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## Presentation Abstract

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Presentation Title: What brain rhythms reveal about functional brain connectivity

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**Abstract:** Recent studies of electroencephalogram (EEG) data as well as of extracellular recordings (local field potentials) in acute brain slices have demonstrated that both macroscopic and microscopic neural networks exhibit multiple activity rhythms. In the power spectrum these rhythms appear as a number of frequency bands which are evenly spaced on a logarithmic scale, thereby reducing the potential for cross-talk (phase-locking) or mutual entrainment between frequency bands. Furthermore, the frequency bands are superimposed on a background of pink noise; that is, the baseline of the power spectrum for brain dynamics decreases proportionally to a power of the inverse of the frequency, which is a feature common to many complex systems. Using mathematical tools recently developed for solving inverse problems, as well as stochastic theory, we set out to reverse-engineer network configurations, or “virtual brains”, that recreate multi-oscillatory brain dynamics on a pink-noise background. **We hypothesized that those virtual brains would share common features, such as functional connectivity and dynamics, among themselves and also with actual brains.** Characterizing these commonalities in turn would help us identify anatomical and physiological features of healthy brains, such as the balance between excitation and inhibition, the relative number of highly connected nodes (hubs), the probability of finding certain structural motifs, etc. In addition, since the multi-oscillatory activity of the brain is known to be altered in disease, we also set out to reconstruct virtual brains that reproduce altered EEG patterns such as those observed in epilepsy and schizophrenia. We expected to find alterations of connectivity

and dynamics in these altered virtual brains that would give us some insight into structural and physiological changes associated with the above pathologies. **Our results show that the presence of brain rhythms is indicative of a hierarchical network structure with high complexity, in which certain motifs with reciprocal connections are more probable than others.** Alterations of the multi-oscillatory activity in two different ways, by reducing the high-frequency content or by allowing cross-talk between different rhythms, lead to a reduction of neural complexity, changes in the hierarchical structure and in the probability of finding certain motifs. We predict that our results will also be found in actual brains in health and disease.

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