
Society for Chaos Theory in Psychology & Life Sciences
Abstracts to the
24th Annual International
Conference, Milwaukee, WI
2014
Dedicated to the development of
nonlinear science worldwide
since 1991

Society for Chaos Theory in Psychology & Life Sciences[1]
24th Annual International Conference
31 July - 2 August 2014
Marquette University, Milwaukee, Wisconsin, USA

About the Conference

Stephen Dietz
2014 Conference

The Annual Conference for the Society for Chaos Theory in Psychology and Life Sciences is the premier venue for training, networking, and sharing the latest empirical and applied developments in nonlinear dynamics across psychology, the life sciences and beyond. For 23 years, the Society and its conferences have been founded in the principles of interdisciplinary work, acknowledging the ubiquity of nonlinear dynamics across the behavioral, social, and life sciences. The conference is typically intimate in size with attendees representing psychology, biology, economics, business, physics, mathematics, and other scholars organized around a common interest in nonlinear dynamics. Attendance is typically broad geographically as well, with membership in SCTPLS representing each of the global continents. This year's program includes prominent keynote speakers, cutting-edge pre-conference workshops, symposia, and individual sessions.

This year brings the 24th Annual Conference to the North Midwestern United States, the sublimely gothic city of Milwaukee and campus of Marquette University. The dates for the conference are set for July 31 through August 2, 2014. A festive dinner for all attendees and their guests is planned for the night of August 1 (Friday), which will feature one of our guest speakers.

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Keynote Speakers:

J. Barkley Rosser, Jr.

James Madison University

Complexity and Behavioral Economics

This paper considers the relationship between complexity economics and behavioral economics. A crucial key to this is to understand that Herbert Simon was both the founder of explicitly modern behavioral economics as well as one of the early developers of complexity theory. Bounded rationality was essentially derived from Simon's view of the impossibility of full rationality on the part of economic agents. Modern complexity theory through such approaches as agent-based modeling offers an approach to understanding behavioral economics by allowing for specific behavioral responses to be assigned to agents who interact within this context, even without full rationality. Other parts of modern complexity theory will also be considered in terms of their relationships with behavioral economics. Fundamentally, complexity provides an ultimate foundation for bounded rationality and hence the need to use behavioral economics.

John Barkley Rosser, Jr. is Professor of Economics and Kirby L. Cramer, Jr. Professor of Business Administration at James Madison University, where he has taught since 1977. He received his Ph.D. in Economics from the University of Wisconsin-Madison in 1976, where he has also been a Visiting Professor, in addition to universities in Sweden, Australia, France, Italy, and Japan. Dr. Rosser is best known for applying ideas from complex nonlinear dynamics to various sub-fields of economics. He has published about 150 books, articles, comments, book chapters, and book reviews. His books include *From Catastrophe to Chaos: A General Theory of Economic Discontinuities* (1991, second edition, 2000), *Comparative Economics in a Transforming World Economy* (1996, second edition, 2004), *Complexity in Economics* (2004), *The Changing Face of Economics* (2004), *Handbook of Complexity Research* (2009), and *European Economics at a Crossroads* (2010). Dr. Rosser has advised the City of Madison, WI, the City of Harrisonburg, VA, the legislature of Wisconsin, the legislature of Virginia, the U.S. National Forest Service, U.S. agencies related to national security, the U.S. House of Representatives, various presidential candidates, and international bodies, including the National Science Foundation of Japan and the Organization for Economic Cooperation and Development.

David Schuldberg, Ph.D.

University of Montana

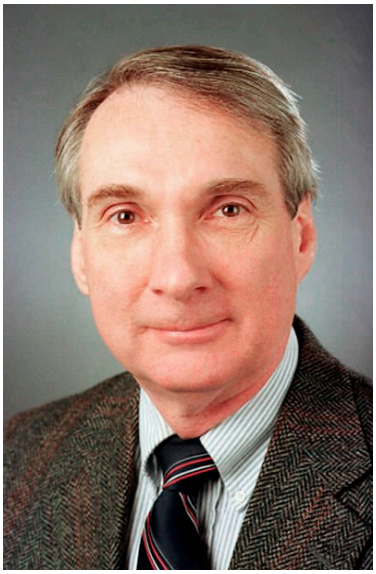
Developing a "Feel" for Nonlinear Systems: How to Work with Impossible Problems

From coping with climate change to salvaging American health care our most pressing current problems involve complicated nonlinear inter-relationships and complex, often baffling behavior. We are called upon to recognize when "systemic causation" must replace old-school cause-and-effect. Planners must consider unintended consequences, tipping, normal accidents, and "ironic" or "revenge" effects. This presentation investigates methods and vocabularies for identifying systems-level health and pathology. It then describes emerging heuristic approaches, incremental solutions to intractable, seemingly impossible problems; it traces the art of improvisational repair across levels of complexity. It concludes with my hopes for a future where young people -- who grew up with intricate simulations like *Sim City* and *Kerbal Space Program*, as well as immersive and interactive virtual worlds -- will bring more sophisticated systems-level skills to the world's problems.

David Schuldberg, Ph.D.is Professor of Psychology at the University of Montana, Missoula, and has published extensively on nonlinear dynamics. He was born in Los Angeles, California and grew up in Seattle, Washington. After a B.A. in Social Relations from Harvard University in 1973 (including a brief period majoring in physics), he received his M.A. and then Ph.D. (in 1981) from the University of California, Berkeley, with a Postdoctoral Fellowship in Clinical Research in the Department of Psychiatry at Yale in 1988-89. Dr. Schuldberg joined the faculty of The University of Montana in 1984, now serving as the Director of Evaluation at the SAMHSA-funded National Native Children's Trauma Center at UM, and is a licensed clinical psychologist. A former Director of Clinical Training, he teaches undergraduate and graduate students and supervises both research and clinical work. Dr. Schuldberg is particularly interested

in applications of nonlinear dynamics to positive human functioning, including creativity and psychological well-being. He is currently working on the definition and modeling of health processes – both psychological and physical – and on nonlinear facets of health care services and health care reform.

J. C. Sprott
University of Wisconsin-Madison



Lessons Learned from 19 Years of Chaos and Complexity

As we conclude the nineteenth year of the Chaos and Complex Systems Seminar, I would like to discuss some of the lessons I have learned from listening to over 500 talks, from my own research, and from the many books and articles I have read on the subject. This will be a rather personal and subjective talk and thus probably controversial. In particular, I will argue that the feedback, nonlinearities, and self-organization that characterize all real dynamical systems are more likely to ameliorate the dire consequences that others have predicted than to exacerbate them as so many fear. This is not a prediction that our problems will vanish or an argument for ignoring them. On the contrary, our choices and actions are the means by which society will reorganize to become even better in the decades to follow, albeit surely not a Utopia.

Julien Clinton Sprott received his B.S. in physics from the Massachusetts Institute of Technology in 1964 and his Ph.D. in physics from the University of Wisconsin in 1969. He worked at the Oak Ridge National Laboratory for several years before returning to the University of Wisconsin to join the physics faculty in 1973. In 2008, he became an Emeritus Professor of Physics. His research has been primarily in the area of experimental plasma physics and controlled nuclear fusion. In 1989 his interests turned to nonlinear dynamics, chaos, fractals, and complexity. He has authored or coauthored over 400 scientific papers in these and related fields. Professor Sprott has written a number of books, including "Introduction to Modern Electronics", "Numerical Recipes and Examples in BASIC," "Strange Attractors: Creating Patterns in Chaos," "Chaos and Time-series Analysis," "Images of a Complex World: The Art and Poetry of Chaos," "Physics Demonstrations: A Sourcebook for Teachers of Physics," and "Elegant Chaos: Algebraically Simple Chaotic Flows." He has produced dozens of educational videos and has given his popular presentation of "The Wonders of Physics" over 200 times to a total audience of over 80,000. He has produced several commercial educational software programs, one of which won the first annual "Computers in Physics" award for innovative software in physics education. He received the John Glover Award from Dickinson College, the Van Hise Outreach Award for Excellence in Teaching from the University of Wisconsin-Madison, a Lifetime Achievement Award from the Wisconsin Association of Physics Teachers, and a Distinguished Service Award from the UW Physics Department for his work in public science education.

Alphabetical List of Authors & Abstracts

Thomas Arnold
University of Cincinnati

A Proposed Solution to the Age Crime Curve Puzzle

The age crime curve presents a puzzle for criminologists. Why do crime rates rise from near zero in childhood, grow almost exponentially in adolescence, and then suddenly drop almost as rapidly in adulthood until returning to near zero in old age? Why is this pattern found in all cultures? Why is there such a rapid reversal in adulthood when criminological theories predict stability? Why does age seem to be independent of other criminological variables? A solution to the age crime curve puzzle can be constructed by proposing two nonlinear processes. The first nonlinear process involves a capacity vs. control theory of crime extended over the life course. Control theories posit that people naturally commit crimes without some type of control process that prevents crime. It appears that the timing of physical and mental development creates a maturation gap in adolescence where physical capacity for crime develops before the mental capacity to control behavior. As physical capacity peaks in adulthood, mental capacity continues to grow, causing a decline in crime. Crime declines further in old age because strength declines. The developmental interaction between strength and mental capacity over the life course creates the age distribution of criminal propensity. The second process involves a nonlinear relationship between criminal propensity and crime rates. Because criminal propensity is normally distributed, and society selects behaviors from one end of the deviant behavior distribution to sanction as crimes, linear changes in the mean level of criminal propensity create a sigmoid response curve in the crime rates.

Najia Bao, The Fu Foundation School of Engineering and Applied Science, Columbia University; B & B Institute of Human Brain Potential
Nangui Bao, B & B Institute of Human Brain Potential
Nasha Bao, Jiangnan University

Comparison on Significant Differences in Left and Right Brain Activities among Four Engineers Based on ApEn and Coherence Analysis of EEG

This research combined nonlinear dynamic analysis on EEG (mesoscopic) with cognitive psychology (macroscopic) to explore highly complex cognitive activity - STEM (Science, Technology, Engineering, and Mathematics) thinking. Thereby, it opens up a path for theory research and to guide practice in the development of brain potential. The subjects were 4 engineers, two female and two male. All of them were healthy. Test material, from "Item Bank System of 1000-problem Solved by Spatial Imagination", was composed of 15 questions similar to Fundamentals of Engineering (FE) Exam, a part of exam to licensure as a professional engineer in USA. FE exam covers a comprehensive range of various subjects as taught in an undergraduate engineering program. Test items were presented visually. Time limitation: 45 minutes (average 3 minutes per item). The four subjects were divided into two groups. Group 1, "solving problem by spatial imagination with open eyes", consisted of two (one female and one male) and its average age was 58.5 years. No pencil-paper, calculator, or formula was allowed. Group 2, "solving problem by pencil-paper", consisted of two (one female and one male) and its average age was 38 years. Pencil-paper, calculator, and formula were allowed to use during test. Test results showed that average percentage of correct answers from the group of "solving problem by spatial imagination with open eyes" was 100% and average total solution time was 22.5 minutes, while average percentage of correct answers from the group of "solving problem by pencil-paper" was 80% and average total solution time was 40.7 minutes. The results of EEG analysis showed that entropy value of right brain in the group of "solving problem by spatial imagination with open eyes" were significant higher than those in the group of "solving problem by pencil-paper". Coherence analysis indicated more synchronous between left and right brain areas in the group of "solving problem by spatial imagination with open eyes". This study was a continuation of Bao s research on "developing right brain potential" based on the theory of functional specialization of the cerebral hemispheres. The development of right brain function implies activating the right hemisphere by a variety of means to make it work and exerting its tremendous potential, which includes the exploitation of rich imagination, inexhaustible creativity, high-speed right brain memory, efficient comprehension, and correct intuition ability hidden in right hemisphere. The engineers in the group of "solving problem by spatial imagination with open eyes" tended to simultaneously use both right and left hemispheres as much as possible based on dominant side thinking. Our nonlinear dynamic analysis of EEG sustained this point.

Najia Bao, The Fu Foundation School of Engineering and Applied Science, Columbia University; B & B Institute of Human Brain Potential
Nangui Bao, B & B Institute of Human Brain Potential
Nasha Bao, Jiangnan University

A Case Study: Problem Solving by Highly Difficult Spatial Imagination Contributes to Large Increase in Complexity of Right Brain

The purpose of this experiment is to test the effect of the cognitive activity, "solving problems by spatial imagination with closed eyes", on the development of right brain potential. The subject was a 74-year-old educator (male and healthy). Test material, one set of sample questions (15 items with time limitation of 45 minutes totally) similar to Fundamentals of Engineering (FE) Exam - a part of exam to licensure as Professional Engineer in USA, covered a comprehensive range of disciplines such as Mathematics, Chemistry, Engineering Mechanics (Statics and Dynamics), Electricity, Fluid Mechanics, Strength of Materials, Material Properties, etc. Our test purposely increased the difficulty level of FE standard exam because no pencil-paper or calculator was allowed and even each test item was presented by orally instead of visually in order to make the subject solve problems only by spatial imagination with closed eyes. Test results showed that percentage of correct answers was 93.3% and total solution time was 25.8 minutes. The results of complexity analysis of electroencephalography showed that solving problems by spatial imagination at super-high difficulty level led to a large increase in entropy value of the subject s right brain, particularly right prefrontal, frontal temporal and medial temporal areas. This study contributes to the implementation of Federal STEM educational program. STEM program is a 5-year Federal Science, Technology, Engineering, and Mathematics Education Strategic Plan in response to the situation that current U.S. education system are not cultivating a sufficiently large STEM workforce necessary for our country. This program focuses on improving K-12 and undergraduate STEM instruction and enhancing students cognitive ability qualified for STEM education by supporting partnerships among school districts and universities, science agencies, businesses, and other community partners to transform teaching and learning. The results of this research showed that the thinking way of "problem-solving by spatial imagination with closed eyes" could fully develop right brain potential. By using right brain to the full, even though far away from the learning period of youth, the subject s long-term memory (retrieval of engineering concepts), working memory (short time operation on information), metacognition (advanced monitoring and regulation), and spatial imagination were still extremely outstanding. The experiment provided the sample data of successful cognitive activity for STEM learning and teaching practice.

Camelo Castillo, European Society for the Study of Human Evolution

Emergence as Major Transitions: how natural selection, information and self-organization generate complex structure

A comparative analysis of the major transitions in cosmology and biology (Smith, Szathmary, 1995) shows that major emergence events share highly convergent models of non-linear dynamics. Inverted models of entropy (e.g. negentropy) like Darwinian natural selection, Shannon information and Bakian self-organization all model the growth of order through a process of stochastic selection from increasing spectrums of interaction. Analysis of the similarities between these models indicates the potential for a unified model of emergence that can be tested against the evidence of the major transitions. This analysis proposes a methodology and evidence for a unified and testable model of universal emergence.

A. Steven Dietz, Texas State University
Keith Owen, Somerset Consulting Group

Coaching and Leadership: The Importance of Time and Space

Most of us think we equip our people to be successful on the job by providing them with learning and development opportunities. This is a myth, as most learning occurs on the job. According to studies done by Princeton, about 70 percent of organizational learning takes place on the job, about 20 percent occurs through drawing on the knowledge of others in the workplace like peers, coaches and managers, and about 10 percent occurs through formal learning. In spite of this, organizations invest at least 80 percent of their learning and development budgets in formal learning, where little of job/workplace learning takes place. The results of an evidence based impact evaluation of the leadership development programs in two Fortune 250 companies were examined. In both organizations, groups of high potential managers were selected to participate in the programs. Six months after the conclusion of the programs, data were collected from participants, their one-up managers, and their direct reports by having them complete the Learning and Development Stickiness Questionnaire. In addition, using a protocol based on the Learning and Development Stickiness model, a sample of participants and one-up managers were interviewed. 149 participants, 69 one-up managers, and 889 direct reports participated in these studies. Our findings were interesting and suggested that when there were meaningful and relevant opportunities to use new learning in a way that helped the organization to succeed and when there was a high degree of coaching,

feedback and systemic support, program impact was very large (a 50:1 return on invested dollars) while this impact was essentially zero when there was little coaching and feedback coupled with few relevant opportunities for application. In other words, the results showed that for these programs the largest contribution to impact was the availability and quality of systemic after care, and the availability of relevant opportunities to apply the new skills. These results imply several interesting things concerning self-organization and emergent behavior in organizations.

A. Steven Dietz, Texas State University
Keith Owen, Somerset Consulting Group

Stochastic and chaotic dynamics of social development according to theory of chaos and self-organization

We can present many different examples of global laws evolution by researching different dynamical systems behavior, but the main example is connected with social evolution. A. Toynbee tried to divide all types of social systems into 21 types. But now for the authors it is evident that there are only 3 types of society: first types is deterministic (or traditional) type of society with a hierarchical structure of its organization; second type is stochastic society (called as technological society) where there is no any leader of society and some strata (party, group of people, ruling upper circles) are of interest of all the society; the third (and the last) type of society is the synergetic (or chaotic) type of human organization where there is also no leader or some strata. This type is opposed to deterministic or stochastic society. Here everyone (if he/she wants to be an order parameter a person as a part of society) may present own ideas and society should analyze it and apply it in different spheres of activity (social, political, technical and many others, including science). The synergetic type of society should live according to I. Kant s law May you live your life as if the maxim of your actions were to become universal law . Perhaps, this statement does not reflect all nuances, but the message is clear. Let us note some main features of these types of societies. We may present the traditional (deterministic or strong functional) type of society as a triangle (hierarchy) where the highest level is occupied by a king, a feudal or a general secretary (in the USSR and other communist countries). The top level of such triangle is presented by authority. A very powerful deterministic society has the strong leader (see Pol Pot s policy in Cambodia). It is a striking example of a dictator society. The wishes of a dictator are the law for everybody in such a society (if you do not agree with him, the death will be guaranteed). The second type of society stochastic (or technological) type does not have such a strict scheme. The top level of stochastic society is presented by a group of people (party, class). It is a typical stochastic society because the opinion of one person is unimportant and there is a distribution of all opinions. For example, sometimes one of party members can be agree or cannot with a general party. There are opinions for and against. The democratic (stochastic) society has J. Gauss distribution of opinions. There are also global laws of fractal evolution of different dynamic systems (for example: unique human or mankind mind). On the other hand, we have such transformation for science when we observe the change of deterministic paradigm to stochastic paradigm and at the end of such transformation we will create a synergetic paradigm.

Valery Eskov, **Alexander Khadartsev**,
Olga Filatova, Surgut State University

Neural computer analysis of chaotic dynamics of tremor parameters in different subjects' mental states under stimulation of auditory analyzer

Psychic and emotional status of a person has a significant effect on the parameters of autonomic and motor activity of the person. Mental condition significantly affects the quality and accuracy of the different movements, holding poses. However, there is an important problem of identifying the common regulatory mechanisms in the responses of cardio - vascular system - CVS and the neuromuscular system - NMS to external (e.g., auditory) stimulus. In our studies we have revealed some general patterns in chaotic dynamics of cardiac and tremor parameters at 4 types of sound effects (rhythmic and classical music, hard-rock and white noise). From the theory of chaos and self - organization quasi-attractors parameters of tremor and RR intervals (coordinates x1 and x2 = dx1/dt) in the phase space of states for 25 subjects (5 presentations for everyone) and using neurocomputer weights coefficient for each state for all (5 groups measurements) were determined. From the standpoint of stochastics and chaos we have revealed significant differences of weighting coefficients of a neural emulator, they are order parameters for the calm state and under classical music. Mental states are ranked under hard rock, rhythm and white noise in the analysis of quasi-attractors parameters tremor of left and right hands. We propose a method for identifying functional asymmetry according to tremor parameters obtained after sound effects. It is proved that there are no differences in quasi-attractors in a group of subjects in tremor parameters of left or right hands. We proved that while studying the chaotic dynamics of two groups of measurements (left and right hands) differences are clearly diagnosed by neural emulator and thus the most significant mental state of the subjects identified. Specificity of previous works is use of neural emulators that divide quasi-attractors under mode of binary classification. It is essential that as diagnostic signs we use not only psychophysiological indicators xi, but five types of quasi-attractors characterizing normal mental state and four special mental states, which in the stochastic and deterministic absolutely cannot be diagnosed. A new method for identifying mental states of groups of people while using chaos theory of chaos and self-organization and neurocomputing is proposed.

This double transition is first used in the scientific world to identify systems with chaotic dynamics behavior. Prospects for its use in the physiology, psychology and medicine are undeniable.

Russell Gonnering, Medical College of Wisconsin
David Logan, Marshall School of Business

Agent-Based Modeling of Organizational Productivity

Improvement of organizational performance is a near universal, yet tantalizingly elusive, goal. We have developed a NetLogo agent-based model that is significantly different from prior models of culture. It explores the nonlinear modulation of organizational productivity through the interrelationship between organizational culture, intellectual capital, shared values and common purpose. The model builds upon a prior presentation in which a similar model confirmed that culture spreads through an organization in meme-like fashion and that cultural propagation is highly dependent on upon the initial state of the culture. This new model mirrors the known phase-transition between stages of culture, the critical impact of shared and resonant core values on performance and the striking non-linear jumps in productivity as the culture shifts. Special emphasis is placed on the influence of: 1) formation of triads (closing Structural Holes in the organization) as a prime tool to effect cultural advancement and increase in organizational productivity and 2) effects of coalescing values and purpose. This approach to performance improvement differs from the more common focus upon the hard aspects of organizations processes, strategy and structure which have produced disappointing gains. The model demonstrates allometric scaling with appropriate utilization constants as a means of understanding nonlinear jumps in organizational productivity, with intellectual capital in the organization analogous to mass in the organism.

Stephen J. Guastello, Katherine Reiter, Marquette University**, Matthew Malon,** University of Wisconsin-Milwaukee

Estimating Appropriate Lag Length for Synchronized Physiological Time Series: The Electrodermal Response

Physiological synchronization is thought to be an important component of work team dynamics, therapist-client relationships, and other interpersonal dynamics. Before it is possible to deploy nonlinear modeling, it is necessary to develop a strategy for determining appropriate lag lengths. This study examined four strategies for doing so in which 73 participants performed a vigilance dual task for 90 min while galvanic skin responses were recorded. Lags based on mutual entropy and the natural rate criteria produced corroborating results, whereas r/e and W strategies did not produce usual results. Some connections between linear autocorrelation strength and performance on the tasks were also uncovered.

Stephen J. Guastello, **Katherine Reite**r, Marquette University, **Matthew Malon**, University of Wisconsin, Milwaukee **James Shaline**, **Justin Abraham**, **Matthew Hilo**, **Joshua Krueger**, **Nicholas McCormack**, **Elaine Sapnu**, Marquette University

Cognitive Workload and Fatigue in a Vigilance Dual Task: Miss Errors, False Alarms, and the Impact of Wearing Biometric Sensors while Working.

The effects of cognitive workload and cognitive fatigue have been difficult to separate in a given task situation, but a series of studies has shown that it is possible to do so by using two cusp catastrophe models and an experimental design that is sufficiently complex to capture all the properties of the model. The two control parameters in the workload cusp were psychological variables for elasticity-rigidity (bifurcation) and levels of workload (asymmetry). The two control parameters in the fatigue cusp were the amount of work done (bifurcation) and compensatory abilities (asymmetry); the fatigue model can also parse learning or practice effects. The experimental revisits a vigilance dual task that was studied previously in which participants watched a VR security camera and rang a bell when they saw an intruder, and they were working on a jigsaw puzzle at the same time. Several new elements were introduced to the present experiment: (a) the VR sequence was redesigned to increase the odds of false positive rates. (b) An expanded list of variables was considered as potential candidates for elasticity-rigidity variables (bifurcation) in the cusp model for workload and as compensatory ability (asymmetry) variables in the cusp model for fatigue. (c) Models were tested for both miss error rates and false alarm rates. (d) Participants (279 undergraduates) were assigned to experimental conditions where they worked alone or in pairs as in the earlier study, but this time there was a condition where they worked in pairs while wearing GSR sensors. The results showed that the cusp model workload was a more accurate explanation for miss rates and false alarm rates in the vigilance task compared to alternative linear models. The cusp for fatigue was a better explanation for fatigue in false alarm rates, but a linear pre-post model was a better explanation for fatigue and miss rates. The strongest elasticity variables were field independence, anxiety, indecisiveness, and inflexibility. Bifurcation variables in the fatigue model included the amount of work done on

the puzzle, working in pairs, and wearing the sensors; compensatory abilities were not found, however. Simply wearing the GSR sensors with the data acquisition equipment operating appeared to be inducing new complications to the situation, and in turn has implications for research programs designed to study biometric measurements of cognitive workload or fatigue.

Shan Guisinger, Clinical Psychologist, Private Practice, Missoula, MT

Revisiting the butterfly catastrophe in anorexia nervosa

Although they are starving, people with anorexia nervosa (AN) eat little, often exercise excessively and do not acknowledge that they are ill. The symptoms are remarkably homogeneous and completely counterintuitive. People who develop anorexia talk of it abruptly taking over their minds; loved ones may feel they have been possessed. In the 1970s E. C. Zeeman used this descent into AN as one of his real-life examples of a catastrophe, as did Callahan and Sashin in the 1980 s. Zeeman modelled anorexia as a butterfly catastrophe that also accounted for normal eating, binging and purging. A crucial variable affecting eating and satiety he called abnormality in attitudes toward food. Recently neuroscience findings revealed that anorexia s symptoms are triggered by falling levels of leptin, the hormone that registers fat stores in the brain. I argue for re-interpreting Zeeman s abnormality as a proxy for leptin level, biological rather than psychological. This is consistent with my proposal (Guisinger, 2003) that AN s symptoms were once adaptations selected when migration was the best solution to local famine. The ability to ignore hunger, mobilize energy, and believe one has fat reserves would have helped starving hunter-gatherers flee famine. Now these adaptations may be turned on by weight loss (and sinking leptin levels) in their descendants. This revised catastrophe model is applied to clinical experiences of patients in various stages of illness and weight restoration. The behavior of Zeeman s model also furthers nonlinear dynamical interpretations of the concept of archetypes in extreme or heroic behavior.

Rachel Heath, SykTek, Valentine, NSW, Australia

Permutation Entropy and Human Biometrics

Lifestyle monitoring devices, such as BodyMedia Fit and FitBit, provide a wealth of useful data to monitor human performance. Activity time series, acquired from such devices over extended time-periods, can be used to compute complexity indicators such as permutation entropy (PE). PE quantifies the nonlinear complexity of time series fluctuations by comparing the information contained in the frequency distribution of all possible orderings of data acquired within a short moving window of the series with random noise as a referent. PE is invariant up to a monotonic transformation of the data, noise-tolerant, and sensitive to nonstationary in the time series. PE has been used successfully in medical applications such as the detection of epileptic episodes and cardiac irregularities, as well as in the analysis of financial time series. The detection of statistically significant changes in PE can be achieved using surrogate comparison data. In this way, changes in one s activity over time, such as during rest and active periods, can be estimated. Potential applications to be discussed include monitoring activity over extended time periods of up to several weeks as a diagnostic aid for detecting mood fluctuations, the prediction of dramatic changes of mood in people diagnosed with bipolar disorder, and the use of PE as an indicator of sleep quality.

Adam W. Kiefer, Division of Sports Medicine, Cincinnati Children's Hospital Medical Center
Gregory D. Myer, Division of Sports Medicine, Cincinnati Children's Hospital Medical Center

Training the antifragile athlete: A preliminary analysis

The prevention of black swan-events incidents that are traumatic, of low-probability and unpredictable (e.g., non-contact knee ligament injury)-is a primary goal of integrative neuromuscular training (INT). INT likely influences adaptations to an athlete s neuromuscular system that make it both robust against black swan events and promote increased resilience when faced with unexpected challenges. We use the term antifragile , introduced by Taleb (2012), to describe the resultant neuromuscular system. Accordingly, the baseline behavior of this system should exhibit attributes that allow it to remain poised for beneficial responses to unexpected challenges, such as awkward landings or reactionary movements. Twenty-three female athletes (M=15.84±1.37 years) participated in either INT (N=16) or did not receive a training intervention (N=7). Prior to and following the intervention, all athletes performed three trials of a drop-vertical jump task. Surface electromyography (EMG) was collected from the gluteus medius muscle on the right leg and was submitted to recurrence quantification analysis. This muscle is a primary stabilizer against hip adduction and protects the knee from injury. Following training, the INT group exhibited lower percent recurrence (M=.09±.02 vs .16±.03), trapping time (M=7.13±0.97 vs. 10.84±1.08) and vertical maxline (M=84.31±17.70 vs. 147.76±15.25) in the moments prior to landing and before the initial vertical jump (i.e., the pre-action phase) compared to the no-training group. These results

indicated a less predictable, more protean profile of muscle activation exhibited by the trained athletes prior to their intended action, and may have implications for the design and implementation of injury prevention training protocols.

Min Lei, Shanghai Jiao Tong University, China; Vanderbilt University, USA
Guang Meng, Shanghai Jiao Tong University, China
Nilanjan Sarkar, **Jing Fan**, **Josh Wade**, **Dayi Bian**
Vanderbilt University, USA

Nonlinear analysis of electroencephalograms of healthy people during driving test based on symplectic principal component analysis method

Symplectic principal component method for nonlinearity has been used in order to detect the existence of nonlinear dynamics. We applied symplectic principal component index on the electrocortical activity as discriminative statistics. Our particular interest in this study was to investigate the nonlinearity of electrocortical signals in driving and nondriving. We performed the nonlinearity test of different principal component data by using symplectic principal component index and surrogate data generated by the algorithm of a monotonic, instantaneous, time-independent nonlinear function. The results indicated that cortical signals have mostly nonlinear properties during all experimental conditions in healthy people although the index values are different to depend on different persons. The research found that the underlying physiological mechanisms of the brain may be explained by the high dimensional nonlinear dynamics. And in contrast with the entropy analysis, results of testing nonlinearity by symplectic principal component index as discriminative statistic are more stable than those obtained by the approximate entropy.

Julie Lein, University of Utah

Engaging Complexity through Aesthetic Selection: A Case Study in Poetry

In Rejection of Closure, a seminal essay on literary form, poet Lyn Hejinian writes that The undifferentiated is one mass, the differentiated is multiple. This explicitly aesthetic observation resonates with a key concept in complexity science: that breaking symmetries generates a constrained release of energy to do work, constructing new patterns which in turn can be broken again all the while increasing diversity and expanding potential. Embracing these literary and scientific models and exploring possible connections between them, 11/11 Breaking Symmetries is the record and result of a month-long experiment with complexity principles in my daily poetic practice. This paper shares excerpts from that project along with the poetic constraints developed in response to Douglas Hofstadter s notion of a parallel terraced scan and Melanie Mitchell s further characterization of living systems various modes of information processing that helped generate it. Although the immediate aim of this poetic experiment was to see how a text/writer/environment(s) might co-construct each other as a complex adaptive system, it also serves as a case study through which to ask broader questions relating to the role(s) of aesthetic selection in other dynamic systems involving humans. Stuart Kauffman, for instance, has remarked that biological order arises from a poorly understood marriage of self-organization and selection. How might aesthetics participate in and help us better understand the dynamics of that relationship? How might aesthetic selection contribute to change in human organizations and in their engagements with non-human systems?

Herbert Maier, TactiCog (sm)

Orbital Decomposition of High-Speed Dyadic Tactical Decision Making

High speed and consequence, plus unreliable information, amplifies the challenges of a researcher s decision-making task design. Adding a live opponent, setting a few rules, and letting such a system-of-systems run is exactly the format in which we live our daily lives. Levels of consequence may change, and are sometimes only understood in hind-sight, but everyday interaction happens on a second-by-second basis. The essence of all interactions is a dyad, so it is peculiar how few researchers go there, and how many activities modeled seem convenience ones like team sports, which have too many alternatives to track precisely. A dyadic training format at the Aplysia scale of complexity exists in curricula of certain combat-oriented martial arts. Thinking with your hands makes processing cycles under 1-second externally observable. In earlier stages of this study, 4 performance dimensions were defined. Data showed that an essence I termed cognitive load (CL) was dynamically distributed in an engineering fashion. P-values were high enough to agree with the classroom reality that a trained instructor tracks, critiques and teaches skill development in this activity. A weight-like scale of this CL was devised, based on how much of an individual s instantaneous capacity was occupied. Defining individual capacity was supported by observation of overload, with several classes of failure and recovery. Evidence was strong that a nonlinear or dynamical system approach would reveal the next level of understanding but which procedure? This paper presents the first stage of viewing the LinSao activity through orbital decomposition.

Joshua Mittler, Texas State University, San Marcos, TX

How Work Gets Done: Understanding Organizational Reality

Organizations exist in a highly competitive environment characterized by constant change, abundant information, diversity, and technological advancement. There are blurred boundaries and inextricably intertwined relationships within the organization and its interactions with the environment. Long-term outcomes are not predictable and decisions delegated by leadership in an autocratic fashion often produce unintended results. Lane and Klenke (2004) stated that leadership in organizations must adroitly address and be tolerant of organizational and environmental ambiguities to maintain and thrive in the dynamic global environment. They suggested managing uncertainty and coping with ambiguity fundamental competencies of leadership. Thus, tolerance of ambiguity may be a key marker in evaluating leadership of the present era.Strange Attractor Pull (SAP), an organizational systems simulation-game, provides a means by which participants experiment with and elucidate factors influencing organizational performance. Organizational structure and processes become readily apparent in the unique and tangible physical shape that emerges from connections participants make with bungee cords. The goal of running the SAP simulation is to create a situation that closely approximates organizational reality and provide insight into the dynamic nature of organizational change. Participants operate with a paucity of information initially supplied by the facilitators. Subsequently, they self-organize and problem solve in a climate that continuously introduces change and unplanned occurrences. A single behavioral change or action can be realized as having a long reaching and substantial impact upon organizational goal achievement. It is the manner by which participants integrate and adapt to dynamic change or disturbance that is fundamental to success. Hence, giving rise notion that such events create conflict or interactive tension, a likely force underpinning creativity and growth. Data measuring ambiguity tolerance and emergent leadership was collected from participants during several SAP sessions. In this presentation we shall discuss our findings as well as potential future applications for the research.

David Pincus, Chapman University

One Bad Apple: Experimental Effects of Psychological Conflict on Social Resilience

Past research suggests that small group dynamics are self-organizing systems, and that social resilience may be measured as the meta-flexibility of group dynamics: the ability to shift back and forth from flexiblity to rigidity in response to conflict. The current study extends these prior results, examining the impact of experimentally induced internal conflict and group-level conflict resolution on group dynamics whether one bad apple can spoil the bunch. Six exprimental groups with four members each participated in a series of four 25-minute discussions. The first two discussions served as a baseline condition. Internal conflict was induced to one or more group members prior to discussion three, with the prediction that higher levels of conflict induction would lead to significant drops in group flexibility creating a press on the group s resilience, whereas conflict resolution in disucssion four was expected to allow for a rebound in group flexibility. Consistent with prior research, the turn-taking dynamics of each the 24 groups were distributed as inverse power-laws ($R2 = .86$ to .99) providing evidence for self-organization. Further, there were significant study-wise negative correlatiosn between levels of personality conflict and two measures of flexibility: information entropy ($r = -.47$, $p = .019$) and Fractal Dimension ($r = -.42$, $p = .037$). Altogether, these results suggest that: (a) small groups are self-organizing systems with structure and flexibility providing social resilience, and (b) individual conflict is able to spread to higher level social dynamics, creating pressure on social resilience. Practical implications for assessment of, and intervention with, psychosocial resilience are discussed.

David Pincus, Chapman University

Emotional inertia: A key to understanding psychotherapy process and outcome

The processes underlying psychotherapeutic change have increasingly been emphasized in both research and clinical practice. Nonlinear dynamical systems theory (NDS) offers a transdisciplinary scientific approach to the study of these processes. This paper introduces the NDS concept of emotional inertia , the property of human emotion by which it retains its course so long as it is not acted upon by an external force, as a key to understanding moment-by-moment and also longer-term change processes within psychotherapy. A testable mathematical model of emotional inertia is presented that represents specific impacts of psychotherapeutic processes on emotional dynamics over time. Emotional trajectories in phase space, treatment energy, and the interaction between them are the essential elements of the model, and a detailed explanation is provided. Procedures for testing this model are described, such as by tracking the movement of emotion in phase space within and across therapy sessions, along with clinical implications of the model, which can potentially help to make more clear the complementary roles of therapeutic force, timing, and leverage.

Diane Rosen, State University of New York

Accessing creativity: Chaos, wandering minds, and Jungian night-sea journeys

NDS theory has been meaningfully applied to the dynamics of creativity and psychology. These complex, interactive systems have much in common, including a broad definition of "product" as new order emerging from disorder, or a new whole (etymologically, "health") out of disintegration or destabilization. From a nonlinear dynamics perspective, this paper explores far-from-equilibrium pathways to creativity: in the primordial chaos of Jungian unconscious, a mythic prima materia for transformative night-sea journeys; and the flux of internal content in the brain"s Default Network, considered the wellspring of creative ideation within the larger neural matrix. Idea elements, determined yet infinite, are generated chaotically. They tend toward strange attractors, recombine unpredictably, self-organize and produce change. Antinomies such as noetic consciousness (light) and the poetic unconscious (darkness), when neutrally valenced (i.e. neither suppressed nor contributing to psychosis), galvanize both creativity and the psyche; growth arises from the tension of opposites. Examples from my own work illustrate this dialectic of creative process. Looking back to the mythos of primal chaos, and forward to the neuroscience of mind wandering, we find fresh indications that the darkness of the unknown, bizarre, or irrational is, paradoxically, the illuminative source and strength of creativity. Chaos is ideally suited to model this constructive blending and bending of boundaries between reason and imagination, self and world.

Janice Ryan, East TN Community College Alliance

The nonlinear neurodynamics of play therapy for people with dementia

This presentation explains current work applying nonlinear neurodynamical science to treatment of clients with dementia. Behavioral challenges associated with dementia will be conceptually related to the emotional dysregulation that emerges from feelings of social isolation, exclusion or other triggers for ongoing, negative influences of the ought-avoidance bifurcation factor examined by Stamovlasis and Sideridis in the January, 2014 volume of Nonlinear Dynamics, Psychology, and Life Sciences. A psychotherapeutic approach called Play Therapy for People with Dementia will be introduced and its evolutionary neurobiological underpinnings discussed. Attendees will understand how self-organized developmental learning environments can be used to generate opportunities for therapeutic neuroadaptation in clients at all stages of dementia. The theoretic rationale of self-organized developmental learning environments as system containers for play therapy exchanges and multi-sensory integration cues will be explained. The evolutionary neurobiological theory that enhanced human consciousness supports the emergent state of cognitive-psychomotor-affective system self-organization will be described. Results of ORBDE video analysis of client occupational performance, attention-switching and group dynamics in palliative person-environment-occupation networks will be presented. ORBDE will be used to analyze recurring patterns as "nominally-coded time series data" (Guastello, 2014).

Thomas Taylor, **Mickie Vanhoy**,
Jingjing Wang, **Shanshan Haung**,
University of Central Oklahoma

Primary motor cortex stimulation affects visual guidance and attention systems

Someone"s hands position relative to a visible object may facilitate object perception, perhaps because objects near hands are likely important. Although other research describes the effects of hand proximity on response time and accuracy in dual haptic-visual task, no analysis has been made of the finer-grained structure of performance. Participants completed dual task trials where they kept a steady pattern of right-hand motion whilst simultaneously identifying Chinese or English characters on a computer monitor. An articulating arm held the monitor above the desk, occluding participants" hands. On each trial, a cue notified the participants to move the mouse across the desk from the right to the left side of the monitor. Another cue, 1200 ms later, cued the participant to return the mouse to the starting position as the characters appeared either in the lower left or right of the screen before being masked. The power spectra of the time series were estimated with Wavelet Transform Modulus Maxima, a way to measure the fractal dimension of a time series.

Carlos A. Torre, Yale University

Hearts & Minds: Nonlinear Approaches to the Physiology of Emotions & the Readiness-to-Learn

Using Recurrence Quantification Analysis (RQA) to examine heart-rate variability (HRV) data, I found a recurrence point difference of approximately seven percent between monolingual (English) and bilingual (Spanish dominant) students in affective-perceptive activity and in cognitive activity in which the teaching/learning process was conducted in English. However, there was virtually no difference between the two groups of students in pragmatic (hands-on) activity. These findings demonstrate that advanced, nonlinear analytical methods, such as RQA, can provide more

comprehensive means of examination than standard techniques alone when applied to physiological systems. When used appropriately, RQA can be an effective discriminatory tool, for analyzing cardiac signals. Because it is not stymied by size of or bifurcations (state changes) in the data nor by degrees of complexity and/or randomness in the data, RQA can provide objectivity about the degree of determinism in a given physiological system, as well as disambiguate among a range of emotions represented by a multiplicity of physiological responses). This paper outlines successful strategies for applying quantification of recurrences when analyzing changes in non-stationary cardiac signals, which are not detected easily by conventional approaches. It also serves as initial evidence of how different educational (teaching) methodologies can affect physiological/emotional responses and, perhaps, students ability to learn and develop. Through the use of Holter monitors and Recurrence Quantification Analysis (RQA), my research seeks to identify characteristic patterns in the autonomic nervous system associated with specific emotions, as well as explore emotions children experience while learning and how different educational processes mediate emotions.

Rita M. Weinberg, National Louis University

Chaos, Complexity and Personality Assessment

Personality is a complex system. It involves qualities, dispositions, and attributes which can change over time and under specific environmental events. Complex systems invoke being non-linear and able to self organize. In general psychology, it includes principles related to perception, motivation, learning, thinking, organic wholeness and awareness of self and individuality. It includes relationships with others-so it involves social-biological identities. Experiences and events can alter personality qualities, e.g., serving in the war in Iraq or Vietnam can produce Post Traumatic Stress Disorder (PTSD). How do we assess such a complex system? We learn that complex systems include agents, hierarchy, co-evolution, far-from-equilibrium dynamics, an internal structure which reflects past experiences. Parts may be hidden. There is an ergonomic field in space, and a personality mixture of self and non self. And all within a time and environmental field. In this paper we will discuss how assessment can be applied to multiple objects and characteristics such as in a complex system. We analyze and tease out a person s attributes such as intelligence, ability to think about and solve a problem we set before him or her. We give examples of the projective tests we use and what we can learn from their responses. In using projective tests, that is, tests which present vague perceptual stimuli such as ink blots, or pictures to which they are asked to make up a story, or to copy designs-these may produce perturbations, dis-order in their systems and they may find it difficult to follow directions. Chaos theory states that when systems become disorganized, they self organize. Fractals are also involved since personality attributes are those of scale. They may become more pronounced or be very small and rarely expressed. The Rorschach Ink Blot Test appears to be the most challenging since the perceptual stimuli on each card are vague, amorphous. Our brain tries to comprehend what it means, what the ink blot could be. There are no guidelines to follow. Some follow habit patterns, or produce unusual responses, or become completely blocked from making any response. In such cases we consider that they have become psychologically blocked. We note how long it takes for recovery to happen. Chaos theory reminds us to look at small data or themes which come up again and again, for unusual responses,for the ability to network and re-organize what they see in a meaningful way. We look for patterns and how they deal with cognitive and emotional challenges. In cases of severe trauma, we assess pathological changes in thinking, emotions, and behaviors.

Toru Yazawa, Tokyo Metropolitan University

A stress-quantification gadget: mDFA of heartbeats, from crustacean animal models to humans

Crustaceans are a miraculous specimen for studying stress-quantification. Heartbeats are controlled by the nerves (ANS). In hermit crabs, both the acceleratory nerves (CA) and the inhibitory nerves (CI) fired at about 0Hz - 5Hz and 0Hz - 60Hz, respectively. When I approached the crabs, the activity of CI dropped and CA remained, i.e., the heart rate was increased by stress (acute-stressful state). In turn, CI worked a lot while resting: A brief-period-slowdown in rate was observed that repeated regularly (stress-free state with ANS-induced slowdown). I thus can tell whether a crab is happy or nervous by the EKGs. This study aimed to quantify stress. As quantification tools, a modified detrended fluctuation analysis (mDFA) was used. It checks power-law characteristics of the heartbeat-intervals data. I studied EKGs of both, crustaceans and humans, to determine whether mDFA could be a useful tool, a gadget, for the evaluation of the subject fs quality of an illness and transition to and from a normal healthy state. Heartbeats of stress-free lobsters exhibited a normal scaling exponent ¿ = 0.99 } 0.38, and stressful lobsters exhibited a lower scaling exponent of ¿ = 0.55 } 0.21. Human hearts reflected a mental condition, as in chronic job stress. The perceived level of wellness varies among the subjects, because there are no two individuals that are identical physiologically. Our mDFA can individually be a tool to quantify the degree of wellness and the transition from sickness to wellness and vice versa.

Michael Zimin, Canada, **Taras Gavrilenko**, **Michael Filatov**, **Julia Vochmina**, Surgut State University

Are there stationary mode in the control system of human movements?

The traditional deterministic-stochastic approach (paradigm - DSP) in modern science provides only primitive description of real complex work of all neural-networks. It is reality for our mind, global control of human organism state in normogenesis and pathogenesis and many different other types of brain control. During the whole century physiologists and psychologists have been discussing voluntary or involuntary control of tremor. The discussions are still continued but now it is evident for us the discussion has no any chance to find solution of the problem according to DSP. It is real situation turned to DSP doesn t take into account the basic property of all complex biosystems: the systems state vector (SSV) which describes all different biomedical systems state (especially biomechanical movements) does uninterrupted movements in phase space of states (PSS). Other way SSV x=x(t)=(x1,x2, ,xm)T in PSS has chaotic movements at some special volume of PSS called by us as quasi-attractor (QA). Such QA presents all the information about behavior of SSV in PSS and other types of presentations (according to DSP) present only unique (instantaneous) state of biomedical systems. The tremor, tremorograms present only unique picture about biosystem state as a system of third type (STT), and traditional deterministic condition of stationary mode as dx/dt=0 and xi(t)=const is not useful. Moreover, stochastic approaches of stationary mode like stable state of function distribution f(x) is not suitable. For every time interval t1=t2=t3 and t1+t2+t3 =T = 4.5 sec of tremorogram every f1(x)≠f2(x) ≠f3(x) (every interval ti has its specific function distribution). The f(x) is not reproducible. For every examined at short time interval ti we have unrepeatable f(x) for tremor (or cardiointerval miogram). We have indefinite changes of f(x) and probabilistic definiteness is a myth in case of systems of third type. We have a great number of examples for such illustration (more then 20000 experiments). Now we create special procedure (according to Chebyshev polynomes) which provides strong distinguishing between chaotic and stochastic characteristics of all type of STT. Different illustration of such method we present now. Now we prove that standard procedure for identification of human movement control and other STT can be realized by brain by billion variants of its internal state. It is a real chaos of brain internal state and output as tremor present only an instantaneous unique state of human brain. We create the theory for such chaotic states description. The theory called by us theory of chaos-selforganization and all its fundamental principles we present in the article. The main principle of the theory (and the internal mechanisms of brain chaos) is based on uninterrupted chaotic movements of SSV (normal state of human organism). It means that dx/dt≠0 and x≠const for any time τ and the trajectory of SSV in PSS unrepeatable but the Lyapunov value λi has no any positive value, because any phase trajectory may cross each other and classic chaotic theory (according to DSP) is unsuccessful and unsuitable for brain, muscle and other STT description. According to our new theory we present the model of Parkinson"s disease.