CORTICITY: Comparative Investigation of the Cortical Circuits in Mouse, NHP and Human

Main area: HBP03_Comparative aspects of brain function and connectivity
Keywords:
Duration (months): 36
Total project funding: € 762.511

Abstract

The proposal investigates the differences in physiology, anatomy and organization of the cortex in mouse, non-human primate (NHP) and human. This work will require tight collaborations between physiologists, anatomists and theoreticians. Our capacity to successfully integrate across these approaches is strongly supported by the numerous joint publications linking these disciplines in leading international journals by the PI's of the consortium. Anatomy: Tract-tracing will be used to build macaque and mouse inter-areal cortical connectomes. This work will generate large data bases on inter-areal connection weights and quantitative measures of laminar distributions as well as atlases of mouse and macaque. The structural basis of hierarchy and local-global integration will be investigated with viral tracers that will be used to map the long distance and local input to the parent neurons of feedforward and feedback connections in visual cortex of mouse and macaque. Physiology: Hierarchical processing in the human, NHP and mouse brains will be compared using electrophysiological and imaging approaches and together with the tract tracing, will inform embedded large-scale dynamic models of inter-areal processing in the cortex. Differences in the inter-areal matrix density lead to widely different core structures across the three species, which will be explored by weighted network structural analysis, thereby revealing the structure of the Global Neuronal Workspace. We will manipulate consciousness with anesthetics and stimulation techniques in macaque and mouse by exploring Global Neuronal Workspace function via auditory signatures of consciousness in a predictive coding paradigm. Modeling: Conditional Granger causality analysis on multi-variate time series recordings will help identify functional subnetwork motifs, in order to explore the links between structural and dynamical features in the networks across these model brains. Whole-brain computational modeling will address the functional role of the underlying anatomy by studying in silico information of theoretical measures of integration and segregation allowing topological hierarchical analyses of effective connectivity rather than on the anatomical or functional connectivity. These findings will provide quantitative metrics for comparing differences in brain organization related to changes in brain size and order, and will provide an improved understanding of the relevance of investigations in the mouse and macaque for understanding the human brain.

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