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NETWORK MODELING OF SPATIAL PROPERTIES OF UNITS IN STRIATE CORTEX.

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We have used the back-propagation learning algorithm to model single unit data from macaque V1 cortex. Stimuli were 400 spatial patterns, including bars, sinusoidal gratings, textures, and 3-D shaded objects. The algorithm was used to integrate these data to produce a model of the cell's response properties. To create the network, the same images used as stimuli were repeatedly presented to the network's input layer, which consisted of several hundred units with receptive fields similar to those of retinal ganglion cells. The output layer had one unit, representing the neuron being modeled, and the middle layer had from 4-10 units. The network was trained so that its output in response to each image reproduced the activity of the actual neuron, using average firing rate as a measure of activity.

The resulting network was able to reproduce responses of the cortical neuron with a correlation of 0.8-0.85, when tested with images that were not included in the training set but for which we had data. This ability of the network to generalize well to images not part of the training set shows that it has captured most of the spatial properties of the cell, including nonlinear ones. We believe that this is the first use of back-propagation to directly model neurophysiological data. This technique may be useful as a more comprehensive and objective means of determining neural response properties, especially in extrastriate cortex, where receptive fields are particularly complex.