How do we go from oriented lines to complex shapes?

Hubel and Wiesel (1959) J. Physiol. 148: 574-591


Divide and conquer strategy: multiple small steps are required to solve a complex task
Adventures into *terra incognita*

Felleman and Van Essen. *Cerebral Cortex* 1991
Exhaustive exploration of the high dimensional image space is not possible with current techniques.
Response latency increases along the visual hierarchy

Each additional processing step takes ~15 ms

Schmolesky et al 1998
Receptive field size increases along the ventral visual stream

Fig. 2. Schematic diagram showing convergence achieved by the forward projections in the visual system, and the types of representation that may be built by competitive networks operating at each stage of the system from the primary visual cortex (V1) to the inferior temporal visual cortex (area TE) (see text). Area TEO forms the posterior inferior temporal cortex. The receptive fields in the inferior temporal visual cortex (e.g. in the TE areas) cross the vertical midline (not shown). Abbreviation: LGN, lateral geniculate nucleus.
Varied responses along the ventral visual stream

Increase in “complexity” of feature preferences along the ventral visual stream

Increase in “complexity” of feature preferences along the ventral visual stream

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Neurons in V4 show color selectivity


FIG. 2. A: example of the responses of a neuron in area V4 to patches of different isoluminant colors presented against a gray background. Spike rasters and response histograms are plotted with reference to the CIE chromaticity diagram. The bar under each histogram shows the duration of stimulus presentation (1 s). The neuron responded best to the blue stimulus. B: histogram showing the distribution of spectral preferences of all the V4 neurons recorded in these experiments. C: schematic representation of the part of the brain from which recordings were made. The dashed line on the lateral view of the monkey brain shows the approximate position of the coronal section (right). □, spectrally tuned neurons.
The strength of attention effects follows the reverse hierarchy

**FIG. 1.** Example stimulus sequences for sequential and simultaneous trials. The receptive field (RF) of the cell being recorded was mapped before data collection and is represented by the region enclosed by a dashed line. When both sequential and simultaneous trials were used with the inside/inside configuration (as shown here), different orientations and colors were used at the 2 locations, 1 of which was effective at driving the cell and 1 of which was ineffective. For many cells, however, all trials were sequential and the same stimuli were used at both locations. The same stimuli were typically used at both locations in the inside/outside configuration.

Neurophysiological recordings in the human brain

- Patients with pharmacologically intractable epilepsy
- Multiple electrodes implanted to localize seizure focus
- Targets typically include the temporal lobe (inferior temporal cortex, fusiform gyrus), medial temporal lobe (hippocampus, entorhinal cortex, amygdala and parahippocampal gyrus)
- Patients stay in the hospital for about 7-10 days
Shape selectivity in human extrastriate visual cortex

Liu et al. Neuron 2009
Visual shape selectivity is largely focused along the ventral visual stream.
Further reading


Original articles cited in class (see lecture notes for complete list)