Color Vision

steven j. barnes

- Explain the trichromatic theory of color vision
- Explain the opponent color theory of color vision
- Explain color constancy and its important implications
- Summarize the gist of the retinex theory of color vision and explain how it relates to the phenomenon of color constancy.

Learning Goals

"Color," said Isaac Newton, "belongs to the mind and not the object."

Color Perception

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The psychological characteristics of color depend on an observer (Palmer, 1999).

Color naming is "guided by social values" such as culture as well as physiological constraints (MacLaury, 1991).

Color Perception

Color can influence our moods, emotions, and even taste perception, etc.

More importantly, our ability to see colors has practical and adaptive functions.

Color Perception

Why is it important to see colors?

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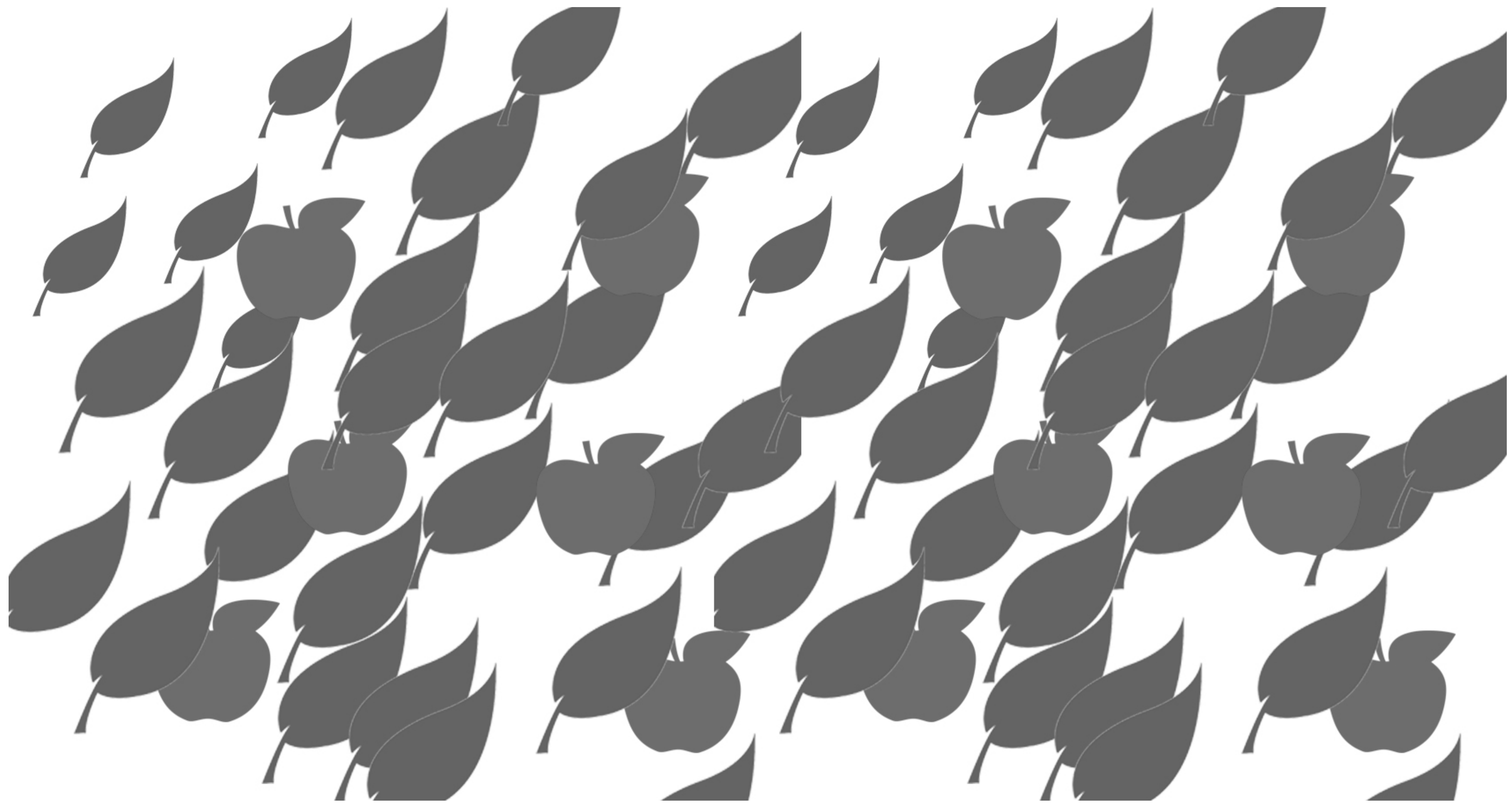
Facilitates object detection by increasing figure/ground segmentation.

Aids in object discrimination by allowing objects to be distinguished on the basis of color.

How many apples are in this picture?



Color Perception

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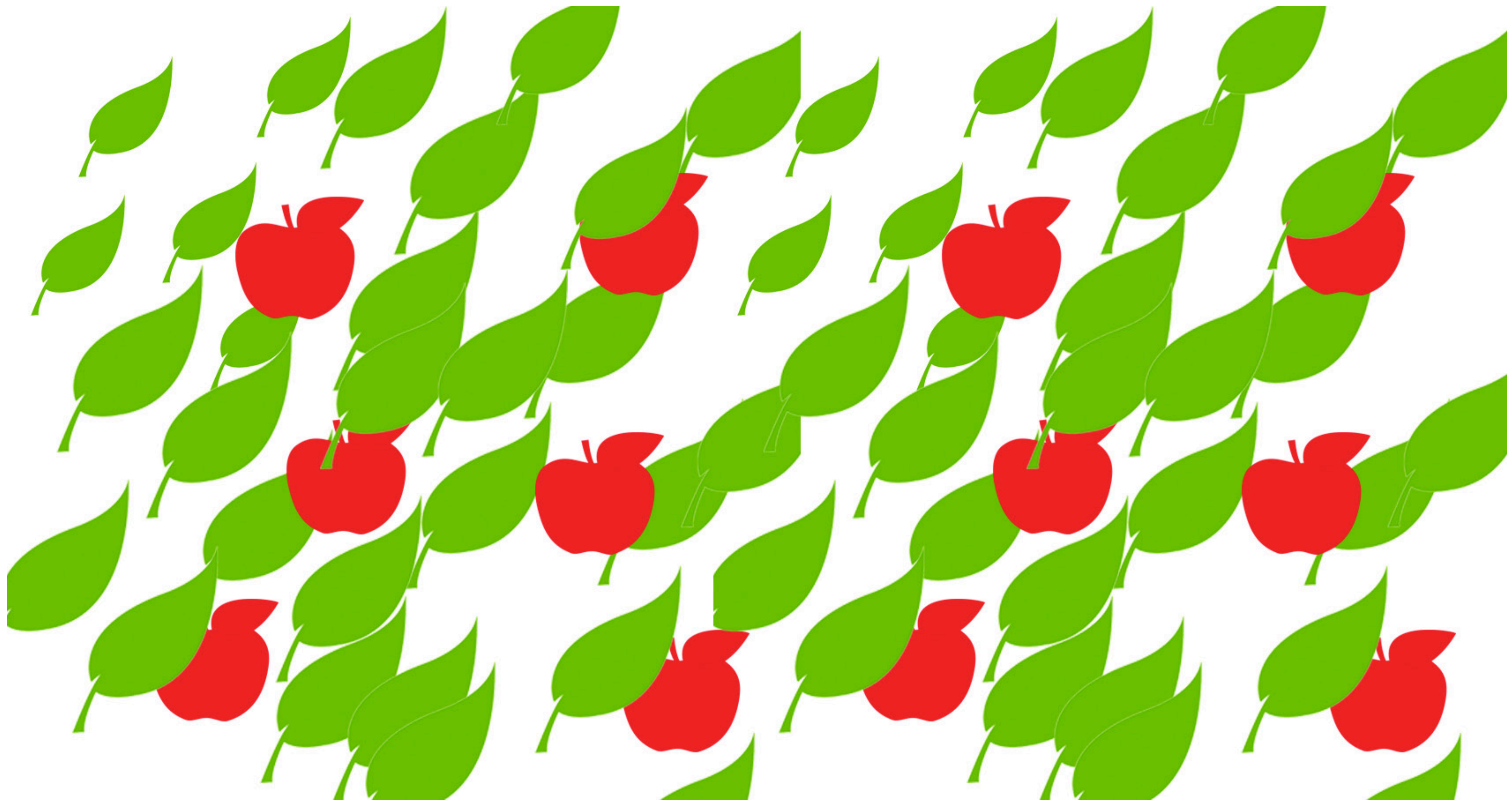
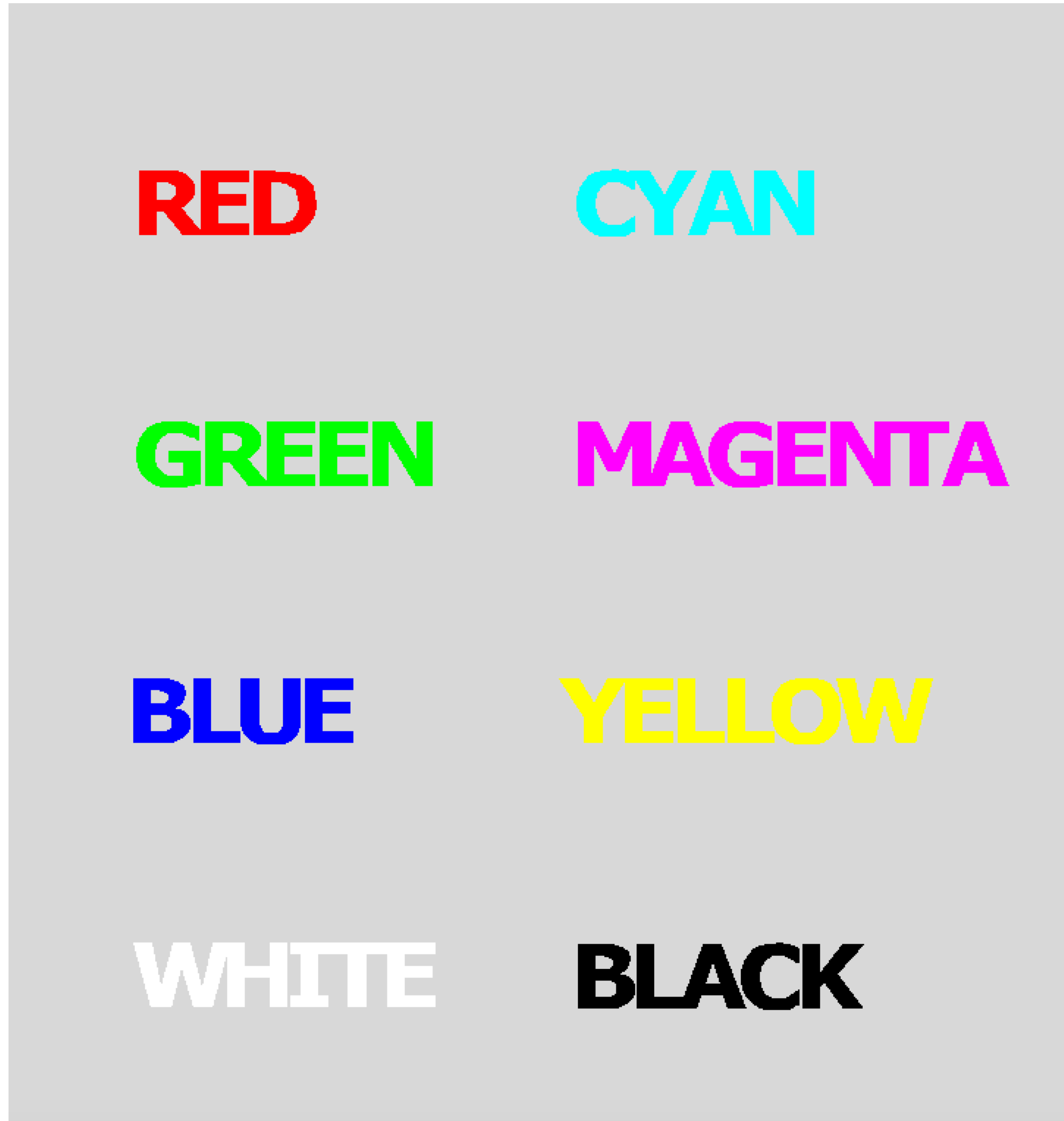


Color Perception

Read the following words out loud as fast as possible:

Name each of the following colors as fast as possible:



Color Perception

One more time:

Name each of the following colors as fast as possible:

Color Perception

Stroop Task (1935)

Color Perception

Color: Not a physical property but rather a psychophysical property.

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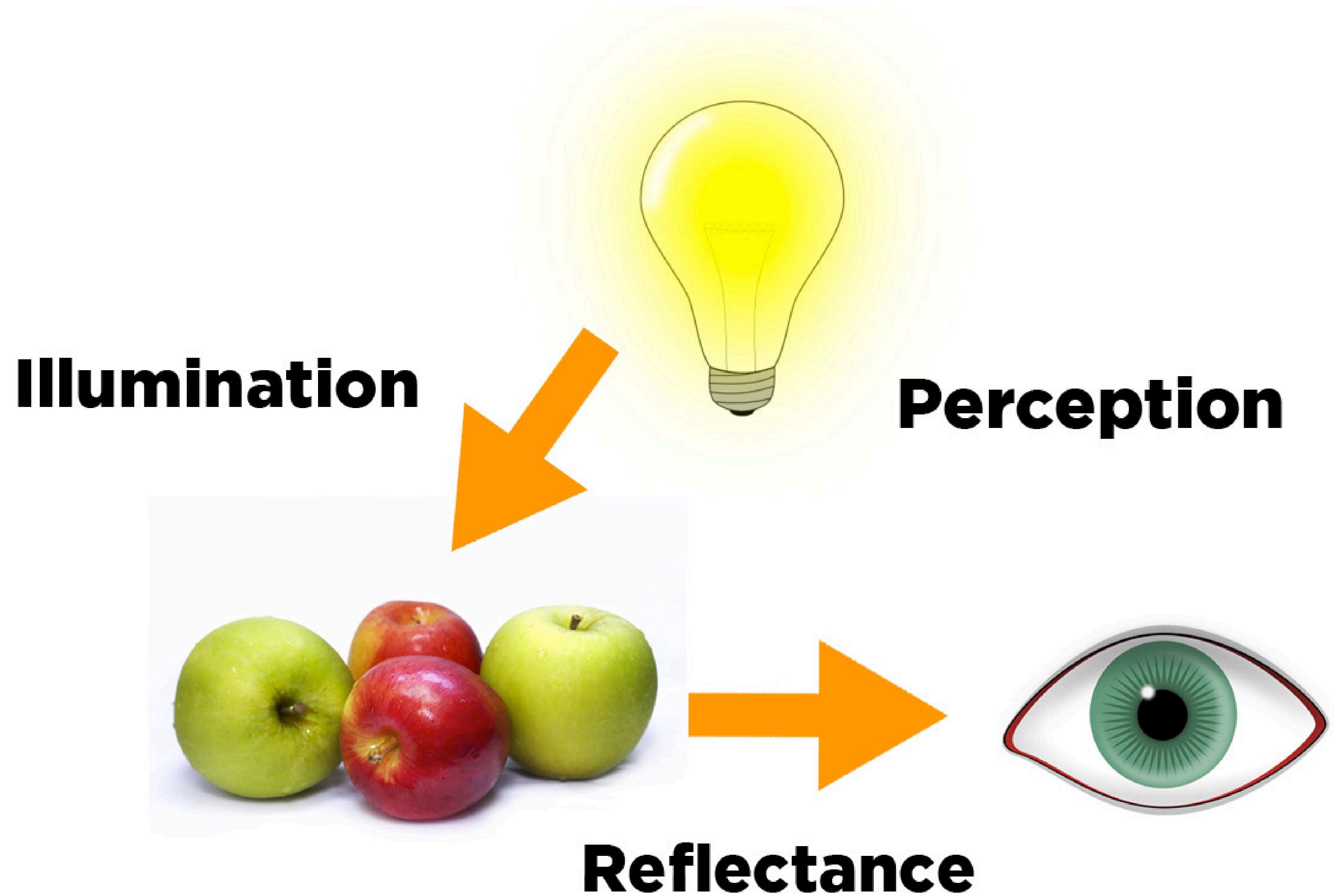

Color Perception

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Trichromacy of Human Vision

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Because the cones have different absorption spectra, any wavelength will produce three responses: A trio that is not likely to be confused with any other single wavelength.

Trichromacy of Human Vision

Trichromacy: The theory that the color of any light is defined in our visual system by the relationships between a set of three numbers, the outputs of three receptor types, now known to be the three cone types (The Young-Helmholtz theory).

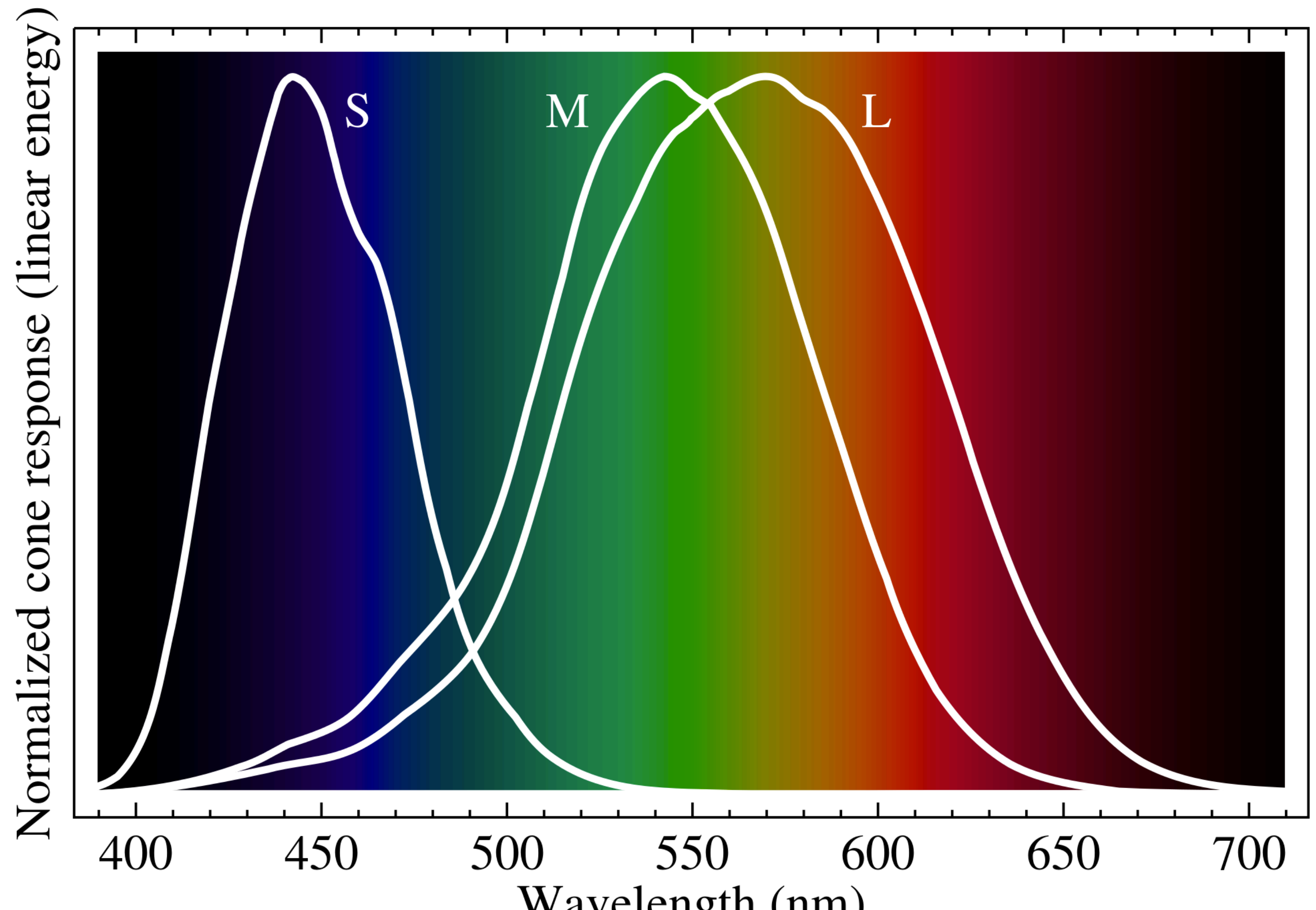
Trichromacy of Human Vision

The three cone types, named for the wavelength of their pigment sensitivity, are:

S cones = short-wavelength sensitive (~440 nm)

M cones = medium-wavelength sensitive (~535 nm)

L cones = long-wavelength sensitive (~565 nm)



Trichromacy of Human Vision

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Opponent color theory: The theory that the perception of color is based on the output of three mechanisms, each of them an opponency between two colors; red–green, blue–yellow, and black–white.

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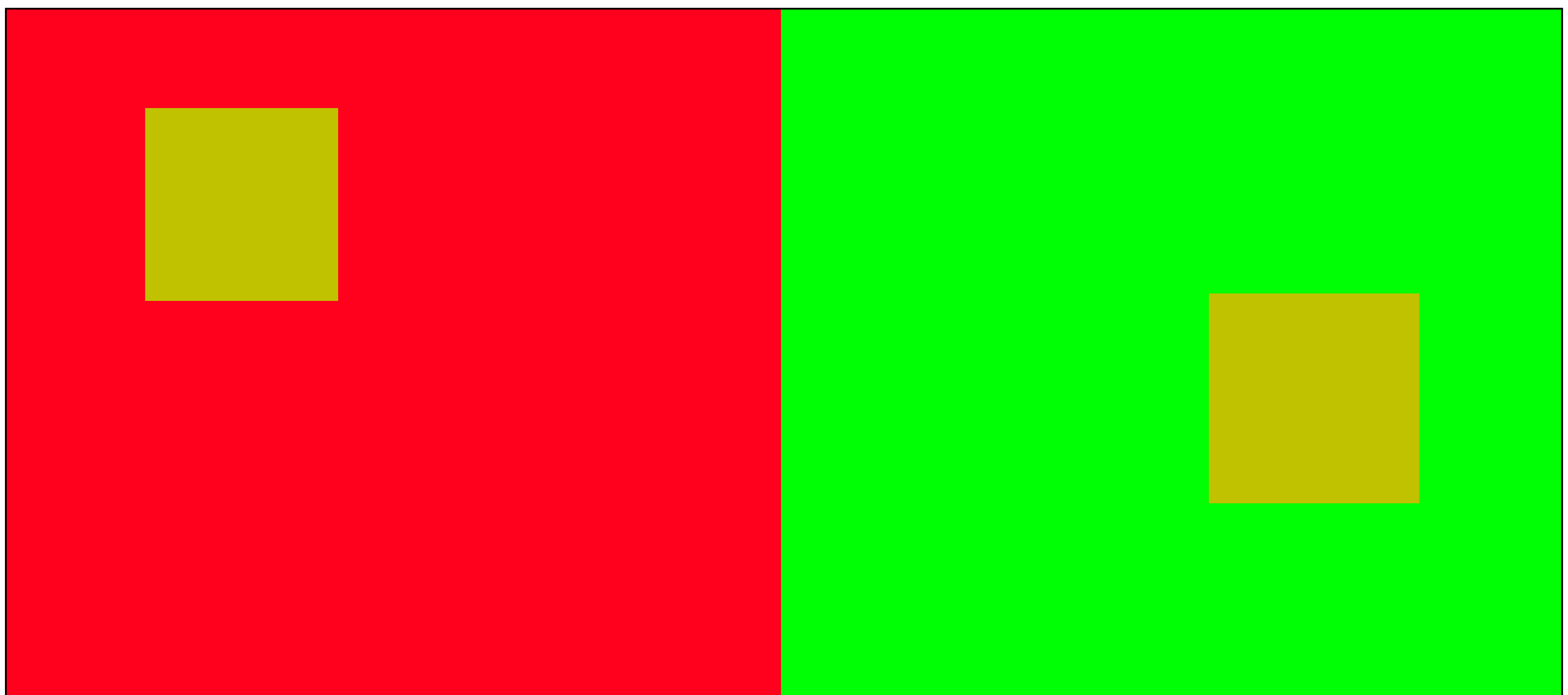

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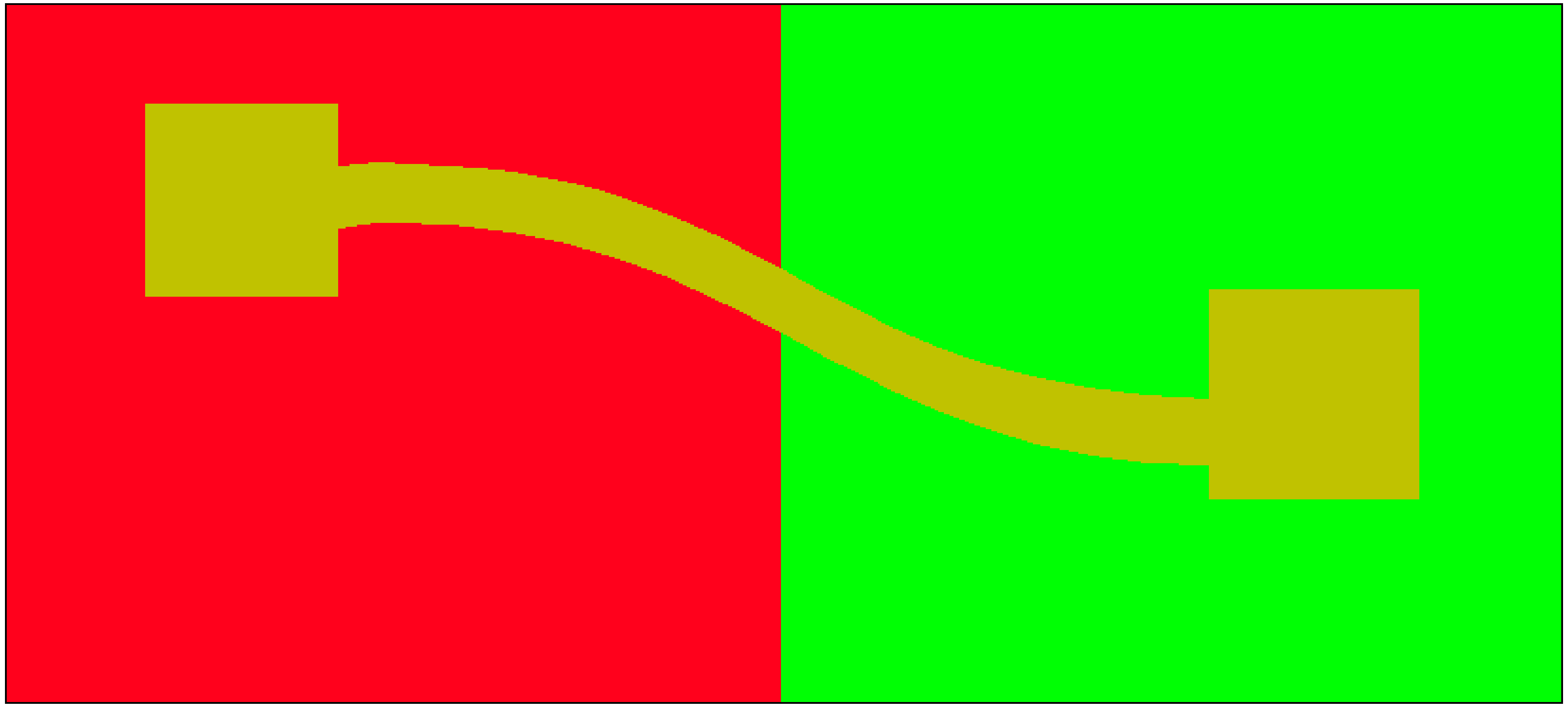

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Color contrast effects suggest the existence of antagonistic linkages in the neural machinery that processes color information.

Color Opponency

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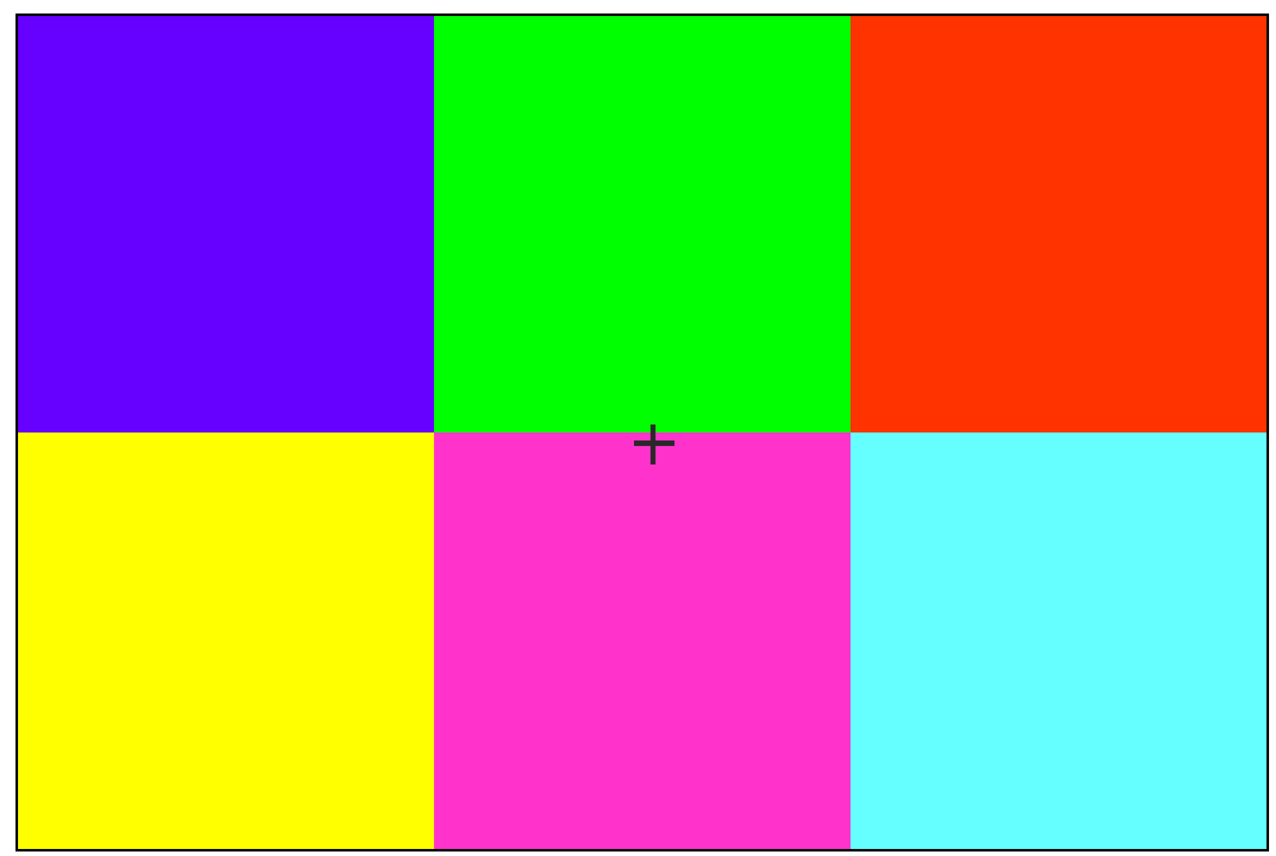

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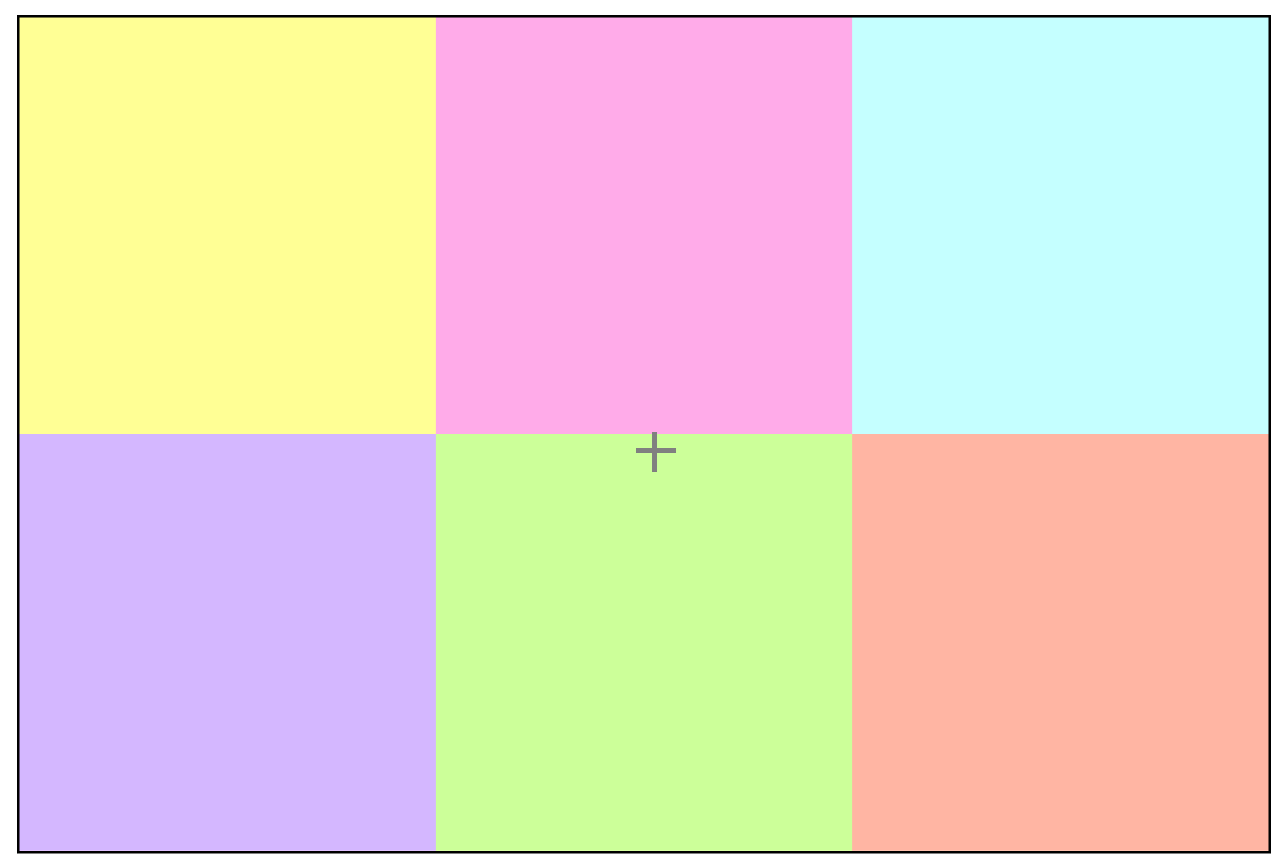
The negative afterimage



Color afterimages are one of the reasons that color opponency was originally hypothesized.

Afterimage: A visual image seen after the stimulus has been removed.

Negative afterimage: An afterimage whose polarity is the opposite of the original stimulus. Light stimuli produce dark negative afterimages. Colors are complementary: red produces green; yellow produces blue.

Opponent Processes

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The phenomenon of color constancy.

Real World Color

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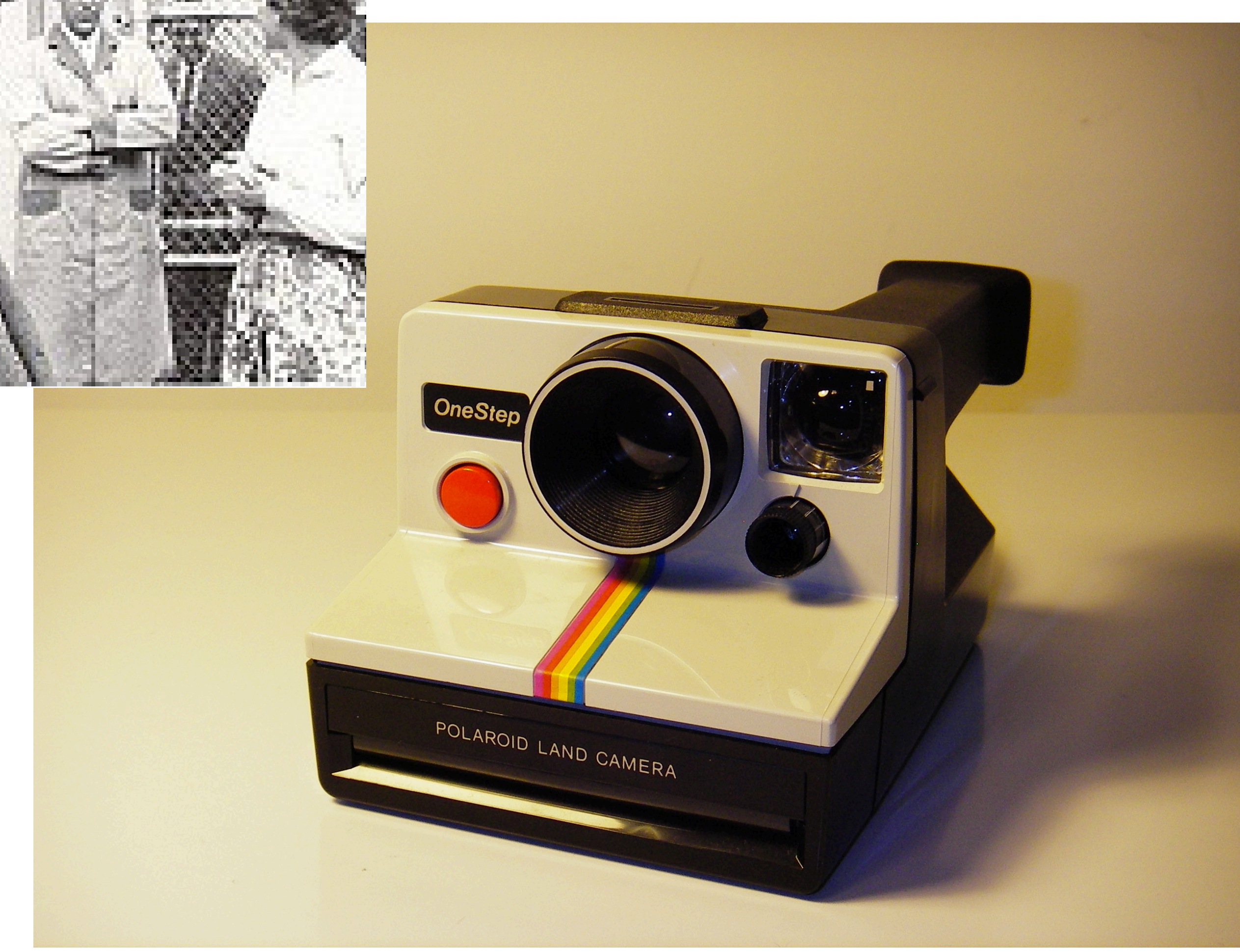
Color constancy: Tendency for an object to stay the same color despite major changes in luminosity (and therefore reflected wavelengths).

Real World Color

Edwin Land's "Mondrian" experiments

Squares of color with identical radiated wavelengths can yield very different color perceptions.



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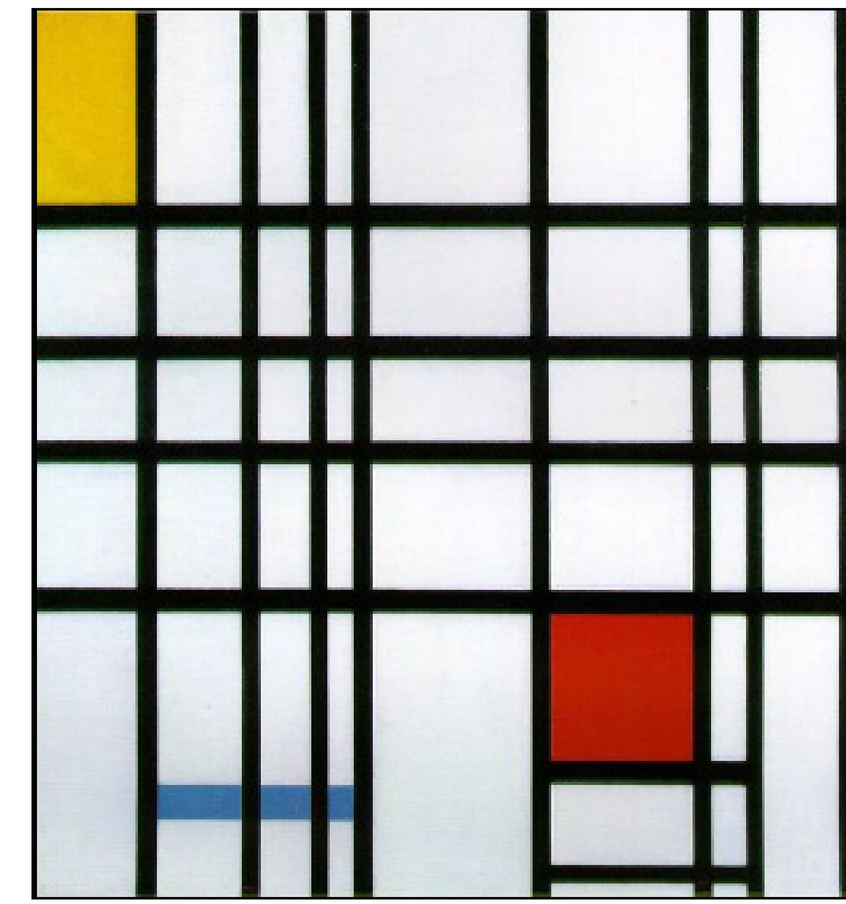
Named after the paintings of Piet Mondrian.



Composition with Yellow, Blue, and Red (Piet Mondrian, 1921).

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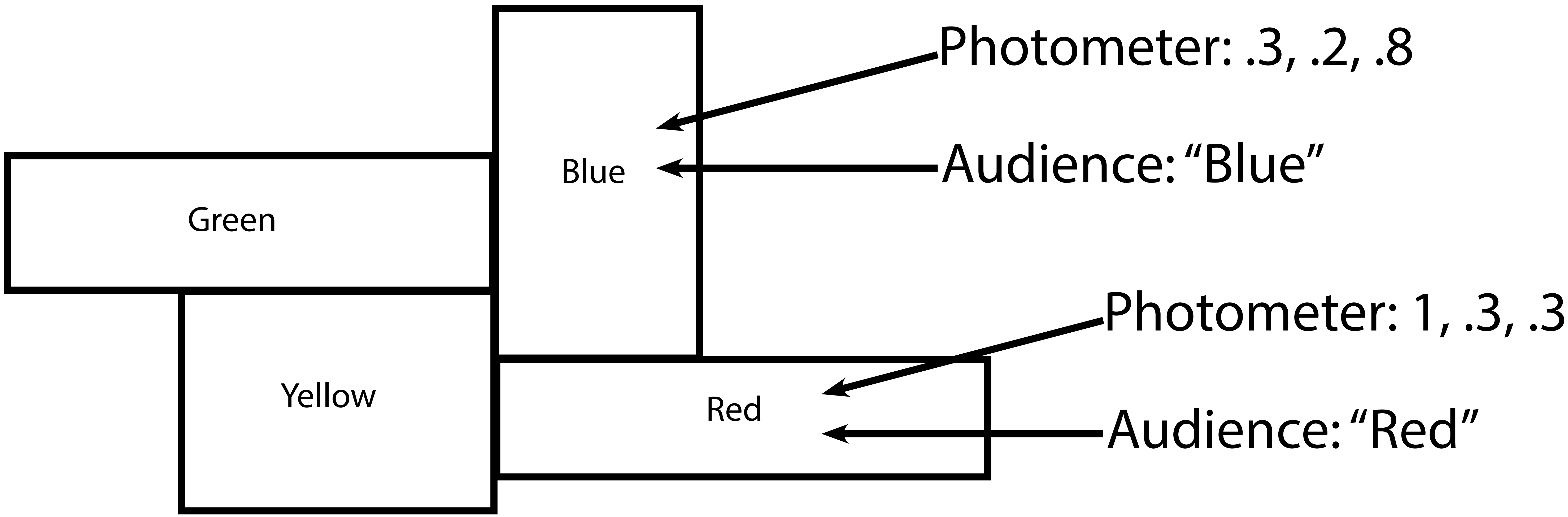

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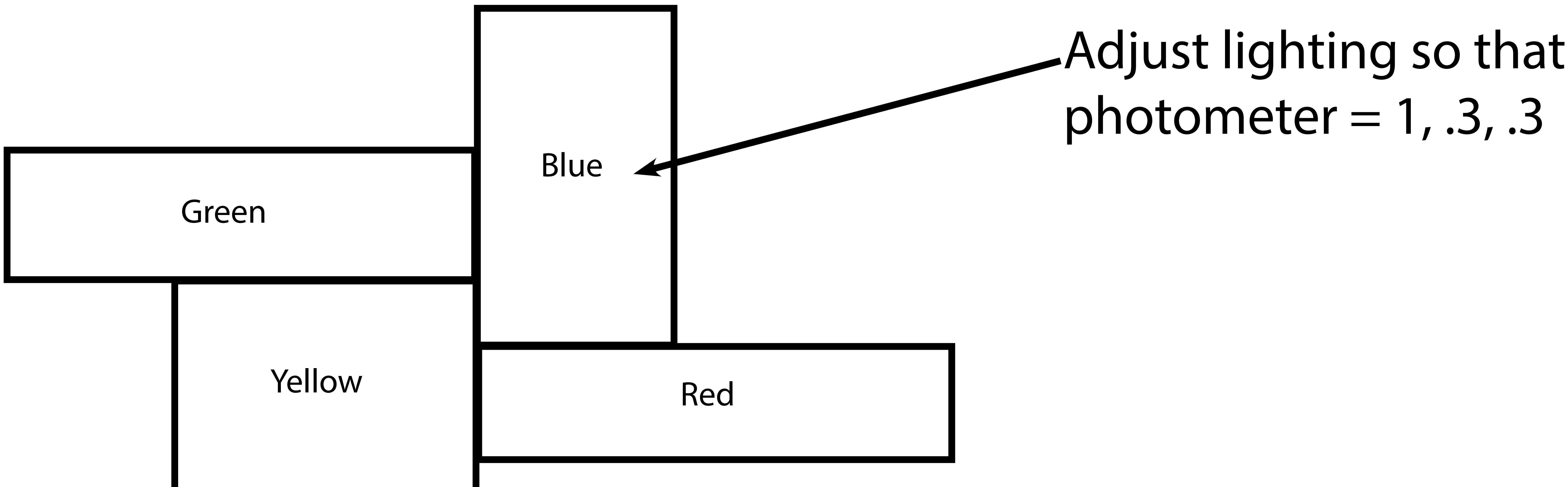

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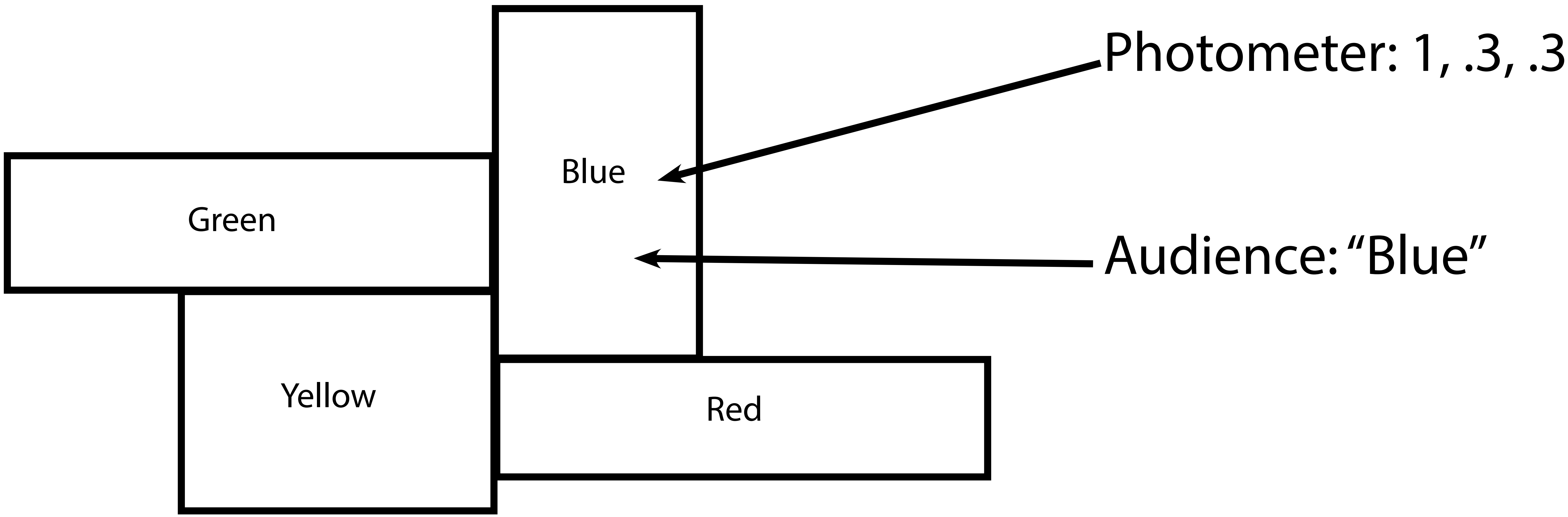

Edwin Land's "Mondrian" experiments

The results of Land's work were summarized in his "retinex" (retina + cortex) theory of color vision: The color of an object is determined by the reflectance of the whole surface of that object as well as its surroundings.