

# Nonlinear Dynamics, Psychology and Life Sciences

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## Special Issue: Advanced Modeling Methods for Dynamics in Organizations

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### **Advanced Modeling Methods for Studying Individual Differences and Dynamics in Organizations: Introduction to the Special Issue**

**Andrea Ceschi, Riccardo Sartori, University of Verona, Italy, Guest Editors**  
and **Stephen J. Guastello, Marquette University, Milwaukee, WI**

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### **Application of Psychological Theories in Agent-Based Modeling: The Case of the Theory of Planned Behavior**

**Andrea Scalco, Andrea Ceschi, and Riccardo Sartori, University of Verona, Italy**

***Abstract:** It is likely that computer simulations will assume a greater role in the next future to investigate and understand reality (Rand & Rust, 2011). Particularly, agent-based models (ABMs) represent a method of investigation of social phenomena that blend the knowledge of social sciences with the advantages of virtual simulations. Within this context, the development of algorithms able to recreate the reasoning engine of autonomous virtual agents represents one of the most fragile aspects and it is indeed crucial to establish such models on well-supported psychological theoretical frameworks. For this reason, the present work discusses the application case of the theory of planned behavior (TPB; Ajzen, 1991) in the context of agent-based modeling: It is argued that this framework might be helpful more than others to develop a valid representation of human behavior in computer simulations. Accordingly, the current contribution considers issues related with the application of the model proposed by the TPB inside computer simulations and suggests potential solutions with the hope to contribute to shorten the distance between the fields of psychology and computer science.*

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### **An Estimation of a Nonlinear Dynamic Process Using Latent Class Extended Mixed Models: Affect Profiles After Terrorist Attacks**

**Roberto Burro, Daniela Raccanello, Margherita Pasini, and Margherita Brondino, University of Verona, Italy**

***Abstract:** Conceptualizing affect as a complex nonlinear dynamic process, we used latent class extended mixed models (LCMM) to understand whether there were unobserved groupings in a dataset including longitudinal measures. Our aim was to identify affect profiles over time in people vicariously exposed to terrorism, studying their relations with personality traits. The participants were 193*

university students who completed online measures of affect during the seven days following two terrorist attacks (Paris, November 13, 2015; Brussels, March 22, 2016); Big Five personality traits; and antecedents of affect. After selecting students whose negative affect was influenced by the two attacks (33%), we analysed the data with the LCMM package of R. We identified two affect profiles, characterized by different trends over time: The first profile comprised students with lower positive affect and higher negative affect compared to the second profile. Concerning personality traits, conscientiousness was lower for the first profile compared to the second profile, and vice versa for neuroticism. Findings are discussed for both their theoretical and applied relevance.

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## **Second-Order Growth Mixture Modeling in Organizational Psychology: An Application in the Study of Job Performance Using the Cusp Catastrophe Model**

**Guido Alessandri, Enrico Perinelli, Evelina De Longis, and Annalisa Theodorou, Sapienza University of Rome, Italy**

**Abstract:** In recent years, research in organizational psychology has witnessed a shift in attention from a mostly variable-focused approach, to a mostly person-focused approach. Indeed, it has been widely recognized that the study of worker's heterogeneity is a meaningful and necessary task of researchers dealing with human behavior in organizational contexts. As a consequence, there has been growing interest in the application of statistical analyses able to uncover latent sub-groups of workers. The present contribution was conceived as a tutorial for the application of one of these statistical analyses, namely second-order growth mixture modeling, and to illustrate its inner links with concepts from nonlinear dynamic models. Throughout the paper, we provided (a) a discussion on the relationships between growth mixture modeling and the cusp catastrophe model; (b) Mplus syntaxes and output excerpts of a longitudinal analysis conducted on job performance ( $N = 420$  employees rated once a year for four consecutive years); (c) an overview of two important topics regarding the correct implementation of growth mixture modeling (i.e., optimal number of classes and local maxima).

pp. 77-102.

## **The Influence of Homophilous Interactions on Diversity Effects in Group Problem-Solving**

**Claudia P. Estévez-Mujica, Andrés Acero, William Jiménez-Leal, and César García-Díaz, Universidad de los Andes, Bogotá, Colombia**

**Abstract:** Increasingly diversity researchers call for further studies of group micro-processes and dynamics to understand the paradoxical effects of diversity on group performance. In this study, based on analyses of in-group, networked, homophilous interactions, we aim to explain further the effects of diversity on group performance in a parallel problem-solving task, both experimentally and computationally. We developed a "whodunit" problem-solving experiment with 116 participants assigned to different-sized groups. Experimental results show that low diversity and high homophily levels are associated with lower performance while the effects of group size are not significant. To investigate this further, we developed an agent-based computational model (ABM), through which we inspected (a) the effect of different homophily and diversity strengths on performance, and (b) the robustness of such effects across group size variations. Overall, modeling results were consistent with our experimental findings, and revealed that the strength of homophily can drive diversity towards a positive or negative impact on performance. We also observed that increasing group size has a very marginal effect. Our work contributes to a better understanding of the implications of diversity in-group problem-solving by providing an integration of both experimental and computational perspectives in the analysis of group processes.

pp. 103-125.

## **Emotions as Proximal Causes of Word of Mouth: A Nonlinear Approach**

**Rita Rueff Lopes, University Ramon Llull, Barcelona, Spain, José Navarro, Universitat de Barcelona, Spain, and Ana Junça Silva, Instituto Universitário de Lisboa (ISCTE-IUL), Lisboa, Portugal**

**Abstract:** Service research tends to operationalize word of mouth (WOM) behavior as one of the many responses to service satisfaction. In this sense, little is known about its antecedents or moderators. The objective of this study was to investigate the role of customers' emotions during service experiences on WOM, applying nonlinear techniques and exploring the moderating role of customers' propensity for emotional contagion. Using the critical incidents technique, 122 customers recalled significant service experiences and the emotions they aroused, and reported if they shared said experiences with other individuals. We found that, whereas linear methods presented non-significant results in the emotions-WOM relationship, nonlinear ones (artificial neural networks) explained 46% of variance. Negative emotions were stronger predictors of WOM and the importance of emotions for WOM was significantly higher for individuals with high propensity for emotional contagion ( $R^2 = .79$ ) than for those with lower levels ( $R^2 = .48$ ). Theoretical and practical implications are discussed.

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## **Investigating Balance in Teacher Job Attitudes using Polynomial Regression and Response Surface Methodology**

**Christopher R. Warren**, California State University, Long Beach, CA

***Abstract:** Organizational theorists have long advocated the importance of attending to multiple stakeholders. However, limited empirical research has been devoted to the ways in which to identify balance, or imbalance, between stakeholder groups possibly due to methodological issues with modeling such complex nomological nets. The current study utilized the multiple stakeholder climate framework to test hypothesized relationships between perceptions of support and affectively-based criteria using polynomial regression and response surface methodology to test discreet regression lines representing predictions. Results from 297 teachers surveyed indicated that support for each group led to positive outcomes for teachers (higher job-specific positive affect and organizational commitment, and lower negative affect). Further, when the support for teachers exceeded or fell short of the support for students, indicating imbalance, negative affect increased.*

pp. 153-171.

## **Evidence of Chaos in a Routine Watchstanding Task**

**David Kern**, Kern Technology Group LLC, Virginia Beach, VA, **Waldemar Karwowski**, **Edgar Gutiérrez Franco**, University of Central Florida, Orlando, FL, and **Atsuo Murata**, Okayama University, Okayama, Japan

***Abstract:** Research into human performance on naval ships often emphasizes the significance of shaping factors, such as vigilance, fatigue and circadian rhythm. However, few report on the presence of complex nonlinear dynamics and fractal dimensionality. This study examines over 7000 routine topside security checks on a U.S. Navy Destroyer performed over a twelve-month period. Time series analysis (0-1 test, analysis of Lyapunov exponent, state space plots, and graphical analysis) reveal the presence of chaotic behavior, harmonics attractors, and fractal structures. The presence of this level of complexity in a simple task demonstrates the need to integrate previous findings in human performance with new discoveries in complexity and fractional dynamics.*