THE UNIVERSITY OF CHICAGO

Department of Statistics

# STATISTICS COLLOQUIUM

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## The Functional Contribution of Synaptic Complexity to Learning and Memory

**MONDAY, November 18, 2013 at 4:00 PM**

133 Eckhart Hall, 5734 S. University Avenue

*Refreshments following the seminar in Eckhart 110*

## ABSTRACT


An incredible gulf separates theoretical models of synapses, often described solely by a single scalar value denoting the size of a postsynaptic potential, from the immense complexity of molecular signaling pathways underlying real synapses. To understand the functional contribution of such molecular complexity to learning and memory, it is essential to expand our theoretical conception of a synapse from a single scalar to an entire dynamical system with many internal molecular functional states. Moreover, theoretical considerations alone demand such an expansion; network models with scalar synapses assuming finite numbers of distinguishable synaptic strengths have strikingly limited memory capacity. This raises the fundamental question, how does synaptic complexity give rise to memory? To address this, we develop new mathematical theorems elucidating the relationship between the structural organization and memory properties of complex synapses that are themselves molecular networks. Moreover, in proving such theorems, we uncover a framework, based on first passage time theory, to impose an order on the internal states of complex synaptic models, thereby simplifying the relationship between synaptic structure and function.

We also apply our theories to model the time course of learning gain changes in the rodent vestibular oculomotor reflex, both in wildtype mice, and knockout mice in which cerebellar long term depression is enhanced; our results indicate that synaptic complexity is necessary to explain diverse behavioral learning curves arising from interactions of prior experience and enhanced LTD.


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