Society for Chaos Theory in Psychology & Life Sciences

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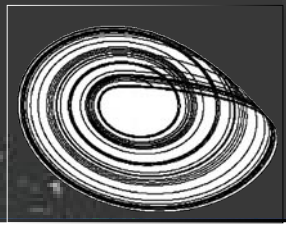
Abstracts to the 5th International Nonlinear Science Conference, University of Barcelona, Spain

2012



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*Messages from the **SCTPLS** President and the **INSC** Conference Chair*

Welcome to the ***5th International Nonlinear Science Conference***. This conference has been organized by the Society for Chaos Theory in Psychology and Life in conjunction with University of Barcelona. The event reflects a commitment on the part of our organizations to facilitate international collaboration and to encourage the cultivation of scientific partnerships across the globe. We are able to offer you a rich and varied program or presentations, covering a wide range of scholarly disciplines and including theoretical as well as applied approaches. It attests to the international character our scholarly community that we have presenters from many countries to share their work in nonlinear dynamics, including scholars from the U.S., Eastern and Western Europe as well as Asia. This conference has become part of a long-standing tradition of international scholarly exchange, which has surely strengthened our nonlinear dynamical systems community and the impact of our work.

David Pincus, Ph.D President
Society for Chaos Theory and Life Sciences
http://www.societyforchaostheory.org

Dear Conference Attendees,

On the behalf of the conference committee, I would like to welcome you to the University of Barcelona as well as the 5th International Nonlinear Science Conference. We hope that all of you will take advantage of this opportunity to share experiences and intellectual achievements in a synergic environment as in previous years. This year's presentations have been selected from various disciplines: psychology, economy, management, language, sociology, physics, informatics, ecology or medicine. Nonlinear sciences paradigms are once more at the basis of all models and applications presented, which helps promote scholarly exchange in a true multidisciplinary environment. In addition, Barcelona is a good place to think in nonlinear and complexity terms. It has several research centers dedicated to the study of nonlinear and complex behavior, and one on its most representative artists, Antoni Gaudí, created a new architecture by trying to imitate natural forms while avoiding straight lines and perfect shapes. A wink of complicity to our interest in the nonlinearity!

Jose Navarro, PhD
Chair, 5th INSC 2012
University of Barcelona, Spain

Featured Keynote Speakers:

Peter Allen

"Complexity, Understanding and Evolution"

In hard science a new theory must be capable of being falsified, and therefore must produce testable predictions, which if not falsified lead to genuine cumulative knowledge. In complex systems however, which are of course where we live, clean predictions are often no longer possible and our understanding evolves under less severe selection criteria. In ecological and human systems structural attractors can emerge and persist for some time, simply because their particular emergent capabilities/behaviours succeed in getting resources from the environment. Institutions, firms, fashions, lifestyles, art, artefacts and communities of practice can emerge and survive providing that there is a clientele for them willing to provide the resources they need to maintain themselves. Such things are not about being "true or false" but more about whether they find an adequate niche in the environment. Living systems create a world of connected, co-evolved, multi-level structures which although temporally, sufficiently self-consistent to 'operate' for a time, will inevitably evolve, adapt and change over longer periods. We shall present a number of real-world examples in which successful emergence and persistence of structure and organization requires not only elements that obey the current rules but also internal layers, elements and individuals who, while inhabiting the current structure, have their own ideas about how satisfactory it is, and how they might perhaps change it to their advantage. Complexity therefore leads to temporally stable, paradoxical systems that include heterogeneous elements and layers with multiple views and perspectives. Knowledge and truth are less present than belief and habit. In this way, complex systems allow adaptation, change and creativity by having different kinds of explorers and exploiters simultaneously present within them. In an ecosystem, a society or a market place, we find that elements need to experiment with their behaviour in order to find out how to continually explore the pay-offs of possible novel behaviour within the changing constellation of others. Of course, luck will play a role in any successes obtained, but 'pro-active' learning through experimentation will do better than just hoping. In the examples given here of automobile and aerospace manufacturing, we can actually break down organizational behaviour into its "atomic" components of working practices, skills and techniques. Complexity tells us that as well as the "organization you see" - the set of practices - continuing success requires that there must always be organizational flexibility enough to allow the testing of (invented or copied) of new practices. Such initiatives can gain from the imagination and modelling of possible new actions, in order to try to evaluate which ones may be positive. Today complexity, evolution and understanding meet together within our interpretive frameworks. Our qualitative or quantitative mathematical models, complex and agent based, are therefore part of the political reality as they can and do change the behaviour that is included within them. In a range of examples that will be briefly presented we shall show the importance of complexity in issues such as climate change, social and economic change and development, markets and fashions as well as such technical issues as electricity distribution and Smart Grids. In summary, most knowledge is only belief, and beliefs are gained pragmatically. Part of the fabric of ecosystems and of societies, the part which gives them their vitality and creativity, are the changing multiple perspectives and understandings that inhabit them.

Peter Allen is the founder of the Complex Systems Research centre at the Cranfield School of Management, UK. PhD in Theoretical Physics, was a Royal Society European Research Fellow 1969 - 71 and a Senior Research Fellow at the Universite Libre de Bruxelles from 1972 – 1987. He has written and edited several books (for example, *The SAGE Handbook of Complexity and Management* edited jointly with Steve Maquire and Bill McKelvey London, Sage, 2011) and published well over 200 articles in a range of fields including ecology, social science, urban and regional science, economics, systems theory, and physics. Currently he is the Editor in Chief of *Emergence: Complexity and Organization*.

Albert Diaz-Guilera

"*Networks of Networks*"

Complexity spans over different scales, ranging from the atom to the large scale of the galaxies forming intricate geometric patterns. Complex emergent behavior can have different origins, but nowadays it is clear that beyond nonlinear interactions between units, a key role is played by the topology of interactions, forming networks of connections at all levels. Moreover, networks at different levels are interacting. In this talk we will review the different levels of description in living systems at which we find complex networks and show how they emerge at different scales and how they interact. This ranges from cellular scale by means of metabolic or gene regulatory networks to networks of individuals, like Facebook or Twitter, in our modern communicate society, or networks of interacting species in complex ecosystems.

Albert Diaz-Guilera got his degree in Physics at Universitat de Barcelona (1983). PhD in Science at Universitat Autonoma de Barcelona (1987). Postdoctoral stays in Gorlaeus Laboratories (Leiden, The Netherlands) and "Centre de Physique de Solide" (Sherbrooke, Canada). His research is currently focused on general aspects of complexity, particularly in complex networks. Being by education a statistical physicist, his research lines had been broadening to cover aspects in many different fields: biology, economy, social sciences, computer science, linguistics. Direct collaborations with scientists with different backgrounds have been possible by means of stays in different centers (Mathematics at Imperial College London, Chemical and Biological Engineering at Northwestern University, Ecologia UNAM, Potsdam Institute of Climatogy, Potsdam Psychology, Sociology at ETHZ). Author of more than 70 articles in physics and interdisciplinary journals. He has given about one hundred of talks at conferences and research centers. Leader of the research group PHYSCOMP2, PI of projects from Catalan and Spanish Governments and EU. Coordinator of the Spanish network "Econosociofisica: Dinámica y fenómenos colectivos de sistemas socioeconómicos". Currently is Deputy Spokesperson of the Spanish node of the European Flagship iniciative "FuturICT".

Jorge Wagensberg

"*Individuals versus individualities: A Darwinian Approach*"

The idea that natural selection acts on many levels -and not only at the level of organisms or individual genes- is increasingly accepted among biologists. However, it is not easy to reconcile this idea with the strictly "individualistic" conception of the evolutionary process that has always characterised Darwinian thought. In addition, the individuality of some forms of life is a vague concept and, therefore, it is controversial. This is the case of Candidatus Magnetoglobus multicellularis which discovery immediately inspired the following question: Does the concept of individuality have degrees? Alternatively, how far is this structure of prokaryotic cells from deserving to be called an organism? In this paper, we propose a new conceptual scheme based on an idea of individuality that is not limited to organisms and that makes sense in terms of Darwinian evolution. In this conceptual scheme, selection at levels above that of the individual-organism is interpreted as the evolutionary emergence of higher level individuality. This proposal may serve as a basis on which to construct an eventual hierarchical evolutionary theory.

Jorge Wagensberg, Doctor of Physics, is professor of Irreversible Process Theory at the University of Barcelona. He not only investigates and disseminates science, but is also a dynamic promoter of the debate of ideas, which has achieved him Catalonia's National Prize for Scientific Thought and Culture, among other awards. He is the director of Metatemas collection and responsible for the Scientific and Environmental Area of the "la Caixa" Foundation, after having directed the scientific museum CosmoCaixa, a reference for science museums around the world. He is the author of a dozen books and of many works of investigation on thermodynamics, mathematics, biophysics, microbiology, paleontology, entomology, scientific museology, and the philosophy of science, as well as of journalistic articles on a number of different topics.

David Pincus

"*Complex Biopsychosocial Dynamics, Behavioral Medicine, and Psychotherapy*"

Complexity science offers a new, broader paradigm for understanding and intervening in developmental processes within and across personality and social dynamics. This address will begin with a review of empirical results applying nonlinear dynamics to the understanding of relationship development and group dynamics, with an emphasis on understanding the functional roles of rigidity and flexibility in health. Noteworthy conclusions from this line of research are that relationship structures appear to be self-organizing and fractal, with higher complexity generally associated with health. Next, we will examine complementary evidence for self-organization in personality structure, again with complexity operating as an index of health. Finally, these lines of research will be integrated within a general model of self-organization in biopsychosocial resilience. The aim of this general model is to guide future research applying nonlinear dynamics to health research, as well as to inform the development of novel interventions in psychotherapy and behavioral medicine.

Dr. David Pincus began his career in 1991 as a youth and family therapist working in public mental health in WaukeshaWisconsin. He obtained his M.S. and Ph.D. in Clinical Psychology at MarquetteUniversity, followed by a clinical postdoctoral fellowship at the University of California Davis Department of Psychiatry. Currently, Dr. Pincus is an assistant professor within the faculty of psychology in the school of health sciences at Chapman University, the director of The Francis L. Smith Community Clinic, and licensed psychologist in private practice. He is the author of the recent book applying NDS to imagery-based psychotherapies: *Imagery for Pain Relief: A Scientifically Grounded Guidebook for Clinicians.* He also served as a co-editor for *Chaos and Complexity in Psychology: The Theory of Nonlinear Dynamical Systems* (Cambridge Univ. Press). In addition, Dr. Pincus has produced numerous other publications (e.g., journal articles, book chapters, workbooks, and instructional videos) to diverse topic areas in clinical psychology.

University of Barcelona, Faculty of Psychology-Theater

Communications and other proposals by alphabetic order

Sensitivity to Initial Conditions in Random Networks

Gaetano L. Aiello , *Universita' degli Studi di Palermo, Italy*

The state of the network is a binary string, the number of 1s being its strength. Initial state of insufficient strength causes the system to die off, while too much strength leads to saturation. Scrambling the order of 1s may also have similar effect because - unlike the number of "axons" per cell - the number of "synapses" varies with the wiring scheme. Likewise, any instance of random network with given connectivity has a different wiring scheme, therefore a different distribution of synapses, and thus different responses. Several scrambled versions, or "variants", of the initial string were tested. Sensitivity to a variant was annoted if a phase-transition, e.g., a change from chaos to periodic oscillations, or a period change was detected. We have already investigated phase-transitions induced by varying the connectivity. The observed distribution of periods for the same value of connectivity indicates a sensitivity to the wiring scheme as well. The effect is similar to delivering stimulus variants to a network with fixed wiring scheme, which indicates an additional form of sensitivity to initial conditions. The results suggest that this observed chaos obeys most of the tenets of time series of known kernels, along with a non-trivial dependence to initial conditions which ranges from high sensitivity to robustness. A conclusion can be drawn that chaos in real world systems does not necessarily complies with all the strict paradigms of complex nonlinear dynamical system, rather it has its very own signature that can only be revealed through direct empirical observations.

Nonlinear Dynamics of the Psychobiological Adaptation to Exhausting Exercise

Natalia Balagué, *INEFC Barcelona*
Robert Hristovski, *St. Cyril and Methodius Univ., Skopje*
Pablo Vázquez, *INEFC Barcelona*
Daniel Aragonés, *INEFC Barcelona, Spain*

Researchers of the exercise induced fatigue recognize the limitations of the reductionistic models to study it and recommend the application of integrative approaches. The psychobiological integration during exercise performed until the termination point is currently viewed under the scope of traditional control theories. To study it under the nonlinear dynamics perspective a set of experiments were performed. The behavior of 4 different potential order parameters informing about the state of the performer-task interactions while performing 3 different constant exercises until the termination point was continuously monitored and analyzed. The control parameter was the accumulated effort in all exercises. 1. Isometric arm-curl flexion On 5 alternating days during 2 weeks, six well-trained participants, who were familiar with the task, performed a quasi isometric arm-curl exercise holding an Olympic bar (weight: 80% 1RM) with an initial elbow flexion of 90 deg. until the fatigue-induced spontaneous termination point (FISTP). Participants were encouraged to persist even if the initial 90ϒ position was lost. Changes in both elbow angles during the trial were registered at a rate of 50 Hz by an electrogoniometer (Biometrics, software by Ebiom). Results show that as fatigue develops the elbow angle increases its variability. An enhancement of the elbow angle fluctuations precedes the sudden fall of the angle which coincides with the FISTP. The power spectrum data shows a globally-correlated enhancement of the elbow-joint angle variability and a difference between the values of the first and the last third part of the exercise. The spectral degrees of freedom analysis also reveal a highly significant reduction as the FISTP approaches. 2. Cycling at 70 RPM Twelve triathletes performed a continuous cycle ergometer exercise at 80% of their max. workload. The task goal was to keep a pace of 70 RPM until their FISTP. The RPM values were recorded continuously by a cycle ergometer system (Sport Excalibur 925900). The spectral indexes were calculated estimating the linear fit slope of the power spectrum with respect to frequency in logarithmic coordinates. A scale invariant relation was found between the spectral power of the RPM variability and the frequency. The variability values point to the presence of a fractal time structure (from anti-persistent to persistent fractional Brownian motion (fBm) as fatigue develops. 3. Running at constant velocity while imposing a Task-Unrelated Thought (TUT) Eleven participants ran twice on a treadmill at an intensity of 80% of their HRmax until exhaustion while self-monitoring and reporting their thoughts. During the first run their intrinsic dynamics of thoughts was established. As no participant reported an emergence of TUT, during the second run they were asked to intentionally maintain TUT, and reporting back about spontaneous switches from TUT to TRT, and vice versa. Results revealed that the intentionally imposed TUT was stable at the beginning of the exercise but switched spontaneously to TRT with accumulated effort. Close to exhaustion the TUT and TRT competed, showing a fully developed meta-stability until the final TRT state prevailed. In conclusion, a nonlinear dynamic effect of thought processes (loss of stability of TUT, spontaneous emergence of TRT, spontaneous switches from TUT to TRT (a meta-stable dynamical regime), and finally, an absolute destabilization of TUT and spontaneous transition to TRT) during fatiguing exercise was noted until the termination of effort. Three different phases of effort may be discerned in the different experiments. The first is characterized by small values of fluctuations and their dominantly antipersistent profile as well as the larger values of the spectral degrees of freedom on the kinematic level. The ability of performers to maintain the intentionally imposed TUT and the low probability of finding urges to terminate the exercise witness the stability and flexibility present on the psychological level. The second interval is characterized by a relative stability on the kinematic level but the spontaneous, i.e. involuntary, emergence of TRT like body monitoring, shows first signs of

destabilizing effects of the accumulated effort. Within this interval there is a metastable regime characterized by switching from TRT to TUT and vice versa, as well as balanced probabilities of urges to continue and to terminate the exercise. The third interval is characterized by reduction of the spectral degrees of freedom of the order parameter (in the quasi-static exercise) or persistent or superdiffusive fBm (in the dynamic exercise) and enhanced fluctuations on the kinematic level. Such profile signifies a formation of low dimensional competition between two increasingly coherent processes of inhibition and excitation correlated along the whole neuro-muscular axis of performers. On psychological level these processes are associated with dominance of the urges to terminate, the lost of stability of the TUT and stabilization of TRT. The stabilization of the TRT points to the lost of flexibility and lowering of the dimensionality of the attentional/thought processes, which corresponds to the lowering of the spectral degrees of freedom on the kinematic level. Eventually, TRT become stabilized close and in the termination point. Such picture points to a psychobiological integration which is not fixed but at some points creates association between psychological and biological spaces. Especially close to the termination point their mutual coupling resulting in the lower dimensional dynamics becomes dominant. As it has been shown in the different experiments the dynamics of the psychobiological adaptation to exhausting exercise is highly likely to be nonlinear, soft-assembled and metastable. These findings pose a challenge on the future research of the psycho-biological integration during exercise, and might have important implications on the cognitive and physical interventions used to improve performance.

Negative Cognitive Emotion Regulation Style as Associated with Widespread Diminished EEG Fractal Dimension

Maria Balle, **Alfonso Morillas & Blanca Aguayo**
IUNICS, University of the Balearic Islands, Spain

The cognitive regulation of emotions is important for human adaptation. Negative emotion regulation (ER) strategies have been linked to the development and persistence of anxiety and depression. A vast array of research has provided valuable knowledge about the neural correlates of the use of specific cognitive ER strategies; however, the resting neural correlates of cognitive ER styles are largely unknown. In this study, associations between negative ER style and the complexity (fractal dimension, FD) of the resting EEG at frontal, central, parietal and occipital regions were investigated in fifty-eight healthy volunteers. The Cognitive Emotion Regulation Questionnaire was used as the self-report measure of ER style. Results showed that a diminished FD over the scalp significantly correlated with negative ER style scores, even after controlling for negative affect. The lower the EEG FD, the higher the negative ER style scores. Correlational analyses of specific negative ER strategies showed that self-blaming and rumination were negatively associated with diminished FD of the EEG, but catastrophizing and blaming others were not. No significant correlations were found for positive ER strategies. Results are discussed within the self-organized criticality theory of brain dynamics: people prone to ruminate and self-blame show a less complex resting EEG activity which may make more difficult for them to exit their negative emotional state.

Complexity and the Emerging Post-Newtonian Approach to Social Sciences

Ken Baskin, *Institute for the Study of Coherence and Emergence, USA*

The current ferment in thought about the social sciences Big History in history, Actor Network Theory in sociology, neuroplasticity in psychology reflects an ongoing phase transition from the Newtonian worldview to a post-Newtonian worldview, as the 20th century sciences have inverted many of the central assumptions of the Newtonian paradigm. This paper will examine the emerging post-Newtonian worldview and the way it suggests a very different understanding of human social systems, as fostered by such sciences as relativity, quantum mechanics, neurobiology, and complexity science. The presenter will attempt to integrate the work of such pioneering thinkers as Karen Barad, and her philosophy of agential realism, grounded in quantum mechanics; Bruno Latour, and his dynamic sociology, Actor Network Theory; and the story complexity approach to organizational dynamics of David Boje. At the heart of this attempt to begin defining the emerging post-Newtonian conception of social sciences are the principles of complexity science, which appear to be as valid for the study of organizations, religion, economics, and culture, as they are for fluid dynamics, ecosystem studies, or meteorology.

Long-range temporal correlations in resting EEG are associated with negative emotion regulation strategies and depression

Xavier Bornas, **Alfonso Morillas**, **Blanca Aguayo**, **Jordi Llabrıs**, & **Miquel Tortella-Feliu**, *IUNICS, University of the Balearic Islands, Spain*

Several studies have reported differences in long-range temporal correlations of EEG oscillations between depressed and non-depressed individuals. The question wether these differences are linked also to negative emotion regulation strategies that configure a depressive style remains open. In this study we applied detrended fluctuation analysis to the amplitude envelope of broad band and narrow band (theta and alpha) spontaneous EEG oscillations of a sample (N=56) of young non-depressed individuals who were administered several emotion-regulation and depression questionnares. Linear negative correlations between the scaling exponents of both broad band and narrow (theta but not alpha) band oscillations and negative emotion regulation strategies and depression scores were found. These results suggest that

previously found differences between depressed and non-depressed individuals may exist before depression is diagnosed, as differences could be linked to a negative ER style that in some cases could lead to the development of a depressive disorder. As all the scaling exponents were between 0.5 and 1, these results confirm previous findings that the underlying dynamics od brain oscillations is the same for individuals using negative and positive ER strategies.

Establishing Synchrony Between Client and Therapist Enhances Interactive Behavior

Anna Bosman, *Radboud University Nijmegen*
Sonja van Veen-Graafstal, & **Carine Heijligers**
De La Salle, Boxtel, Radboud University Nijmegen, Netherland

When interactive behavior of children with mild intellectual disabilities is disturbed, it is usually not possible to help these children with a verbal therapy. We present the results of a body-language therapy that was used in three client-therapist dyads. The interactive behavior was analyzed by means of Linell"s Initiative Response Analysis (IRA) and Cross Recurrence Quantification Analysis (CRQA). Results showed an increase in synchronicity between client and therapist. We will present the idiosyncratic findings of each of the dyads and show how current nonlinear techniques quantitatively analyze time-series data of case studies.

Chaos Investigation on Visits to an Italian Daily Newspaper Website

Maria Carmela Catone, *Doctorate in Methodology of Social Science, Florence University, Italy*

The aim of this work is to study time series of the number of daily visits to the Italian newspaper website Il Corriere della Sera , using the chaos theory techniques. The series was initially examined through the Visual Recurrence Analysis software. In particular, the recurrence plot of the series has been worked out, calculating the distance between delayed vectors. These distances are represented by shades of color from small (light) to large (dark). The recurrence plot is not homogeneous and it is characterized by white diagonal lines, showing a non stationary process and elements of determinism. I then identified the correlation dimension and I observed that it converges towards a non-integer value, revealing the presence of a chaotic attractor. Representing the data in the phase space in relation to the previous week, there is a strong clustering of points around the bisecting line, showing a similar trend after seven days. In space phase with a one-day delay, points are located around the bisector and two of its parallels. This configuration indicates the inertia, increase and decrease of visits. Using a large part of series, it was possible to forecast the remaining and following data. Then the series was analyzed with Chaos Data Analyzer (CDA): the correlation dimension has been recalculated, confirming as result an almost constant level; moreover, the Lyapunov exponent was positive, indicating the sensitivity to initial conditions. Finally an eighteen-day forecast was formulated using CDA.

Modeling Workplace Bullying Behaviors Using the Catastrophe Theory Approach: Are the Nonlinear Models Better than the Linear Models?

Lucía Ceja, *IESE Business School, Family Business Chair*, **Jordi Escartín**, & **José Navarro**, *Department of Social Psychology, University of Barcelona, Spain*

Workplace bullying is defined as negative behaviors directed to organizational members or their work context that occur regularly and repeatedly over a period of time. Employees perceptions of psychological safety climate, workplace bullying victimization and workplace bullying perpetration were assessed within a sample of nearly 5000 workers. Linear and nonlinear approaches were applied in order to model both continuous and sudden changes in workplace bullying. More specifically, the present study examines whether a nonlinear dynamical systems model (i.e., cusp catastrophe model) is superior to the linear combination of variables for predicting the effect of psychosocial safety climate and workplace bullying victimization on workplace bullying perpetration. According to the R2, AICc and BIC indexes, the linear regression model fits the data better than the cusp catastrophe model. The study concludes that some phenomena, especially unhealthy behaviors at work (like workplace bullying) may be better studied using linear approaches as opposed to non-linear dynamical systems models. This can be explained through the nonlinear healthy variability hypothesis, which argues that positive organizational behavior is likely to present nonlinear behavior as well as sudden changes, while a decrease in such nonlinearity, may be indicating the occurrence of negative behaviors at work. Overall, this study represents an interesting step towards gaining a deeper understanding of the nonlinear healthy variability hypothesis, considering the relatively little research that exists with regard to the restrained variability observed in workplace bullying.

A System Dynamic Model to Help Decision Makers in Adopting Effective Public Policies Aimed to Prevent the Cardiovascular Diseases in Italy

Francesco Ceresia, University of Palermo
Maria Concetta Verso, University of Palermo, Italy

Cardiovascular diseases (CVDs) are one of the most important problems that public health faces. Indicators such as mortality, healthcare and pharmaceutical expenditure highlight the severity of human, social and economic consequences of this kind of disease, that is in first place among the leading causes of disability and mortality all around the world. In fact, CVDs accounted for 30% of deaths worldwide from all causes, while in Italy they account for 42% of the causes of

death (ISTAT, 2010). Due to the high level of health and social alarm generated by this phenomenon, it is essential to identify the profile of people at high risk of CVDs for planning an effective primary prevention. An adequate prevention program should also be focused on the adoption of specific public policies aimed to reduce the likelihood of the CVDs, mainly through remarkable changes in people s lifestyle and dietary habits. The main aim of the research project is to build a System Dynamics Model (SDM) for helping public decision makers in adopting effective public policies focused on primary prevention of CVDs, by a quantitative nonlinear model able to supports cost-and-benefit analysis of primary prevention public policies. The results show that the adoption of a systemic, nonlinear and multi-dimensional approach allows public managers to properly evaluate the effects of these prevention public policies, both in the short and medium-long term.

System Dynamics Models to Support Health Care Companies in Managing Clinical Risk from a Behavioral Operations Perspective

Francesco Ceresia, & **Valentina Aiello**,
University of Palermo, Italy

Recently, the attention of Health Care Companies managers towards the topic of clinical risk management increased because of the higher people s sensibility about patient safety, the greater stress given by the media to news related to clinical and medical errors, the relevant increase of insurance costs and, finally, the higher number of compensation claims. As a consequence, patient safety has gained increasing interest and Health Care Companies have imported risk management method successfully applied in the industrial sector, such as the Incident Reporting, the Root Causes Analysis, the Failure Mode Effectiveness and Criticality Analysis. However, traditional CRM methods do not take into account costs and their effects on personnel management. Consequently, it may occur that a health company does not invest in CRM because of the costs and the increasing complexity of the operating procedures that this investment may imply. Therefore, it could be useful to adopt the SD methodology that allows health companies managements to properly evaluate the effects of policies of clinical risk management on organizations" performance, both in the short and medium-long term. More in details, the application of the System Dynamics methodology to clinical risk management facilitates a deep analysis of business and psychological processes in order to identify the areas of criticality and the potential interventions to reduce the probability of adverse events. A central objective of this research is to extend and highlight the significant impact of behavioral operations on the systemic internal and external efficiency and effectiveness of operations management practices in complex healthcare organizations. Our research findings suggest that it would be feasible for these companies, to invest financial resources to achieve a certain level of CRM quality. However, according to the simulation results, increasing the level of CRM quality could be at the expense of financial bottom-line.

Markov Process in Modeling Time-Trajectory of Self-Efficacy: Application in Adolescent HIV Prevention in the Bahamas

Bonita Stanton, & **Xiaoming Li**, *Wayne State University*
Pediatric Prevention Research Center, Bahamas

Self-efficacy refers to beliefs a person has regarding his or her capability to perform a specific task or set of tasks (Bandura, 1997; Ormrod, 2000). Self-efficacy plays a critical role in promoting purposeful behavior change. In a previous study, we have documented that levels of self-efficacy at an early time can impact its level at a later time up to one year. In this study, we tested the hypothesis that changes in self-efficacy follow the Markov Chain process. Methods and materials: Data used for this study were derived from an NIH funded project to evaluate a intervention program Focus on Youth in the Caribbean (FOYC) in promoting condom use among Bahamian adolescents (n=1360, 863 received intervention). Self-efficacy for condom use (5 levels with 1=the lowest and 5=the highest, Cronbach alpha=0.82). Transitional probabilities were computed as the ratio of subjects with the same self-efficacy measure (integer) at the baseline to various levels at the 12-month follow-up. The transitional probabilities were then modeled using the Markov Chain method. Findings: Transition probabilities were computed for both the intervention and the control youth. Eigenvalue=1 was found for both groups, indicating that changes in self-efficacy over time can be described by a stable Markov Chain. With this model, the estimated ultimate effect size from receiving FOYC = 0.42. There was a deviation of the model-predicted and observed levels of self-efficacy after 12 months, indicating the effect of the two boosters applied at 12 and 24 months. Discussion and conclusions: Changes in self-efficacy for condom use among Bahamian adolescents appear to follow the stable Markov Chain process when the transition was measured at 12 month intervals. This finding provides a mechanism to predict long-term ultimate program without following study participants for long time. Acknowledgements: This study was supported in part by an NIH grant (R01MH069229)

Information and Communication Technology (ICT) and the 2011 Arab Spring

Alexander Dawoody, *Marywood University, USA,*

Since January 2011 a wave of revolutions have erupted in the Arab world, starting with the Jasmine Revolution in Tunisia, and continuing in Egypt, Yemen, Syria, Bahrain, Libya, Iraq, Jordan, and Saudi Arabia. Although the trajectory of these revolutions in each Arab country differ, they all share one common ingredients: the use of Information and Communication Technology (ICT), especially in the form of social media in order to generate awareness, galvanize public

opinion, and mobilize citizens demand for change through sound governance. ICT, as such, is transforming the citizen into a global participant-observer (GPO) and we see emulation of the Arab Spring extending throughout the world in call for transparency, openness and accountability. The latest of these episodes are the Occupy the Wall Street movement in the United States. This article observes ICT as a factor in the generation of the Arab Spring and its regional and global trajectory. It observes the emerging GPO as an innovation in networking, and civic participation through autonomous, reflective, informative, inquisitive, leaderless, and self-organizing means of engagement. While classic citizenship continues to be limited to the boundaries of the nation-state, ICT is transforming citizenship throughout the world into GPO with increased interconnectedness through the use of information and communication technology and transcending traditional cultural, economic, and political barriers. The research utilizes self-organization and S-Matrix as prisms in both observing and analyzing ICT as a strange attractor, outlines the strengths and weaknesses of such emergence through SWOT analysis.

Ecology and Psychoanalysis at the Edge of Chaos

Joseph Dodds, *University of New York in Prague, Anglo-American University, Czech Psychoanalytical Society (IPA), Charles University, Czech Republic*

This paper argues that psychoanalysis has a crucial role to play in the climate change debate, helping to unmask the anxieties, deficits, conflicts, phantasies and defences crucial in understanding the human dimension of the ecological crisis. However, it still remains largely a ”psychology without ecology”. Drawing on the author”s recent book ”Psychoanalysis and Ecology at the Edge of Chaos: Complexity theory, Deleuze|Guattari, and psychoanalysis for a climate in crisis” (Dodds 2011) ecological relations need to be understood as emerging alongside and with object relations. The philosophy of Deleuze and Guattari combined with the sciences of complexity and chaos can build on psychoanalytic perspectives to offer a new framework, or rather a ”meshwork” (DeLanda 2006), able to integrate Guattari”s (2000) ”three ecologies” of mind, nature and society. Focusing on nonlinear networks of affect and phantasy, and their rhizomatic interaction and fractal interpenetration with social and natural ecologies, this paper suggests the need to move psychoanalytic perspectives beyond the confines of the family and even the wider social system, to include relations with the other than human world, a move begun long ago by Searles (1960, 1972), but until very recently almost entirely ignored by his psychoanalytic colleagues. Complexity and chaos theory provide a crucial language able to connect the various nonlinear dynamical systems at all levels crucial in dealing with the realities of a changing climate and the global environmental challenges effecting our planets future.

A-KinGDom: An Agent-based Model and Software for the Emergence of Social Structure in Primates.

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Social structure in primate societies is a complex and self-organized phenomenon that integrates kinship, competition and cooperation behaviors, and which can be explained using simple rules according to the adaptive behavior approach.Although it is not currently a common approach, some incipient agent-based simulations have been used in order to define the emergence patterns of social organization in primates. Hemelrijk (1998) presented an agent-based model, called DomWorld, where the spatial distribution observed in the agents depended on their attack strategies. More recently, and based on the co-variation hypothesis (Thierry, 2004), Puga-Gonzαlez et al. (2009) developed GrooFiWorld, an agent-based model that integrates competition and cooperation behaviors observed in macaques societies.We have developed A-KinGDom, an agent-based model where dyadic social interaction between agents allows the emergence of the patterns that define social organization in Cercopithecinae. This model includes the same attack strategies as DomWorld (Hemelrijk, 1998), integrates social affiliation as in GrooFiWorld (Puga-Gonzαlez et al., 2009), and introduces the kinship in a model called KinWorld. Moreover, our model has been extended in order to include different species of the subfamily Cercopithecinae. In this paper we present our A-KinGDom model and software, show how social organization emerges in despotic and relaxed societies, and how it can be defined using different quantitative measures.

Correlation Between Mortality of Prehospital Trauma Patients and their Heart Rate Complexity

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Heart rate complexity (HRC) is a measure of the beat-to-beat variations in heart rate which can be used in patients to identify their physiologic deterioration caused by critical injury. This measurement is the results of nonlinear analysis to the R-to-R interval (RRI) of the electrocardiogram (ECG) of pre-hospital trauma patients. Power spectra, entropy, fractal dimension, auto-correlation function and auto-correlation time are some tools for this nonlinear analysis of ECG signal. However, the measurements of these tools for some RRI data in the heart rates for healthy subjects and those with congestive heart failure are so close and hard to distinguish and use for further emergency care. In this case, surrogating raw data by some manipulated data will provide more

informative vital signs. In this article, we will compare the nonlinear analysis of raw data by manipulated data using dominant frequency extraction. Here, we will use real data of 270-beat sections of ECG from 50 emergency patients brought to Shiraz Rejaee Hospital prior to any medication.

Dynamical Analysis of Mathematical Model Presented by Fractional Differential Equations, Describing Effector Immune and Cancer Cells Interactions & Chemotherapy Optimal Control

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It is well known that the tumor chemotherapy treatment has damaging side effects and hence, optimal control of this treatment is extremely important. With this vision an accurate and comprehensive mathematical model can be supportive. Various mathematical models have been derived to describe not only the beneficial effects of the immune system on controlling the growing tumor, but also to track directly the detrimental effects of chemotherapy on both the tumor cell and the immune cell populations. In this article, we present a novel mathematical model presented by fractional differential equations. We will then use this model to analyze the bifurcation and stability of the complex dynamics which occur in the local interaction of effector-immune cell and tumor cells in a solid tumor. We will also investigate the optimal control of combined chemo-immunotherapy. As we will discuss, non-local properties of fractional differential equations and their advantages in modeling problems with non-smooth domains will create more accurate results in comparing with those ordinary differential equations counterpart. Of course, in our case the model may facilitates more understanding of the natural immune interactions to tumor and of the detrimental side-effects which chemotherapy may have on a patient s immune system.

Scaling in inflection graphs

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We investigate inflection structure of a synthetic language using Latin and Polish as examples. We construct a bipartite graph in which one group of vertices correspond to dictionary headwords and the other group to inflected forms encountered in a given text. Each inflected form is connected to its corresponding headword, which in some cases in non-unique. The resulting sparse graph decomposes into a large number of connected components, to be called word groups. Distribution of sizes of connected components of this graphs exhibit some remarkable properties, resembling cluster distribution in a lattice percolation near the critical point. We propose nonlinear dynamical process which produces graph of this type, reproducing the desired cluster distribution.

Further Steps towards Functional Modeling of Consciousness

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This paper will continue the exploration of the role of consciousness within brain function begun at INSC 2010. How what we experience as consciousness awareness is related to brain function is still not well understood, but the phenomenology of human consciousness is currently receiving increasing attention within brain modeling. I propose that consciousness is critical functionally to brain capabilities for generating, organizing and controlling purposeful behavior in a world in which what is learned from experience must be continuously adapted to situations with inherent unpredictability, i.e. containing elements that must be addressed but cannot be fully anticipated. I propose that conscious awareness provides specific types of problem space representations that the conscious individual uses to generate, monitor and adjust functional engagement. Generation of representation of conscious awareness thus becomes functionally integral to much of behavioral control. Background and evidence for this modeling and some implications concerning learning and human purposeful behavior will be discussed.

Forecasting and Estimating SETAR Models under the Influence of Chaotic Dynamics

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Ruth Mateos de Cabo, *Universidad CEU San Pablo*
Lorenzo Escot, *Universidad Complutense de Madrid*
Pilar Grau, *Universidad Rey Juan Carlos, Spain*
Elena Olmedo, *Universidad de Sevilla, Spain*

In recent years the SETAR models have capture an increasing attention by the literature, but little attention has been paid to the internal dynamics of the model. The asymptotic behavior of a SETAR model is rich and plays an important role both, in the estimation differences and forecasting among them. The present article shows how the appearance of chaotic behavior in the deterministic part of a SETAR model can change the statistical properties of the estimated parameters. It becomes also clear that chaos plays a key role in the forecasting accuracy of the model. Short term prediction of the SETAR model only beats the linear alternative if a chaos attractor is present. Forecasting horizon of the SETAR model has a clear relationship with the stability of the attractor associate with the model. Then we apply our findings to the estimation of SETAR models for a set of US business cycle time series.

Cusp Catastrophe Models for Cognitive Workload and Fatigue: A Comparison of Seven Task Types

Stephen J. Guastello, **Henry Boeh**, **Hillary Gorin**, **Samuel Huschen**, **Natalie E. Peters**, **Megan Fabisch**, **& Kirsten Poston**, *Marquette University, USA*

The study addresses several unresolved problems concerning cognitive workload and fatigue: (a)how to separate the effects of workload versus fatigue, (b)whether the upper boundaries of cognitive channel capacity are fixed or variable, and how multi-tasking produces a bottleneck phenomenon, (c) that prolonged time on task can produce performance decrements but also produce improvements in task performance associated with practice and automaticity, and that (d)task switching can alleviate fatigue but could be mentally costly. This study describes two mathematical models that have become useful for separating the workload and fatigue performance phenomena. Two further objectives are to find a range of psychological variables that contribute to elasticity or resilience in the workload model and compensatory abilities in the fatigue model. In the experiment, 105 undergraduates completed seven computer-based tasks seven times under one of four experimental conditions: tasks fully alternated, tasks aggregated with the multi-task module performed first, aggregated with the multi-task module performed last, and where the participants chose the task order themselves. Results supported both the cusp models such that fatigue effects were stronger for tasks with higher memory or attentional demand, and were often counteracted by practice effects; spelling ability acted as a compensation variable in most cases, and the intervening amount of work done acted as the bifurcation variable. For cognitive workload, catastrophic shifts in performance were noted between the single tasks and the multi-task, with relative difficulty of the single task acting as the load (asymmetry) variable and the flexible task ordering condition as the bifurcation variable.

Embracing Philosophical Pragmatism to Advance Towards a Complexity Perspective of Organizational Dynamics

Jaume Guia, *University of Girona, Spain*

Over the past two decades, complexity thinking has moved beyond the natural sciences and begun to penetrate the research agendas of organizational theorists. However, in some cases, researchers just take the main principles of complexity theory out of context and re-contetualize them within the dominant rationalist discourse, so that complexity theory and its implications are seriously distorted. In other cases, where the main tenets of the complexity paradigm are adequately treated, their approach still shows a supremacy of either the organism (constructivism) or the environment (post-Darwinism) instead of keeping the balance of the two, characteristic of complexity theory. A great part of the ecological implications for understanding organizational dynamics are thus lost. However, if we understand human and social processes from the perspective of Mead s philosophical pragmatism, this loss is avoided. In Mead s philosophical pragmatism individual and organization both co-emerge an, thus, are inseparable. Pragmatism is also consistent with both the idea of an entropic process in nature within which far-from-equilibrium processes emerge, and the idea of deterministic chaos. From this perspective people (and managers) are both participants and observers at the same time. Evolving organizational and individual identities are understood to emerge in the local communicative interacting of people in organizations. They cannot step outside the conversational processes that constitute the organization and control them, simply because their work require them to talk to an be talked by others. Their intentions are but gestures made to others in an organization and what happens unfolds from the ongoing responses.

A Complexity Approach to Crafting Values: an Application of Value Crafting

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This exploratory study is about value crafting: the deliberate selection, planning, application, and use of organizational values in daily work. First, a dynamic approach to work is discussed. Based on the complexity lens, a normative model is put forth in which two developmental mechanisms are suggested (i.e. translation and transcendence) as part of a bifurcation process. Then, based on an integral-theory perspective framework, value crafting is conceptualized as a complex process by which employees develop norms, intentions, behaviors, and roles in order to proactively co-create the work environment using organizational values as attractors for the development of this process. We then review two empirical studies to put both work and value crafting into practice. Work crafting has been explored by means of an experimental intervention in a technical improvement team, and value crafting has been implemented in two research and development (R&D) teams of an international corporation. The interventions were all videotaped and team members filled out individual questionnaires and participated in focus groups. Lastly, the natural unfolding of value-crafting occurrences was studied in 71 individual employees of the same international corporation over a period of four weeks following the company s roll-out of new organizational values. The deliberate utilization of these values in people s daily work was measured by administering weekly questionnaires, and the resulting data were analyzed by using patterns analysis techniques. The relationship of work situations and triggers to use organizational values in a different context were explored by using multilevel analysis.

Nonlinear Change and the Black Box Problem In Educational Research

Matthijs Koopmans, *Mercy College, USA*

While the nonlinear dynamical systems (NDS) paradigm has been highly influential in psychology, economics and the life sciences, its impact in the field of education has been disturbingly modest, some significant recent empirical work (e.g., Stamovlasis, 2006) notwithstanding. Most influential recent research in education in the United States is notoriously linear in how it addresses the policy questions that dominate the field, presupposing linear cause and effect relationships in the assessment of the impact of interventions and school policies on student learning and academic achievement. The measurement of such outcomes without assessing the constituent change processes has been acknowledged in the literature as the black box problem, This presentation will focus on two major aspects of the status quo in educational research and policy to which the black box problem is a side-effect, namely a) our reliance on high stakes standardized testing to measure student achievement and instructional effectiveness, and b) the reliance on school-level randomized control trial studies to establish causal links between interventions and outcomes. NDS provides an alternative understanding of causality in education, focusing on detailed assessments of student learning over time, and a fine-grained analysis of the processes and contingencies through which transitions occur in students learning trajectories (e.g., self-organized criticality, sensitive dependence on initial conditions). Some relevant examples from the NDS literature in developmental psychology will be discussed to illustrate this point.

The Pattern Models of Creativity of Young People

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The purpose of our study is to investigate creativity of young people and its role as a component of their psychological development. Specifically, the aim of the research is to investigate the role of creativity as a possible natural protective and prophylactic outlet for addressing mental ”disorders” of adolescence, like anxiety or depression. Creativity is understood as an observable and identifiable process. It is examined whether young people use his process to gain the capacity to differentiate and then to integrate their own inner experiences, thus allowing them to achieve internal dynamic order and find direction to their future. For this qualitative research, hermeneutic/ontology linked with the narrative/biography methodology was chosen. As a process of interpretation of the data, we create conceptual models called pattern models of the process of creativity of our participants by applying the concepts of complexity science, especially self-organization combined with Dabrowski”s theory of positive disintegration, and Plutchik”s theory of primary emotions. We look at these models as a map of concepts and their relationships in a form of meaningful organization. They serve as a conceptual tool to enhance our understanding of studied phenomena. Several examples of our models will be presented. In general, creativity of young people could be modeled as ”self-organizing dissipative structures” that originate spontaneously in far-from-equilibrium created and maintained by their complex emotions like curiosity, enthusiasm, passion, resourcefulness or delight. These emotions are the driving force generating order and complexity not only in their creativity but above all in their psychological development.

The Evolution as a Fractal

Constantinos Maritsas, *Independent scholar*

Man (referring primarily to male) was subject to destruction for two reasons: he was an easy prey to predators, and males died in the inner species battle. Consequently, male was doomed to extinction. The only solution was to replace the violent inner species struggle with other selection criteria. Man has gone from the natural (subconscious) selection to the acquired (conscious) selection. The same logic applies from the cells until the man and to the non-biological life from the atoms until galaxies. We can say that natural selection (the survival of the fittest) and civilization (survival of the weak) have existed since the creation of the Universe. In Earth”s history the dominations of civilized species of life, massive creation, caused the massive disappearance of the corresponding types of uncivilized life (see Analytical Table of Geological Time as a "fractal"). The process of transition from one level of civilization to the next is the same, as a fractal. Uncivilized animal species fight among themselves; some weak ones eliminate violence among them, unite, civilize and create the next uncivilized animal species. The same logic applies from the cells until the man and to the non-biological life. And this process, called self-similarity, created today s man from the cells and the galaxies from the atoms. Life, death, natural selection and civilization are natural processes that were created at the time of the creation of the Universe. In this paper life is defined as decrease of entropy, and death as increase of entropy. Natural selection is defined as the survival of the fittest and civilization as the survival of the weak. These definitions are valid for biological and non-biological processes in nature. At the end it will turn out that civilization created man.

Complex dynamics in a Solow-Swan growth model with VES production function

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Elisabetta Michetti, *University of Macerata*
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Dynamic economic growth models have often considered the standard one-sector Solow-Swan model. Such a model shows that the system monotonically converges to the steady state so neither cycles nor complex dynamics can be observed. More recently, in Bohm and Kaas (2000) the role of differential simple savings" behavior as proposed by Kaldor (1956) and its distribution effects with regard to the stability of stationary steady states has been investigated for the discrete-time Solow growth model. Differently from Bohm and Kaas (2000), Brianzoni et al. (2007) and (2009) investigated the neoclassical growth model in discrete time with differential savings and endogenous labour force growth rate while assuming CES production function. In the present work we study the dynamics shown by the discrete time neoclassical one-sector growth model with differential savings as in Bohm and Kaas (2000) while assuming VES production function in the form given by Revankar (1971). It is shown that the model can exhibit unbounded endogenous growth despite the absence of exogenous technical change and the presence of non-reproducible factors if the elasticity of substitution is greater than one. We then consider parameters range related to non-trivial dynamics (i.e. the elasticity of substitution in less than one and shareholders save more than workers) and we focus on local and global bifurcations causing the transition to more and more complex asymptotic dynamics. In particular, as our map is non-differentiable in a subset of the states space, we show that border collision bifurcations occur. Several numerical simulations support the analysis.

Multilayer Models for the Refraction of Emotional Vectors in Psychosocial Fields

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A mental psychosocial field is a virtual set of space-time experienced by social structures containing, as an atmosphere, emotional energy. The intensity of its forces (hunger, war, sex) can vectorially orient the emotional organization of sub-systems included in the social (institutions, groups, individuals). The mental spaces appear stratified as paralleling the stratified relationships among the entities that give rise to them. In this way the mental field of the institution affects the mental field of the group that, in turn, affects the individual one and vice-versa. The relationship inside these stratified virtual realities, enunciate affinities with those happenings in similar stratified realities of the physical world: for example neural networks, magnetic resonance, geophysical layers, satellite communication. In parallel with a communication of content between entities (exchange of information), a communication of context is instituted. The latter conveys mainly emotional fields, receptive qualities, identity granting. The model hypotheses mental receptors, scattered along different layers of the system. They are apt to receive the effects of refraction of the different emotive density of the fields and to convey them, for there imaginary elaboration, to an organ, parallel to the C plane of the complex numbers, deductible in analogy from the quoted physical systems. In this way this organ of complex elaboration gives out centrifugally the global imaginary product conformed to the different contexts they belong: to the single it becomes dream, myth to the group, organization to the institution, knowledge to the culture.

A Network Analysis of Complexity Dynamics in a Bureaucratically Pressured Organization

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This research paper explores complex dynamics in an innovative but bureaucratized public school setting. It is framed by works of Boisot and McKelvey (2010) and Uhl-Bien, Marion, & McKelvey (2007). Uhl-Bien et al. developed a complexity leadership model that proposes interactions among adaptive (i.e., complex), administrative (exploitative), and enabling (manages complexity contexts) functions in an organization. Boisot and McKelvey proposed that requisite complexity (e.g., balance between adaptive and administrative functions) should be adapted to environmental complexity (e.g., by enabling leaders). This study applies qualitative and dynamic network analysis (DNA) methodologies to explore such balancing dynamics under conflicting pressures of bureaucracy and innovation. The qualitative analysis utilized grounded theory methodology (Corbin & Strauss, 2008) to explore within school and school/community processes. DNA (Carley & Reminga, 2004) was applied to test the theoretical model. DNA identified informal leaders, network viability, network weaknesses, and influence patterns. Surface plot analysis is used to understand how network variables influence student well-being outcomes. Results of the qualitative analysis suggest weak school/community interdependencies and immature adaptive processes. DNA analyses will be completed in January. The study challenges traditional notions in leadership/organization studies regarding the heroic leader, and proposes instead that organizational problems/successes are products of collective dynamics rather than of individual skills. It seeks to understand the affect of bureaucratic suppressors on complex processes. The researchers are not only conducting research, but are helping the school implement changes to improve network dynamics and influence student well-being. The intent is to develop an exportable model of change.

Discrete-Time Delay Dynamics of Boundedly Rational Monopoly

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Ferenc Szidarovszky, *University of Arizona, USA*

This paper discusses delay dynamics of monopoly with discrete time scales. It is assumed that a monopoly has delayed and limited information on demand. Such a boundedly rational monopoly forms the demand expectations using past observed data and adopts the gradient of the marginal profit to determine its output adjustments. In the case of one-step delay in which the expectation is equal to output produced in the previous period, it is shown that the steady state undergoes a period-doubling cascade to chaos. In the cases of two and three delays where data at one, two and three previous time periods are available, it is shown that the steady state undergoes to complex dynamics through either a period-doubling or a Neimark-Sacker bifurcation, depending on the specified values of the parameters. Numerical examples illustrate the theoretical results. Finally the case of geometric delay is also analyzed to show the birth of the period-doubling bifurcation.

Nonlinear Delay Monopoly with Bounded Rationality

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The purpose of this paper is to study the dynamics of a monopolistic firm in a continuous-time framework. The firm is assumed to be boundedly rational and to experience time delays in obtaining and implementing information on output. The dynamic adjustment process is based on the gradient of the expected profit. The paper is divided into three parts: We examine delay effects on dynamics caused by one-time delay and two-time delays in the first two parts. Global dynamics and analytical results on local dynamics are numerically confirmed in the third part. Four main results are demonstrated. First, the stability switch from stability to instability occurs only once in the case of a single delay. Second, the alternation of stability and instability can continue if two time delays are involved. Third, the occurance of Hopf bifurcation is analytically shown if stability is lost. Finally, in a bifurcation process, there are a period-doubling cascade to chaos and a period-halving cascade to the equilibrium point in the case of two time delays if the difference between the two delays is large.

Chaos and secular cycles in a structurally simple model society

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We demonstrate the appearance of chaotic dynamics in model human communities, which consist of producers of agricultural product and producers of agricultural equipment. We show that the chaos can be a result of intercommunity barter as the maximum values of the human population growth rate increases. The horizon of predictability of the chaotic oscillations is found to be limited by 5 years. We demonstrate that the intercommunity interaction can lead to the appearance of long-period harmonics in the chaotic time series. The period of the harmonics is of order 100 and 1000 years. Hence the long-period changes in the population size may be considered as an intrinsic feature of the human population dynamics.

Mathematical description of the creative process

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A creative thought can be described as the establishment of a strange attractor in a complicated dynamical system. The connection between the construction of a sequence of dynamical systems, as in the process of trying to solve a difficult problem, and the discovery of a strange attractor (a solution) is discussed. The starting point is the book by Koestler, The Art of Creation, and empirical work on the process of solving difficult problems. An interesting aspect of this process is in those cases when the solution comes in a dream, or partially conscious state, when memory of the solution can be difficult. The goal of this work is to better understand this aspect of the creative process, and to be able to use that understanding to help people become better problem solvers.

Using nonlinear modeling for analysis of personal motivational dynamics

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Moscow City University in Education and Psychology, Russia
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In our study we were thinking about the motivational system as the way how the inner personal energy finds its emotional expression. According to a dynamic conception of motivation (Atkinson & Birch, 1970), several basic motives compete with each other generating a "stream of motivational themes"in consciousness or behavior. This stream depends on which motivational theme becomes dominant at successive points in time. Such view on motivational process allow to apply nonlinear model using differential equations of concurrent-cooperative interaction and coexistence of several subsystems as a whole. Three basic motives were measured using operant motive test (OMT): achievement, affiliation, power. Implicit test includes story on 15 pictures which demonstrate the situations from everyday life. Special coders interpret these stories according the special schema and put it on one of named motives. We suppose that each of 15 measures can be interpreted as a motivational theme which is dominant at a given time. As a result we are able to reconstruct time series

for expression of 3 motives and analyze it including interaction with each other. Data were obtained on different subsamples (according to specialties and psychological status) in Germany (totally more than 1000 people).

Fluctuations in work motivation: Task does no matter!

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Different previous studies have shown that work motivation fluctuates a lot, and in a nonlinear way over time. In the present research we are interested in knowing if the task carried out influence, or not, in the appearance of these fluctuations. We gathered daily registers from 32 workers during 21 consecutive working days (with a total of 2927 registers) of task developed, level of motivation, level of self-efficacy and level of instrumentalities perception. Then were categorised the list of labour activities in task categories and task subcategories by means of three judges with a high level of agreement (99,76% for categories, and 99,49% for subcategories). Taking the MSSD statistic (Mean Squared Successive Difference) of the average of motivation, self-efficacy and instrumentality, and using hierarchical regression analysis we have found that categories (b = ,080; p = ,188) and subcategories (b = ,063; p = ,268) do not have any influence in the presence of the motivation fluctuations. These results reveal there is instability in the motivation independently from the categories and subcategories that the tasks were grouped. Fluctuations in work motivation show, then, a fractal structure across the different tasks we do in a working day. Implications of these result to motivational theory will be discuss and we propose some possible explanations (e.g. the influence of affect in work motivation) as ways to explore in the future research.

The role of emotional inertia in the prediction of psychotherapy outcome

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The importance of the time course of change during the treatment of mental disorders is increasingly been recognized in both research and clinical practice. Nonlinear dynamic systems theory (NDS) is one of the major scientific developments in the study of change. The aim of this study is to introduce the concept of emotional inertia and to explain how it can help to understand both short-term and long-term goals of psychotherapy. While changing the trajectory of the system may be enough for immediate psychotherapeutic benefits, therapists should reconfigure the patient s emotional phase space in order to achieve long term benefits and to prevent future relapse. The concepts of phase space, emotional inertia, and therapy energy included in NDS are presented. Specific procedures for measuring these concepts are described and the clinical implications of the NDS approach are pointed out. In summary, NDS is a promising tool for the study of change and the prediction of outcome in mental health. Suggestions for future research in this area are proposed.

Stimulating Evolution in Human Systems with Compelling Complexity Metaphors

Edwin Olson, *University of Maryland, University College, USA*

The mind uses metaphors to dissolve the influence of currently held mental models. The generative impact exposes and examines taken-for-granted value systems, personal epistemologies, and stereotypes. Complexity theory provides generative metaphors that challenge assumptions of stability and episodic change and helps human systems to adopt compelling metaphors that will change the interaction of the system parts. In my work in human systems I have used complexity metaphors and parables to transfer information from one area of knowledge to another, to create space in the decision-process for the emergence of solutions, to work across system boundaries, and to foster ethical and moral consciousness. To illustrate how the participants can use complexity metaphors in their work I will use the rhizome metaphor to describe how a human system ceaselessly establishes connections, spreading towards available spaces, eroding what is in its way. The rhizome is an open network that can be connected with something else in all of its dimensions. The thinking that creates symbolic constructions in human systems takes place in the interactions at the connections. Implications for constructing and navigating a local situated path in dialogue and negotiation through a rhizomous labyrinth will be discussed. Participants will have the opportunity to apply the rhizome metaphor to their organizations along with such complexity metaphors as self-organized criticality, stretch and fold, adjacent possible, coupling, strange attractor, top-down causation, and fractals.

Bifurcations and Phase Transitions in Exceptional Language Development

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Developmental neurocognitive studies have shown that the brain systems supporting the emergence of sensory and cognitive abilities display different profiles of neuroplasticity (Bavelier & Neville, 2002; Steven & Neville, 2009). The observation that neural networks do not develop simultaneously suggests system-specific differences in

experience dependency. The research question posed here is to what extent sensory deprivation influences the dynamics of language development. We start from the assumption that (i) the auditory system has similar stimulus decomposition parameters to those in the visual cortex and that (ii) the spatiotemporal envelope of visual and acoustic signals serves as a base-camp for the bootstrapping into higher-level structures (Sireteanu, Encke & Bachert, 2005; Peltzer-Karpf & Zangl, 2001; Hohenberger & Peltzer-Karpf, 2009). The findings reported are grounded on studies with vision-impaired (age-range 1;5-3 years; N=8) and hearing-impaired children (age range 3-6 years; N=12) with sighted and hearing peers featuring as controls (Peltzer-Karpf et al. 1994; 1999). The data give evidence that language acquisition in sensory impaired children follows the same overall chaotic itinerancy (Kaneko & Tsuda, 2003) with respect to macro-structural changes and the succession of phase-shifts. System-specific temporal discrepancies expressed in protracted phase-shifts and delayed increases of variability are most evident in the early phases. The most dramatic bifurcation concerns the delayed break into syntax. We use SOMs (Kohonen 32001) for the visualization of semantic clusters and the ensuing definition of prototypes. DST-oriented developmental profiles will illustrate individual and group-specific variation.

The Problem of Applying Fractal Analysis to a Small Range of Scales: Evidence From Cardiac Dynamics

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Gustavo Reyes del Paso, *University of Jaen, Spain*
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Fractal measures of heart rate variability have been proposed as complementary to time and frequency domain indices and, in many cases, have proven to be valid predictors of cardiovascular disease. However, their relationship with more common health indicators such as vagal tone is still not clear. Here, we examine the effect of pharmacological parasympathetic blockade on the fractal properties of short-term cardiac dynamics. Atropine was administered to six healthy males in a controlled laboratory setting. Parasympathetic blockade produced a significant increase in the short term scaling exponent assessed by detrended fluctuation analysis ($F(1,5)=19.55$, $p<0.05$). We applied a recursive filter to track the temporal evolution of the heart rate scaling exponent. Our findings reveal that the effect of parasympathetic blockade on the fractal analysis of short-term heart rate variability is an artifact related to the influence of systematic trends on scaling analysis. Our results call attention to a methodological and conceptual problem related to the application of fractal measures to a small range of scales in which single physiological control mechanisms exert a dominant influence.

Complexity, Connectivity, Dynamic Causal Modeling and Structural Equation Modeling as Opener's Network on fMRI Experiments

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From the appearance of Bertalanffy's propositions for the study of the organization of the structure and dynamics of systems as a result more complex than the sum of its parts, has made this particular view of nature into a source of models to represent reality in analog form. The contributions from various fields of knowledge, ranging from Wiener cybernetics to Prigogine's dissipative structures have been used to generate options for the analysis of many phenomena and very special in the field of Social Sciences. In recent years, these subjects have spread widely and have come to bring analysis and methodological advances in new areas, most especially, research in neuroscience brain connectivity. The problem neuroscientists want to solve is to capture network effects on neuronal activity and establishing analog models to show the structural relationships between brain locations. Many of these approaches, although based on some understanding of the complexity, still based on very concrete and specific aspects such as Independent Component Analysis (ICA) estimates or models like Structural Equation Models. These details lead us to the consideration of what has been called Quantitative & Computational Neuroscience as a field of methodological advances that cannot stay away instrumental and statistical research since they will be key players in advancing these issues. In fact, examples of computational models can be found in all cognitive domains, including perception, learning, language, planning, decision-making, communication, and reasoning, but with results sometimes implausible around brain functioning. However, there are ways to deal with this situation by identifying sources of complexity in these models and investigating if they can be removed from the model without loss of explanatory power. Thus, the objective of this contribution is to show some recent aspects in this domain in order to analyze the state of the art elements of the Structural Equation Models as a adequate approach to modeling complexity, dynamic causal and linear or non linear network to represent the flexibility and evolvability of brain activities from fMRI paradigm and experimental designs.

Nonlinear Dynamics of Language Processing: the Case of First- and Second Language Use

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Real time language processing in multilingual speakers is one of the least understood types of human cognition. Many studies have focused on developmental stages and outcomes, but relatively few studies focus on the developmental process.

Especially the processing difference between the speaker s mother tongue (L1) and additional languages (L2) has challenged many researchers in the past 20 years and has led to models that represent a static, linear view of language processing. Recent work in cognitive linguistics using spectral analyses of language use have shown dynamic patterns in variability that have traditionally been regarded as irrelevant noise , but that reveal highly significant dynamical hues in processing (Van Orden, Holden & Turvey, 2003). These dynamic patterns of variability have become the main focus in a longitudinal case study over a two year time span that has generated large amounts of reaction time data. An advanced learner of English took part in a word naming experiment in his L1 and L2. This has yielded remarkable results that link the context in which language (both L1 and L2) is used to the degree of automatization. The language used most recently showed a much clearer fractal pattern after being used exclusively, which is associated with increased control. At the same time, the language that had not been used had changed toward the more random pattern, reflecting perturbations from the most recently used language. In this paper we will elaborate on the dynamic analysis of language processing and present the results of this study.

MovAgent: An Agent-based Model and Software for the Emergence of Auto-organized, Coordinated Collective Motion

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Coordinated collective motion (CCM) is a common phenomenon in numerous animal species and consists of many individuals adjusting their movements to achieve coherent group travel. Two CCM models of bird flocking and fish schooling had been proposed by Reynolds (1987) and Huth and Wissel (1994), in which the agents behavioral rules were directly related to the macro parameters that define CCM at a global level (polarization, speed adjustment and aggregation). We have developed MovAgent, an agent-based CCM model whose agents local rules are more molecular than those in Reynolds and Huth and Wissel s models. Although MovAgent rules simply specify how ideal distances among agents change as a result of their interactions, when the model is simulated, CCM emerges as an auto-organized, leaderless process, i.e., the virtual agents tend to aggregate and polarize much like real fish and birds do. That is, agent-to-agent rules acting locally make auto-organization emerge, a global and unexpected phenomenon that is not prescribed in the rules. In this paper we present our MovAgent model and software (both in 2D and 3D), show how CCM can emerge in specific circumstances (agents perceptual parameters, etc.), and how coordination, apparent leadership in motion, and group segmentation are measured.

Formulating a Dynamic Semiotic Model of Perception

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Few processes are more dynamic and complex than perception. Perception is a pure process related to the meaning of things and how we use and discuss them. Despite the importance of process in perception (and brain function in general), we lack a sophisticated understanding of how a process itself can provide the ontological basis for both cognition and semantics. To develop a fully processual approach to perception, we need a more dynamic and semiotic understanding in which categorisation links holistic differentiation, meaning and readiness for both action and expression. We contend that meaning stems from categorisation based on a process rather than on things. In Dynamic Semiotics process based categories are known as dynamic Gestalts . We show that tropology, the coordination of the major tropes (i.e., metaphor, metonymy, synecdoche and irony), is central to perception as semiosis, how phenomenal experience is categorised into dynamic Gestalts. The interaction between the tropology and Gestalt principles governs the differentiation of the semiotic process, as meaning becomes progressively specified through sensorimotor activity and language. Our thesis provides the first step to a reassessment of forebrain function in fully processual terms where Time is the ultimate Gestalt.

Predicting Job Performance in Small Samples using the Generalized Maximum Entropy Formulation

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Despite the realization that job performance is a dynamic phenomena, a great deal remains unknown about the relationship between performance and their predictors over time. The current study follows the theoretical model developed by Murphy (1989). The model postulates that workers alternate between transition stages, where workers are performing unfamiliar tasks, and maintenance stages, where workers are performing well-learned tasks. Recent research demonstrated that performance fluctuates substantially in maintenance stage. Our study is aimed to test if causal relationships between several predictors and performance changes over time during maintenance stage. The predictors were chosen by reviewing previous literature. Some are positively (i.e. motivation, self-efficacy, positive affect, and extraversion, openness to experience, agreeableness and conscientiousness personality traits) and others negatively (i.e. negative affect and neuroticism) related with performance. Participants were basketball players who filled a questionnaire that include the predictors on three different occasions. We also measured three performance dimensions (i.e. task

performance, contextual performance, and objective outcomes). Given our small data set (n=25) the estimation from traditional regression analysis was not reliable. As alternative we used the Generalized Maximum Entropy formulation to take advantage from the limited information available. Results show that all variables excepting motivation predict performance, but their contribution is different depending on performance dimension and time of measurement. Our conclusions are that researchers and practitioners interested in the prediction of performance must take into account not only the fluctuations of performance itself, but also the changes in their predictors, even in situations where is expected higher stability.

Understanding Change in Self-Organizing Systems: a Systemic View

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The concept of autopoiesis introduced by Maturana and Varela has, in the last four decades, triggered intellectual efforts for the understanding of phenomena of self-organization in general. This contribution aims at conceptualizing and applying two aspects of autopoiesis operational closure and self-reference in respect of social organizations. We will, first, try to formalize the concepts of operational closure and self-reference. Second, we will demonstrate the power of these concepts to explain change processes in organizations, with the help of a pertinent case study. On that basis, a quantitative simulation model will be developed. The simulations show a bifurcation pattern, which unveils counterintuitive, new insights for the design of change processes in organizations.

Investigating Coupling and Symmetry-Breaking Signatures in Discrete Bimanual Aiming Tasks

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The hallmark property of self-organized bimanual coordination is the presence of an intrinsic tendency toward coupling (synchronization). It has been shown that, in rhythmic coordination tasks, the increase of the degree of asymmetry between the neuro-mechanical properties of the limbs is responsible of a symmetry-breaking phenomenon (Kelso et al., 1990), which favours the maintenance tendency of the limbs (de-synchronization). On the basis of previous empirical findings (Kelso et al., 1979; Corcos, 1984), the dynamic model proposed by Schoner (1990) attempted to capture how the interplay of coupling and limb-component properties could shape discrete bimanual behaviour. However, this model remains to be validated for a wide range of inter-limb asymmetry values and under different task manipulations. The present study explored this issue. The degree of inter-limb synchronization was considered as the primary behavioural signature of coupling. Three types of asymmetry manipulations were investigated, which indeed yielded different behavioural adaptations: (i) the introduction of inter-limb asymmetry through increase in accuracy demands was less, if any, constraining on the expression of bimanual coupling; (ii) inter-limb asymmetry resulting from manipulation of movement amplitude induced a progressive inter-limb de-synchronization; and (iii) the manipulation of movement amplitude while keeping the targets position unchanged reduced the de-synchronization effect. Thus, the exploration of the mechanisms underlying inter-limb coupling/de-coupling in discrete coordination revealed how the task manipulation modality and its related attentional constraints co-determine the breakdown of inter-limb synchronization. Interest and limits of the model proposed by Schoner (1990) will be discussed.

Effects of task- and CVA-induced asymmetries on inter-limb interactions following stroke

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According to the dynamical models of bimanual coordination, inter-limb synchronization expresses the results of the competing effects of coupling and symmetry-breaking mechanisms. Following stroke, neural substrates of inter-limb coupling may be damaged so that bimanual coupling could be altered or even lost. Moreover, CVA-induced unilateral impairments (paresis, stiffness changes) can dramatically increase inter-manual asymmetries, which would favour symmetry-breaking. Such imbalance between coupling and symmetry breaking mechanisms was hypothesized to disturb bimanual synergies and mask coupling signatures (Sleimen-Malkoun et al., 2011). In an exploratory study with hemiparetic participants we used symmetrical/asymmetrical Fitts aiming tasks to investigate: (i) to which extent stroke-related alterations perturb inter-limb interactions and lead to a de-synchronized bimanual behaviour; and (ii) how task constraints could be used to favour bimanual (re)synchronization. The analysis of intra-individual repertoire was used to give a qualitative proof of the on-going, from trial to trial, struggle between the CVA-induced and the intended/task-imposed coordination tendencies. Our observations revealed the presence of multiple bimanual patterns, characterized by a more or less synchronized behaviour. The occurrence of these patterns was considered as an indicator of how stroke patients managed the balance between coupling and symmetry-breaking under different task constraints. In addition, the more impaired participants had a less stable behavioural repertoire and a weaker coupling. However, they seemed to benefit from the asymmetric task conditions to re-stabilize the synchronized behaviour. The

present study provided proof-of-concept for the hypothesized struggle between coupling and symmetry-breaking phenomena and opened doors to novel assessment methods and rehabilitation interventions in stroke.

Bifurcations and Hysteresis Effects in School Performance: A cusp Catastrophe Model for Conceptual Change

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Cognitive psychology has provided educational science with theories of conceptual change, which has essentially shaped both theoretical perspectives and practices. The conceptual-change theories provided a deeper understanding of learning processes and formation of mental models, which has been a core issue for numerous investigations particularly in science education. A central and unresolved theoretical issue in all conceptual change perspectives is the linear versus nonlinear nature of the processes under investigation. The present work contributes to this discussion and attempts to elucidate this issue by applying nonlinear methods. The research uses psychometric variables which are known to be predictive for students achievement in science education: Logical thinking, field dependence/independence and convergent/divergent thinking are implemented as controls in cusp models for conceptual change. The cusp catastrophe model proved superior comparing to the pre-post linear counterpart and demonstrated nonlinearity at the behavioral level. The nonlinear phenomenology: hysteresis effects and bifurcation supported self-organization mechanism underpinning conceptual change processing and thus build bridges between NDS and conceptual change theories. Empirical evidences supporting the nonlinear perspective have important theoretical implications and they suggest reconsideration of the epistemological and ontological assumptions driven the scientific research in this area.

Health Care Reform - a CAS approach

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Di O"Halloran, *Sydney University, Australia*
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Health systems reform is the mantra to the growing problems of rapidly rising demand for health services and its associated costs. Various strategies in many different settings have been tried to meet the challenges, however, none have really resulted in convincing improvements. These failures are not surprising when viewed through a complex adaptive system s lens, as they fail to understand the interconnected behaviour of the systems agents, the constraints of the local environment and the importance of the system s core values. Our analysis suggests that different agents at different levels within the system pursue different values/drivers protocols and control at the policy/bureaucracy level and patient-centred care at the delivery level. These differences reflect the different perceptions arising from the scale and complexity relationship (Bar-Yam) on the one hand, and a lack of clarity of the core values within the system on the other. We have developed the health care vortex as a practical metaphor to understanding the complex interactions at the various levels and functions within and across the healthcare system. This presentation illustrates the dysfunction of the current system based on the above factors. A reformed health care system would have the patient s need at its centre. This value/driver would allow the emergence of new structures and functions of the health system s agents. The implications of a patient-centred core value on the structure and function of the health care vortex are outlined, and the changes and impediments to the adaptive change process are examined.

Network Structure of Emotion-associated Words

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Despite the amount of research that has been conducted on emotion-associated words, its structural properties remain poorly understood. In this study, the structure of emotion-associated words was investigated using a network analysis of free word associations. One hundred sixty-one participants were asked to write down the first noun that came to mind when presented with nine printed emotion prototypes: Happiness, Sadness, Anger, Disgust, Fear, Surprise, Calmness, Excitement, and Relaxation. A mean of 8.95 respondents per participant, that is, 1441 respondents in total, was derived. Since the derived data were 2-mode, they were transformed into 1-mode data in order to make co-occurrence matrices, and a UCINET-based network analysis was performed. As a result, some kinds of network parameters were computed. First, the longest shortest path length, a network diameter, was six from ice cream to street at night, and the average distance between the respondents was 3.74, which showed a small-world network. Second, density, which referred to the extent to which all possible linkages were present, was 0.01, thus indicating a limited efficiency of information flow. Finally, emotion-associated words that had high betweenness centrality were dog, music, etc. Network analyses in terms of complex networks provided fruitful implications that can be applied to nonlinear science, network science, cognitive psychology, and psychology on emotions.

Epidemiologic Validation of a Complex Systems Heath Model

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The study of complexity has been advanced as a method to better understand health and illness. While varied systems lenses have been proposed through which to view complexity,

what we desire is a complex systems model of health which may be tested for validity against real world data. A pilot individual health potential model was developed to guide larger epidemiological efforts using probability theory and simple qualitative observations. An evolutionary development functional definition of health as genetic survival potential was integral to this work. Definitions of disease, illness, and mortality were mathematically derived from this. Model validation included exploration of its phase space for robustness and a comparison of its manifold to published growth, development, and mortality curves. Preliminary results show areas of both agreement and divergence between model prediction and human data. One-Sample Kolmogorov-Smirnov analysis of human mortality data showed > 95% concordance with some model predictions when combined with a Monte Carlo simulation. Epidemiological patterns over 2 millenia were consistent and contributed to improvements in the pilot model. This use of probability distributions over time emphasizes the long-term impact of initial early investments in human health at young ages and is consistent with other published work. New attractors were then derived for health potential and health probability across a population over time. These remain to be validated but may further support the benefit of a fundamental redistribution of health care resources for more effective prevention and treatment of human illness.

An Ethnographic Landscape of Clinicians Understanding of Complex Systems Principles

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Complexity is suggested to be a new paradigm for a potentially post-modern science. Complexity in all of its systems science variations is promisingly interdisciplinary and non- linear, but such a paradigm shift may also appear far removed from clinical healing practice. We need to build bridges between basic science researchers and clinical science experts. This project describes how clinicians use metaphorical pattern recognition to make sense of the often complex systems in clinical practice. A broad overview will be presented describing how physician researchers and clinicians understand and use a range of new systems research findings which are changing our understanding of human health and disease. Clinical applications of nonlinearity will begin with human anatomy and physiology, proceed through the simpler regions of biomedical disease and critical care medicine, and then proceed to extend the discussion towards more difficult areas of theoretical application. Appropriate scale, prevalent power laws, the highly accessible use of fractal example and metaphor are combined with literature citation to illuminate clinically relevant paradoxes in human health. This survey of clinicians ethnographic understanding of complex systems principles will conclude with discussion of environmental health, healthy aging, home care and public health policy, and finally the biopsychosocial core theory and praxis of family medicine.

Complexity & the Ecology of Education: Why It Matters

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Although human societies have always been multifaceted, the level of complexity increased exponentially with transitions from hunter-gatherers to agriculture to industrialization, and beyond. Unavoidably, education followed a similar route. It is a bottom-up emergent phenomenon. Everyone is interconnected. Behaviors are Interdependent (socially, psychologically, etc.), everyone s behavior depends on others and adapting accordingly. Forms of adaptation are often unpredictable producing large events : educational crisis, when unsuitable, or positive educational transformations, making the process remarkably robust. Ironically, the vary interdependence and adaptability that make education a robust system, produces complexity that renders it both blessing and burden. If excessively interconnected, interdependent, diverse, education might lose complexity and collapse into an incomprehensible mangle. These properties of education make it interesting from intellectual and pragmatic perspectives. Given a volatile society and increasing complexity, there s no choice but to emphasize education as a highly complex phenomenon. Yet, such complexity is too intricate to understand, without new paradigms. Complexity Theory and the concept of ecology serve this purpose. I will provide a conceptual understanding of complexity in education with implications. Understanding to develop robust education processes, can foster conducive learning environments to addressing the complex realities of our agricultural, industrial, post industrial world. Identifying conditions ripe to generate crisis, can help head them off judiciously. Understanding the complex ecology of education, can help us nudge / harness it and illuminate fascinating mysteries: the emergence of learning; phase transitions of going from novice to expert; tipping points for spending on education; the creation of novelty; etc.

Nonlinear Models of Processes in Psychotherapy and Psychopathology

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Laurent Pezard, *University of Provence, France*
Fabian Ramseyer, *University of Bern, Stanford University*
Uli Junghan, *University of Bern, Switzerland*
Karyn Doba, *University of Lille, France*
Jean-Louis Nandrino, *University of Lille, France*

Laurent Pezard, Karyn Doba and Jean-Louis Nandrino "The dynamics of emotional interactions in family therapy" Although adolescents with anorexia nervosa have shown positive responses to structural family therapy, the key features of therapeutic changes still require identification. The goal of structural therapy treatment is to alter specific patterns of dysfunctional interaction that maintain symptoms but investigations of change processes over the course of therapy are notably absent. Family therapy sessions were videotaped during six-month follow-up in ten families. The evolution of

emotional interactions, conflictual communications and nonverbal affiliative behaviors were studied as indicators of family interaction changes. The changes in nutritional and psychosocial status of the patients were also evaluated. The dynamics of emotional interactions were characterized using algorithmic complexity and stochastic methods. An improvement in clinical symptoms and psychosocial functioning of restrictive-type patients was observed together with changes in the conflictual communications and affiliative nonverbal behavior. The evolution of interactive behavior differs clearly between family members: fathers and patients with anorexia nervosa reduce their affiliative behavior during conflictual communications, whereas no significant differences are observed for mothers. The complexity and structure of the emotional interactions are also specifically modified. This study identified specific changes in affiliative behavior and in emotional interactions during conflictual communication as features of therapeutic changes in families of anorexic patients during family-based therapy. Fabian Ramseyer "Nonverbal synchrony as a marker of psychotherapy" Synchronization is a core marker of systems that undergo pattern formation dynamics. Recent research in cognitive science has also pointed to the significance of the embodiment of cognition. System dynamics and embodiment together are manifested in the nonverbal synchrony of interactands. In psychotherapy process, nonverbal synchrony between patient and therapist may be a candidate marker of the therapeutic relationship, a well-documented common factor of successful psychotherapy. Empirical evidence beyond single case studies for the association between nonverbal coordination and therapeutic bond was unavailable until recently. We wished to test nonverbal synchrony against a control condition (proof of existence) and assess its association with therapy quality. A novel, automated method based on frame-by-frame video analysis (Motion Energy Analysis, MEA) was applied to N=105 sessions of dyadic psychotherapy. Sessions were randomly drawn from a large archive of routinely videotaped cognitive-behavioral psychotherapies. Nonverbal synchrony was measured through simultaneous and lagged cross-correlations of movements of patient and therapist. A control condition (pseudosynchrony) was defined by shuffling of original data. Multilevel modeling was used as the primary analytic tool, with sessions nested within patients and within therapists. Consistent with our hypothesis of embodied communication, our data showed that, in psychotherapeutic interactions, synchrony was found at a level clearly above chance. Nonverbal synchrony was positively correlated with the quality of the therapeutic bond and therapy outcome. There was a characteristic pattern of lagged synchrony within the dyads: in the first third of therapy, therapists" pacing behavior predicted both quality of bond and outcome, whereas in the last third of therapy, leading (patients" imitation of their therapists) was more highly related to these variables. Nonverbal synchrony is a significant marker of the quality of the therapeutic bond and of global therapy outcome. These findings may be viewed in light of the general principle of embodiment, which they support. The processes of relationship development and maintenance in psychotherapy are not confined to verbal exchange; the bodies of interacting persons reflect properties of their psychological relationship and inner states that become observable. Uli Junghan "Power-law functions as a system s fingerprint in mental health service evaluation" In the evaluation of mental health services, a broad consensus exists that continuous quality assessment is necessary. From a systems theory viewpoint, this assessment has to address different system layers that may not be confounded (e.g. service region vs. individual client), as they have different properties. Moreover, only few informative indicators characterize mental health service systems as a whole, one of which is the monitoring of readmission rates. Interestingly, the distributions of readmission rates appear to obey so-called power-law functions that depict attributes of the system they are derived from. One of the interesting properties of power-law functions is scale invariance; power laws are associated with self-organized criticality and with phase transitions in complex systems. Based on utilization data of the Swiss national databank of inpatient mental health service units, we assessed whether readmission patterns can be described by power-law functions. We also investigated their temporal stability and other related determinants. We found that readmission rates in fact followed power-law functions, which provided characteristics stable over time for distinct service regions. Moreover, these power-laws, which can be condensed by means of so-called inequity measures (e.g. Gini s coefficient), were considered useful indicators for mental health service evaluation. Wolfgang Tschacher "Creativity and nonlinear pattern formation" There are various ways by which a system can be ”creative”, i.e. generate novel information. Creative adaptation is of great significance for systems functioning in the fields of health and (psycho)therapy. Creativity can, in principle, arise (1) randomly, (2) through chaotic dynamics, or (3) through self-organization. Option (1), noise, is ruled out from the list of interesting generators of creativity, because randomness provides no pattern, hence no solution to adaptation problems. Chaos has the potential to combine attractor-like dynamics with novelty-generating dynamics, but verification of the existence of chaotic dynamics in psychopathology and psychotherapy has proved difficult. We therefore focus on (3), self-organized pattern formation sensu Haken or Prigogine. Self-organized dynamics is adaptive in that the resulting attractors closely depend on the systems environment, expressed by control parameters. The patterns that emerge are meaningful since they provide a solution to environmental constraints in the sense of maximizing entropy production. Furthermore, a number of recent empirical findings have supported the existence of self-organized pattern formation in the context of psychotherapy. In the course of treatments, it has been found that pattern increases significantly, and that this increase is positively associated with the outcome of treatments.

Order from Chaos in Human Communication

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Niek Lam, *Achmea, Netherland*

We developed a model for the communication between a GP and his patient. Feedback loops were constructed in that model, according to hypotheses about positive and negative feedback between the actors. For the actors themselves we supposed entangled inner feedback loops between the information task and related psycho-social and control processes. Those processes were modeled with non linear differential equations of logistic growth. In a number of simulation studies we proved at face value that this complex model fit patterns we found in video observations of the interaction between a patient and his GP as it was put in SPSS data (Dijkum et al 2008). To explore the model in a more fundamental way we reprogrammed the model in Matlab. We did some experiments with the model in which we explored the interaction between the different components of the model, being in states of order and chaos (Dijkum & Lam 2010). The leading questions of the exploration for this paper are: (1) can a system of which the components are all in a state of chaos produce order; (2) how can this be interpreted for our model of human communication? Reference: Dijkum, C. van, Verheul W., Lam N., Bensing J. (2008). Non Linear Models for the Feedback between GP and Patients. In Trappl R. (Ed). Cybernetics and Systems. Vienna: Austrian Society for Cybernetic Studies, pp. 629-634. Dijkum C. Van, Lam N., (2010). Exploring a Complex Model of Communication. Paper presented on International Conference Operations Research, Mastering complexity. Munchen.

Chaos and Creativity: The Psique as a Complex Dynamical System Creativiy and Arquetipal Psychology

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Yolanda Ng Lee, Research Professor, Universidad Central de Venezuela, Sciences Faculty, Physics School, Caracas,
Maria Elena Gutierrez, Digital Designers, Caracas, Venezuela

This paper is related to the experience obtained from the course entitled Chaos and Creativity offered to a non-specialized and heterogeneous general public in Caracas, Venezuela. This innovative course, in its form and content, in our country, was based in the following premises: Chaos, as a scientific discipline, allows us to see new complex systems as a new model where predictability and instability are accepted as intrinsic and essential factors in any transformation process of a system. The psychological meaning of CHAOS can be seen as something healthy and as a essential part of the creation process. Without this concept, it is impossible to establish a new order. The course content was: 1. Fundamental concepts of non-linear dynamics. Chaos theory. 2. Correlations between concepts of dynamic non-linear theory and archetypal psychology. Internal and external creative process. 3. Fractal nature of creation. Creativity and resilience. The conclusion of this course has been very valuable due to its disclosed and original content and audio-visual presentation. Measured over a participative public interested in changing paradigms from chaos in the psychology field, not just as something inevitable but necessary to open our instinctive creativity. As C.G.Jung said, this is not a gift neither a special grace or capacity, talent or ability but an immense energy that comes out of the human psyche and push us to dedicate to this or that specific goal.

Stock Prices and Volume: Justification by a Heterogeneous Agent Model

Weihong Huang, & **Wanying Wang**, *Nanyang Technological University, Singapore*

In technical analysis, volume has serviced as an important confirmation signal of price action for practitioners. Meanwhile, the nonlinear bi-directional causality relationship between price-volume has also been documented academically by fluids of empirical researches. However, few existing theoretical literatures could reproduce this nonlinear relationship and gave persuasive explanations to this phenomenon. Current study provides a simple heterogeneous agent model that could fill such a gap quite plausibly. Our main findings are as follows. i) We successfully simulate the seemingly chaotic fluctuations in price and volume which is high compatible with the real market with a deterministic nonlinear dynamics. ii) The appearance of certain patterns in the movements of price-volume, especially the combination signals of price-volume widely-used in chart patterns, could be perfectly replicated. iii) With the reasonable setting of the adaptive belief of chartists, we are able to provide economic explanation to support the rationality of the correlations between the stock returns and change of volumes. In this way, by extending the classical Day and Huang(1990)"s market-maker framework, our study offers strong evidences to consolidate the hypothesis that a purely deterministic nonlinear dynamics could be the underlying mechanism that dominates the chaotic movements of asset pricing.

From Chaos Theory to Psychosomatic Harmonization Concept. The Aesthetic-Art model

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Olga Zhirkova, *Saint Petersburg State University Medical College,* & **Arina Skibinskaya**, *Saint Petersburg State University, Petersburg, Russia*

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The concept of psychosomatic harmonization consists of three models based on minimal energy consumption principle was presented at 21 SCTPLS Conference. 55 women aged from 19 to 58 years were investigated. Study design included psychological and psycho-physiological measurements before and after listening to music. After necessary ethic procedure

including writing agreements, all women were examined by physician and tested for emotion psychometrics by the psychologist. Every patient was exposed to classic and techno music styles for 30 minutes. Blood pressure (BP) and EEG were measured during music listening. Fractal analysis were used for both methods. Second psychometric examination and discussion with the psychologist were organized after listening to music. The results showed that there was no relationship between music style sympathy and age. Older patients preferred techno music as often as younger ones. However, we found differences in music preferences related to the BP levels. Patients with low BP preferred techno music, while hypertensive patients preferred classic music. Division between low and high BP groups was made according to the ZhGS formulas for the determination of optimal BP. There was no correlation between BP and psychometric results within both groups of patients at the first testing. Correlations between psychometric data and BP parameters as well as simplification of EEG fractal dimension were found after listening to music. We suggest that energy consumption principle and fractal paradigm can be used in aesthetic-art model for the analysis of music perceptions by women with high and low BP.