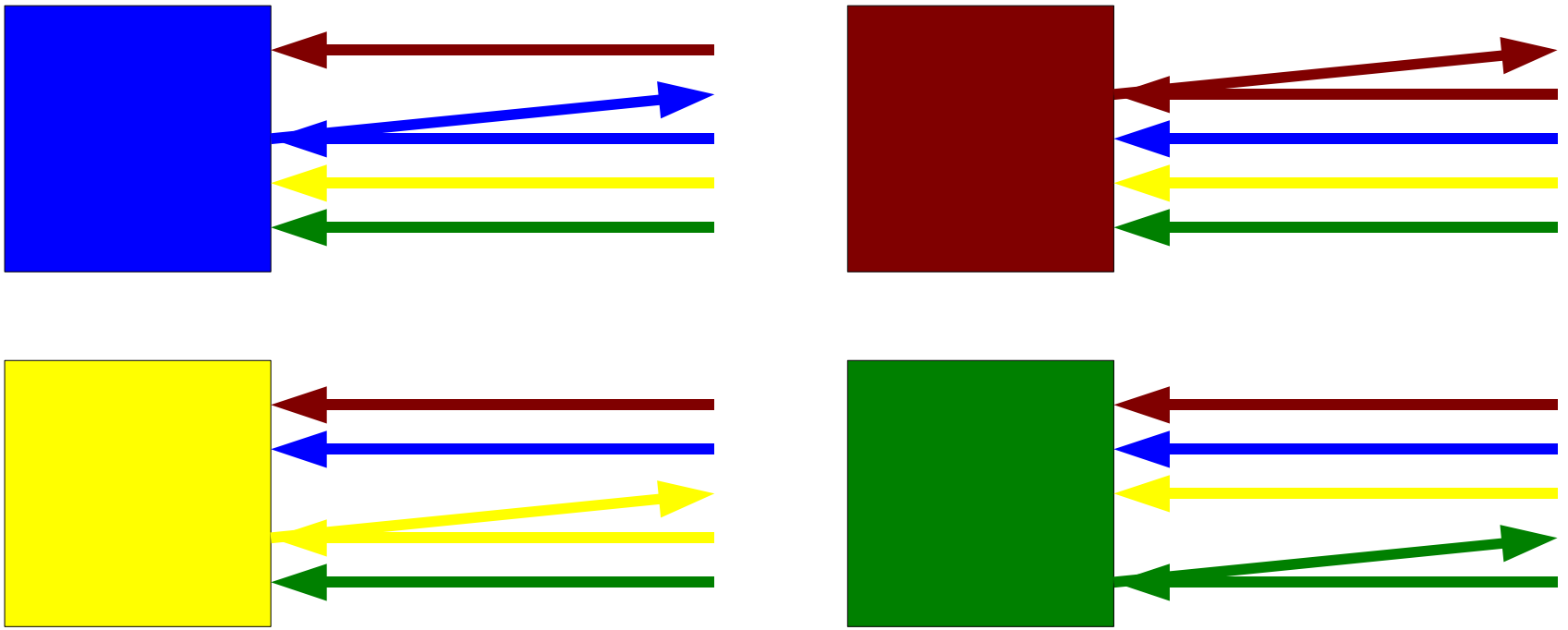
Color Vision

Wavelength properties:

- Hue: psychological reaction to different wavelengths of light. (Basically the same thing as color).
  - Different wavelengths produce different hues.
  - Objects have hue because they absorb most wavelengths but reflect others.

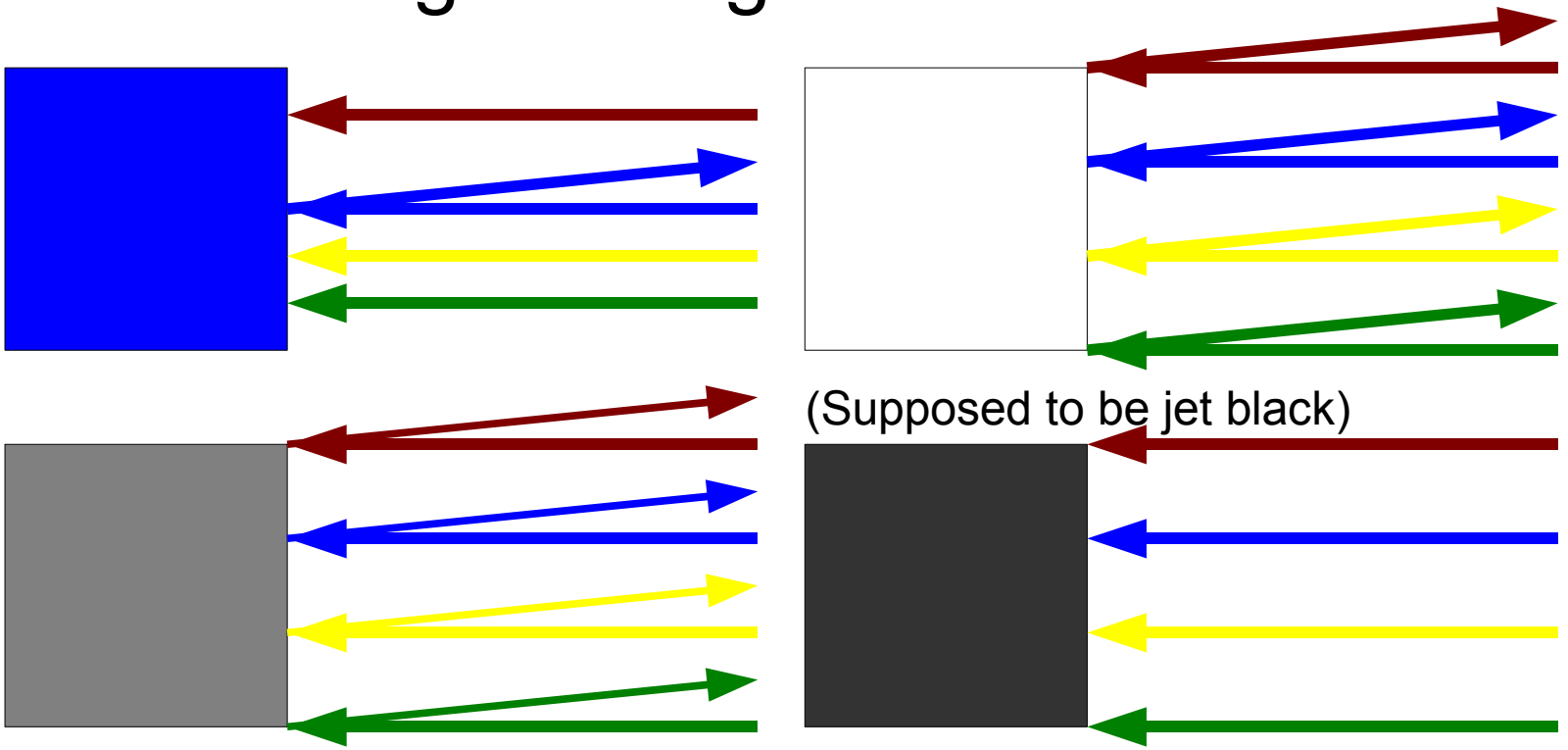
Wavelength properties:

- Hue (cont.):
  - Generally, in normal light all visible wavelengths of light are generated at a light source (the sun, a light bulb, whatever).
  - Those wavelengths that are reflected back determine the object color.

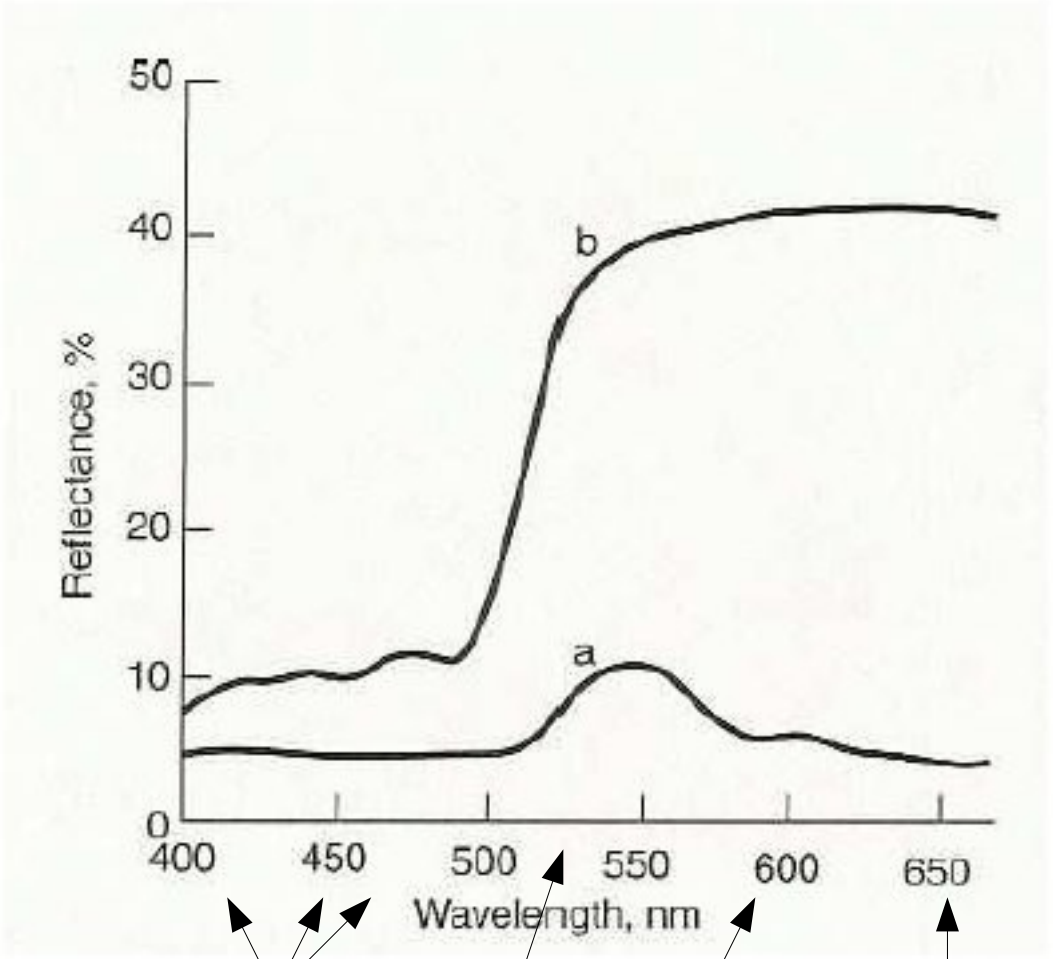


Wavelength properties:

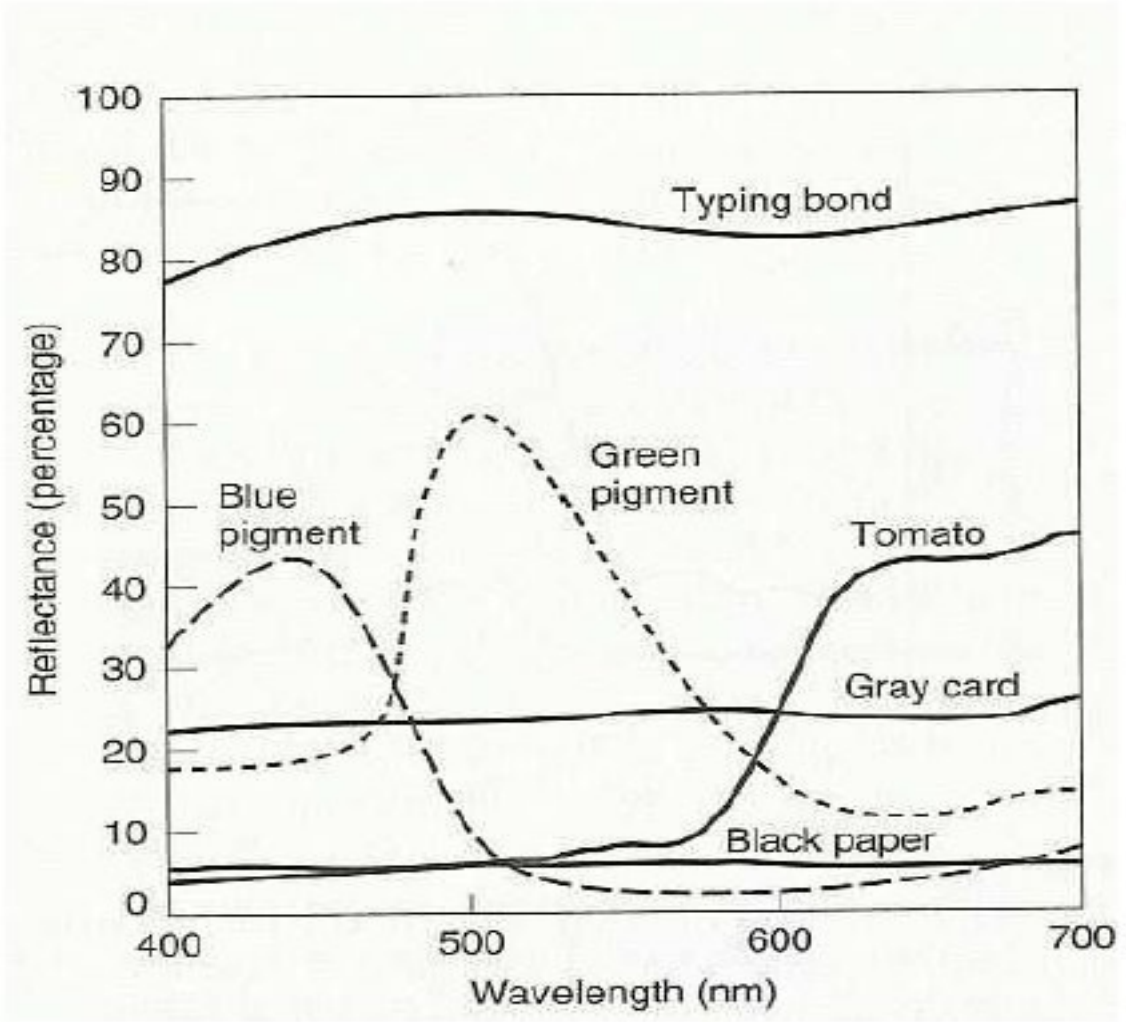
- Hue (cont.):
  - Some colors are monochromatic (one color), and others are achromatic (black, white, gray), which contain approximately equal portions of all wavelengths of light.



- Hue (cont.):
  - Here, a graph depicts the proportion of wavelengths reflected back from a leaf in spring (a) and the same leaf in fall (b)

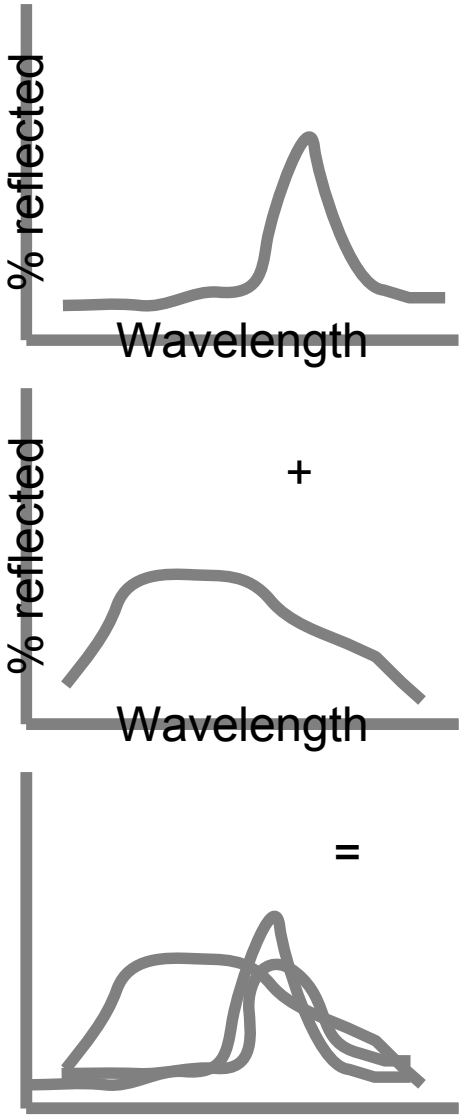


- Hue (cont.):
  - Here, a graph depicts the reflectance patterns of various other materials:

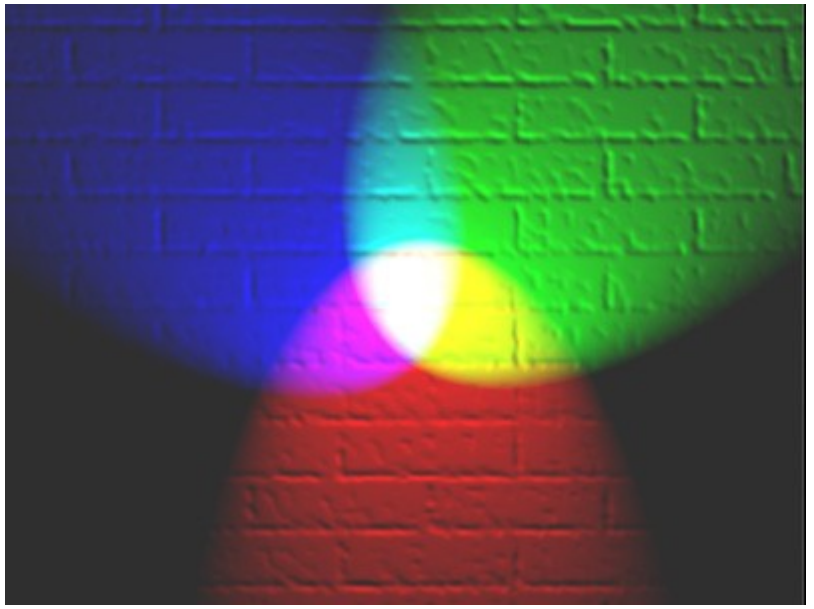


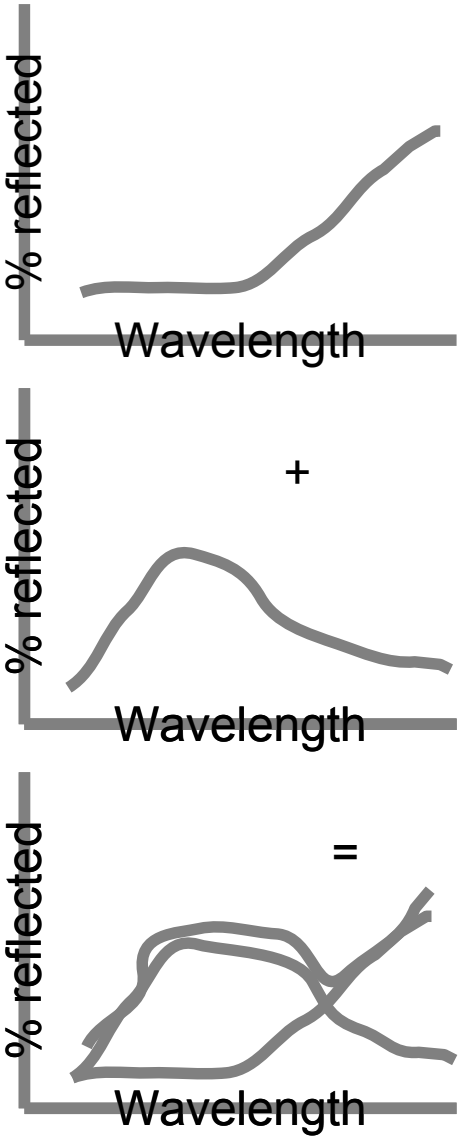
Blues Greens Yellows Reds

- Color mixing: additive vs. subtractive
  - Subtractive color mixing: “yellow and blue make (a somewhat darker) green.”

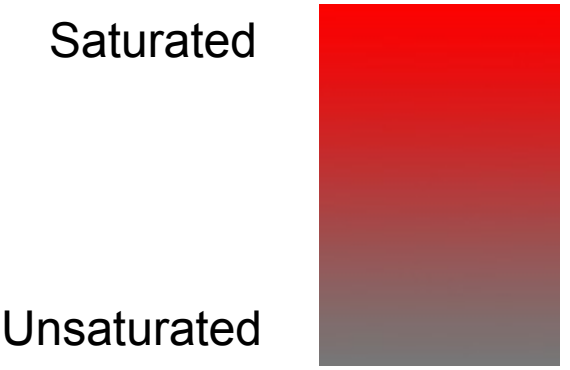


- Color mixing: additive vs. subtractive
  - Additive color mixing: “yellow and blue make . . . white. Anyway, red and green make (a somewhat brighter) yellow.”





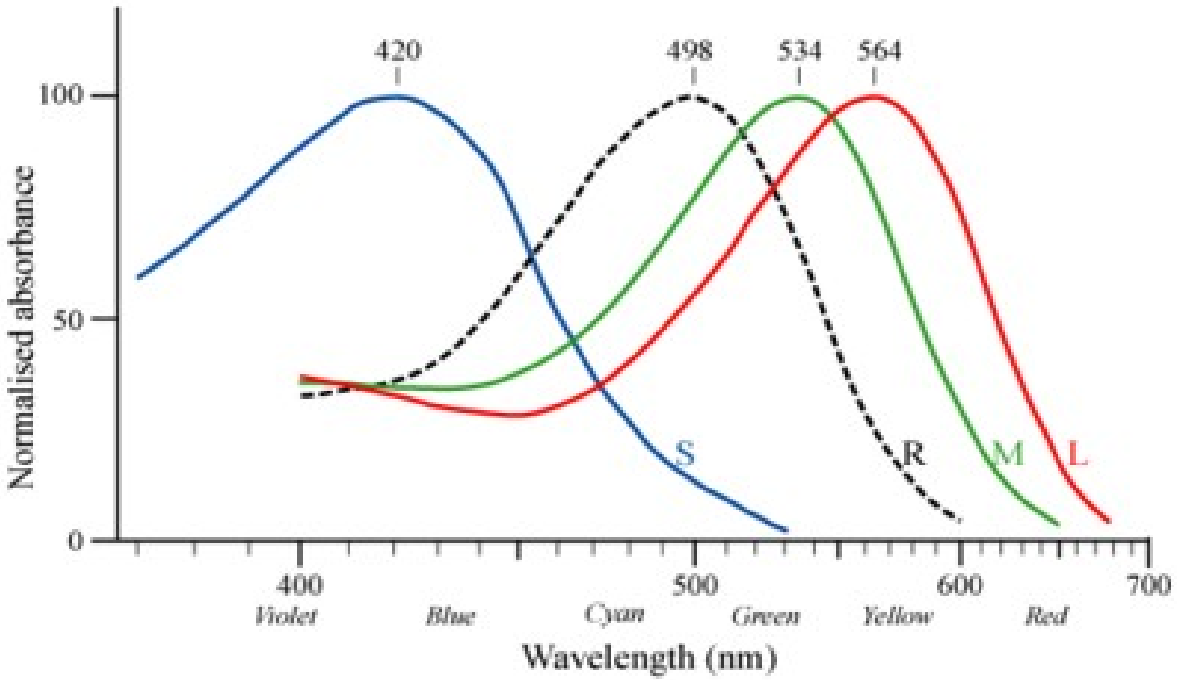
- Saturation, lightness
  - Saturation refers to the intensity of a given hue. A highly unsaturated color is very light, grey, or dark; a highly saturated color is vivid and strong.



  - Lightness refers to the overall amount of reflectance from an object; something that reflects a lot of light overall is light; something that doesn't is dark.

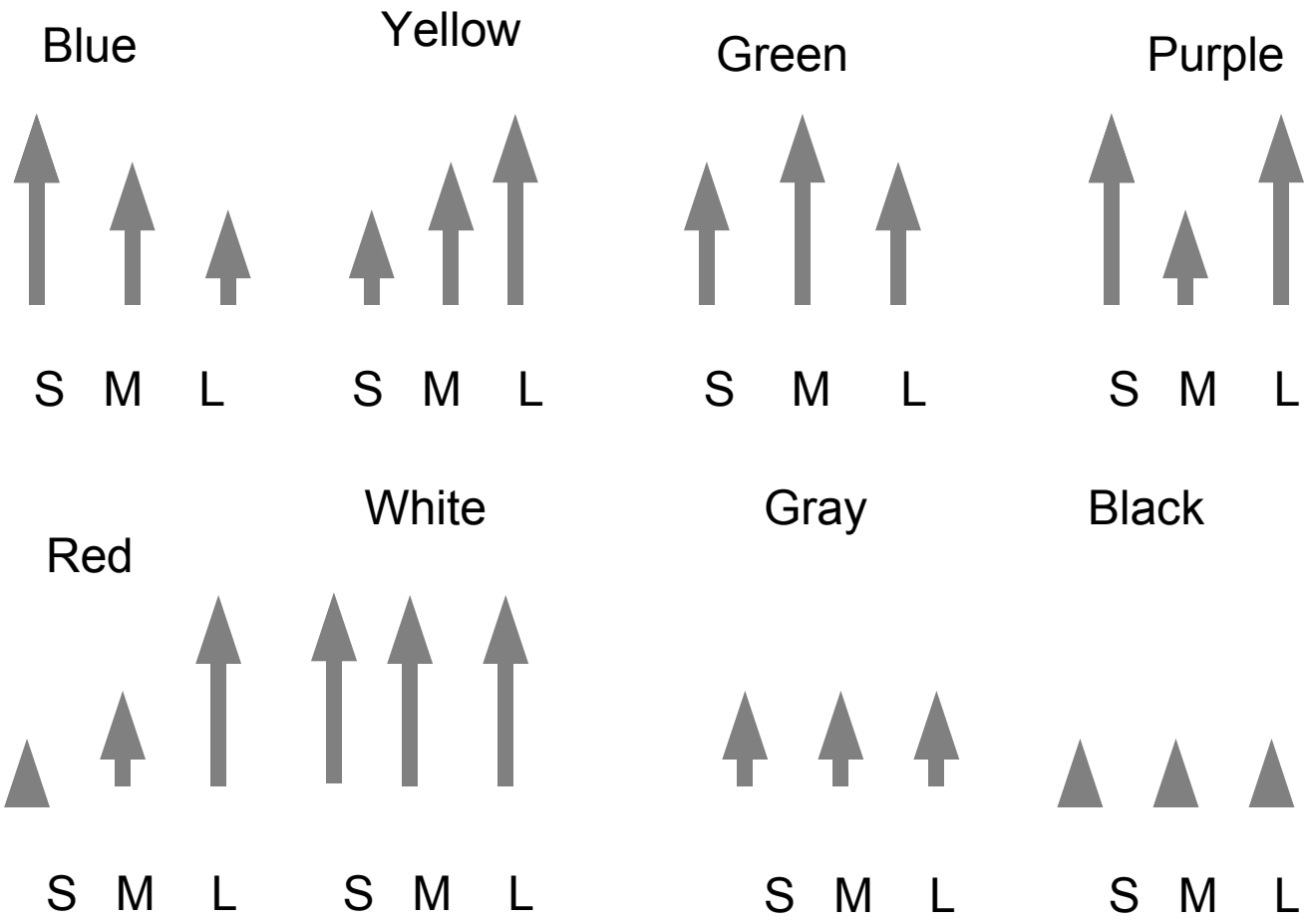
- Theories of color vision: trichromatic vs. opponent process.
  - Trichromatic: humans have three different kinds of cones; enough to produce the multitude of colors we can see.
  - S cones: absorb short wavelengths of light; blue, violet.
  - M cones: absorb medium wavelengths of light; green, yellow.
  - L cones: absorb long wavelengths of light; yellow, orange, red.

•Theories of color vision: trichromatic vs. opponent process.



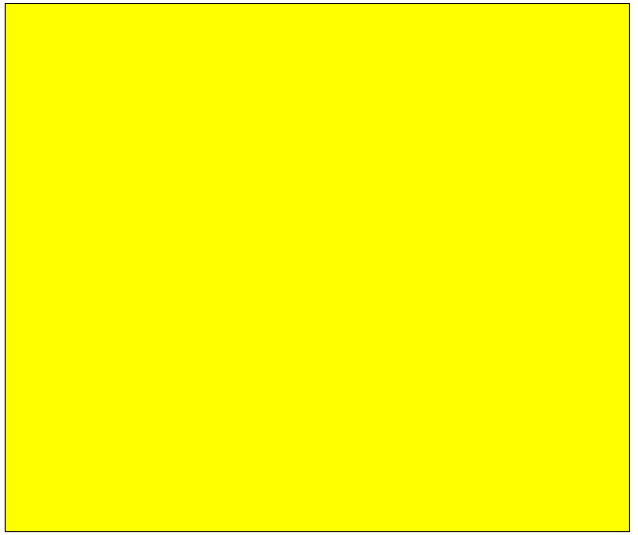
•A single wavelength of light will activate all three types of cones in different amounts

- Theories of color vision: trichromatic vs. opponent process.
  - Color sensations are produced by proportional contributions of the three cone types.

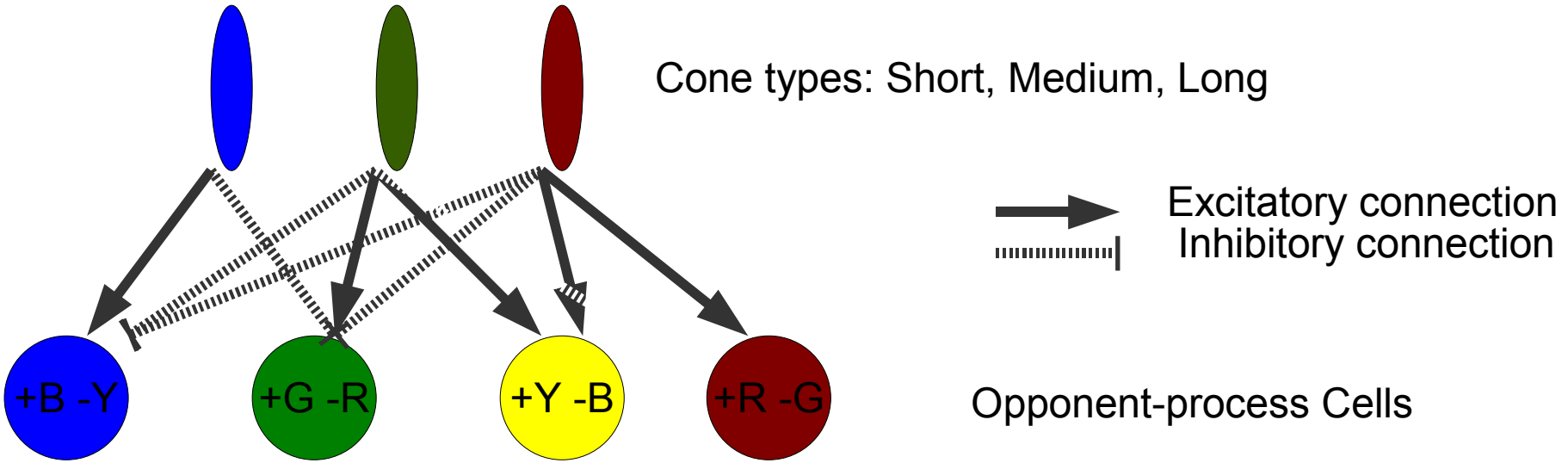


- Theories of color vision: trichromatic vs. opponent process.
  - Color blindness: most often occurs when one type of cone is not working.
    - Protanopia: No l-cone cells
    - Deuteranopia: no M-cone cells
    - Tritanopia (very rare): No S-cone cells.
  - With most kinds of color blindness (all of the above), you can still perceive some color. With monochromacy, a lack of 2 kinds of cone receptors (or all 3), you can't see any color.

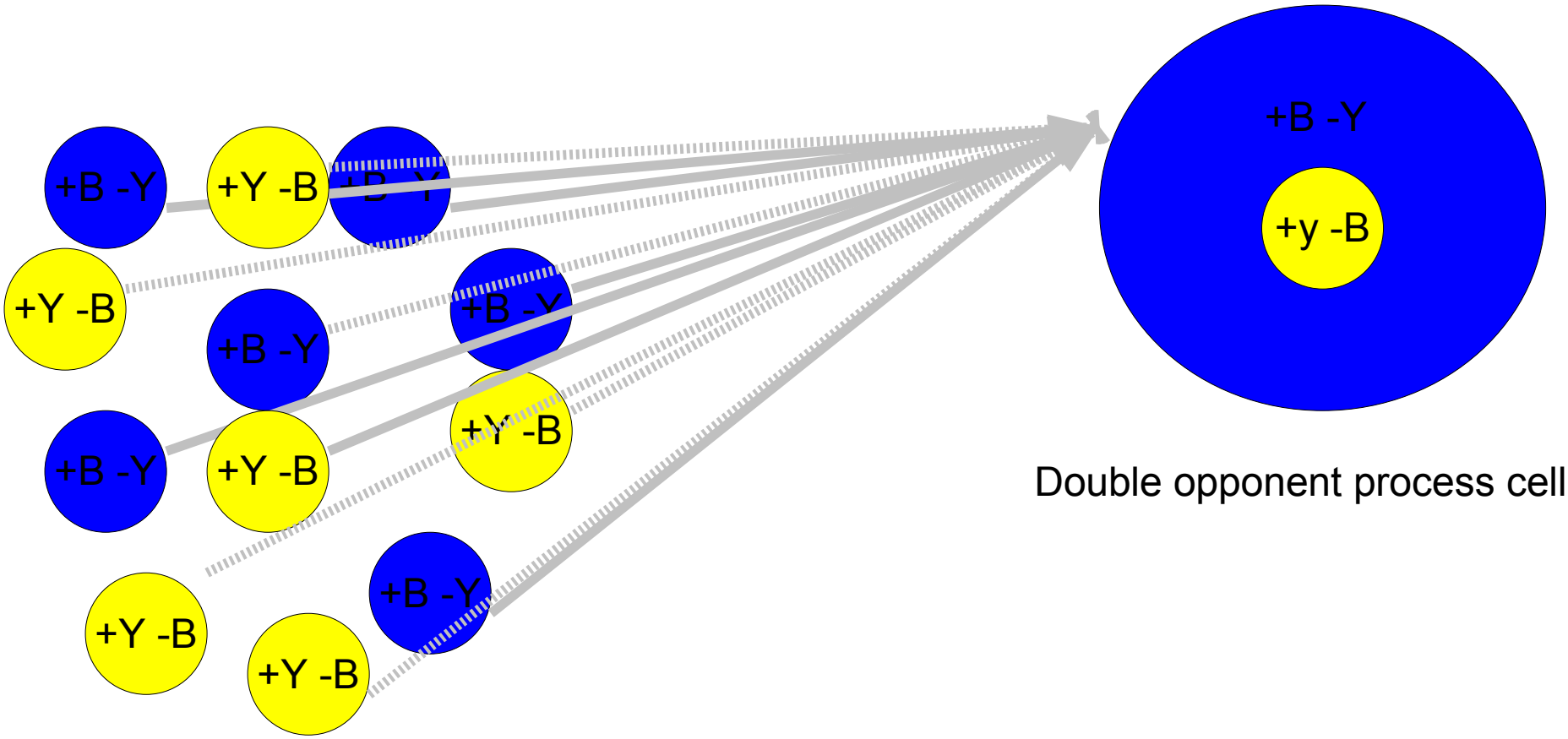
- Theories of color vision: trichromatic vs. opponent process.
  - Opponent process theory: some colors activate some cells and inhibit others.
  - If you stare at a yellow patch of color for a long period of time, then blink and look at a blank wall, you may see its opponent color, blue



- Theories of color vision: trichromatic vs. opponent process.
  - 3 types of opponent process cells:
    - Red-Green: increase when red present, decrease when green present (or vice-versa)
    - Yellow-Blue: increase with yellow, decrease with blue (or vice-versa)
    - Black-white: same for light intensity, not color



- Theories of color vision: trichromatic vs. opponent process.
  - Double opponent-process cells (similar to ganglion cells)

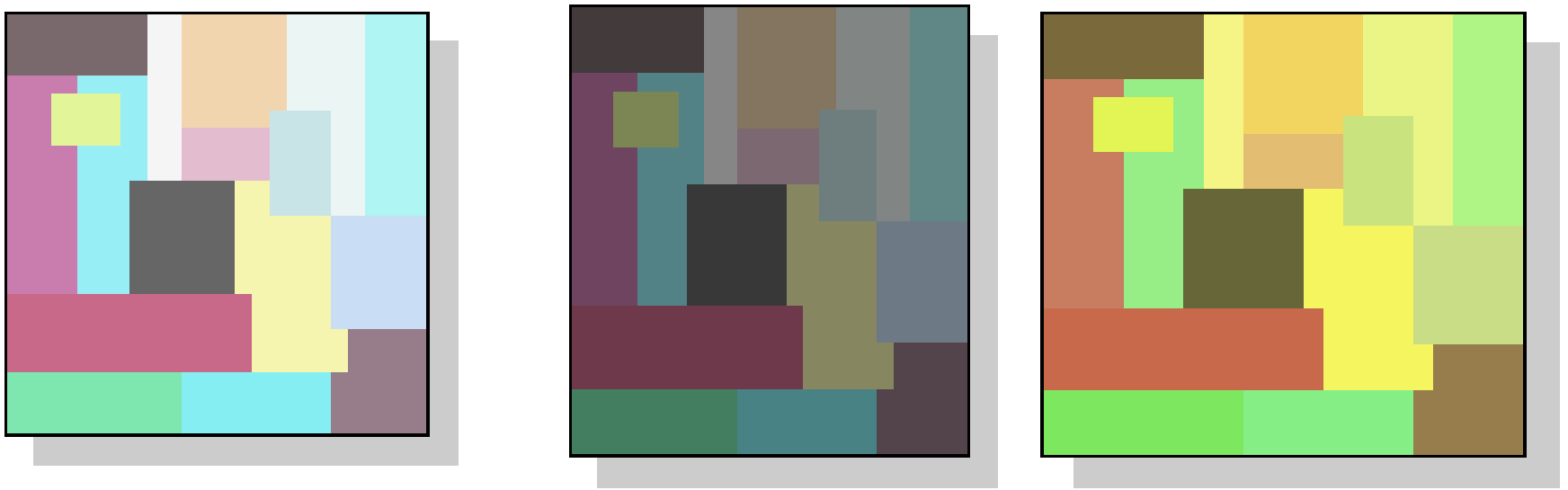


- Color constancy: when the wavelength of the illumination source changes (thus changing the color of the light reflected back to our eyes), we still tend to perceive the same colors.

James quote “The grass out of the window now looks to me of the same green in the sun as in the shade, and yet a painter would have to paint one part of it a dark brown, another part bright yellow to give its real sensational effect.”

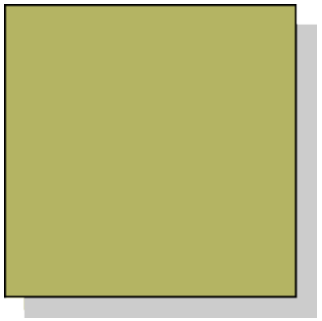
Color constancy isn't perfect. Ever bought something at the store to find that it looks different at home (under different light)?

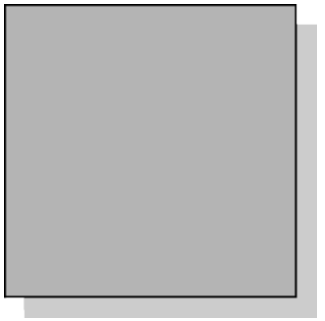
•Color constancy(cont.): Land's Mondrian experiment



By illuminating the color patches with different wavelengths, we can change the light coming back to the eye from any one patch – it only works when you can compare a color to other, nearby colors

- Color constancy(cont.): Land's Mondrian experiment





Is the above a yellow surface that is subsequently illuminated by mostly blue and red light, or a gray surface that was originally lit by yellow light?

List of terms, section 9

Hue

Monochromatic

Achromatic

Reflectance pattern

Additive color mixing

Subtractive color mixing

Saturation

Lightness

Trichromatic theory of color

S, m, l cones

Protanopia, deuteranopia, tritanopia

Monochromacy

Opponent-process theory

Double opponent-process cells

Color constancy

Land's mondrian experiment