Stephenson School of Biomedical Engineering
Presents

Static and Dynamic Measures of Human Brain Connectivity Predict Complementary Aspects of Human Cognitive Performance

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Carson Engineering Center, Room 100
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1:30 P.M.

Michael W. Deem works in the area of evolution, immunology, physiology, and materials. He has brought tools from statistical physics to bear on problems in these areas. Of particular focus to him are those biological issues involving randomness, diversity, and correlations. Deem has developed methods to quantify vaccine effectiveness and antigenic distance for influenza, methods to sculpt the immune system to mitigate immunodominance in dengue fever, a physical theory of the competition that allows HIV to escape from the immune system, the first exact solution of a quasispecies theory of evolution that accounts for cross-species genetic exchange, a hierarchical approach to protein molecular evolution, a `thermodynamic' formulation of evolution, a theory for how biological modularity spontaneously arises in an evolving system, and elucidated how static and dynamic measures of human brain connectivity predict complementary aspects of human cognitive performance. Deem is the recipient of a number of awards, including the NSF CAREER Award, Alfred P. Sloan Fellowship, Camille Dreyfus Teacher-Scholar Award, Allan P. Colburn Award, Professional Progress Award of the AIChE, and Edith and Peter O'Donnell Award of The Academy of Medicine, Engineering & Science of Texas. Deem was a Phi Beta Kappa Visiting Scholar during 2012-2013. He is an editorial board member of the journals "Protein Engineering, Design and Selection," "Physical Biology," and "Bioengineering and Translational Medicine." Deem was a Member of the Board of Governors for the Institute for Complex Adaptive Matter and was a Rice Senator. Deem is a Fellow of the American Institute for Medical and Biological Engineering, the Biomedical Engineering Society, the American Association for the Advancement of Science, and the American Physical Society. Deem is the John W. Cox Professor, Departments of Bioengineering and Physics & Astronomy. Deem is the former Chair of the Bioengineering Department and Founding director of the Systems, Synthetic, and Physical Biology Graduate Program. Deem received his BS from the California Institute of Technology, his PhD from UC Berkeley, and was a postdoctoral fellow at Harvard University.

I will discuss the relationship between modularity of neural activity in the brain and cognitive ability, reviewing observations and theories relating modularity to plasticity of brain neural activity. By analogy with evolutionary biology, I hypothesize that selection for maximum plasticity of the human brain occurs in young adulthood, which implies modularity should peak in young adults. I will show that modularity of neural activity derived from fMRI data rises from childhood, peaks in young adults, and declines in older adults. I will review experiments being carried out by collaborators at Rice to answer three innovative applications in cognitive neuroscience: i) the relation among modularity, task complexity, and performance in the human brain, ii) the relation of task complexity to hierarchical scale of neural activity, and iii) the predictive power of resting state measurements for performance on specific tasks. I will also briefly describe how modularity helps to understand structure and performance in gene networks, with applications to cancer metastasis and recurrence.

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