



Department of
Biomedical Engineering
UNIVERSITY OF WISCONSIN-MADISON

Fall 2017 Seminar Series

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

Monday, September 18, 2017

12 - 1 PM in Tong Auditorium (1003 Engineering Centers)



Michael Deem Rice University

*Department Chair of Bioengineering
John W. Cox Professor in Biochemical & Genetic Engineering
Professor of Physics & Astronomy
Founding Director, Ph.D. Program in Systems, Synthetic, & Physical Biology*

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
- 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.

About the Speaker

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
- an elucidation of how static and dynamic measures of human brain connectivity predict complementary aspects of human cognitive performance.