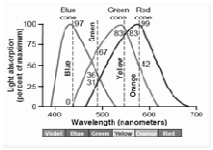
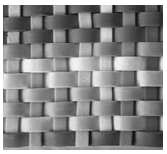
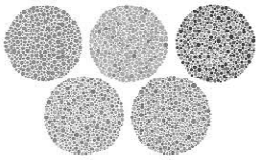
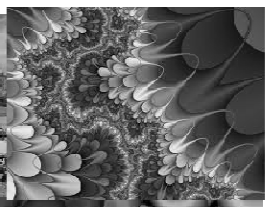
LECTURE 4

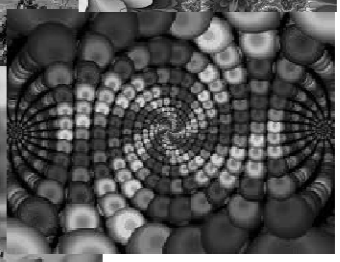
PHYSIOLOGY OF COLOR VISION











Color Vision Concepts

- Colors have three attributes hue, intensity, and saturation (degree of freedom from dilution with white).
- For any color there is a complementary color that, when properly mixed with it, produces a sensation of white
- Black is the sensation produced by the absence of light, but it is probably a positive sensation because the blind eye does not "see black;" rather, it "sees nothing."

Color Vision
3 primary colors

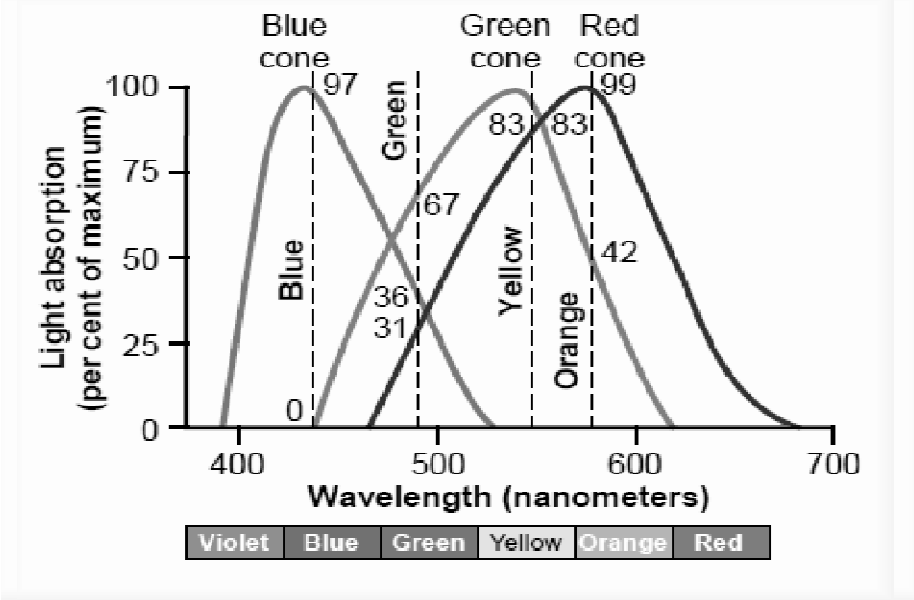
Tricolor Mechanism of Color Detection: When red, green, and blue monochromatic lights are appropriately mixed in different combinations

❖Each cone system respond to its color at a different threshold than needed to sense other colors (red cones respond to red or yellow color at a lower threshold than to green color)

❖Perception of white is due to equal stimulation of blue & red & green cones. There is no wave length corresponds to white, white is a combination of all wave lengths

COLOR VISION THEORY (YOUNG–HELMHOLTZ THEORY)

- **There are 3 kinds of cone photopigments & are sensitive to one of the 3 primary colors**
- **Blue cone system: Conatins S pigment (blue sensation pigment) which respond to short wave length (440nm senses the blue color)**
- **Green cone system: Contains M pigment (green sensation pigment) which respond to middle wave length (535nm senses the green color & less to yellow) & absorb light at the green portion.**
- **Red cone system: Contains L pigment (red sensation pigment) which respond to large wave length at or > 535 nm so senses the red & yellow color & absorb light at the red portion.**

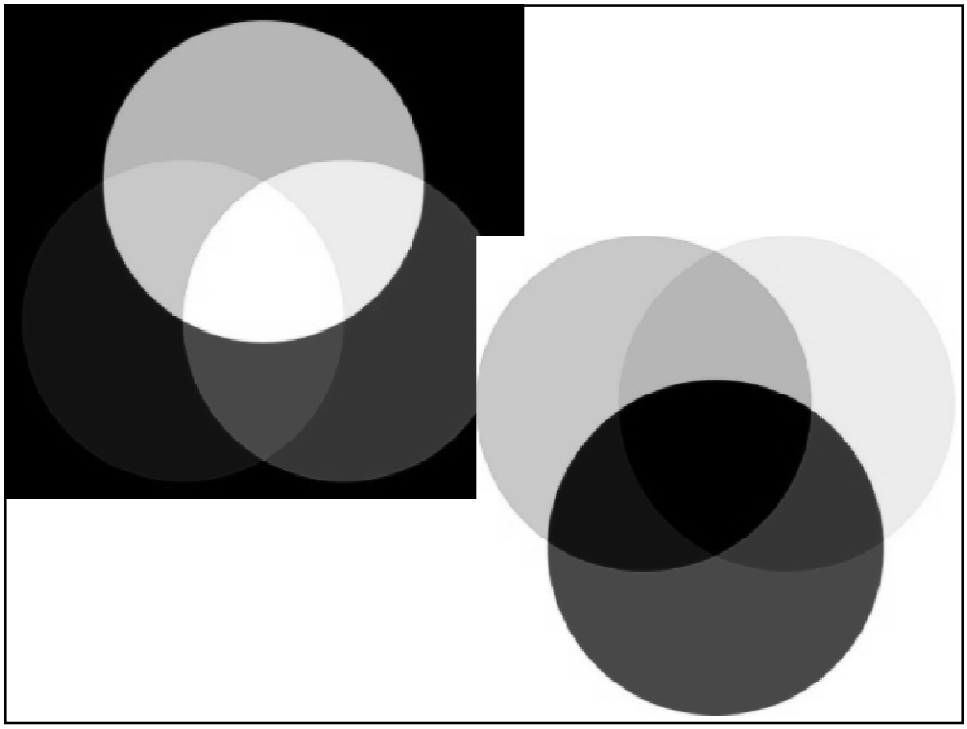


Light absorption by the pigment of the rods and by the pigments of three color-receptive cones of human retina.

Perception of colors

Depends on wave length, amount of light absorbed, threshold of stimulus & frequency of impulses from cones

- **perception of orange is due to stimulation of 99% of red cones & 42% of green cones & 0% of blue cones(so ratio is 99:42: 0)**
- **perception of yellow is due to stimulation of50% of red cones & 50% of green cones & 0% of blue cones(so ratio is 50:50: 0)**
- **perception of blue is due to stimulation of 0% of red cones & 0% of green cones & 97% of blue cones(so ratio is 0:0: 97)**

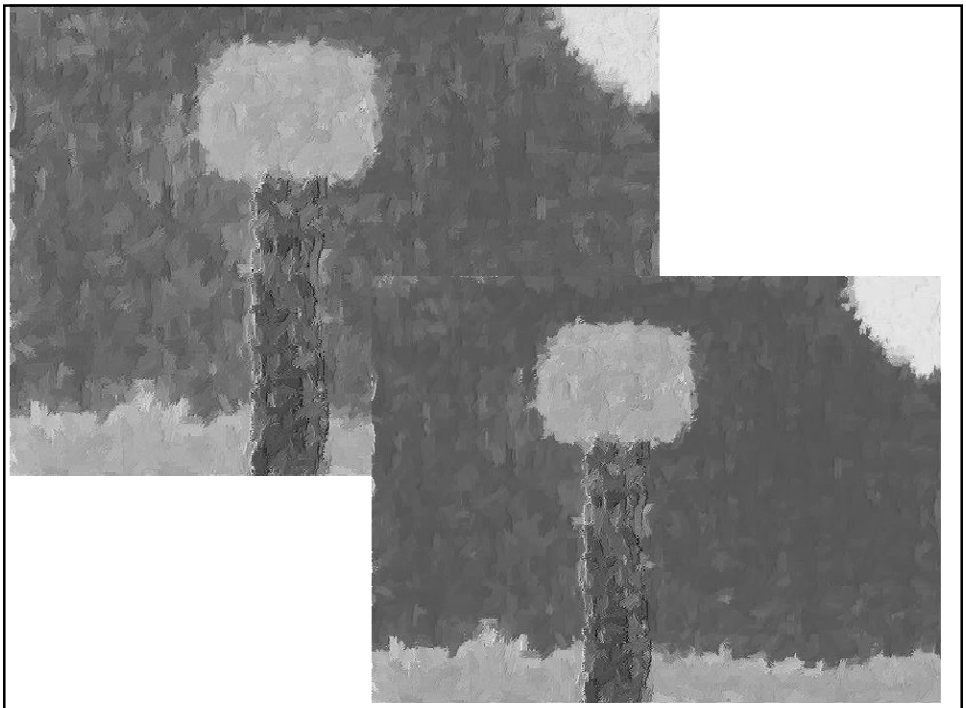


NEURAL MECHANISMS OF COLOR VISION

Color is mediated by ganglion cells that subtract or add input from one type of cone to input from another type

3 TYPES OF NEURAL PATHWAYS PROJECT TO BLOBS IN V1 and layer 4:

- **red– green pathway that signals differences between L and M-cone Responses**
- **blue–yellow pathway that signals differences between S-cone and the sum of L- and M-cone responses**
- **luminance pathway that signals the sum of L- and M-cone**



COLOR BLINDNESS

- **Gene for rhodopsin is on chromosome 3**
- **Gene for blue sensitive S cone pigment is on chromosome 7**
- **Gene for red & green sensitive cone pigment is on X chromosome.**
- **when a single group of color receptive cones is absent (due to absence of there gene) the person can not see or distinguish some colors from others**

COLOR BLINDNESS

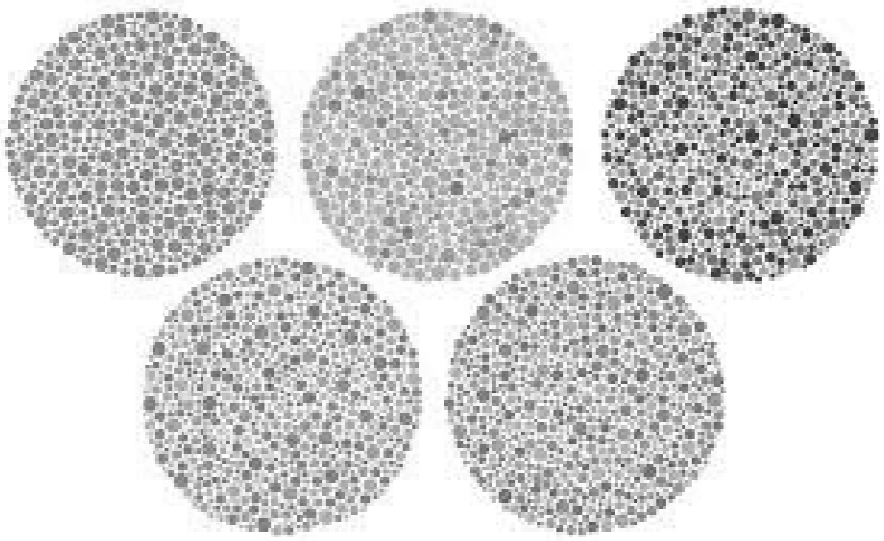
- **Red-green blindness:-**
- **Green & red cones see different colors between wave length 525-675 nm & distinguish them.**
- **If either of these cones are absent, the person can not distinguish 4 colors (red –green-yellow-orange) & he can not distinguish red from green (primary colors)**
- **It is x-linked disease (the gene is on x chromosome). Females from color blind fathers are carriers and transmit the disease to ½ of their sons.**

Color blindness

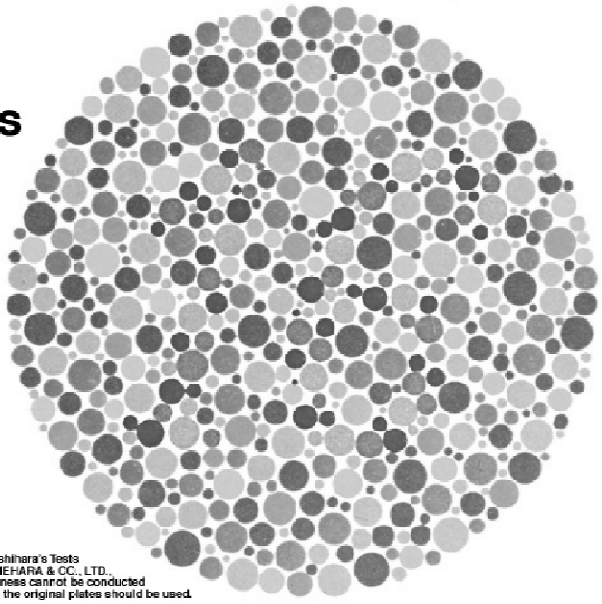
normal | red/green color blind | blue/yellow color blind

People with color deficiencies may have difficulty distinguishing certain colors (e.g., a red/green color deficiency means that reds and greens are more difficult to distinguish). But as this photo demonstrates, many other colors are just as distinguishable to a person with a color deficiency as to someone with normal color vision.

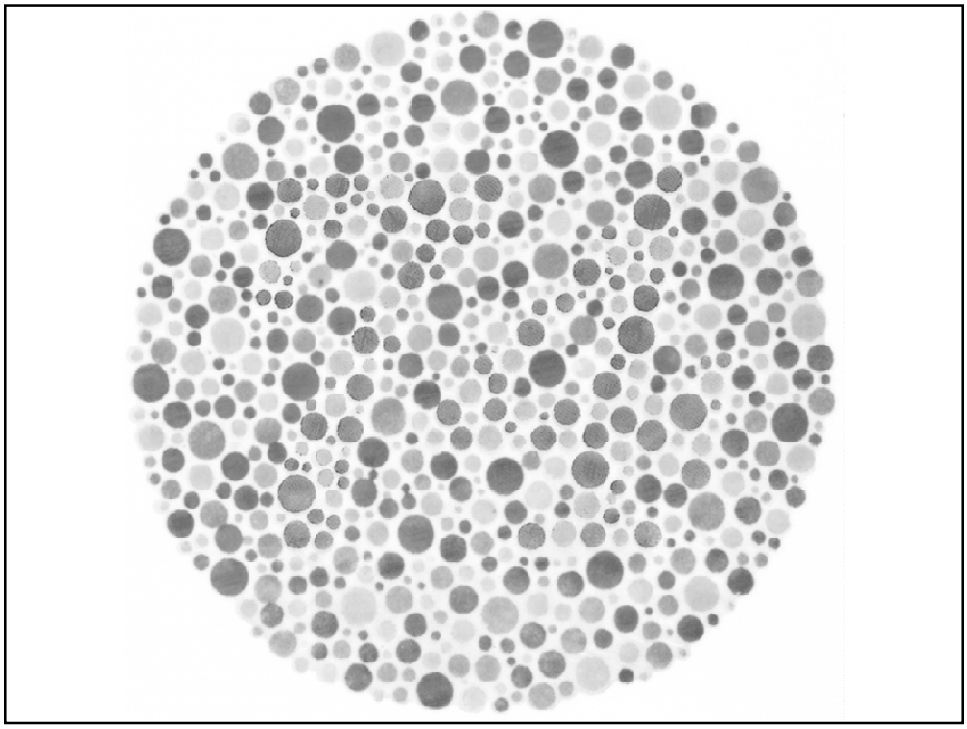
Ishihara charts

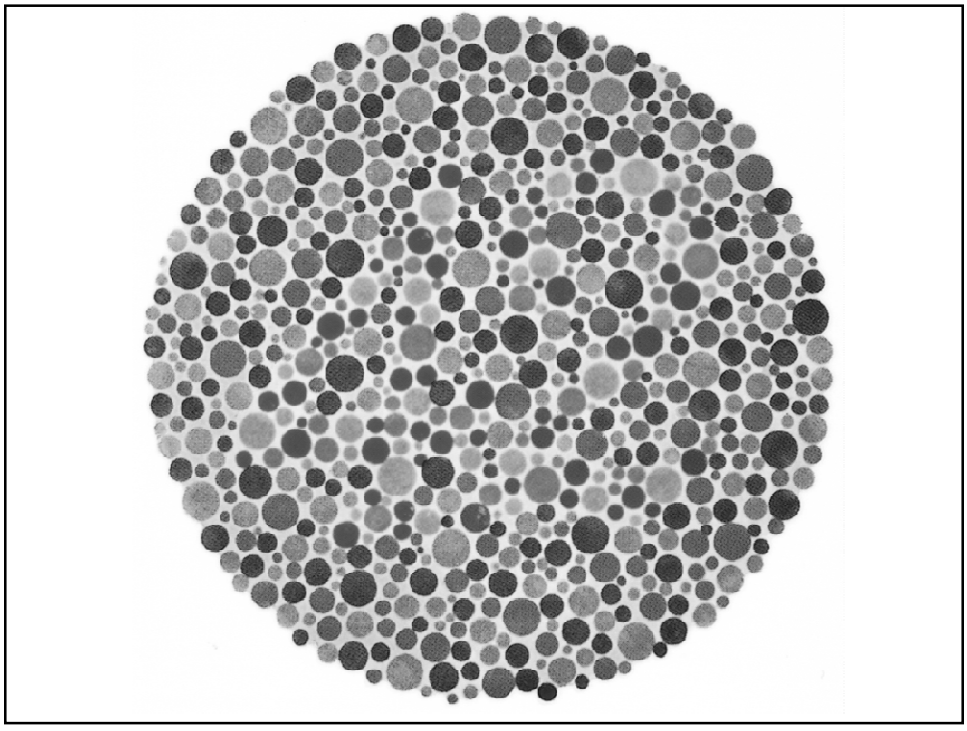


Test for Color Blindness



The above has been reproduced from Ishihara's Tests for Colour Blindness published by KANEHARA & CO., LTD., Tokyo, Japan, but tests for colour blindness cannot be conducted with this material. For accurate testing, the original plates should be used.



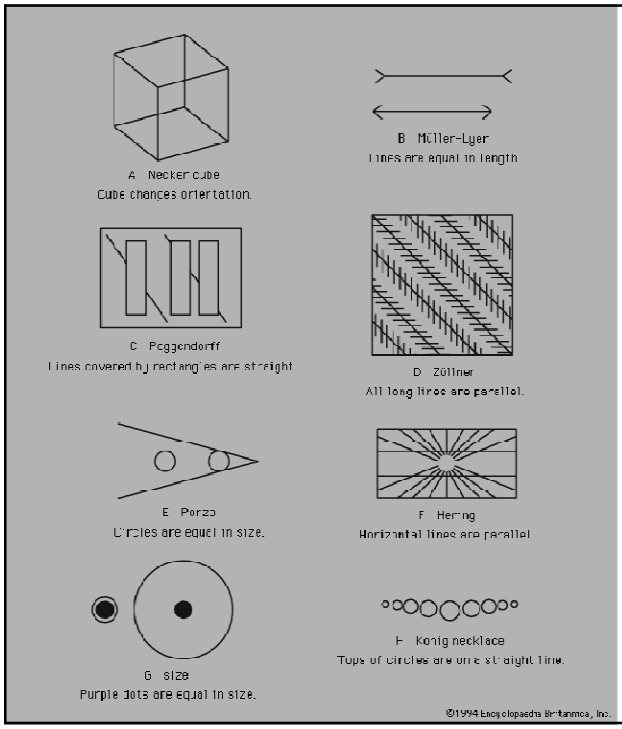


Chromatic theories of color vision

- **Trichromats:-have 3 cone pigments(normal or have slight weakness in detecting red or green or blue color**
- **Dichromats:-have only 2 cone pigments systems only so he is completely blind to red or green or blue (so they may have protanopia, deuteranopia,or tritanopia) they get color by mixing only 2 of the primary colors.**
- **Monochromats:-have only one cone system or loss of all so see only blackor grey or have no color perception.**

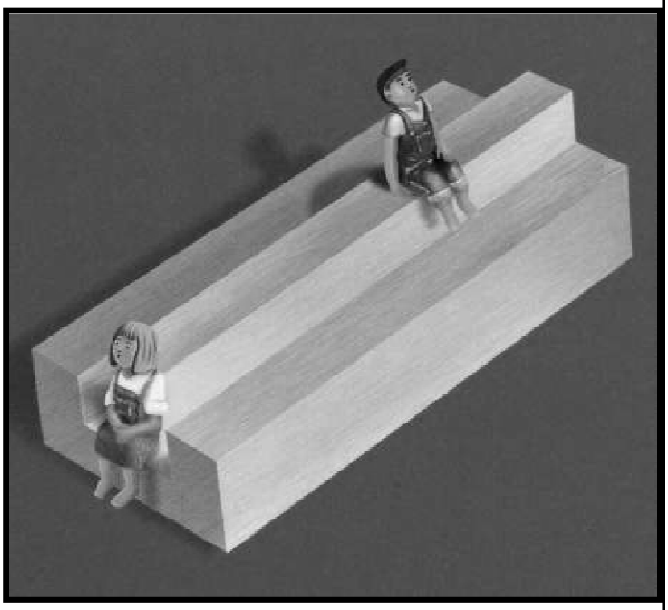
NOPIA (BLINDNESS)
NOMALY (WEAKNESS)

- **1-Protanopia (red-blindness): no red cones system so person has vision in shorter spectrum wave lengths. weakness ➔protanomaly**
- **2-Deutranopia (green -blindness):-no green cones system-so person see only long & short wave length) . weakness ➔ deutranomaly.**
- **3-Tritanopia (blue -blindness) : no blue cones system. weakness ➔ tritanomaly.**



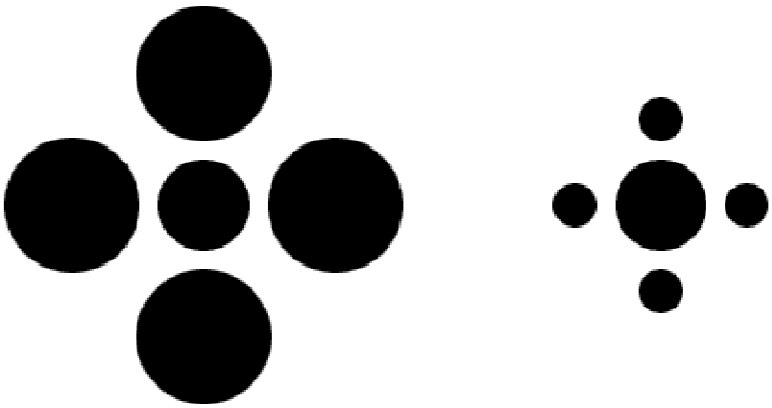
What we see is conditioned by what we expect to see and the context in which we find it. Which of these is hardest to believe.

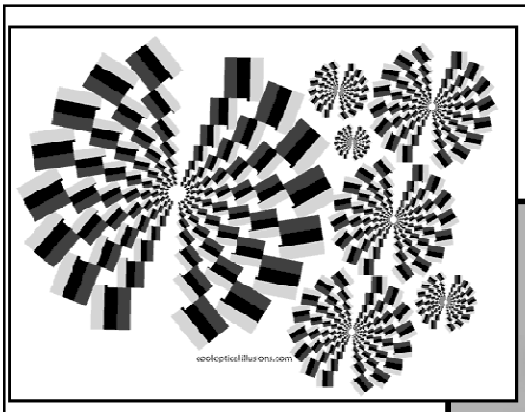
Who is sitting comfortably?



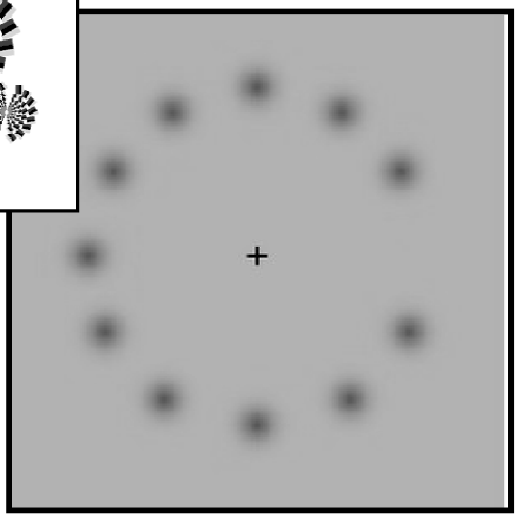
What do you see here?

Which center dot is bigger?





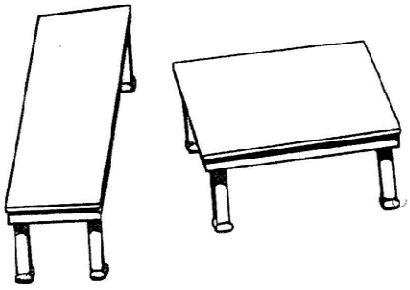
Motion?



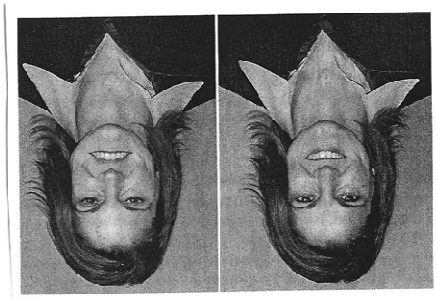
Color?

Only one guy

How do these tables compare?



What do you think of these faces?



What do you think now?