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Unsupervised learning of head-centered representations in a network of spiking neurons

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Movement planning based on visual information requires a transformation from a retina-centered into a head- or body-centered frame of reference. It has been shown that such transformations can be achieved via basis function networks [1,2]. We investigated whether basis functions for coordinate transformations can be learned by a biologically plausible neural network. We employed a model network of spiking neurons that learns invariant representations based on spatio-temporal stimulus correlations [3]. The model consists of a three-stage network of leaky integrate-and-fire neurons with biologically realistic conductances. The network has two input layers, corresponding to neurons representing the retinal image and neurons representing the direction of gaze. These inputs are represented in the map layer via excitatory or modulatory connections, respectively, that exhibit Hebbian-like spike-timing dependent plasticity (STDP). Neurons within the map layer are connected via short-range lateral excitatory connections and unspecific lateral inhibition. We trained the network with stimuli corresponding to typical viewing situations when a visual scene is explored by saccadic eye movements, with gaze direction changing on a faster time scale than object positions in space. After learning, each neuron in the map layer was selective for a small subset of the stimulus space, with excitatory and modulatory connections adapted to achieve a topographic map of the inputs. Neurons in the output layer with a localized receptive field in the map layer were selective for positions in head-centered space, invariant to changes in retinal image due to changes in gaze direction. Our results show that coordinate transformations via basis function networks can be learned in a biologically plausible way by exploiting the spatio-temporal correlations between visual stimulation and eye position signals under natural viewing conditions.

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References

1. Pouget A, Sejnowski TJ: **Spatial transformations in the parietal cortex using basis functions.** *J Cogn Neurosci* 1997, **9:**65-69.
2. Pouget A, Deneve S, Duhamel JR: **A computational perspective on the neural basis of multisensory spatial representations.** *Nat Rev Neurosci* 2002, **3:**741-747.
3. Michler F, Eckhorn R, Wachtler T: **A network of spiking neurons for learning invariant object representations in the visual cortex based on topographic maps and spatio-temporal correlations.** *Society for Neuroscience Annual Meeting* 2007. #394.8.