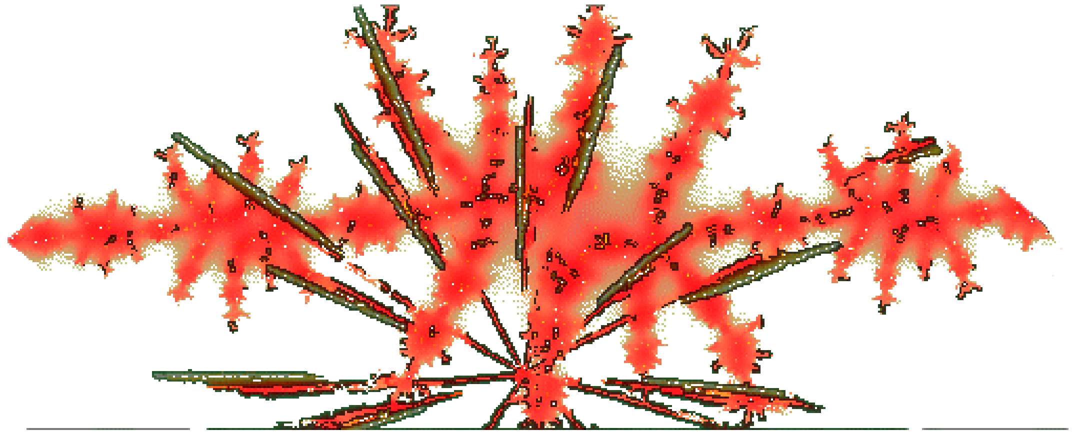

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pp. 345-394.

Complex Adaptive Behavior and Dexterous Action

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Abstract: *Dexterous action, as conceptualized by Bernstein in his influential ecological analysis of human behavior, is revealed in the ability to flexibly generate behaviors that are adaptively tailored to the demands of the context in which they are embedded. Conceived as complex adaptive behavior, dexterity depends upon the qualities of robustness and degeneracy, and is supported by the functional complexity of the agent-environment system. Using Bernstein's and Gibson's ecological analyses of behavior situated in natural environments as conceptual touchstones, we consider the hypothesis that complex adaptive behavior capitalizes upon general principles of self-organization. Here, we outline a perspective in which the complex interactivity of nervous-system, body, and environment is revealed as an essential resource for adaptive behavior. From this perspective, we consider the implications for interpreting the functionality and dysfunctionality of human behavior. This paper demonstrates that, optimal variability, the topic of this special issue, is a logical consequence of interpreting the functionality of human behavior as complex adaptive behavior.*

Key Words**:** biomechanics, variability, robustness, dynamical systems theory, 1/*f* scaling, nonlinear analysis, synergetics, self-organized criticality, multifractals

pp. 395-418.

Dimension and Complexity in Human Movement and Posture

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Abstract: *There has been considerable effort over the last 25 years to under-stand the emergence of complexity in motor output and how this relates to properties of the individual (e.g., age, disease state, etc.), environment (e.g., information) and task (e.g., movement, posture, isometric force). This paper addresses the behavioral dimension of motor complexity in movement and posture from a degrees of freedom (DF) perspective together with the change of complexity through aging, disease and fatigue. The dimension of behavior for a given perceptual-motor output is shown to be relatively low, dependent on the interaction between the individual, environmental, and task constraints and varies within a limited adaptive range for a given motor task. The determination of dimension in movement and* *posture has taken us beyond the traditional motor performance scores of behavior but it is not a sufficient characterization of the adaptive and emergent processes of complexity.*

Key Words: *posture, fractal dimension, entropy, principal components analysis*

pp. 419-436.

What Can Biosignal Entropy Tell Us About Health and Disease? Applications in Some Clinical Fields

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Abstract: *Many physiological systems are paradigmatic examples of complex networks, displaying behaviors best studied by means of tools derived from nonlinear dynamics and fractal geometry. Furthermore, while conventional wisdom considers health as an "orderly" situation (and diseases are often called "disorders"), truth is that health is characterized by a remarkable (pseudo)-randomness, and the loss of this pseudo-randomness (i.e., the "decomplexification" of the system's output) is one of the earliest signs of the system's dysfunction. The potential clinical uses of this information are evident. However, the instruments used to assess complexity are still under debate, and these tools are just beginning to find their place at the bedside. We present a brief overview of the potential uses of complexity analysis in several areas of clinical medicine. We comment on the metrics most frequently used, and we review specifically their application on certain neurologic diseases, aging, diabetes, febrile diseases and the critically ill patient.*

Key Words: complexity, clinical practice, diabetes, fever, aging

pp. 437-464.

Differential Diagnosis: Shape and Function, Fractal Tools in the Pathology Lab

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Abstract: *Fractal analysis is a useful objective tool in describing complexity of shapes and signals providing information for understanding pathological changes. We present fractal approaches and software used in our pathology laboratory to analyze shapes of tumors in tissues and cells, to evaluate the microvessel network complexity in hereditary diseases or the complexity of the surface of blood cells in atherosclerosis-linked condition, as well to analyze function in vasculopathic subjects by chaotic analysis of electrocardiographic signals, in order to perform differential diagnosis. The fractal parameters appear to converge towards distinct values in pathological conditions compared to healthy, approaching the characteristics values of a percolation process or the diffusion-limited aggregation process, respectively: a bifurcation that allows to support the diagnostic process of the pathologist in his daily work. These methods, presented here as a kind of a cookbook ready for the pathologist, are low cost and not time consuming.*

Key Words: human pathology, differential diagnosis, cancer, atherosclerosis, fractal analysis

pp. 465-487.

Different Faces of Variability in the Adaptive Process of Motor Skill Learning

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Abstract: *This study investigated the variability by considering an action programme as hierarchically organized, which reconciles invariant and variant features of motor skills at the macro- and microstructural level of analysis. It was assumed that invariant aspects of skilled actions express the macrostructure and therefore measures of sequencing, relative size, relative timing, relative force and relative pause time. The microstructure was related to the variant aspects so that total size, total movement time, total force, and total pause time were selected as its measures. These propositions were tested in an experimental design comprised by three learning phases: a stabilisation phase that entailed a given number of trials to achieve the functional stabilization on a graphic task, followed by transfer and retention phases. In the transfer phase, the graphic task was modified to yield different demands upon skill reorganization. Two such modifications demanded parametric changes (i.e. microstructure changes), in which graphic size and drawing speed were altered. Another modification demanded structural alterations (i.e. macrostructure change), in which drawing was changed. Overall, results supported the main predictions by showing that parametric changes in the task affected the microstructure, but did not affect the macrostructure consistently. Furthermore, a structural change affected both macro- and microstructure.*

Key Words: adaptation, motor learning, hierarchical organization, internal-external variability

pp. 489-510.

Training the Antifragile Athlete: A Preliminary Analysis of Neuromuscular Training Effects on Muscle Activation Dynamics

Adam W. Kiefer *and* ***Gregory D. Myer,*** *Cincinnati Children's Hospital Medical Center, University of Cincinnati, Ohio*

Abstract: *Athletic injuries typically occur when the stable, emergent coordination between behavioral processes breaks down due to external noise, or variability. A physiological system that operates at an optimal point on a spectrum of rigidity and flexibility may be better prepared to handle extreme external variability, and the purpose of the current experiment was to examine whether targeted neuromuscular training resulted in changes to the rigidity and flexibility of the gluteal muscle tonus signal as measured with electromyography prior to the landing phase of a drop vertical jump task. 10 adolescent female athletes who participated in a targeted 10-week neuromuscular training program and 6 controls participated, and their tonus dynamics were examined with recurrence quantification analysis prior to training and after the 10-week program. The dependent measures, percent laminarity (%LAM) and percent determinism (%DET) were hypothesized to decrease following training, and were submitted to a one tailed mixed-model ANOVA. The training group exhibited a decrease in %LAM and %DET after training compared to pre-training and controls. The present findings indicate increased metaflexibility (i.e., greater intermittency and an increase in internal randomness) in tonus dynamics following neuromuscular training, and have important implications for the prevention of musculoskeletal injury in sport, specifically within the context of external noise and antifragility.*

Key Words: antifragile, intermittency, piecewise determinism, recurrence quantification, electromyography

pp. 511-527.

The Complexity of the Psychological Self and the Principle of Optimum Variability

Stephen J. Guastello, *Marquette University*, Milwaukee, WI

Abstract: *Linville's theory of self-complexity relies of concepts of information measurement to produce its core measurement of complexity, which is in turn thought to be positively correlated with indicators of psychological well-being. Empirical research, however, has not supported this assertion as it was initially intended. Research with complex adaptive systems, however, shows that self-organized systems generally display mid-range values, whereas low-range values denote stereotypic, rigid, and possibly maladaptive behavior. High-range values, furthermore, tend to reflect disordered systems that could be maladaptive for other reasons. As a result, the linear correlations between metrics of complexity of the self and psychological well-being that were widely assumed in the empirical research are not appropriate. The substantive theory of self-complexity, however, is not inconsistent with expectations from complex adaptive systems. Recommendations are given here to improve the data analysis and interpretation of empirical results currently on record concerning the complexity of the self and mental health outcomes.*

Key Words: self, complexity, entropy, complex adaptive systems, optimum variability

pp. 529-552.

Healthy Variability in Organizational Behavior: Empirical Evidence and New Steps for Future Research

José Navarro, *University of Barcelona, Spain,* and **Rita Rueff-Lopes**, *Instituto Universitário de Lisboa, Lisbon, Portugal, and University Ramon Llull, Barcelona Spain.*

Abstract: *The healthy variability thesis suggests that healthy systems function in a complex manner over time. This thesis is well-established in fields like physiology. In the field of organizational behavior, however, this relation is only starting to be explored. The objective of this article is threefold: First, we aim to provide a comprehensive review of the healthy variability thesis including some of the most important findings across different fields, with a focus on evidences from organizational research in work motivation and performance. Second, we discuss an opposite pattern, unhealthy stability, i.e., the relationship between unhealthy behaviors and lower variability. Again, we provide evidence from diverse areas, from affective processes to disruptive organizational comportments like mobbing. Third, we provide a critical evaluation of current methodological trends and highlight what we believe to be the main factors that are stopping organizational research from advancing in the field. Theoretical, methodological and epistemological implications are discussed. To conclude, we draw a compilation of the lessons learned, which hopefully provide insights for prolific research avenues. Our main purpose is to raise awareness of the healthy variability thesis and to enthuse organizational researchers to consider it in order to advance existing knowledge, revisit old theories and create new ones.*

Key Words: healthy variability, organizational research, organizational behavior, unhealthy stability

pp. 553-568.

What is Optimum Variability?

David Schuldberg, *The University of Montana, Missoula*

Abstract: *Guastello (2015a) opened the call for articles for this issue with Goldberger (1991) and colleagues' findings of chaotic variability in healthy heart rate, noting, "the principle of healthy variability has extended to other biomedical and psychological phenomena." He suggests a dialectical underpinning for optimal variability involving "a combination of the minimum entropy or free energy principle that pushes in a downward direction, and Ashby's Law of Requisite Variety that pushes in an upward direction." Each of the papers in this issue addresses optimal variability across a variety of health-related areas. The present article surveys these seven papers in relation to five conceptual questions about optimal variability: (a) Is variability a positive or a negative, and how are positive things related to health? (b) How shall we define and measure variability? (c) What constitutes an optimum, and how do we locate one? (d) What is the relationship between optimum variability and health? Finally, it touches on (e) What are underlying principles and phenomena behind healthy variability, and can they inform our vocabulary for health? The paper concludes by discussing practical approaches to dealing with optimization.*

Key Words: variability, optimality, health, complexity, chaos, homeostasis, nonlinear dynamics, time series