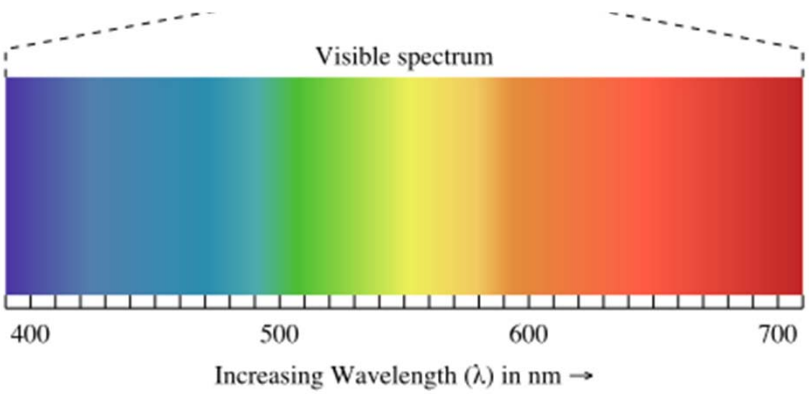
Spatial Vision

- Sensitivity to Color Variations
- Spatial Localization: Phase and Position

Sensitivity to Color Variatio

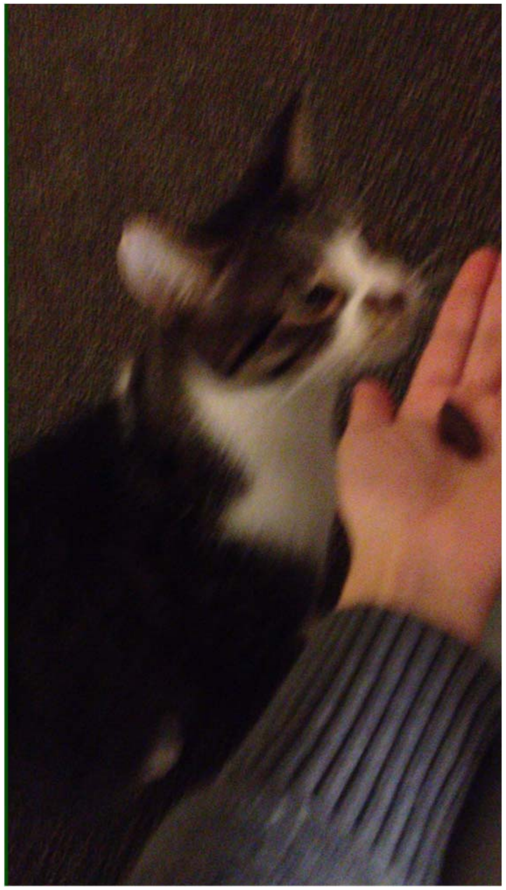
- Why is sunlit sky blue?
- Why is sunrise/sunset red?

Rayleigh scattering



Color vision

Distinguish objects based on the wavelength (or frequencies) of the light they reflect, emit, or transmit.



Color vision

Distinguish objects based on the wavelength (or frequencies) of th light they reflect, emit, or transmit

Fig 1a:Color image (more information)

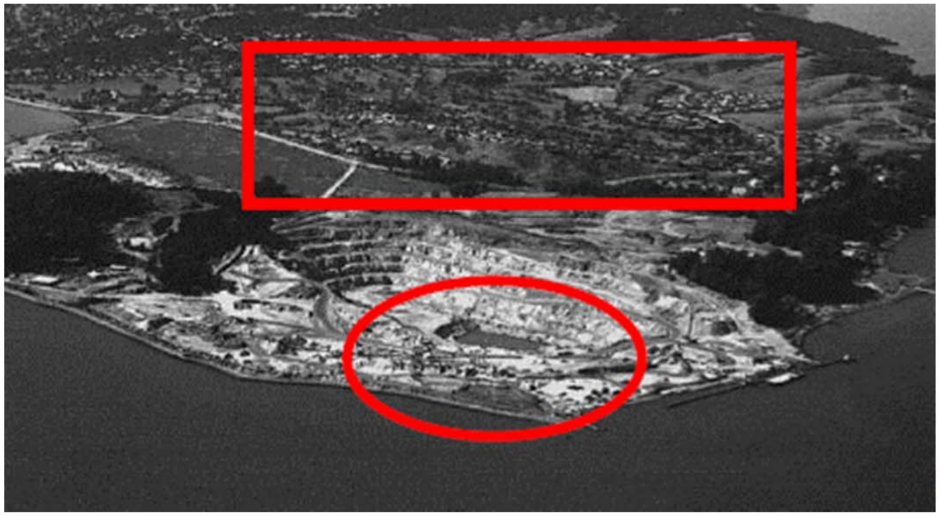
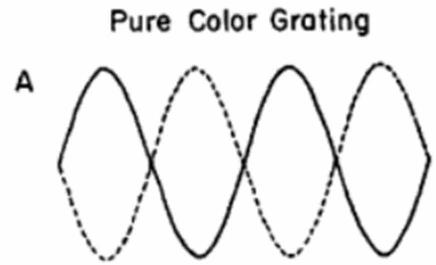
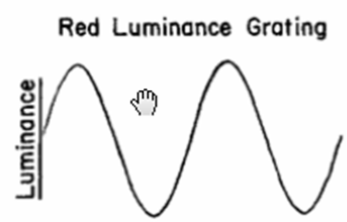


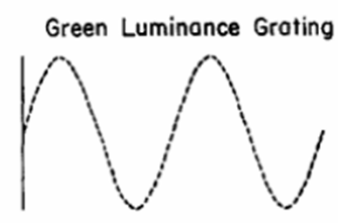
Fig 1b: losing information in the gray scale

Pure Color Gratings

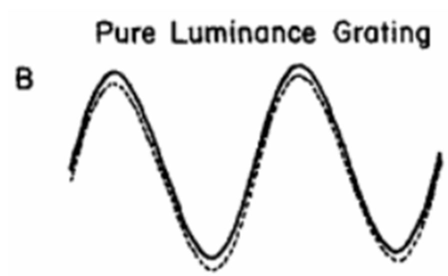
- Out-of-phase summation



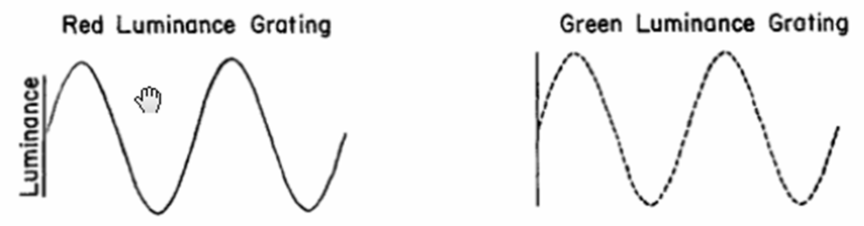




- In-phase summation

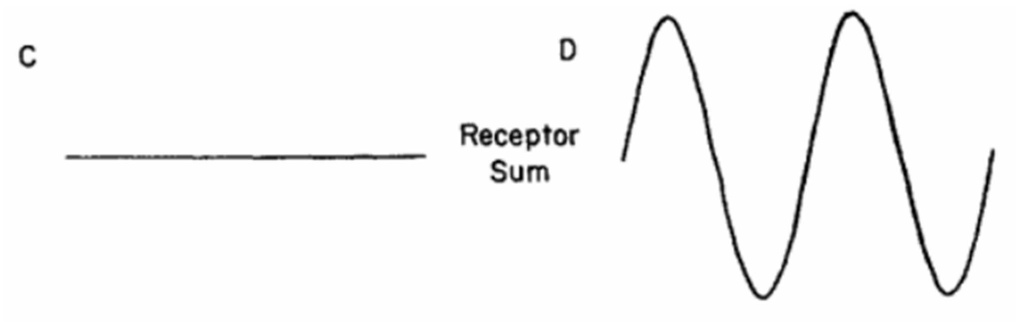


Pure Color Gratings

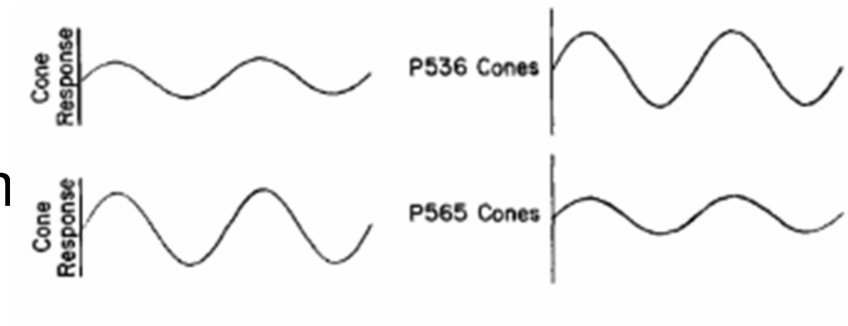


- Sums of the cone responses each of the component patterns

- Receptor sums vary with luminance contrast

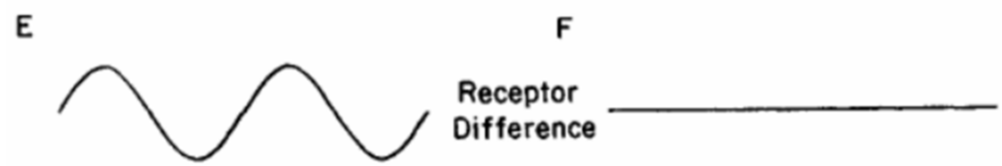


Pure Color Gratings

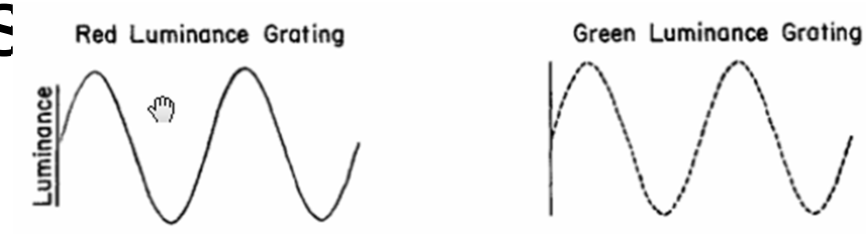


- Differences in the cone respon to the same patterns

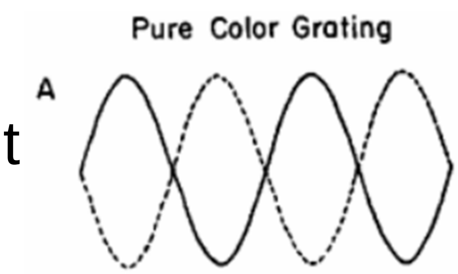
- Receptor differences vary with color contrast

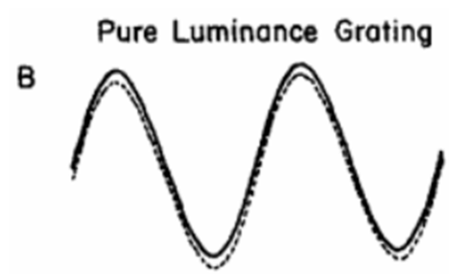


Pure Color Gratings



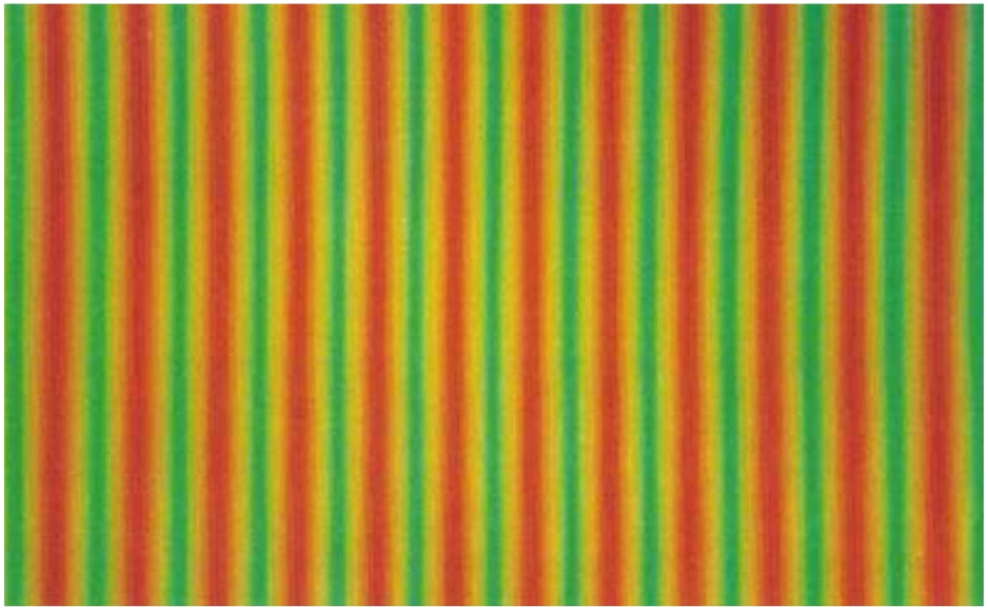
- Out-of-phase summation
  produce a pattern which varies
  in chromaticity but which is
  constant in luminance across its extent
- In-phase summation
  produce a luminance grating
  of the same contrast
  (but twice the mean luminance
  as the individual components).



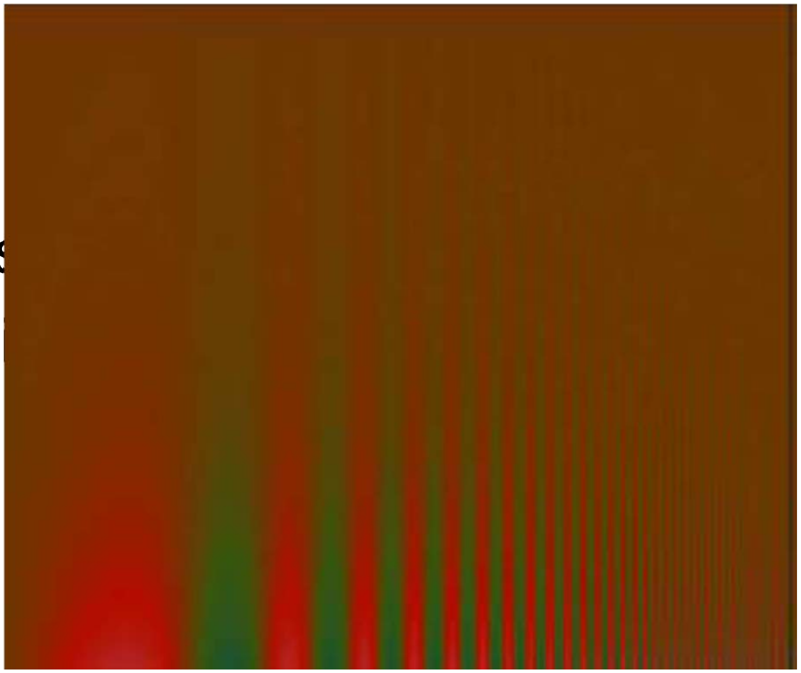


Isoluminant Color Mixture Grating

- Out-of-phase summation



in high frequencies you observe
the isoluminant red-green grating as
yellow-black grating luminance grati



Pure Color Gratings

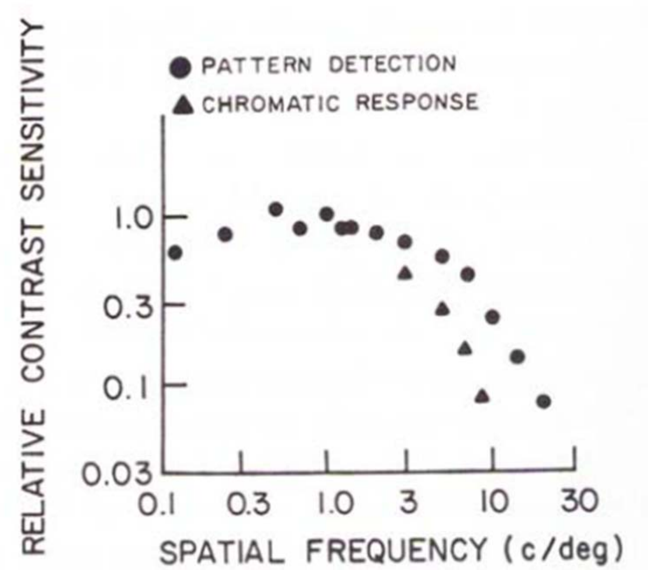
- Three optical factors which could produce a regular luminance variation on the retina from a presumably isoluminant, pure color grating:
    1. axial chromatic aberration
    2. radial chromatic aberration
    3. diffraction by the pupil

axial chromatic aberration

Spatial Color Contrast Sensitivity Function

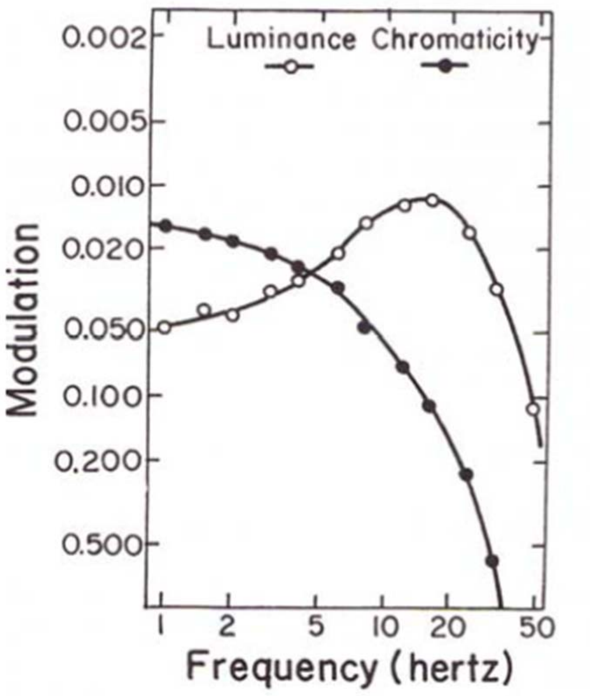
Color and luminance pattern sensitivity for red-green dimension in different spatial frequencies.

the fall-off point of the color pattern is lower than the correspondent luminance pattern



Temporal Color Contrast Sensitivity Function

- Color and luminance temporal CSFs



Color Contrast and Similitude

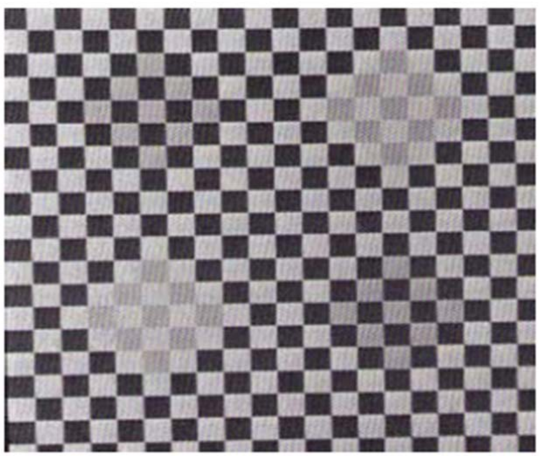
- Sensitivity to luminance patterns is more at mid and high frequencies and less to low frequencies
- Sensitivity to color patterns is more in low frequencies and less to high frequencies

Patterns	Low Spatial frequencies	Mid Spatial frequencies	High Spatial frequencies	Very high Spatial frequencies
Luminance patterns	_	Contrast	Contrast	Similitude
Color patterns	Contrast	Similitude	_	_

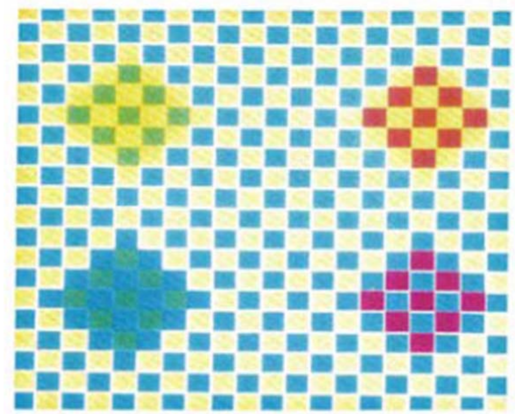
Table 1: Contrast vs. Similitude

Color Contrast and Similitude

- Contrast



Similitude



Minimally distinct borders

- Isoluminant color patterns give minimal distinction in terms of identifying borders.

- Isochromatic luminance patterns or any other pattern which has luminance variations give sharper border and better object detection.

Spatial Localization: Phase and Position

- How the visual system knows where something is?
- How does the system gain, maintain, and process information about spatial coordinates

Absolute vs. Relative Phase

- Absolute Phase get location information:

  Grating is slide along its horizontal axis which is perpendicular to its bars.

  1. Absolute Phase mechanism
  2. Positional mechanism

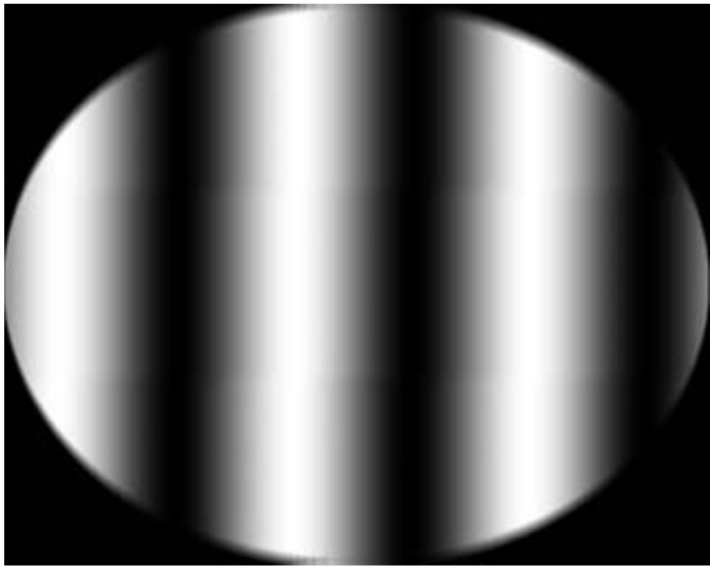
- Relative Phase get location information:

  based on the positional relationship between two or more spatial frequencies in one plane. (object of reference)

- Absolute phase sometimes is difficult to detect.

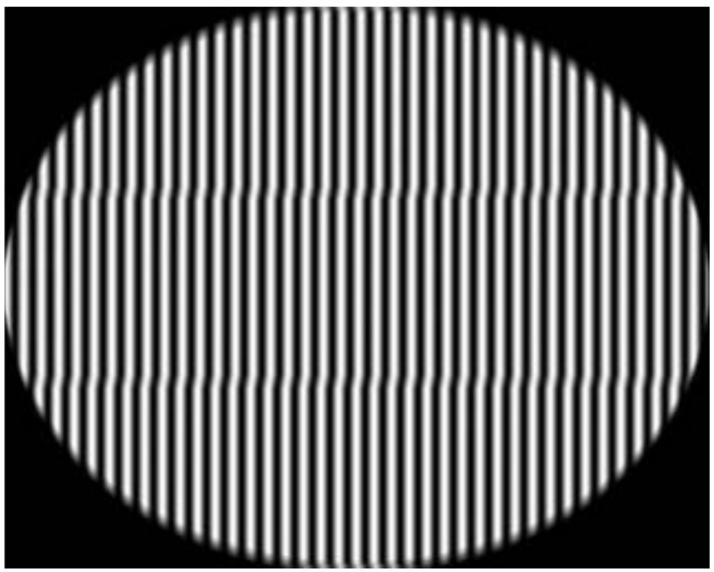
Relative Contribution of Phase and Position in Localization

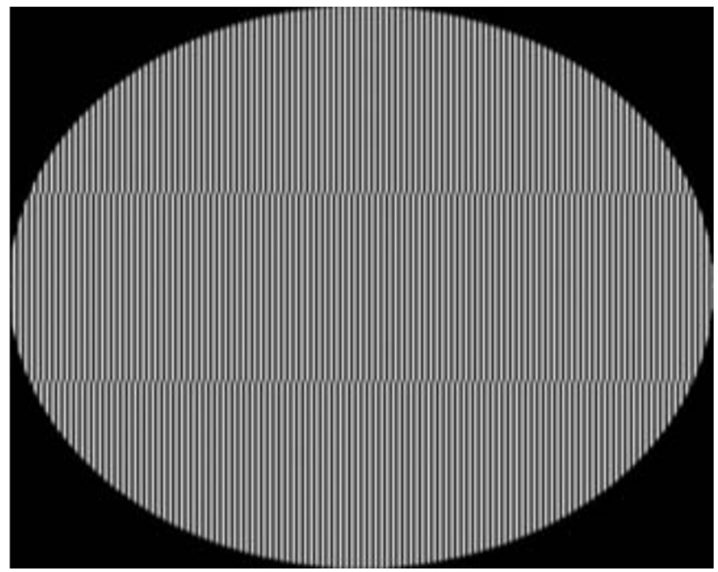
- At low frequencies, the positional term becomes very small compared to phase, thus the threshold will depend on phase.

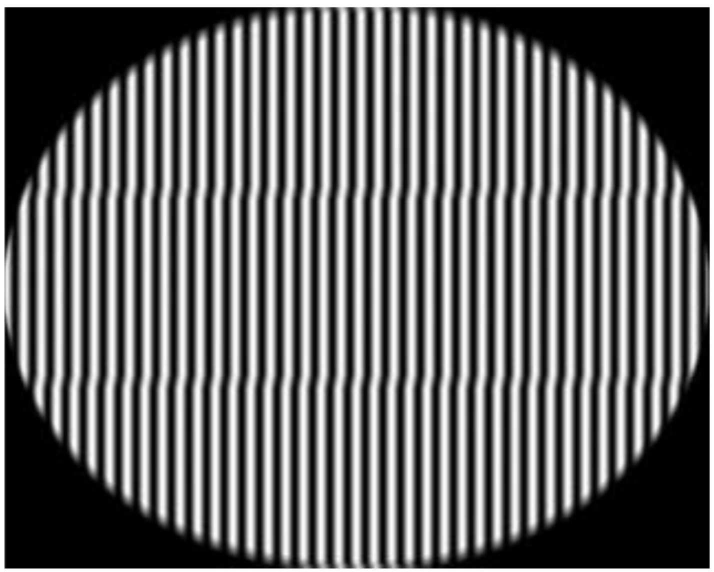


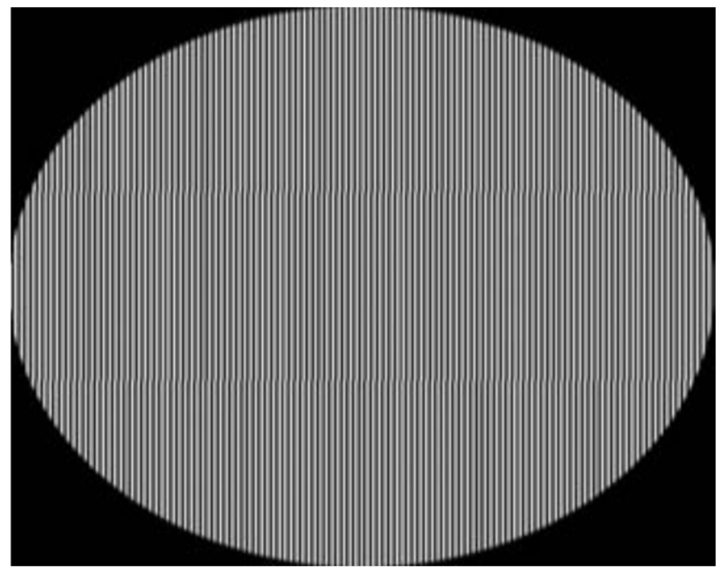
Relative Contribution of Phase and Position in Localization

- At high frequencies, the phase becomes very small comparing to position so position becomes the critical component.

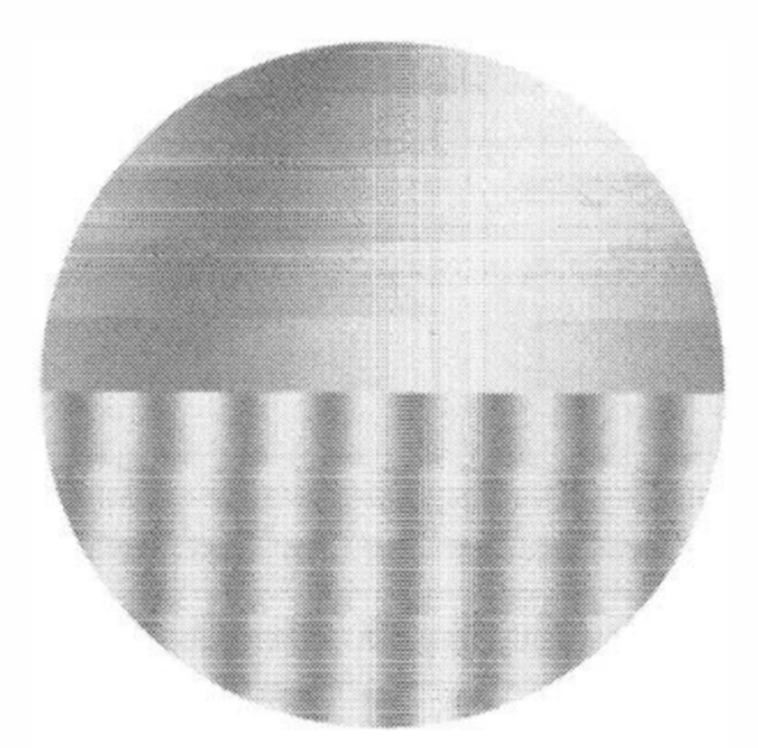


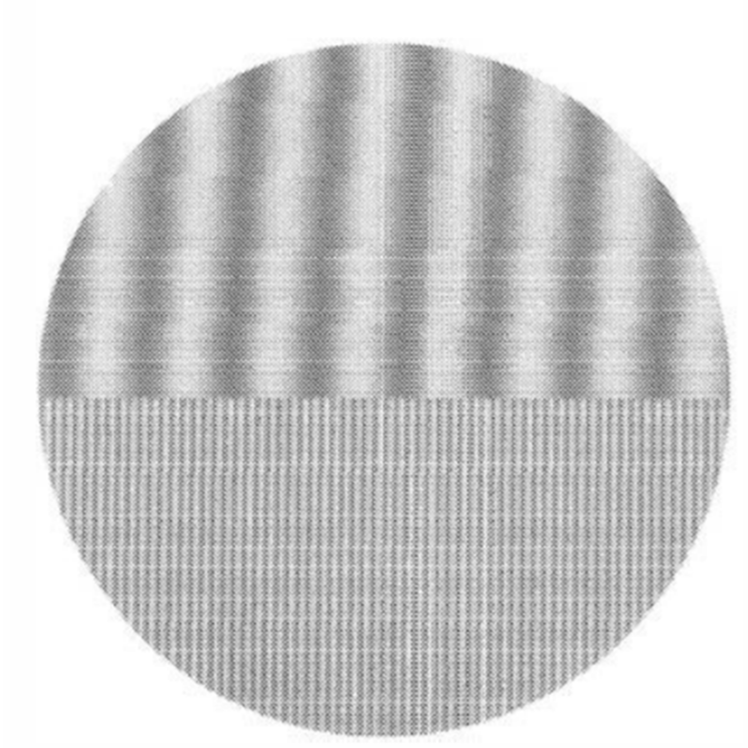




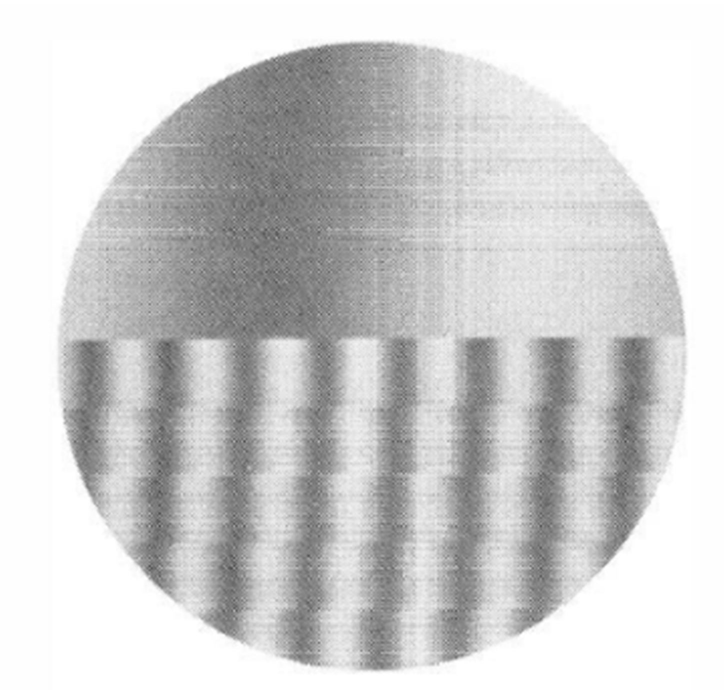


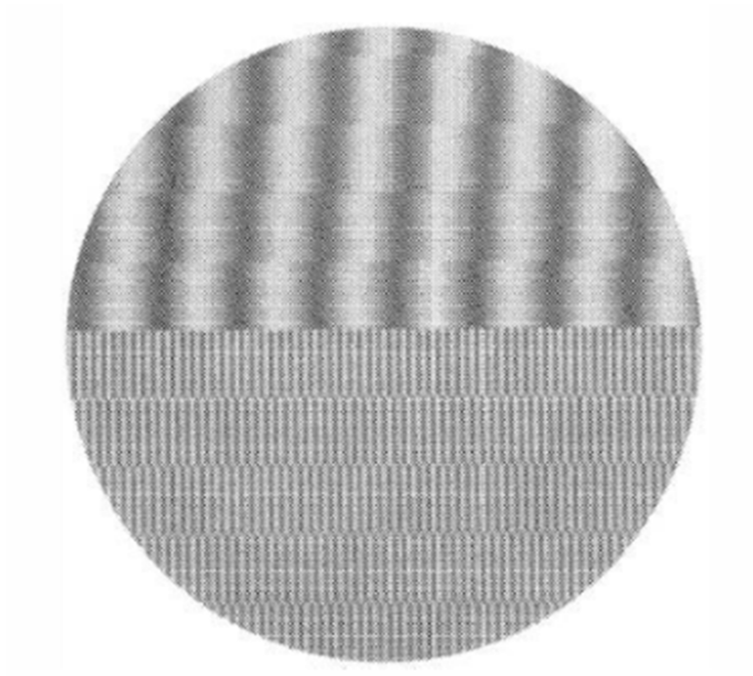
Same phase shift





Same position shift





Sensitivity to Color Phase

- At low spatial frequencies we can distinguish different colors.
- At high spatial frequencies we only perceive a mixture of colors. (we don't have spatial phase information in high frequencies)

Conclusion

- We are sensitive to the spatial phase in some degree although we are almost insensitive to absolute phase and our detection is more position dependent rather than phase dependent in high spatial frequencies