Neural Bases of Vision I: Visual Coding

Readings: Kalat, pp. 154-161; 168-171

1. The Neural Basis of Vision
   - focusing of light onto photoreceptors (rods and cones) via cornea and lens
     - light falls on to retina: a 2D network of photoreceptors at the back of the eye
       - rods and cones pick up light; convert to neural signals
         ▪ c. 6 million cones: basis of colour vision in the fovea
         ▪ c. 120 million rods: basis of nighttime vision, peripheral vision
           - other kinds of cells also found (e.g., bipolar and ganglion cells)
   - final stage is ganglion cell; axons of these (optic nerve) leave eye via blind spot
   - pattern of light has become pattern of ganglion cell signals

2. Colour Perception
   - three different kinds of cones
   - each is sensitive to a particular range of wavelength of the incoming light
   - perceived colour is determined by relative activity of the cones
     - if long-wavelength cone most active: see Red
     - if medium-wavelength cone most active: see Green
     - if short-wavelength cone most active: see Blue
     - if long- and medium-wavelength cones equally active, see Yellow
   - if problems with cone types, can lead to colour-blindness
     - if long-wavelength cone inactive, can’t see red - protanopia
     - if medium-wavelength cone inactive, can’t see green - deuteranopia
     - if short-wavelength cone inactive, can’t see blue - tritanopia
3. Lateral Inhibition

3.1 Basic Effect
- absolute intensity is not that useful; changes whenever light source varies
- better to base vision on changes of intensity across space

\[
\begin{array}{c|c|c}
\text{Intensity} & 100 & 0 \\
\hline
\text{Change} & 0 & 0 \\
\end{array}
\]

- edge detection is carried out by lateral inhibition: suppression by neighbours

\[
\begin{array}{ccc}
100 & 100 & 100 \\
(-.5) & (1.0) & (-.5) \\
-50 & 100 & -50 \\
0 & 0 & 0 \\
\end{array}
\]

- neighbouring cells decrease (inhibit) signal of central neuron
  - low response to uniform intensities, high response to differences

3.2. Simultaneous Lightness (Brightness) Contrast
- illusion in which perception of brightness doesn’t correspond to reality
  - perceived brightness of square depends on brightness of neighbours

\[
\begin{array}{c}
\text{Square} \\
\hline
\text{Square} \\
\end{array}
\]

- possible explanation: neighbours suppress local brightness estimates

the brighter the neighbouring regions, the more the suppression (and thus the darker the perceived brightness)

Can this be explained by the neural circuits in the eye?
3.3. Possible Explanation of the Illusion

- as neighbours get brighter, local brightness estimate decreases