On the Unique Roles of Neurocomputational States in Neocortical Circuits

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This work employed an information theoretic approach in order to understand how information is stored and manipulated in mammalian neocortical circuits. Through massive in silico simulations of the mammalian neocortex based on the Izhikevich neuron model, we determined how five different neurocomputational states (regular spiking, intrinsic bursting, fast spiking, chattering, and low threshold spiking) uniquely contribute to different aspects of information flow and storage. Arriving at a p-value of 2.6*10^266 from over 15,000 trials, we first established that the different classes of neurons in the mammalian neocortex do indeed have statistically significantly different ways of relaying information. We then proceeded to highlight each individual neurocomputational states weaknesses and strengths across case studies in controlling input/output information loss, reducing input noise susceptibility, communicating across synapses and chains, and forming polychronous groups. Overall, this work establishes foundational insights into how distinct neurocellular motifs specifically encode information. In the future, the mathematical insights discovered in this work can be used to explain neocortical functional losses in neurological disorders such as schizophrenia and autism, and to better engineer circuits which harness the power of biological neuron-based computing.

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