Spatial Distribution of Functional Connection Strengths in Patterned Neuronal Networks of Varying Convergence

Sankaraleengam Alagapan, Eric W. Franca, Liangbin Pan, Thomas B. DeMarse, Gregory J. Brewer and Bruce C. Wheeler, *Member, IEEE*

THE precise relation between the structural connectivity in a network and its functional connectivity is currently unknown. Patterned in vitro neuronal networks coupled to multi electrode arrays constitute a model living system where the topology can be defined a priori and functional properties can be studied [1], [2]. Recent studies by our colleagues [3] and others [4] showed that network activity patterns varied when the topology of the network was varied. Thus these networks serve as a useful platform to study the effect of structural connectivity on functional connectivity.

In this work, we constrained neurons in a dissociated culture to topologies that have different levels of convergence and studied the effect convergence level had on the functional connectivity measured using Granger Causality. We define convergence as the number of nearest neighbors to which each node in the pattern was connected (Fig 1a). We hypothesized that higher convergence in networks should lead to higher functional connection strengths between regions of the network. Also the effect of this topology should influence the spatial distribution of strength of functional connections. Our results showed that although the functional connection strengths remain relatively similar (Fig 1b) irrespective of the topology; the spatial distribution was indeed affected by the topology of the network. Functional connection strengths in topologies with higher convergence changed less over distance compared to those with lower convergence (Fig 1c). Also the fidelity of information propagation in these networks as measured by Victor-Purpura metric was significantly different for different topologies.

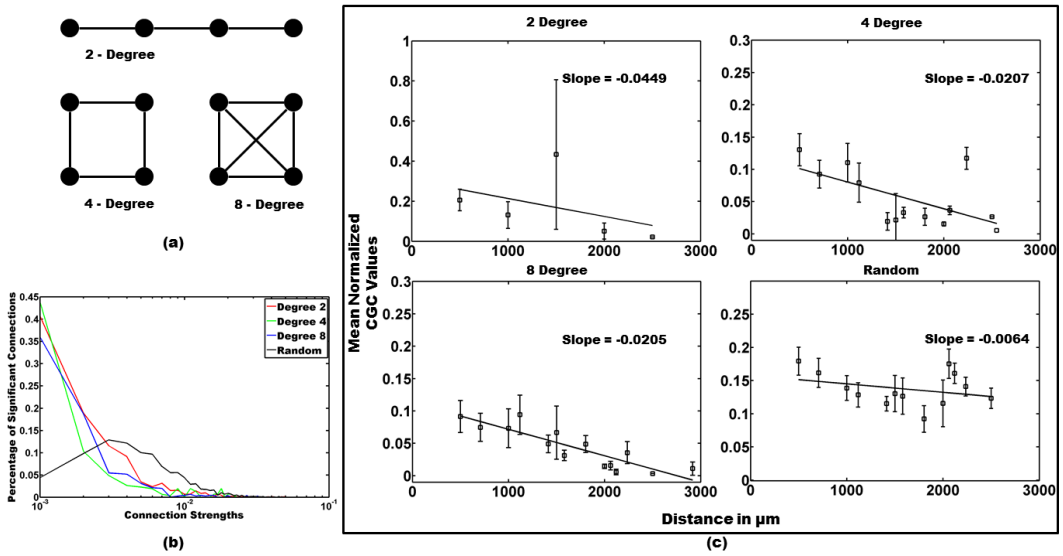

Fig 1

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S. Alagapan, E. W. Franca, L. Pan, T. B. DeMarse and B. C. Wheeler are with the J Crayton Pruitt Family Department of Biomedical Engineering, Universtity of Florida, Gainesville, FL 32601 USA (corresponding authors e-mail: bwheeler@ufl.edu, tdemarse@bme.ufl.edu)

G J Brewer is with Department of Biomedical Engineering, University of California, Irvine, CA 92697.