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Cooperative synapse formation in the neocortex

Tarec Fares and Armen Stepanyants*

Address: Department of Physics, Northeastern University, Boston, MA 02115, USA

Email: Armen Stepanyants* - a.stepanyants@neu.edu

* Corresponding author

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Introduction

Neuron morphology plays an important role in defining synaptic connectivity. Clearly, only pairs of neurons with closely positioned axonal and dendritic branches can be synaptically coupled. For excitatory neurons in the cerebral cortex, such axo-dendritic oppositions, or potential synapses, must be bridged by dendritic spines to form synaptic connections. To explore the rules by which synaptic connections are formed within the constraints imposed by neuron morphology, we compared the distributions of the numbers of actual and potential synapses between pre- and post-synaptic neurons forming different laminar projections in rat barrel cortex. Quantitative comparison explicitly ruled out the hypothesis that individual synapses between neurons are formed independently of each other. Instead, the data are consistent with a cooperative scheme of synapse formation, where multiple-synaptic connections between neurons are stabilized, while neurons that do not establish a critical number of synapses are not likely to remain synaptically coupled.

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