Colour Perception - II
What did you see?

"29"
Those with normal color vision see a 29.

"70"
Those with red green color blindness see a 70.

Nothing
Those with total color blindness see nothing.

http://www.colour-blindness.com/colour-blindness-tests/ishihara-colour-test-plates/
What did you see?

“15”
Those with normal color vision see a 15.

“17”
Those with red green color blindness see a 17.

Nothing
Those with total color blindness see nothing.
What did you see?

“45”

Those with normal color vision see a 45.

Nothing

The majority of color blind people cannot see this number clearly.
What did you see?

Nothing

People with normal vision or total color blindness should not be able to see any number.

"45"

Those with red green color blindness should see a 45
Those with normal color vision should see a 42.

Red color blind (protanopia) people will see a 2, mild red color blind people (protanomaly) will also faintly see a number 4.

Green color blind (deuteranopia) people will see a 4, mild green color blind people (deuteranomaly) may also faintly see a number 2.
trichromat: 3 cones
conal map of eye
Representation of the retina

Blue area: where most cones located

Red area: where most rods located

Black area: where optic nerve exits the retina
Various types of “colour blindness” /alternate colour vision:

- 3 types of cones present, but 1 type of cone is anomalous
  *anomalous trichromats*

- 1 type of cone completely absent
  *dichromats*

- Other instances where only 1 type of cone present, or all types of cones absent, are extremely rare
NORMAL CONE SENSITIVITY CURVES (TRICHRATOM)
Protan Dichromat
(no red cones; only green and blue)
Deutan Dichromat
(no green cones; only red and blue)
Tritan Dichromat: no S-cones (tritanope)
On the left side is what a “normal” trichromat would see; on the right is what a tritanope could see.
Besides rods and cones, there is one other type of light receptor in the eye:

certain ganglion cells contain the photopigment **melanopsin**

present in approximately 2000 cells

peak sensitivity at 480nm

regulates circadian rhythm, pupil dilation, melatonin production → directly connected to nervous system
Section of a mouse retina showing the cones of the outer layer (green), and a large melanopsin-expressing ganglion cell (red) in the inner layer.

http://www2.cnrs.fr/en/1637.htm
people who are blind, without functioning rod & cone cells, have functioning melanopsin networks

recently found that information from melanopsin network feeds into visual information network of rods & cones

may be possible to restore sight (to some degree) in blind people, using melanopsin network

current research into dynamic lighting systems: lighting that changes spectral distribution throughout day → activating melanopsin network appropriately throughout day
Adaptive processes

- bleaching
- colour constancy
- afterimage
- simultaneous contrast
**Colour constancy:** ability to discern colour, independent of illumination conditions (A and B have the same grey value!)
Afterimage:
stare at black dot on left for 30-60 seconds
stare at back dot on right
Simultaneous contrast
Metamerism: “Does it match the standard under all illuminants?”

Dyes used:

Illuminants:

M. Hubbe
Metamers

different spectra

same perceived colour

by Jeff Beall, Adam Doppelt and John F. Hughes
(c) 1995 Brown University and the NSF Graphics and Visualization Center
spectral profile A

trichromatic color matching

primary mixture A

colorimetric match

primary mixture B

spectral profile B
Colour Organizing Systems
Newton: wrapped spectrum to make colour wheel
7 primaries: ROYGBIV
(late 1600’s)
M.E. Chevreul: published Law of Simultaneous Contrast 1839
Chevreul’s Colour Hemisphere
Maxwell constructed a colour triangle to organize colour
spinning disks: generate optical (additive) colour mixtures
every perceived colour can be represented by
fraction of red $r$ + fraction of blue $b$ + fraction of green $g$
Helmholtz (1860) published *Manual of Psychological Optics* 1856
Modern Chromatics

Ogden Rood
published
Modern Chromatics
1879
Rood’s modified colour wheel
A Sunday Afternoon on the Island of La Grande Jatte  
Georges Seurat
development of pointillism

example of partitive mixture

small dots of colour next to each other blend in the eye

additive process
The CIE (Commission Internationale de l'Eclairage) attempted to define an international standard of color measurement in 1931.
CIE chromaticity diagram
Munsell Colour Tree

c. 1905
hue

value

chroma or saturation

3 dimensions of colour