CANON: Investigating the canonical organization of neocortical circuits for sensory integration

Main area: Targeted Mapping of the Mouse Brain
Keywords: Cortical microcircuits; Brain rhythms; Sensory integration; Computational neuroscience
Duration (months): 36
Total project funding: € 577 617

Abstract

The organizational complexity of the cerebral cortex seriously limits our understanding of its operation. Most studies focus on a single aspect of cortical organization, either at the microscopic or macroscopic level, yet an adequate understanding of the integration mechanisms of the brain at circuit level is still missing. The main goal of this project is to shed light on the multiscale organization of cortical computation by integrating neuronal and population activities with inter areal interactions. Recent studies suggest that computations dealing with feedforward transfer of information, such as sensory integration, are primarily performed in supra-granular layers and are mediated by high-frequency oscillations (gamma band). Conversely, feedback processing from higher-order to lower-order areas seems to be performed in infragranular layers and mediated by low-frequency oscillations (alpha and beta bands). This organizational scheme seems highly appropriate for studying the underlying neural mechanisms. Our objective is threefold, as we aim to understand: i) whether the canonical architecture can be actually observed in a cortical circuit subserving multisensory integration, ii) the roles of different neuronal subpopulations in modulating oscillatory activity related to feedforward and feedback processing and iii) whether such architecture is preserved across different mammals. To achieve these goals we will perform whole-cell and ensemble recordings with layer- and cell-type-specificity in the visual cortex of head-fixed, behaving mice, while engaging animals in a multisensory integration task. Comparable ensemble recordings will be performed in ferrets, to investigate whether the same functional architecture is preserved in a species with a highly evolved visual system. Finally, a modeling study will be performed on the collected data to extrapolate a core functional architecture and to quantify inter-species differences. Overall, our project will reveal the microcircuit, columnar mechanisms of cortical processing related to the exchange of information between different areas. This will not only provide crucial data for the Human Brain Project, but will also be a cornerstone in our understanding of the neocortex and ultimately of human intelligence.

Consortium

Conrado A. Bosman, Umberto Olcese - University of Amsterdam - Netherlands - Funded by: NWO - (Coordinator)
Luc Gentet - Institut National de la Santé et de la Recherche Médicale - France - Funded by: ANR
László Négyessy – Wigner Research Center for Physics, Hungarian Academy of Sciences - Hungary - Funded by: NIH