see Intraoperative direct electrocortical stimulation.

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Invasive simultaneous stimulation and recording from intracranial electrodes and microwire arrays were used to investigate direct cortical responses to single pulses of Electrostimulation in humans. Microwire contacts measured surface potentials in cortical microdomains at a distance of 2 - 6 mm from the intracranial electrode. Direct cortical responses to stimulation (< 20 ms) consisted of a larger surface negative potentials. The latencies of these responses were directly or inversely correlated with distances between the intracranial electrode and microwire contacts. They hypothesized that surface negative potentials reflected local synchronous depolarization of apical dendrites of pyramidal neurons in cortical microdomains in the superficial cortical layer and resulted from the activation of gray matter axons that delivered excitatory inputs to apical dendrites after cortical stimulation. We further hypothesized that the positive or inverse distance-latency correlations of the recorded negative responses were measured depending on whether activation of neurons originated at one (crown) or multiple (crown, lip, bank) sites throughout the gyrus simultaneously. The inverse distance-latency correlations then reflected the spatiotemporal superposition of different nearby sources of neuronal recruitment in the gyrus. To prove this hypothesis, we built an anatomically informed and biophysically realistic cortical network model and simulated early responses of cortical neurons to Electrostimulation in this cortical network model. The model simulations yielded negative potentials in simulated microdomains in the cortical model consistent with those recorded from humans. The model predicted sensitivity of cortical responses to the alignment of the stimulating electrode and microwire array with respect to the cortical gyrus and confirmed that gyral geometry has a major impact on direct neuronal recruitment, the timing, and the time course of neuronal activation in cortical microdomains. In this work, we demonstrated how the high-resolution forward network models can be used for better understanding and detailed prediction of cortical stimulation effects. Accurate predictive modeling tools are needed for the progress of brain stimulation therapies [1].

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Functional electrical cortical stimulation is a reliable technique to prevent or minimize motor, sensory, and language deficits and has been used in humans since the 1950s to identify functional cortex, and it can also localize epileptogenic regions [2].

[1]
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[2]
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