Neural image: retinal ganglion cell responses

Input image (cornea) | Array of center-surround receptive fields | "Neural image" (retinal ganglion cells)

Neural image: simple cell responses

Input image (cornea) | Array of orientation-selective receptive fields | "Neural image" (V1 simple cells)

Lots of neural images: V1 simple cells
Lots of neural images

Simple cells

Complex cells

Temporal frequency and Fourier decomposition

Sine wave gratings and spatial frequency

Measured in cycles per degree (cpd or c/deg or c/°) of visual angle.
Theory of spatial pattern analysis by the visual system

Low sf filters encode coarse-scale information (large objects, overall shape)

High sf filters encode fine-scale information (small objects, detail)
Spatial contrast sensitivity

Each channel is sensitive to a narrow range of frequencies. Overall contrast sensitivity depends on all of them together.
Psychophysical/perceptual evidence for spatial-frequency and orientation selective channels

Orientation and spatial frequency selective adaptation: after-effects

Spatial frequency selective adaptation: after-effects
Spatial frequency selective adaptation: sensitivity

Contrast sensitivity before & after adaptation

Figure 3.22
Squares and solid curve: Contrast sensitivity function for a sine-wave grating. (From Campbell & Robson, 1968.) Dotted curve: Contrast sensitivity measured after adaptation to a 7.5 cycles/degree grating.
Psychophysical/perceptual evidence for normalization

Masking

Target | Surround masking | Overlay masking

Suppression factor

Mask orientation (deg)
0 30 60 90

Mask spatial frequency
0.2 0.5 1 2 3 4

Eccentricity (deg)
0 1 2 3 4 5 6 7
Texture

Texture analysis/synthesis
Analysis and synthesis of naturalistic textures

V2 computational theory

Image metamers
Receptive field size in the ventral stream

Physiological measurements of receptive field sizes
Metamer psychometric functions

Critical scaling parameters

Crowding

Visual system can process only a modest number of features. If there are too many features then it can't cope and fails to recognize anything.
Effects of crowding

Responses to naturalistic textures differentiate V2 from V1

fMRI responses
V2 responses predict perceptual sensitivity