Sapienza University of Rome

Department of Physiology and Pharmacology

PhD program in Behavioral Neuroscience

Italian National Institute of Health

National Center for Radiation Protection
and Computational Physics

James Rankin

University of Exeter

Neural field model to reconcile structure with function in primary visual cortex

Monday, May 13
2:30 PM

Aula Luciani
(Sapienza University Campus – Building CU027)

for info: stefano.ferraina@uniroma1.it; 06 49910306
maurizio.mattia@iss.it; 06 49902513

Abstract:

Voltage-sensitive dye imaging experiments in primary visual cortex (V1) have shown that local, oriented visual stimuli elicit stable orientation-selective activation within the stimulus retinotopic footprint (Chavane et al 2011). The cortical activation dynamically extends far beyond the retinotopic footprint, but the peripheral spread stays non-selective - a surprising finding given a number of anatomo-functional studies showing the orientation specificity of long-range connections. Here we use a computational model to investigate this apparent discrepancy by studying the expected population response using known published anatomical constraints. The dynamics of input-driven localized states were simulated in a planar neural field model with multiple sub-populations encoding orientation. The realistic connectivity profile has parameters controlling the clustering of long-range connections and their orientation bias. We found substantial overlap between the anatomically relevant parameter range and a steep decay in orientation selective activation that is consistent with the imaging experiments. In this way our study reconciles the reported orientation bias of long-range connections with the functional expression of orientation selective neural activity. Our results demonstrate this sharp decay is contingent on three factors, that long-range connections are sufficiently diffuse, that the orientation bias of these connections is in an intermediate range (consistent with anatomy) and that excitation is sufficiently balanced by inhibition. Conversely, our modelling results predict that, for reduced global inhibition strength, spurious orientation selective activation could be generated through long-range lateral connections. Furthermore, if the orientation bias of lateral connections is very strong, or if inhibition is particularly weak, the network operates close to an instability leading to unbounded cortical activation.