RAPID CONTOUR INTEGRATION OF MACAQUE MONKEYS AND SPIKING NEURAL NETWORKS

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We compare the performances of macaque monkeys and of different types of spiking neural networks in a contour integration task.

The monkeys were trained in a 4-AFC task in detecting S- and U-shaped contours on the right/left semifield of a stimulus display. The contours consist of colinearily aligned Gabor patches (targets) within a number of randomly oriented Gabors (distractors) distributed evenly over the display. To adjust the difficulty of the task, a random orientation jitter of varying amplitude can be applied to the targets. The performance of integrating contours is measured by the number of correct responses in dependance of the orientation jitter, yielding typical psychometric curves. As an additional parameter, the contours' presentation time can be varied.

The same stimuli are applied to neural networks employing lateral intracortical interactions similar to those observed in anatomical and functional studies of primary visual cortex. We contrast the performance of two networks, namely a 'classical' network with additive synapses, and a network with multiplicative or non-linear (NMDA-) synpases. The neurons interact by exchanging spikes, and are subject to a realistic amount of noise. This approach allows us to investigate explicitly the temporal dynamics of contour integration, and to compare modelling results with experimental findings.

The monkeys show a remarkable performance of contour integration even under strong temporal constraints, closely approaching the performance of an ideal observer. This ability imposes strict bounds on the models investigated, allowing for only three to five spikes per neuron during the integration process. Preliminary data suggest that even if many neural architectures are, in principle, capable of integrating contours, multiplicative or non-linear interactions are required to achieve a comparably fast contour integration.