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Presentation Abstract

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Title:	Estimation of synaptic currents from laminar multi-electrode recordings
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Abstract:	Multi-electrode recording of extracellular potentials shows promise as a technique for constraining biophysical population models of cortical circuits (Einevoll et al., J. Neurophysiol., 2007; Blomquist et al., PLoS Comp. Biol., 2009). As recording technology is rapidly improving, there is a growing need for accurate and validated methods for extracting biologically relevant information from such data. Existing methods using recordings from laminar multielectrode arrays allow calculation for Current Source Density (CSD) - the net trans-membrane currents entering the extracellular medium as a function of cortical depth - under different experimental conditions. The CSD is composed of both synaptic input currents and the resulting passive return currents, complicating the interpretation of the results in terms of synaptic connections. For instance, a CSD sink at a given location can correspond to either a local excitatory synaptic input, or the return current of a remote inhibitory synaptic input. Here we present a framework for disambiguating the synaptic input currents from the return currents, based on extracellular potential recordings. This involves calculation of the passive membrane currents in response to synaptic input currents at different vertical positions, for a collection of reconstructed cell morphologies. For a given frequency *f*, the CSD(Z) as a function of vertical distance, Z, from soma, can be expressed as a linear transformation of

synaptic (or "impressed") currents $I_s(Z')$. Data on realistic cell morphologies and somatic density distribution within each laminar population are then used to construct the population CSD distributions from those predicted for individual cells. The inversion of laminar profiles of synaptic currents from CSD data are performed using a regularized linear estimation framework. The accuracy of the resulting estimates of synaptic input currents is evaluated using model studies with realistic cell morphologies and synaptic distributions. The extraction of synaptic input patterns from multi-electrode recordings is essential for identifying synaptic projections between different laminar populations and should become a valuable tool for development of data-driven network models.

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