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Presentation Abstract

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Title:	Reverse-engineering neural network topology from large-scale recording dynamics
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Abstract:

Introduction:
Study of recorded EEG data has demonstrated that the brain exhibits global dynamics with key spectral properties [1]: the power spectral density averaged across recording channels is characterized by the superposition of background pink noise and a number of evenly spaced frequency bands. It has been observed anatomically that large-scale connectivity in the brain is nonrandom, and is well-characterized as a scale-free topology [2]. The relationship between network topology and observed activity is a topic of ongoing research, but it is known that network topology limits the range of possible observable dynamics evolved by a system [3]. Thus, it is desirable to infer details regarding the connectivity of a neural network based on observation of its dynamics.
Methods:
Using a stochastic dynamical model of large-scale brain activity [2,3], we found a relationship between the power spectrum of EEG recording and the eigenvalues of a connectivity matrix describing the functional architecture of the underlying neural networks. Because many different matrices have the same eigenvalue set, the EEG spectrum alone is not sufficient to determine the underlying network connectivity. We thus impose one constraint: the connectivity matrix must have a scale-free network topology. We then solve the inverse-eigenvalue problem [4] in order to obtain a family of connectivity

matrices compatible with this condition, that in our simulations generate EEG traces with the power spectrum experimentally observed.

Results:

The reconstructed connectivity matrices display globally balanced excitation and inhibition (positive and negative entries, respectively) as well as the presence of hubs, which are characteristic of scale-free networks (Fig. 1).

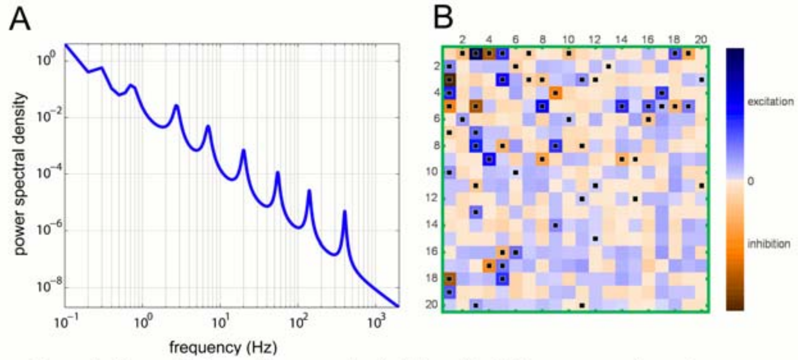

Figure 1: Connectivity matrix reconstructed from the EEG power spectrum. A: Simulated power spectrum of EEG traces. B: Connectivity matrix leading to EEG traces whose averaged power spectrum matches A. Black squares represent the underlying small-world network topology.

References:

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NETWORK

OSCILLATIONS

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