraham, Blueberry Brain Institute,
Martin Gardiner, Brown University

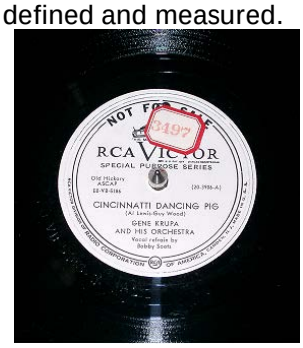
Brief overview of the Panel topic:
Investigation of a Foundation for New Poetic-Scientific Research Instruments

The problem: This panel will explore the possibility for creative heuristics of unknowing to serve as unitary tools to fill the current knowledge gap left by the limited scope and non-overlapping interaction, concepts, and methods of three ways of knowing: scientific (nonlinear dynamics for example), poetic (surrealism), and somatic. This Gap is not irreconcilable, but rather a primal generative void. For example, is the geography of a mountain the same as a painting of its landscape? Geography involves elevations and other concepts and measurements like fractal dimension vs. a landscape which involves form, color, beauty and other sensations, vs. hiking on it. Another example: Experiencing an autopsy where there organs are identified including the evolutionary precision of their assembly vs. the dissection process of opening a person's body vs. the somatic resonance between your body and the dissected corpse. For each contrasting example a gap in knowing and understanding the complete object is apparent. We will define a gap as: The intuitive deep recognition that one's knowledge generated by any single means of a phenomenon or process is critically incomplete, and is seen as a banal or a wondrous mystery constructed upon the *hic et nunc* space-time instant infrastructure of nothingness. Our method for such knowledge construction of the gap is suggested by Blake: What is now proven was once only imagined. The imagination associated with transdisciplinary knowing is the starting point. Building on this, Surrealist dispositions and techniques (automatism, games, illogical juxtapositions, dislocation, etc.) allow the gap's silent mystery (the previously unknowable) to speak and inform the now-emergent known. Such a strategy, since it is partially driven by the individual's speculative reason / surrealistic approach can only be a necessary method, but not sufficient, because the mystery speaking in its *hic et nunc* reveals itself only when extended into the next emergent instant in a chaotic deterministic manner. Within any given set of order parameters, including those of space-time, knowledge in the gap is not discovered but continuously constructed from attractions, interactions, bifurcations, especially in cascades of micro-bifurcations, a process called a macro-, or u-bifurcation and consolidation of shifting memory fragments and poetic memes. Because no single method within itself is sufficient, both the implicit structure of deterministic parameters and the unpredictability of unconscious processes are necessary for transformative reification of what was previously only imagined into new conceptual constructs. Creative heuristics of unknowing are necessary. Perhaps a sentient language or related means contains the elements of knowing in the gap. Artistic and musical creations will illustrate our proposal. The overall value added to the field is to identify new paths for research using new methods, new information, new perspective, new issues and explanations to add clarity and greater completeness to our research strategies and our present understanding.

Zetta Kougiali, University of East London

Directionality and Nonlinearity in the Narrative Construction of Change and Recovery from Addiction

The dominant theoretical perspective that guides treatment evaluations in addiction assumes linearity in the relationship between treatment and outcomes, viewing behavior change as a before and after event. Many measurements of interventions in drug addiction aim to capture such linear change through short-term pre and post measures. Complexity theory and non-linear dynamics have long questioned such simplistic linear models. This paper will draw on these ideas to argue that linear models bear little relation to the complex process of change in recovery from drug addiction. Evidence from fine-grained narrative interviews with active and recovered drug users will be used here to argue for the nonlinearity of the recovery process. A complex system of material and social relationships, activities, and experiences will be mapped drawing on the concepts of non-linear dynamics. Key features and parameters of the system of drug use and recovery will be identified to argue that long-term recovery is represented as being preceded by periods of discontinuity before change is stabilized. Such periods are presented as lasting longer than most short-term pre-post intervention designs can capture, suggesting the need to rethink how change is defined and measured.



Zetta Kougiali, **Laura McGrath**, University of East London

Topology and Complexity in Addiction and Recovery

Psychology as a discipline has been primarily populated by models which are both linear and individualistic. In line with this tradition, studies focusing on addiction and recovery have often posited a subject who is dislocated from the world he/she/they inhabit, and projected along linear trajectories of change and recovery. Complexity and chaos theory offer an alternative model through which to engage with the patterned complexity and contingency of drug use and recovery. This approach is in accord with other ecological approaches within the social sciences which have opened up a concept of the subject as indivisible from material and social context, as always embedded, enacted and embodied. In this paper, we argue that the world of an addict is founded through lived spatial relations founded within the subject (locally) and beyond itself (with the world), which co-create the parameters of drug taking and recovery. We employ a topological analysis which is conducted through fine grained mapping of active use and recovery trajectories. Implications for research and practice are discussed.

David Kreindler, Dept. of Psychiatry, University of Toronto,
Aamir Munshi, Wayne State University

Entropy and Periodicity Analysis of Mood Symptoms in Affective Disorder

Purpose: To better characterize the temporal signatures of symptoms in mood disorders, we pooled data from four long-term studies of mood symptom variability, analyzing the mood records of 6-18 months duration from subjects ages 14-65 years with major depressive disorder (*n*=31), bipolar disorder (*n*=23), other mood instability (*n*=11), and healthy controls (*n*=107). Methods: Sample entropy (SampEn) and power law exponents of periodograms (*alpha*) of each of the records were calculated for eleven separate symptoms of mood disorders, plus a control item, and compared by diagnosis, sex, and study. Results: SampEn and *alpha* for the time series did not reveal significant differences for these indices between diagnostic groups. *Alpha* was generally confined to the interval (-1,0). Conclusions: Our results are consistent with mood having a history: in general, long-term trends predominate over shorter-term fluctuations. The lack of difference in SampEn between diagnostic groups is unexpected and requires replication.

Vivien Marmelat, Nicholas Reynolds, Daniel Jaravata, Amy Hellman
Department of Neurological Sciences, University of Nebraska Medical Center

Fractal Analysis of Gait in People with Parkinson's Disease: Is 3 Minutes enough?

Human gait presents stride-to-stride fluctuations exhibiting a complex, fractal organization over time. In contrast, neurological impairments such as Parkinson's Disease have been suggested to disrupt physiological complexity, leading patients to produce more random stride-to-stride fluctuations. However, most studies investigating the fractal patterning of gait variability in PD patients were restricted to gait trials of 2 to 5 min only; therefore, analyzing stride time series well below the minimal length required to apply reliable fractal analysis (i.e., Detrended Fluctuation Analysis with at least 500 strides). We propose here to determine 1) the reliability of fractal measures of stride time fluctuations obtained from five trials of 3 minutes walking in PD patients, and 2) to compare these 3 min fractal indexes to the 15 min fractal index obtained during continuous 15 minutes walking (i.e., representing individual true level of gait complexity). Our results suggest that the fractal indexes obtained during 3 minutes trials are not reliable (Cronbach's *alpha* from Intra-Class Correlation = -0.73, p=0.82). Further, averaging the 3 min fractal indexes was not consistent with the 15 min fractal index (Cronbach s *alpha* from Intra-Class Correlation = 0.44, p=0.19). Based upon these findings, we think that attempting to assess the fractal properties of gait dynamics using short gait trials is doomed to fail, as there is no shortcut to the intrinsic rigorous conditions of the applicability of fractal analysis.

Vivien Marmelat, Department of Biomechanics, University of Nebraska at Omaha

Periodic versus Variable Pacing of Gait: Continuous Coupling versus Discrete Error Correction

Healthy human gait presents persistent, fractal fluctuations over time (e.g. long strides are likely to be followed by long strides, and conversely). The presence of persistent fluctuation, and its alteration with aging and neurological disease, is commonly thought to reflect the complexity of the locomotor system and its capacity to adapt to altered environmental and organismic constraints. When humans walk with a periodic metronome, stride fluctuations become anti-persistent (e.g. long strides are likely to be followed by short strides, and conversely). This change in gait complexity suggests that stride frequency becomes tightly organized around the single frequency of the metronome. Our group showed that synchronizing steps with a

metronome containing persistent fluctuations yielded persistent fluctuations in stride intervals, similar to those observed in self-paced walking. We here considered two alternatives for modeling persistent fluctuations in stride intervals when gait is paced by a variable metronome. First, we examined how the Super Central Pattern Generators (SCPG) model, which fits well for self-paced and periodic paced walking, could account for non-periodic paced walking when the periodic function in the original model was replaced by an irregularly fluctuating function. Second, we adopted a discrete modeling approach based on the premise that following an irregular and unpredictable metronome requires short-term correction. Our results suggest that synchronization with non-isochronous metronomes may be based on the correction of previous asynchronies to the metronome, whereas synchronization with an isochronous metronome appears to be based on a continuous coupling with the rhythm of the metronome.

Patric Nordbeck, Rachel Kallen, Anthony Chemero, Michael Richardson
University of Cincinnati

Modeling an Object Transportation Task with the Cusp Catastrophe

Non-linear phase transitions between behavioral modes have been demonstrated experimentally by pushing the system beyond the stability of either mode. This is accomplished by scaling a control parameter with respect to a multi-stable behavioral manifold. However, for such behavioral manifolds it is also possible that behavior could change in a gradual manner, or even maintain the same steady state. To investigate this further the Cusp Catastrophe Model was used to explore these possibilities for a ball movement task that included continuously co-present behavioral modes. Participants were sequentially presented with balls at a starting area at varying intervals (long, 14s, down to short, 2s, and vice versa), and were to transport them to a bin located nine meters away. The series of movement distances (before releasing the ball) over the scaling of the control parameter reveal steady states (always throwing or always running), as well as gradual and non-linear transitions between moving short and long distances (or vice versa). The Cusp Catastrophe equation was used to model and simulate movement with distance as the state variable (x), time interval as the control parameter (a), and a non-static splitting variable (b). Change in b was parameterized by a random number generator consisting of a negatively skewed normal distribution. Simulated and human data were found to be qualitatively similar and exemplified the utility of the Cusp Catastrophe Model for behavioral state variables. The study also demonstrates how both steady state linear and non-linear behavioral patterns, as well as metastable and transient behavioral patterns, can all result from the same task dynamic.

Michael O'Hearn, University of Cincinnati, College of Medicine/Lindner Center of HOPE

Therapeutic Drumming: A Complexity-Based Approach to Self-Regulation and Mind-Body Continuity

Self-Organized Criticality (SOC) is a field theory of interactive systems in evolutionary biology. Frequencies and fitness threshold levels of a system's perpetual interactions are chaotic rhythms. Complexity intrinsic to perpetual interactions eventually determines criticality: a tempo for continuity among interaction rhythms and optimized global functioning, including developmental processes. Discontinuity in mental health delivery and treatment technology is structurally integrated from original conditions that offset criticality. This theoretical paper offers the integration of SOC and meditative drumming as a complexity-based intervention for self-regulation. This drumming technology inventory has nine domains, each with subtypes. Individualized drumming algorithms of low, moderate, or high complexity include metronome use, so criticality is a whole system and the treatment process fractal. Targeted transverse and bi-lateral protocols strengthen fine and gross neuromuscular coordination and procedural memory development for greater resilience, self-regulation, and mind-body continuity. Recurring phase transitions like resistance to change and illness progression are fractal treatment pathways to nonlinear efficacy, potentiated by targeted meditative drumming as a treatment component. This complexity-based intervention seemingly has self-similar utility, efficacy, and efficiency across lifespan, demographics, and many specialties and sub-specialties of medicine. Its compatibility with neuroscience research and complexity-based wellness networks is discussed.

David Pincus, Chapman University, Orange CA

Romantic Resilience: Fractal Conflict Dynamics and Dating Satisfaction

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 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; (2a) moderate levels of fractal dimension (i.e., flexibility) and (2b) higher structural integrity (i.e., fit to fractal distribution) will be associated with higher levels of dating satisfaction and commitment. Preliminary results will be presented and discussed.

Michael Radin, Rochester Institute of Technology
Inese Bula, University of Latvia
Nicholas Wilkins, Rochester Institute of Technology

Patterns of Periodic and Eventually Periodic Solutions of Piecewise Difference Equations with Applications

We will analyze the patterns of periodic solutions and eventually periodic solutions of Piece-wise difference equations. In particular, we will begin the $3X+1$ Conjecture, Tent Map, and other piece-wise Difference Equations that exhibit periodic and eventually periodic solutions and their applications in neural networking. In addition, we will discuss the history of such phenomena with sensitivity to initial conditions in Lorenz Attractors and Mandelbrot sets too. Furthermore, we will also investigate the patterns of the transient terms when eventually periodic solutions exist. Moreover, we will also address the vital question: do eventually periodic solutions always exist? We will also discuss the applications of these piecewise difference equations in modeling neural networking and other applications related to biological and medical sciences.

David Schuldberg, University of Montana

Using Toy Models to Explain NDS Concepts: 11 Key Ideas

This presentation describes the use of small models to teach nonlinear dynamics concepts. The paper emphasizes 11 core NLDS ideas. Small models are sometimes called "toy" models to indicate that they are oversimplified and illustrative; they can serve as sketches or cartoons of complex phenomena and provide intuitive grasp of more difficult underlying mathematics. This presentation focuses on the use of actual toys -- and playing with these toys -- as vehicles for communicating important NLDS concepts and their applications in psychology.

Paula Silva, University of Cincinnati
Adam Kiefer, Cincinnati Children s Hospital and Medical Center
Priscila Figueiredo, **Bruna Avelar**, **Sergio Fonseca**, **Marisa Mancini**
Universidade Federal de Minas Gerais

Reduced Adaptability of Upper Limb Performance in Teenagers with Cerebral Palsy: Evidence for a Dynamical Account

A hallmark characteristic of expert motor performance in any task is adaptability. In other words, experts possess the exquisite ability to preserve the intended function (or at least minimize losses in function) under variations in environmental, task and endogenous conditions, even those not previously experienced. This ability is strikingly lacking in individuals with disabilities, whose functional performance in a variety of tasks is easily disturbed by changes in contextual conditions. Current accounts inspired by the dynamical approach to movement coordination have attributed this reduced adaptability to the lack of flexibility in the movement patterns supporting task performance. However, strong empirical ground for this assumption is lacking due to a key limitation in the design of most studies, namely, the absence of systematic manipulations of contextual conditions. Without such manipulations a direct assessment of the adaptability of performance and its supporting processes is not possible. In this talk, we will present a study that addressed this limitation. Specifically, we evaluated the performance of teenagers with and without cerebral palsy (CP) on a reciprocal reaching task under conditions that varied in the level of execution demand. As expected, performance of typical children was significantly more stable across conditions than the performance of children with CP, which confirms their reduced adaptability. This allowed us to assess the hypothesis that adaptability of motor function can be explained by how the dynamical variability of joint movements is structured as task conditions become more challenging. A potential role for attentional processes will be discussed and implications will be highlighted for the design of interventions to promote resilience of movement strategies in the face of contextual change.

Brandon Thomas, University of Utah

False Dichotomies in Psychology: What Self-organization Means for Psychological Phenomena

Self-organization refers to the order that arises from the local interactions of a dynamical system. Self-organization necessitates circular causality, a feedback loop between interacting components (e.g., Haken, 1983; Kelso, 1995). Thus, the patterns that emerge in self-organized systems are a balance between multiple interacting constraints. For example, Turing (1952) modeled the formation of organisms'

morphology within the embryo. He hypothesized that simultaneous reaction and diffusion processes could explain how heterogeneous bodies could be differentiated from homogenous cells. His model has been confirmed experimentally in several contexts and the basic model (patterns formed by the competing constraints of reaction and diffusion) explains a wide range of phenomena. In psychology, reductionist approaches are most commonly adopted. Cognition and behavior are defined as the direct consequence of lower-order component(s), resulting in a quagmire of longstanding dichotomies. Consider nature vs. nurture, bottom-up vs. top-down processing, and internal vs. external causation. On the other hand, if self-organization is used to frame psychological phenomena, several classic dichotomies evaporate. Cognition and behavior are assumed to emerge from the circular causality of multiple competing or cooperating constraints. A self-organized system cannot form psychologically from nature or nurture alone; it necessarily forms from the interaction of both, and cognition and behavior are the emergent patterns. I will discuss how classic psychological dichotomies can be reconsidered within a self-organization framework.

Dieter Vanderelst, University of Cincinnati

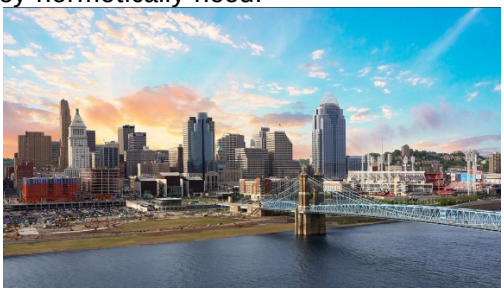
Modeling the Sensorimotor Dynamics Of Bat Prey Capture: Questioning The Optimality Thesis

Tracking targets is critical for many animals. Depending on the motion of the target, various mathematically optimal pursuit strategies have been identified. How well a pursuer can adhere to a theoretically optimal strategy is limited by the available sensory information and the pursuer's motor dynamics. Echolocating bats intercept insect prey on the wing. The range of possible strategies for prey interception in bats is constrained by the directionality of their sonar system and by the aerodynamics demands of their flight. Here, I present simulations of bat prey capture in 3D space, modeling both the bat's sonar directionality and flight aerodynamics. I implement a strategy adjusting the linear and rotational velocity to maintain the prey in the sonar beam. An evaluation of the resulting interception trajectories reveals that the simulated bat converges to a path resembling the constant absolute target direction (CATD) strategy before prey capture. This observation matches the behavior of bats in empirical studies. Indeed, it has been suggested that bats adopt the CADT strategy, as it is an optimal interception strategy for capturing erratically moving prey. However, in the current results, qualitatively and quantitatively similar behavior emerges from a strategy aimed at dealing with the bat's sensory limitations. Indeed, the simulations do not include a sensorimotor loop supporting the CADT strategy. This raises the possibility that sensory and motor constraints drive the behavior observed in bats instead of a theoretical optimum. I conclude that further experimental work is needed to clarify whether bats adopt the CADT strategy.

Ken Ware
NeuroPhysics Therapy Institute, Robina, Queensland, Australia.

Perturbing and Detraining Adults Fear and Avoidance in Pathological Anxiety Disorders

It is understood that long-term elevation of fear and avoidance gives rise to anxiety disorders, including PTSD. Conditioned fear stimuli and associated conditioned fear responses are widely understood factors. Behavioral conditioning methods have included fear extinction and memory consolidation, detraining, exercise, tai chi, and pharmaceuticals. Evidence indicates it is difficult to remove fear in the adult system, and interventions largely cannot resolve chronic anxiety disorders. The medical field's use of hormetic dose response is fairly well-established now, and sports medicine works with non-medicinal doses of stress to provide stimulation in the hermetic low dose zone, followed by an inhibitory response at higher doses: classic hormesis. The benefit of eliciting hormetic dynamics in the human system has been observed with NeuroPhysics Therapy in countless people whose anxiety disorders resolved without medicine. The use of this nonlinear approach addresses stimulus-response conditioning that gives rise to chronic anxiety. This presentation focuses first on the nonlinear dynamics in the biology of fear and anxiety, then describes requirements to hormetically perturb the anxious system under controlled conditions. In that setting, clients are helped to successfully escape the behaviors of attractor landscapes associated with the person's disorders. This is accomplished by using novel, controlled doses directly correlated with everything the client experiences; environmental stimuli are the integral core of the therapy. The presentation then explains how this hormetically-informed use of mild resistance, super slow movements on low weight gym equipment appears to be a powerful way to account for consistent success of addressing anxiety disorders. It sets initial conditions for success because the controlled perturbations of the system are the dose that they hormetically need.



Ken Ware, NeuroPhysics Therapy Institute & Research Centre
Adam Keifer, Cincinnati Children's Hospital and University of Cincinnati
Sara Nora Ross, Neurotricional Sciences Education Pty Ltd and Saybrook University

Transferability of Fractal Properties and Scale-free Transitions: Principles and Rules Leveraged by NeuroPhysics Therapy as a General Framework for Interventions in Other Domains

It is well understood that living systems are connected to, and in constant interaction with, their environment. Thus, living systems can be operationalized via mechanical and informational couplings between pairs of dynamical systems (e.g., human and environment), with system health understood through observable emergent stable states of behavior (i.e., attractors), transitions to other states (i.e., bifurcations), and avoided states (i.e., repellers). This allows for unique interventions designed to transition the system to more efficient behavioral states, resulting in enhanced system-wide complexity. Importantly, humans stand apart from other living systems via our capacity to plan complex interventions, evaluate and learn from their results, and generalize the learning in the form of guiding principles and rules to help replicate successes. The recognition that human system dynamics exhibit fractal patterns, which by their definition occur across all scales of observation, indicates that the replication of effective inter-vention methods from one domain are quite likely to have utility in other human-centered domains. On that basis, this symposium engages two questions: (a) What simple rules and guiding principles have been generalized for Neuro-Physics Therapy (NPT) to replicate its 30 years of treatment successes with a large sample of people across diverse diseases, disorders, injuries, and sports performance issues? (b) How well do those principles and rules developed for NPT's domain seem to apply to dissimilar domains of intervention? Ken Ware, the origina-tor of NeuroPhysics Therapy, will describe the therapy's nonlinear design of dyadic and triadic interactions: client + therapist as well as client + therapist + physical engagement of mild resistance objects. He will explain NPT's simple rules, their rationales, and the guiding principles they reflect. Adam Kiefer will discuss how the complexity of living systems necessitates an understanding of behavioral dynamics in the context of health, and why health interventions must leverage these principles for ultimate success. Sara Ross will compare NPT rules and principles with those used in intervention methods she designed for complex decision-making and social issues, and discuss correlates with fractal action complexity and its nonlinear hierarchy of transition dynamics. Interactive Q&A between presentations will be followed by discussions with session participants to engage at least the additional question of: What principles and rules for successful intervention in other domains are being used that differ from those presented here, and what can we learn from them?

Mikhail Zimin, Moscow State University
Svetlana Zimina

Diagnosing Abnormal Conditions with the Help of Analysis of Dependences of Predictors on Time

The value of a predictor may be time variant. Besides, it often starts to become increasingly out on a limb. Thus, there is the possibility of diagnosing the occurrence of dangerous states with the help of an analysis of the dependence of prognostics factors on time. In many cases parameters describing the investigated object can be measured only with considerable noise. In addition, the form of the reconstructed function is unknown. For example, a relationship may be absent, be linear or amount to a square parabola. In addition, the sample of measure-ments may be small. So, it is necessary to use methodology permitting the selection of a function of optimum form. If a power-law relation is used, a choice between polynomials of degree 0, 1, and more than 1 need to be made. Utilization of Chebyshev polynomials seems optimum because they provide minimization of maximum error. In addition, they are effective in computations. After building dependence, it is possible to see its degree and make conclusion about the object's condition. The method of structural minimization of risk seems to be the most suitable technique to reconstruct regressions for small samples because it correlates the number of a sample's elements and optimum polynomial degree on reasonable mathematical grounds. Thus, it may be recommended for solving such problems. Experience with its use shows high effectiveness of software utilizing corresponding algorithms.