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MODEL OF SPONTANEOUS ACTIVITY IN THE ISOLATED CORTICAL SLAB IN VIVO

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Multisite intracellular and field potential recordings in 10 mm × 6 mm neocortical slabs *in vivo* isolated from all afferents, revealed spontaneous activity that lasted 0.5-1.5 sec separated by silent periods lasting 5-60 sec. During silent periods, small intracellular depolarizing potentials occurred with an increasing frequency just before each active state and which were suppressed immediately following each active period. In larger isolated 20 mm × 10 mm slabs of gyri, the spontaneous activity was replaced by periodic oscillations similar to that observed in intact cortex. The cellular and network mechanisms underlying neuronal activity in the slabs were investigated with computational simulations based on detailed models of cortical pyramidal (PY) cells and interneurons. The summation of the miniature EPSPs during the silent phase of an oscillation could activate the persistent sodium current and depolarize the membrane sufficiently for spike generation. Once the oscillations were initiated, they spread through the network and were maintained by the lateral PY-PY excitation and persistent sodium current. Progressive depression of the excitatory interconnections led to the termination of the fast activity after 300-700 ms. As the number of neurons and synapses in the network increased, the frequency of active periods stabilized. The model predicts that randomly occurring miniature EPSPs and persistent sodium currents are sufficient to explain the nonregular onset of active states in the cortical network and that a minimum number of interconnected cells is required to maintain the periodicity of oscillations. Supported by the Howard Hughes Medical Institute, Sloan Foundation, MRC of Canada and Human Frontier Science Program.