COMPARING NEUROPHYSIOLOGICAL MEASUREMENTS OF SIMULATED AND REAL BRAINS

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SUMMARY

Objectives
The paper compares simulated neurophysiological measurements (single electrode recordings and EEG recordings) of two simulated brains with real measurements from real brains. The comparison is made in terms of statistical properties of the measurements, and its aim is to determine to what extent the considered simulated brains produce naturalistic results.

Context
There are several proposed neuron and neural assembly models, each focusing on different aspects (Freeman, 1994, Gerstein and Kirkland, 2001, Haykin, 1994, Rao and Ballard, 1999). An important issue is to investigate to what extent these models produce similar results to real brains in simulated natural conditions. Such evaluations can provide the basis for selection of models for more detailed investigations. Typically, the aim of these models is to simulate the ideal functioning of the modelled neural system in ideally isolated conditions. Here we adopt a slightly different approach, by analysing simulated brains (brain components) made by such model neurons and neural assemblies.

Methods and results
The existing experimental evidence (Shepherd, 1997) provides a large range of information about the fundamental structure of a patch of the primary visual cortex. Using this information we built the two simulated cortex patches consisting of several adjacent cortical columns.
We chose two neural models to investigate. The first simulated cortex uses the concepts of more classical model neural networks (e.g. Heeger et al., 1996). In this model, neurons have simple tuning curves, which enable them to select local features of the incoming information, and these neurons interact to select the salient global properties of the incoming information (e.g., edges in the visual input). The second simulated cortex follows the columnar architecture, but is built by neural networks that use emerging spatio-temporal patterns to represent information. (Andras, 2001).
We performed simulated single electrode recordings and surface EEG recordings with both model cortex patches. The results were compared to electrode and EEG

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measurements from real brains. In particular, we compared statistical properties (e.g., characteristics of distributions) of the recordings.
The results indicate that in accordance with expectations, the more complex architecture, which uses emerging spatio-temporal patterns, produces measurements that are more similar to the real brain measurements.

Significance
The comparison of simulated brain patches with real brains, based on a comparison of neurophysiological measurements, allows us to evaluate the appropriateness of various neural model proposals. Such evaluations go beyond the level of simply comparing idealized neural models with selected neurons that perform to a large extent according to expectations. A more complex assessment of the properties of neural assemblies built by model neurons can point to major deviations of the models from reality, and as such, can guide the search for models that describe reality more faithfully.

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