Visual areas in the brain

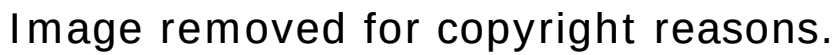
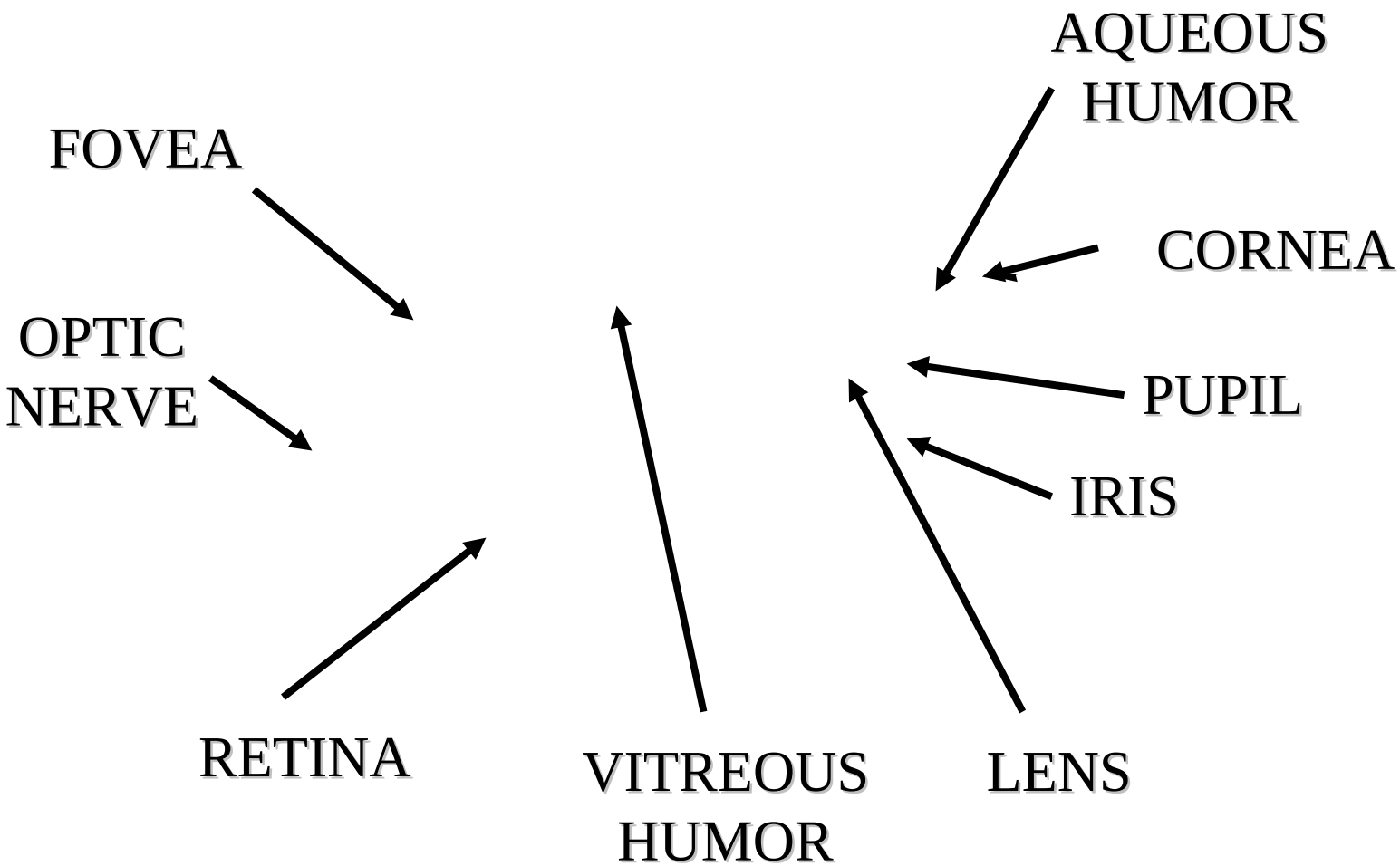
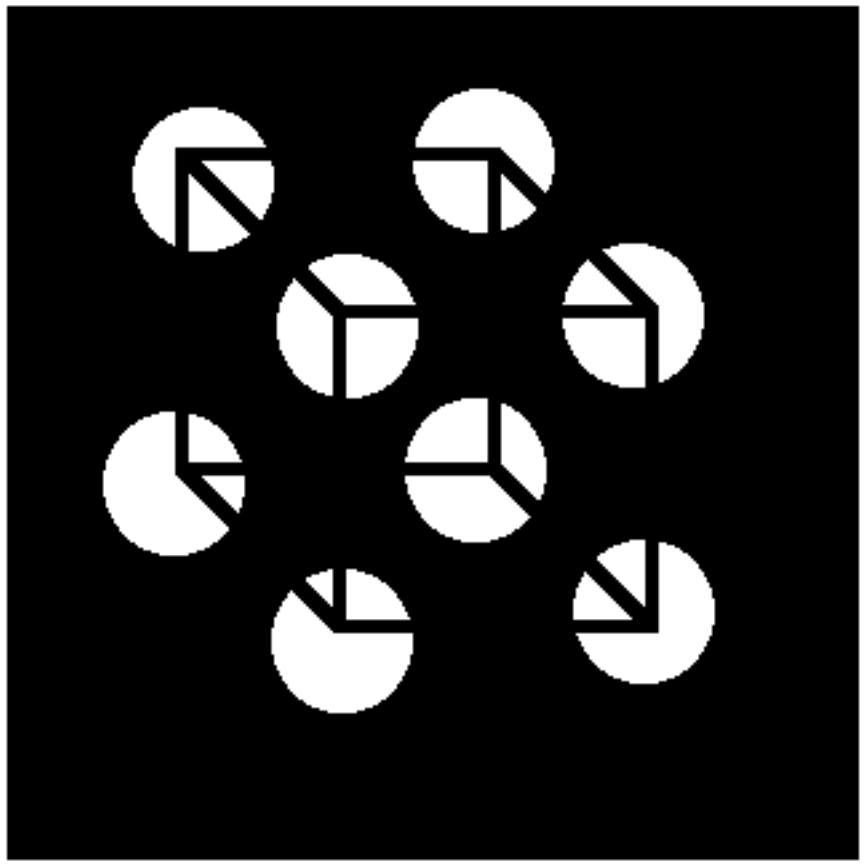


Image removed for copyright reasons.



What do you see?

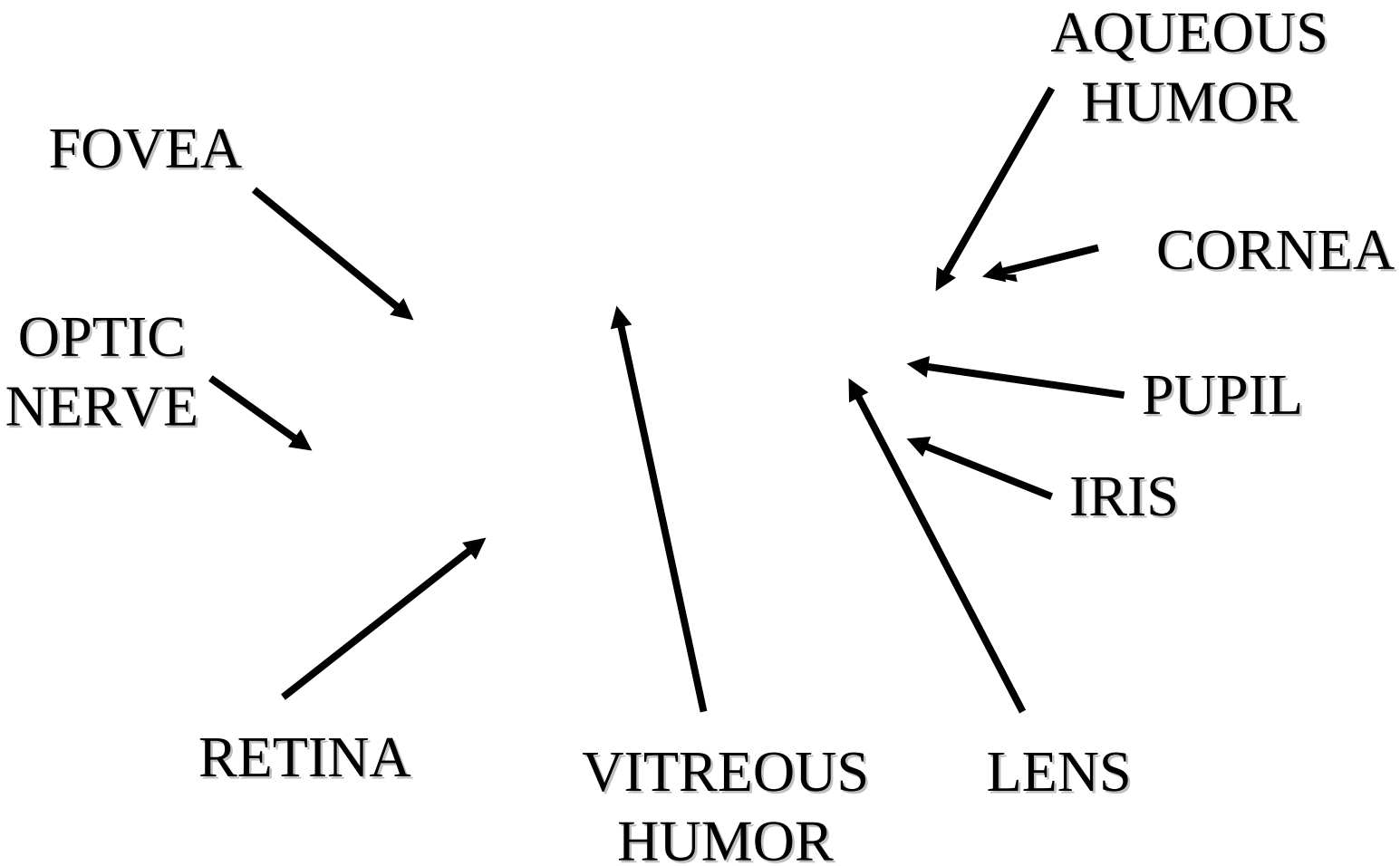


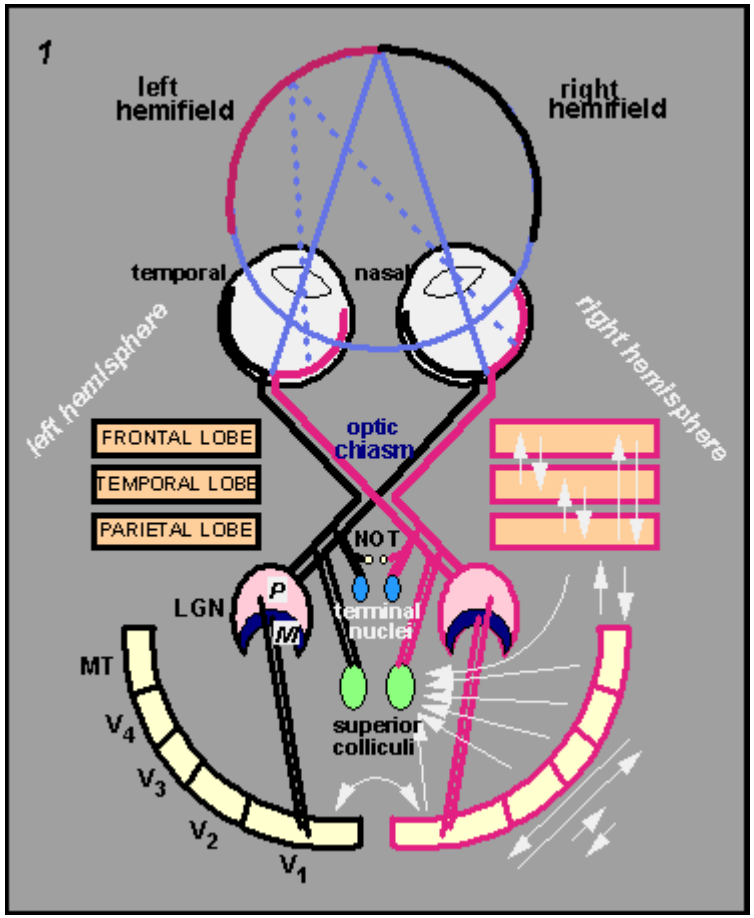
Why?

The world is a complicated place

Image removed for copyright reasons.

Image removed for copyright reasons.





Courtesy of Peter Schiller. Used with permission.

http://web.mit.edu/bcs/schillerlab/research/A-Vision/A2-1.html

Visual Cortex

Outside view

Image removed for copyright reasons.

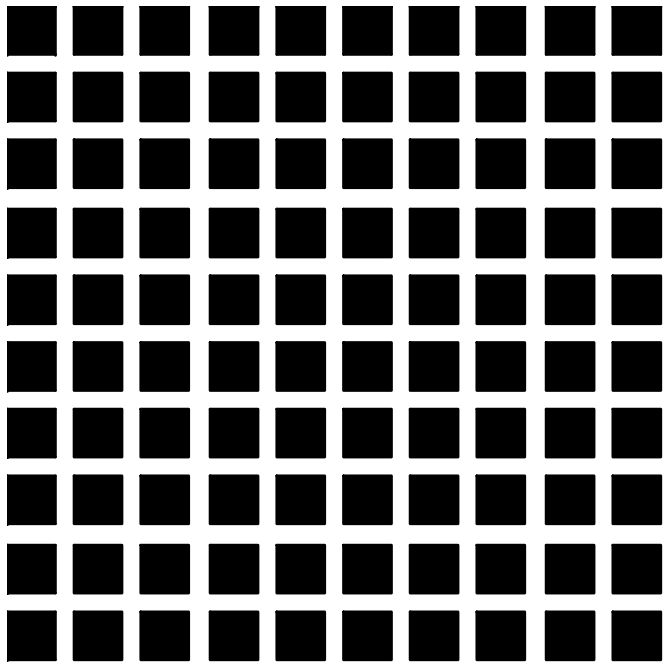
View from the middle

Flatten the brain

(like making a map out of a globe,
Only worse)

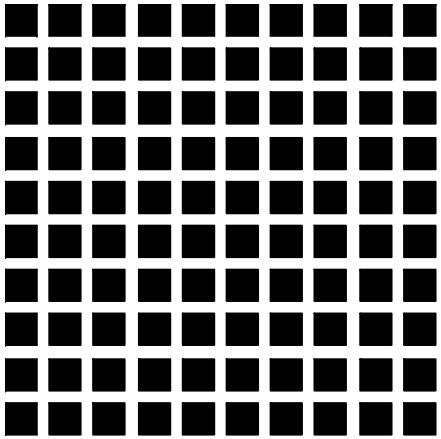
Image removed for copyright reasons.

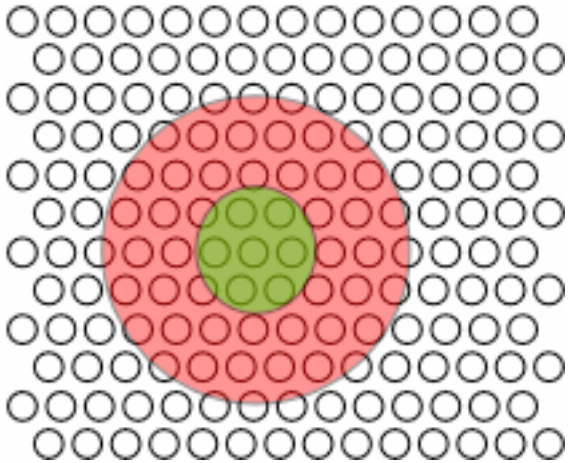
Do we really have center-surround receptive fields?

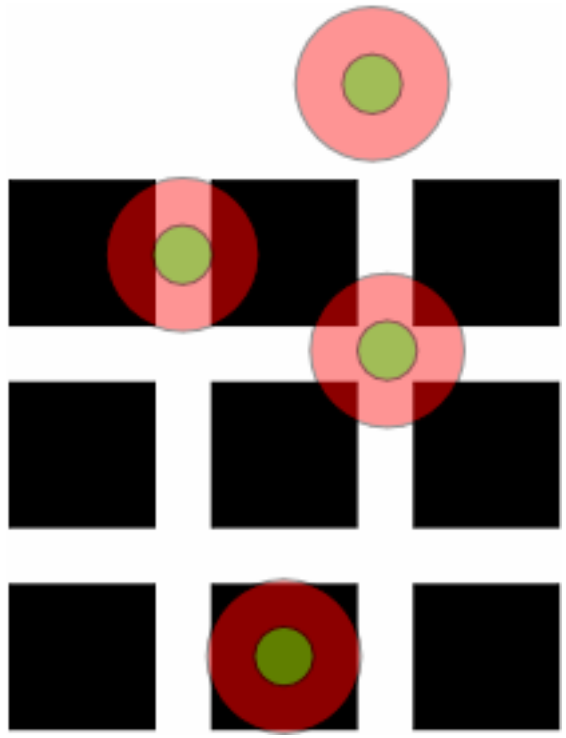


The Hermann Grid

Do we really have center-surround receptive fields?

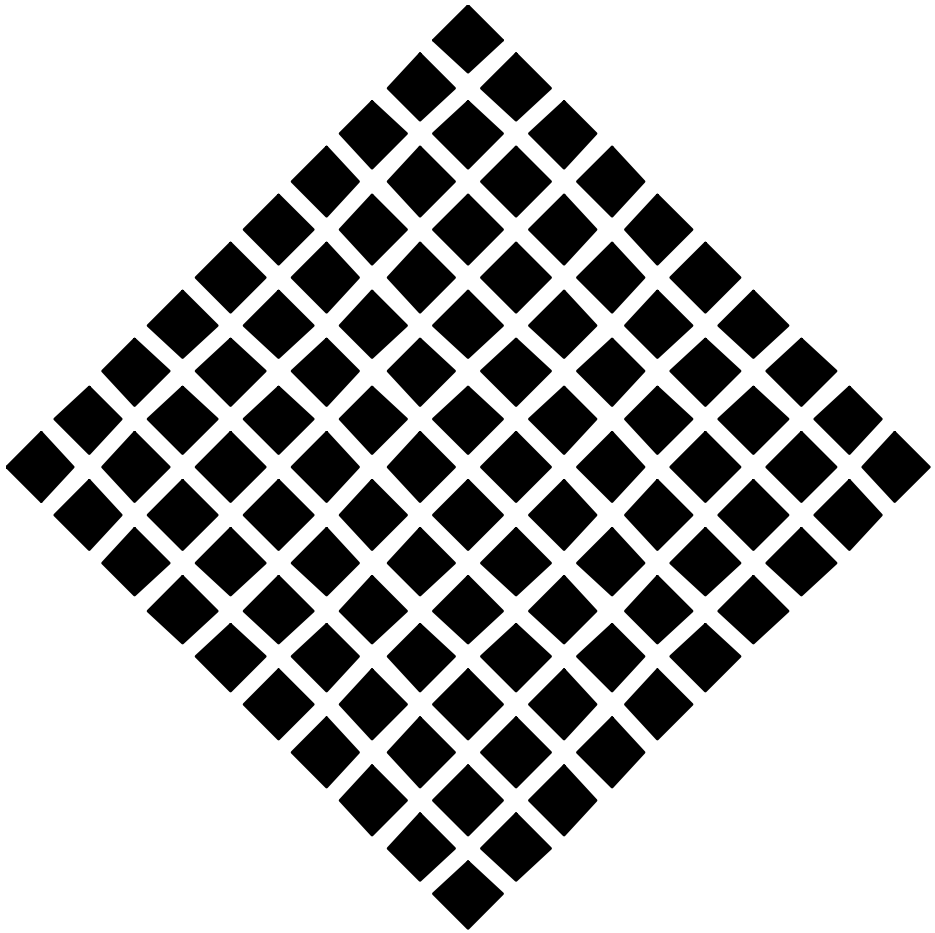




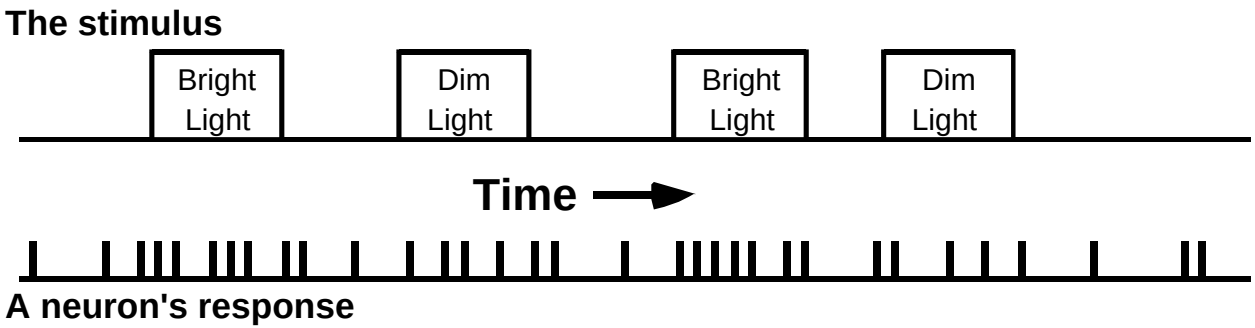


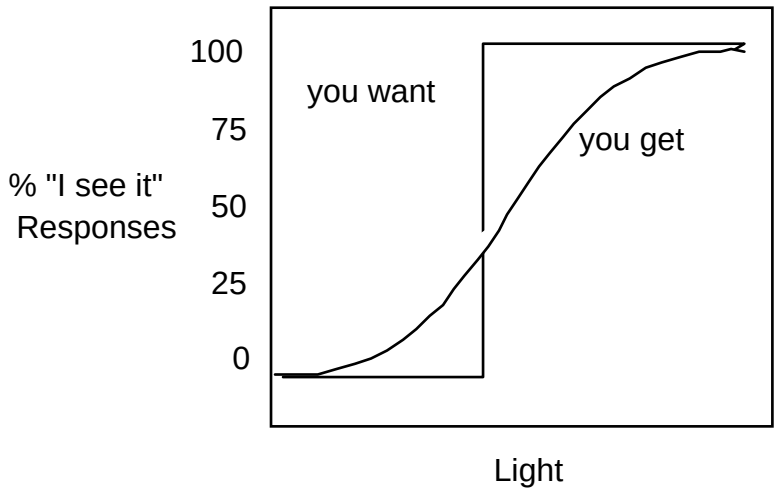
The Hermann Grid

Do we really have center-surround receptive fields?



Umm…what is
happening here?

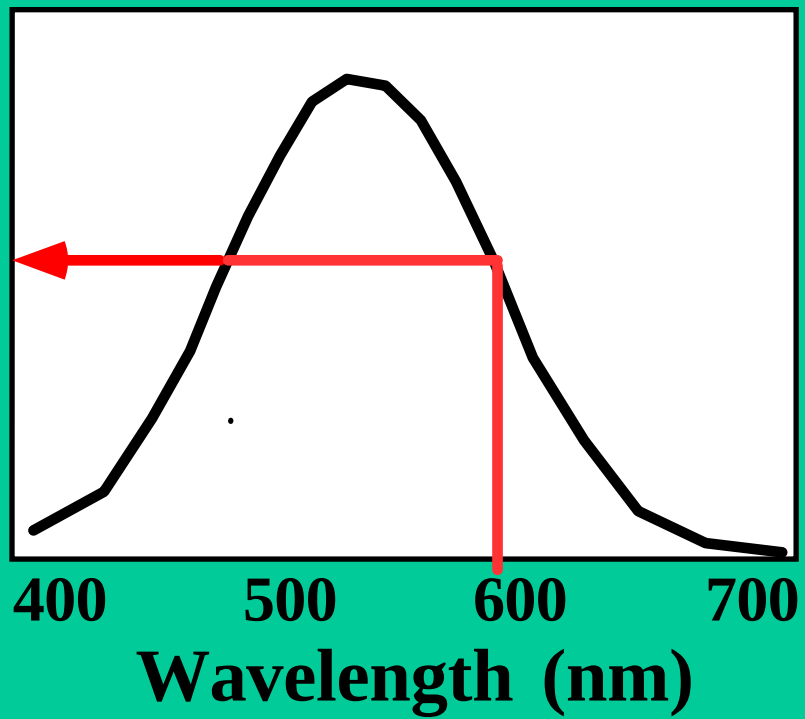

The stimulus
Bright Light
Dim Light
Bright Light
Dim Light
Time
A neuron's response


100
75
50
25
0
% "I see it"
Responses
you want
you get
Light

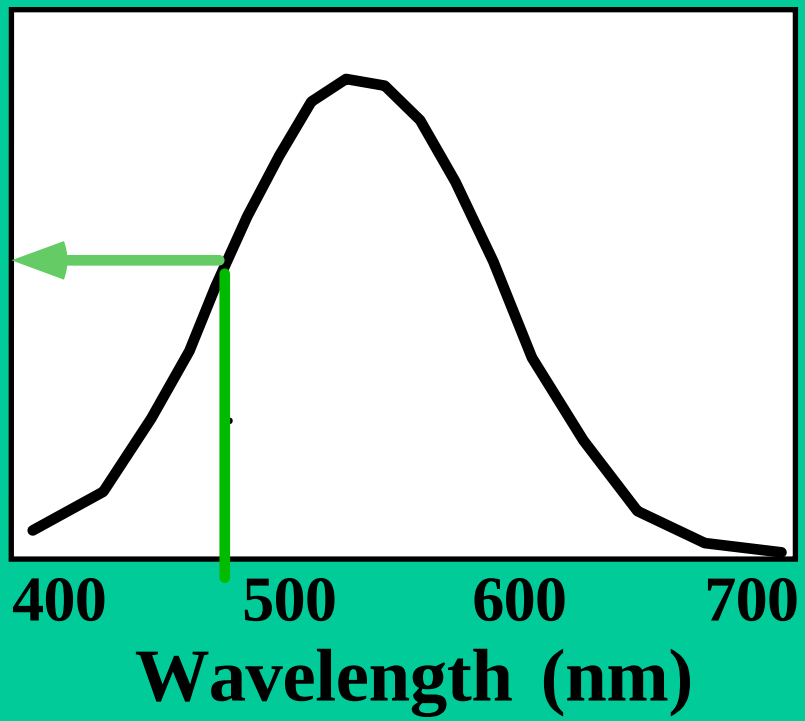
Color

How do you see color?

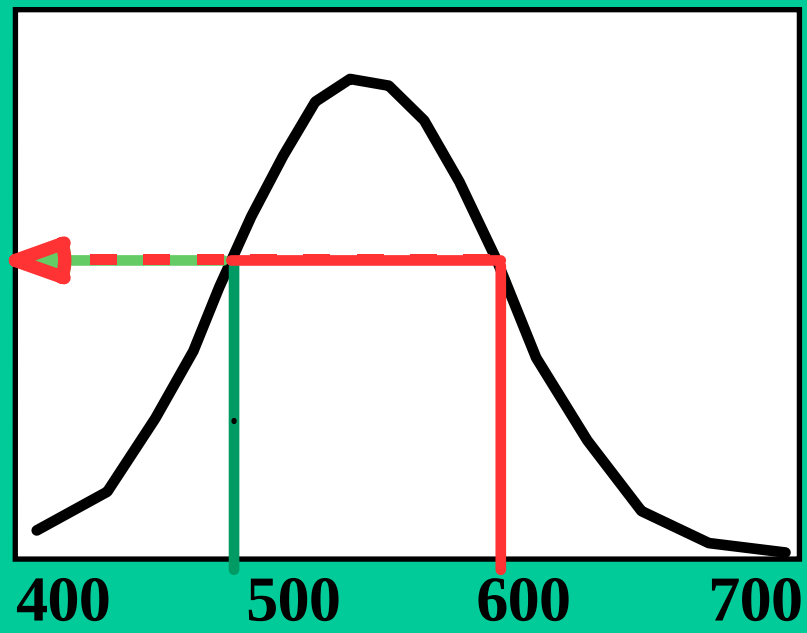
Wavelength 1 produces a response of size X



Wavelength 2 produces a response of size X

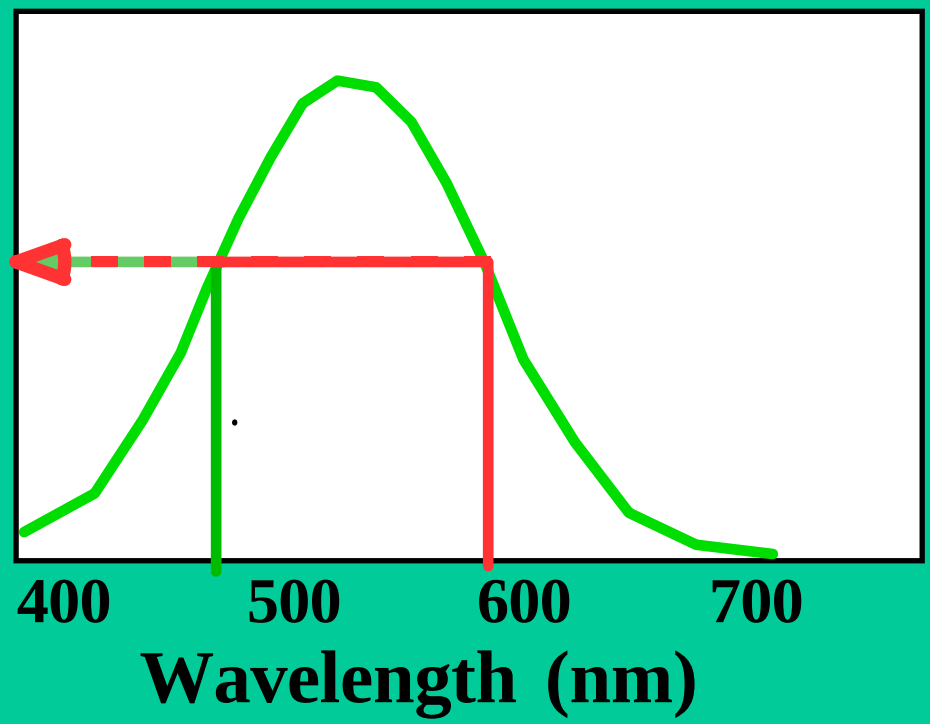


The problem of “univariance”

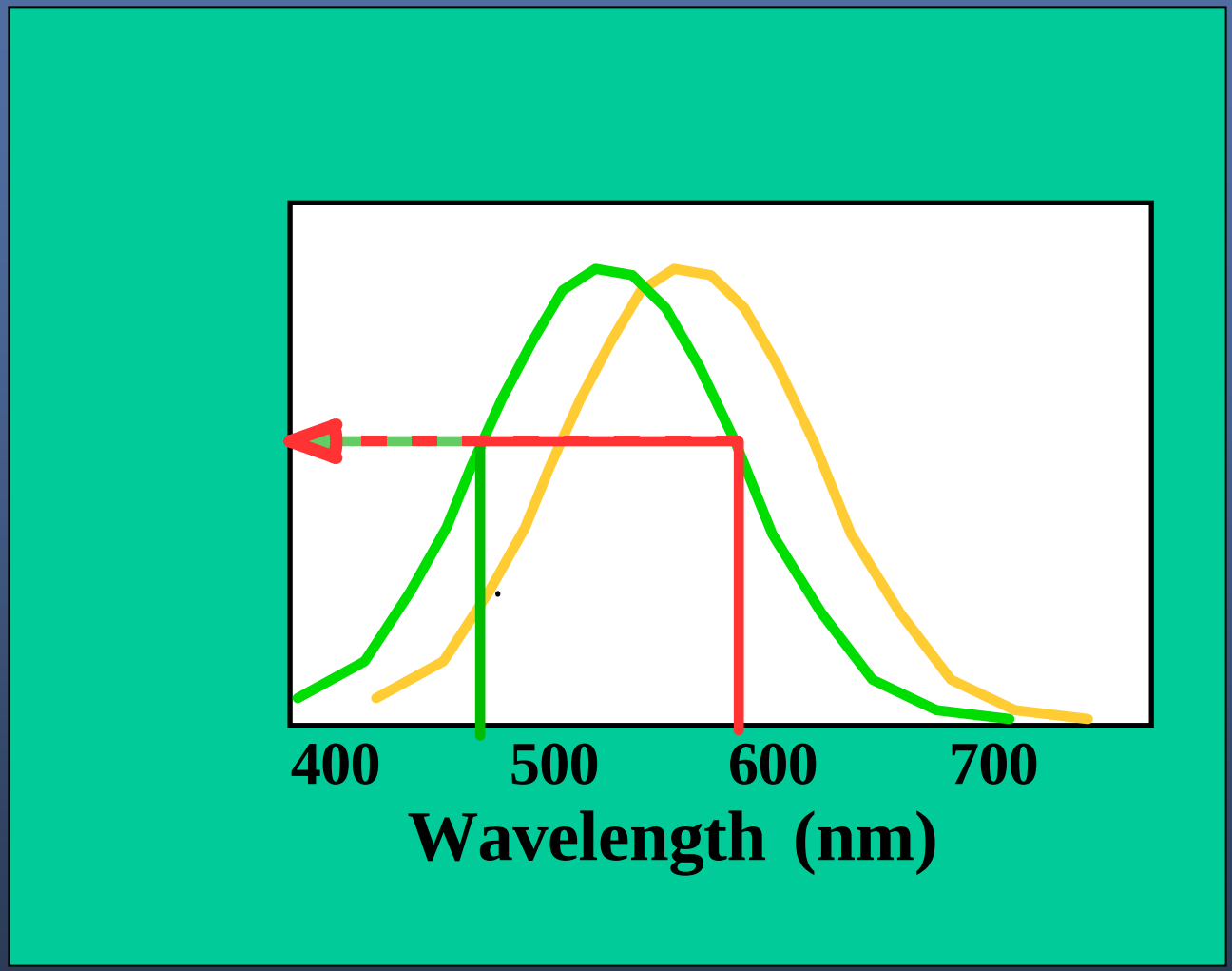


Two wavelengths, one response.

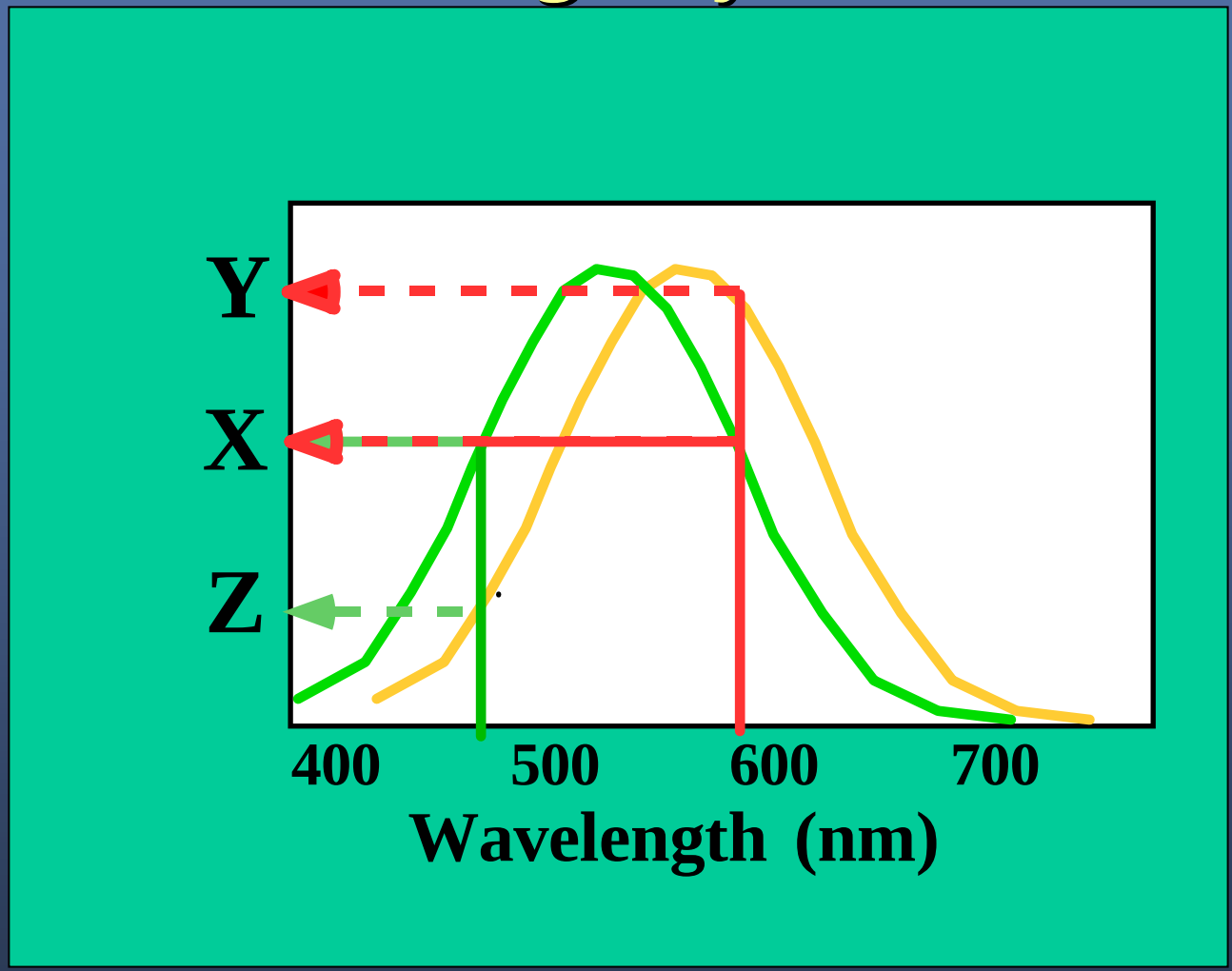
So, we have a problem.



Here is a solution….add another cone type.



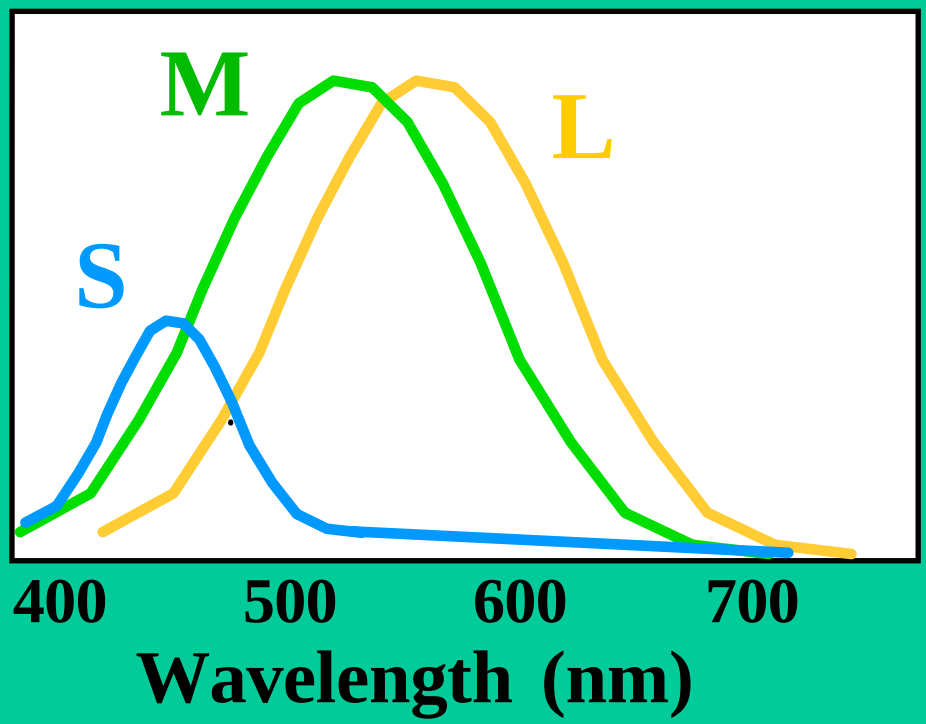
Two cones can give you color vision



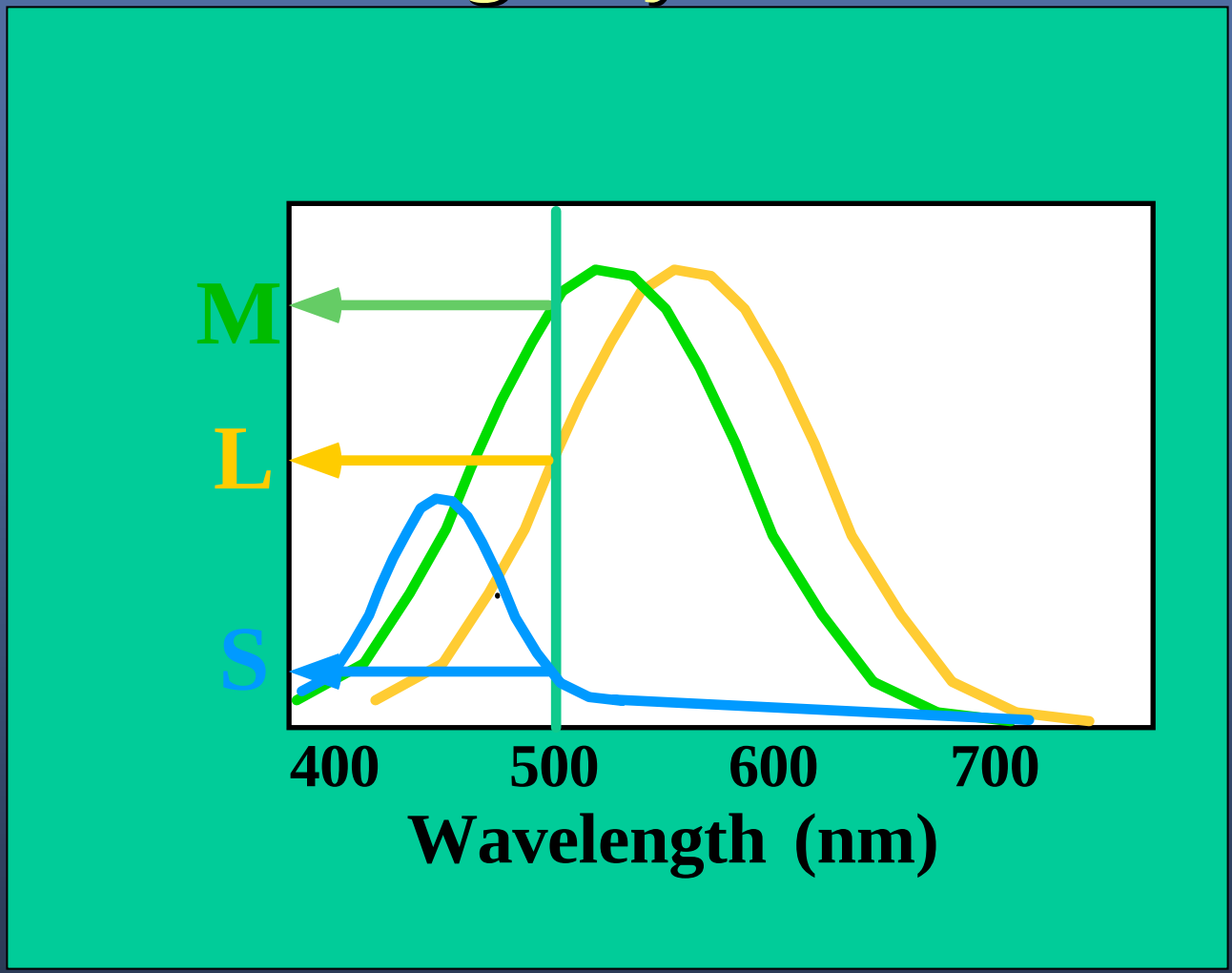
X/Y = red, X/Z = green

COMPARISONS ARE CRITICAL

Three cones give you *Trichromacy*

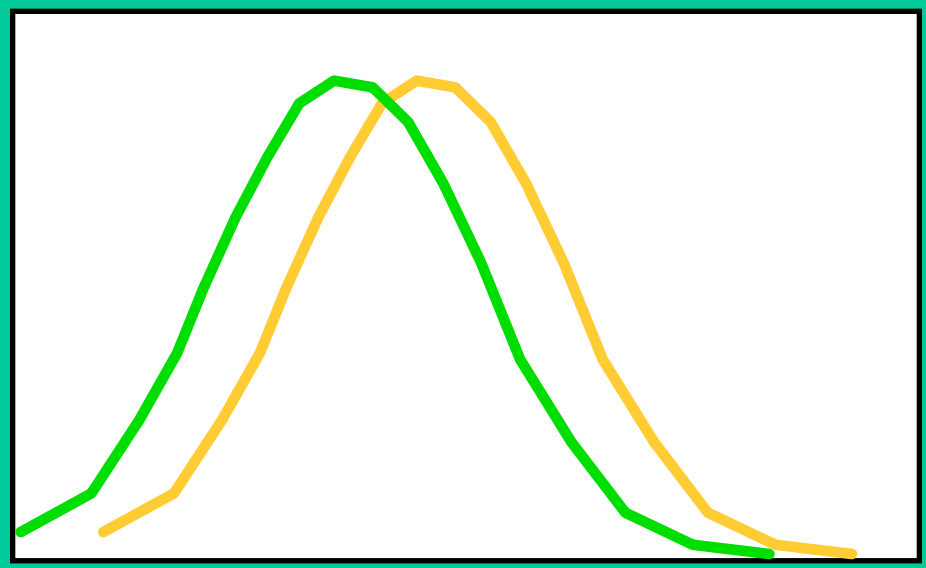


Three cones give you *Trichromacy*



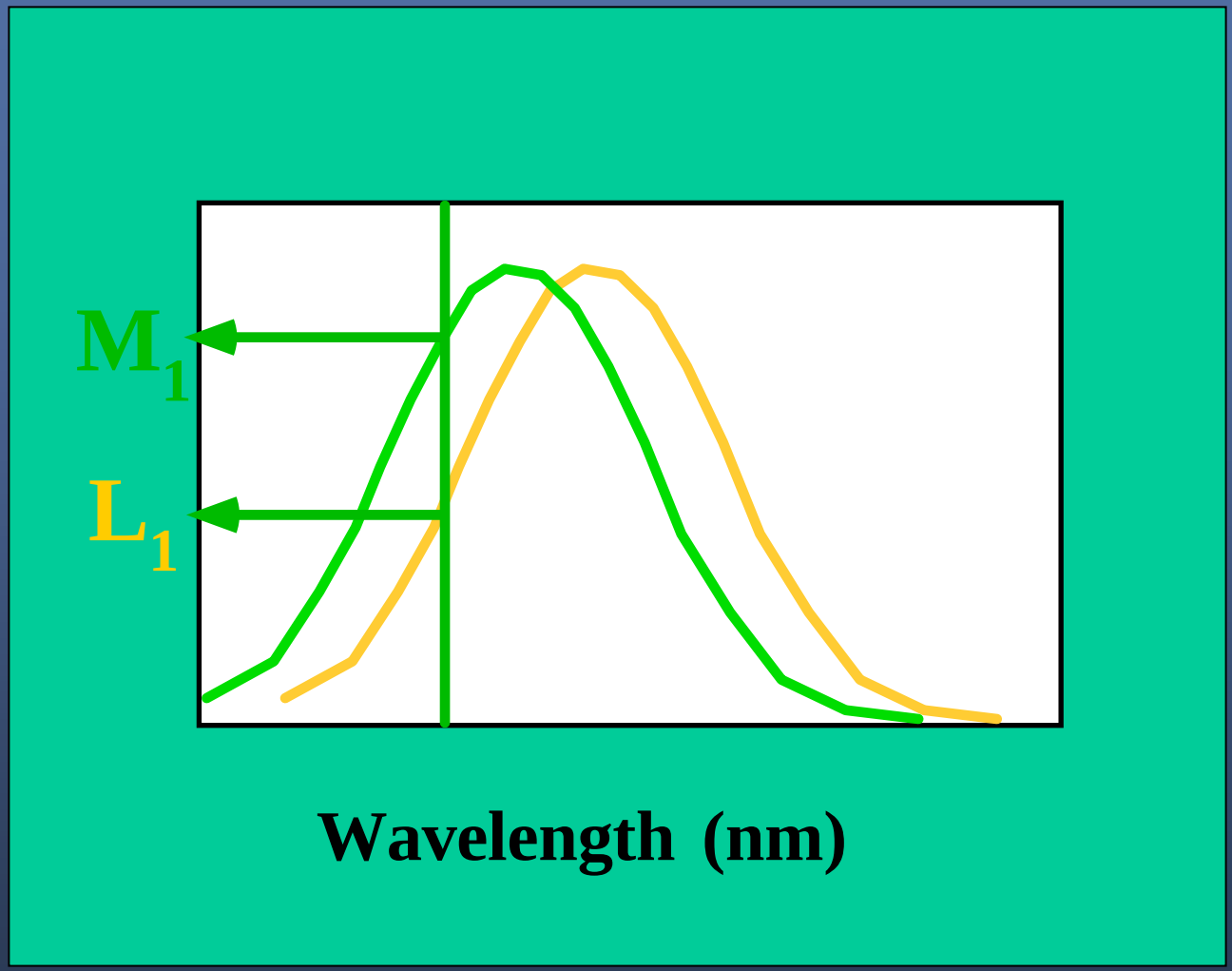
***Any* light = aL + bM + cS**

Let’s add some patches together

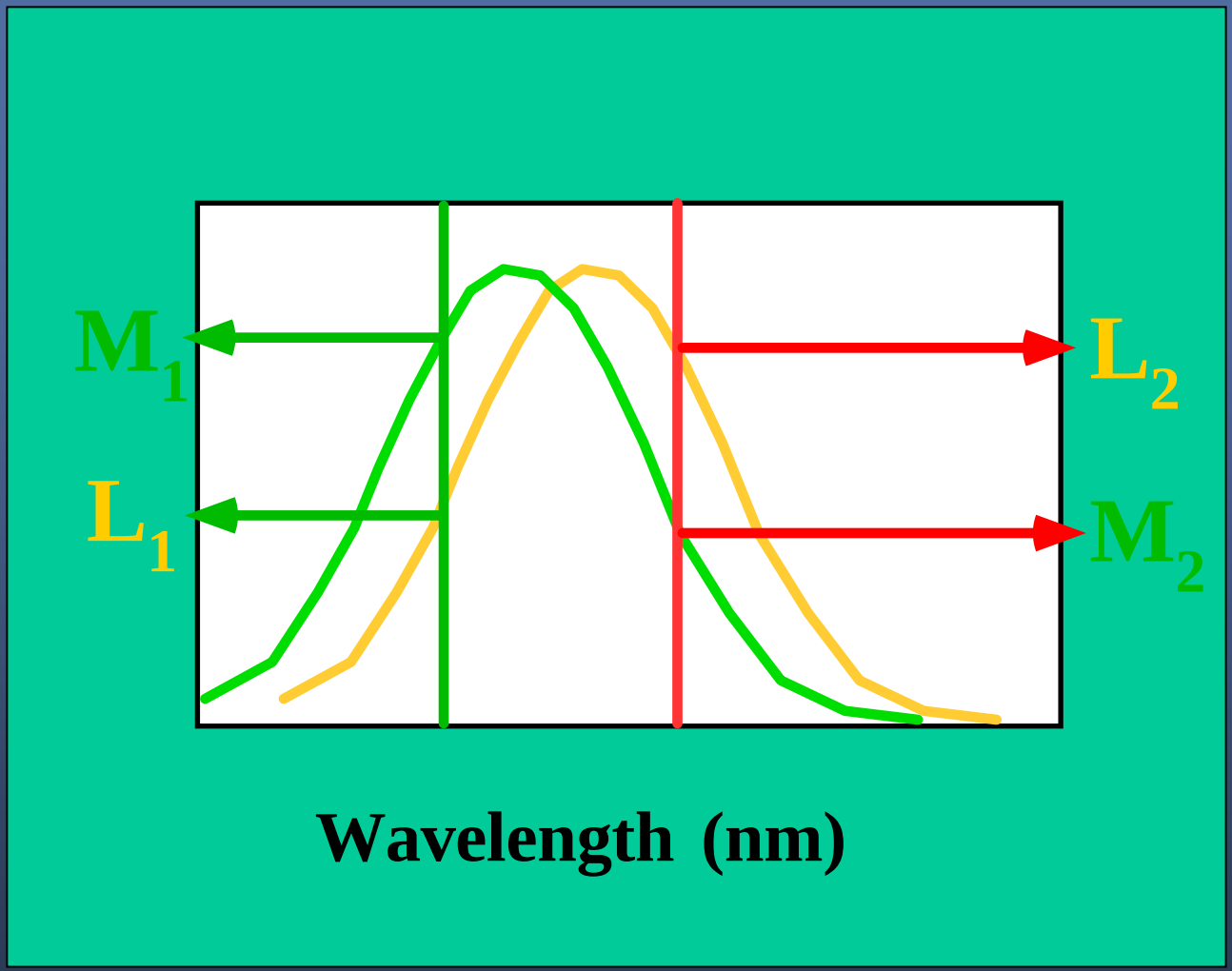


Wavelength (nm)

Let’s take GREEN

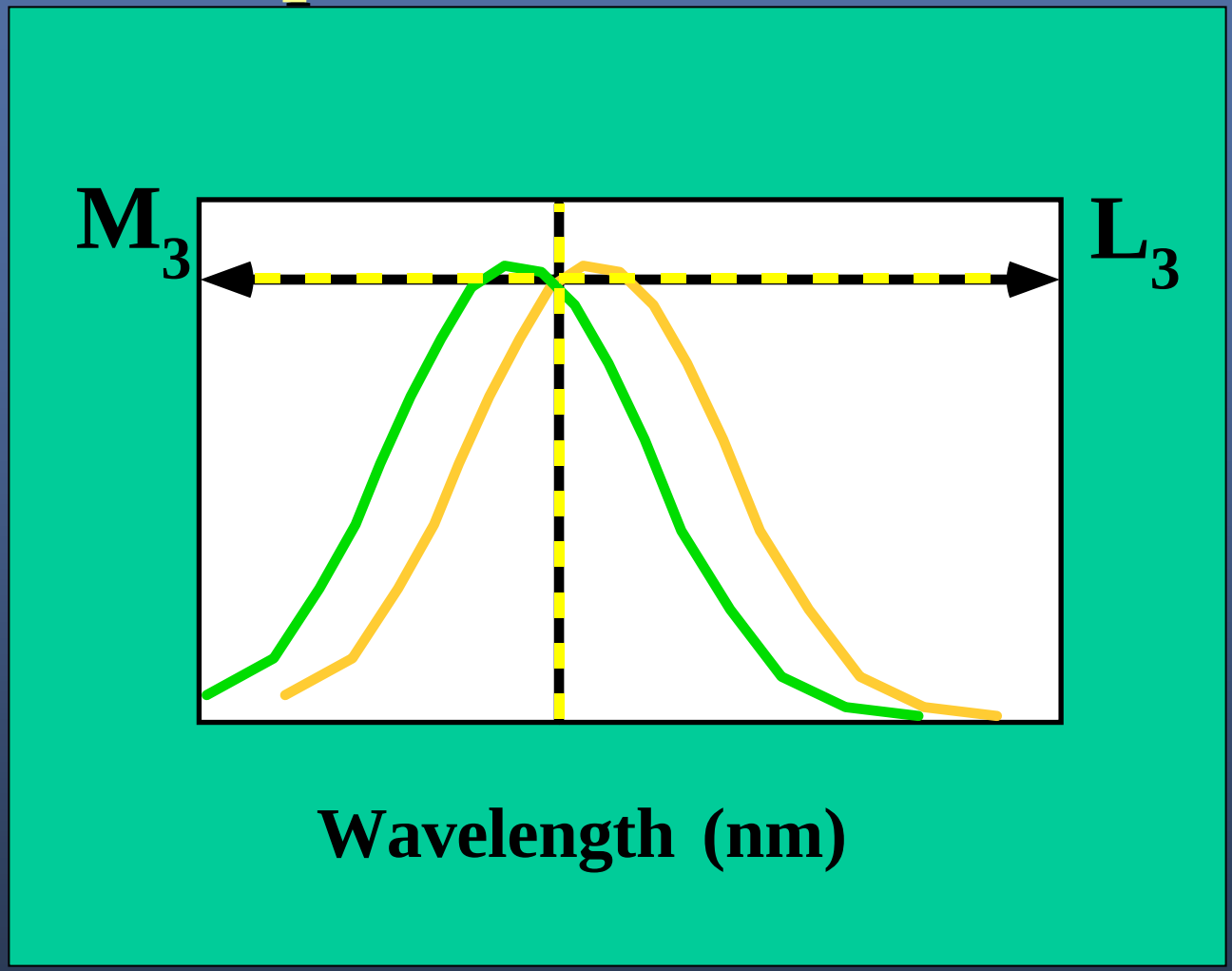


And add RED



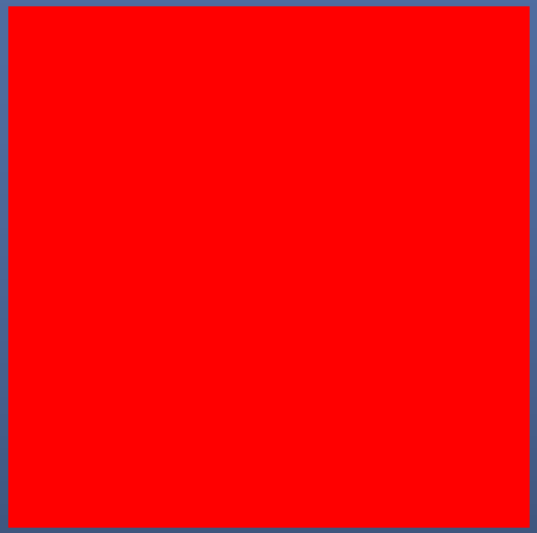
***Red + Green* = (M1+M2)/(L1+L2) = 1**

Compare that to YELLOW



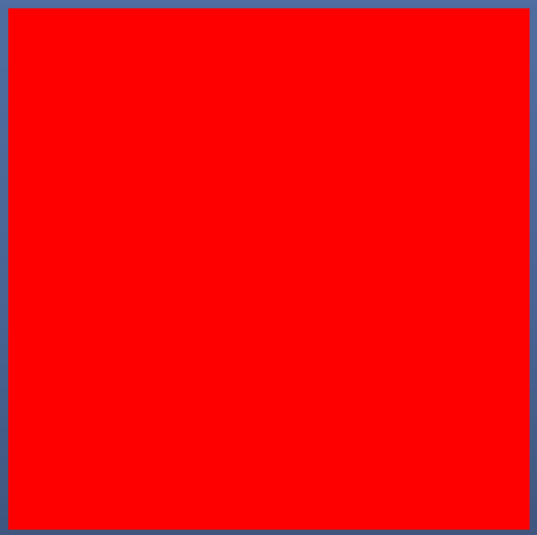
Yellow **= M3/L3 = 1**

It follows that

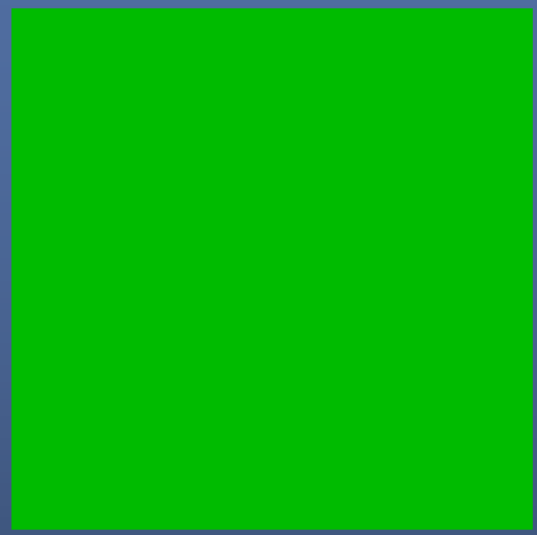


RED

It follows that



plus



RED **GREEN**

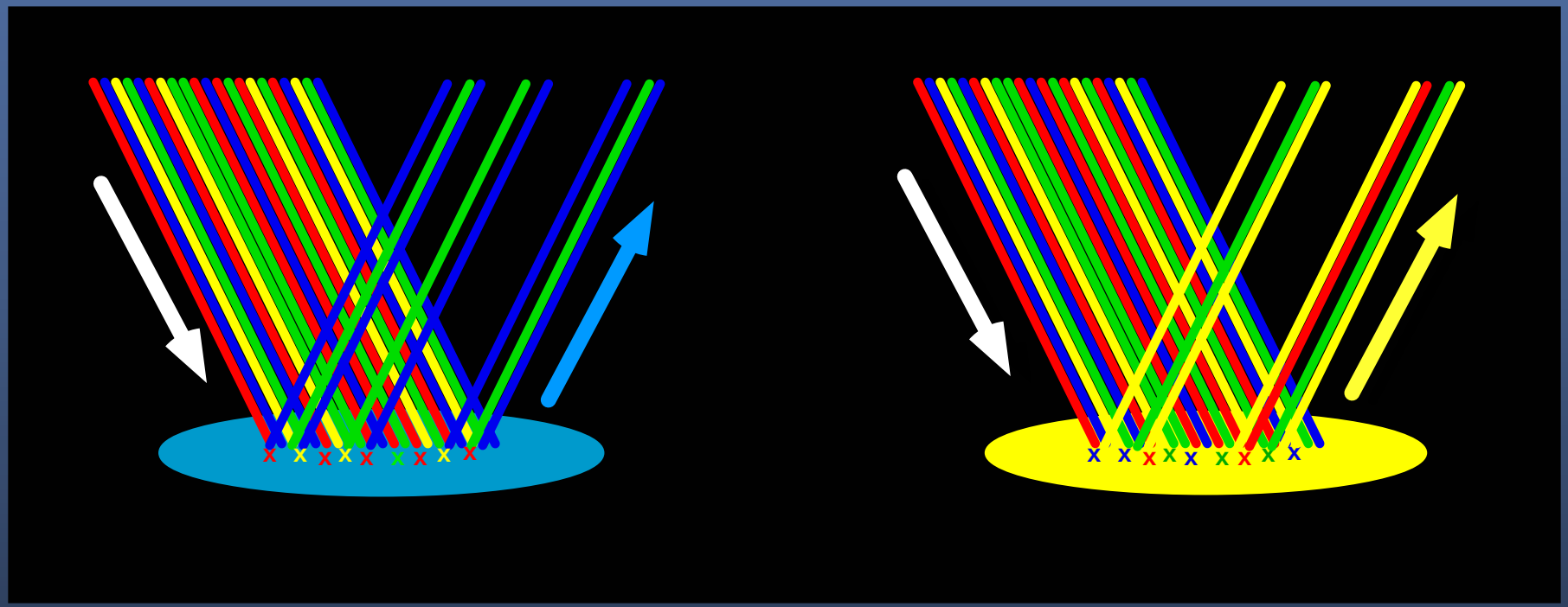
Yields *Yellow*

R+G and Y are

METAMERS

This is ADDITIVE color mixture

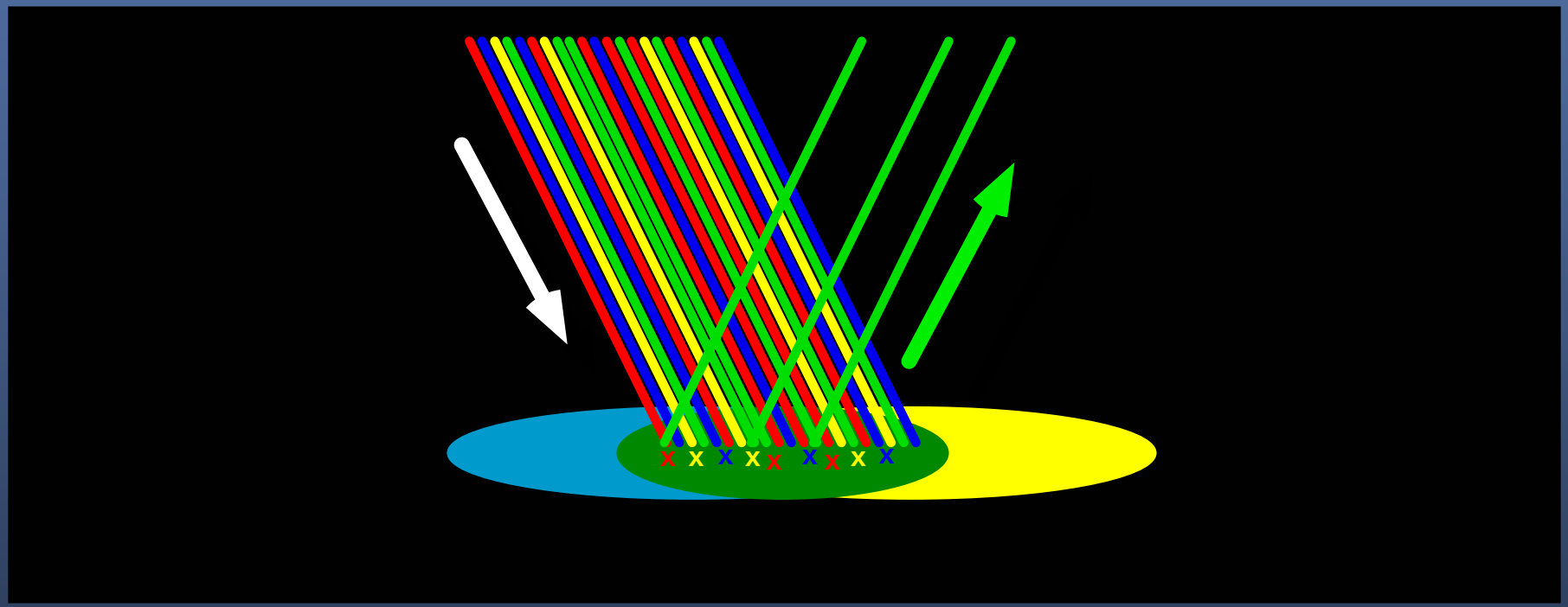
But what about color paint in kindergarten?



Blue paint

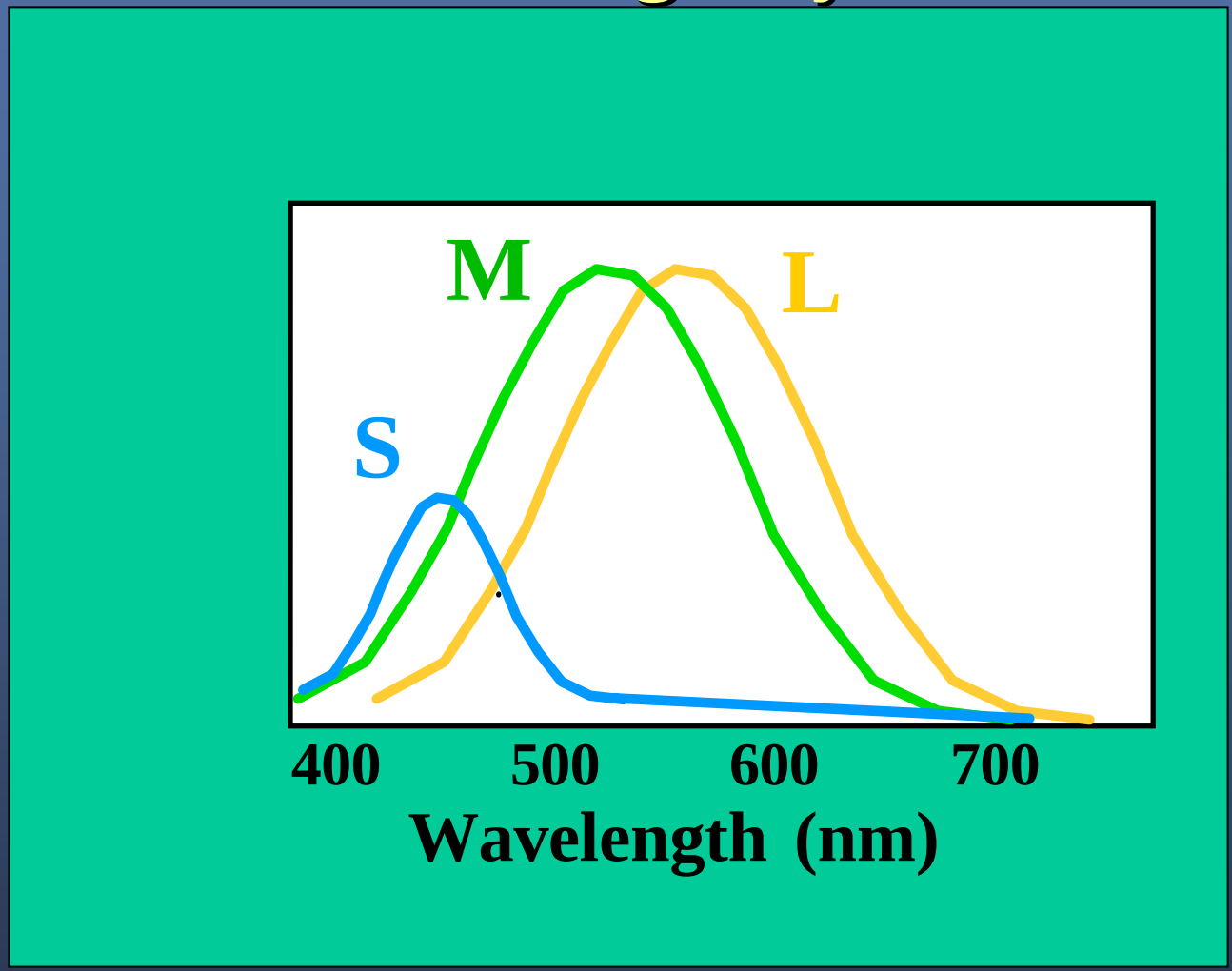
Yellow paint

Mixing paint is SUBTRACTIVE



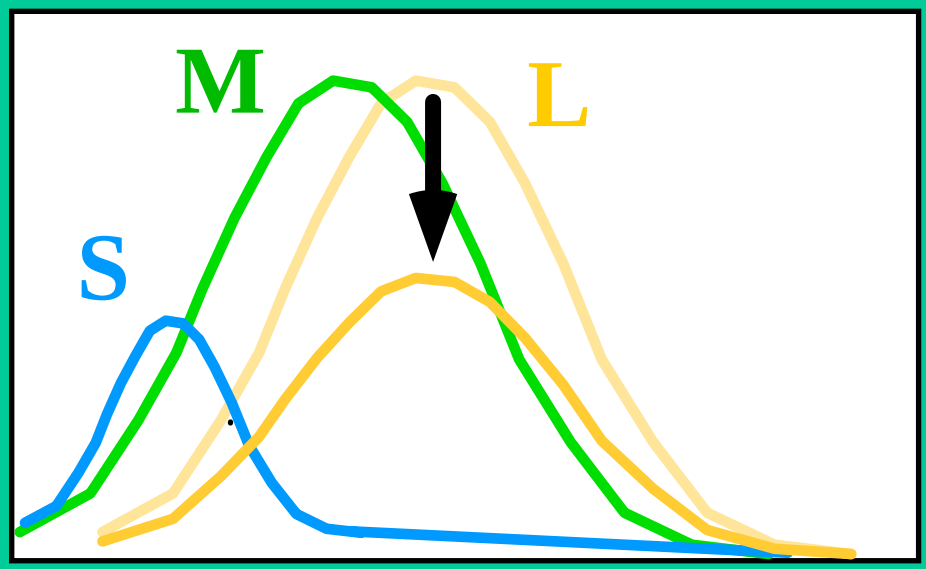
The *intersection* of Blue paint and Yellow paint looks *Green*

Recall…Three cones give you *Trichromacy*



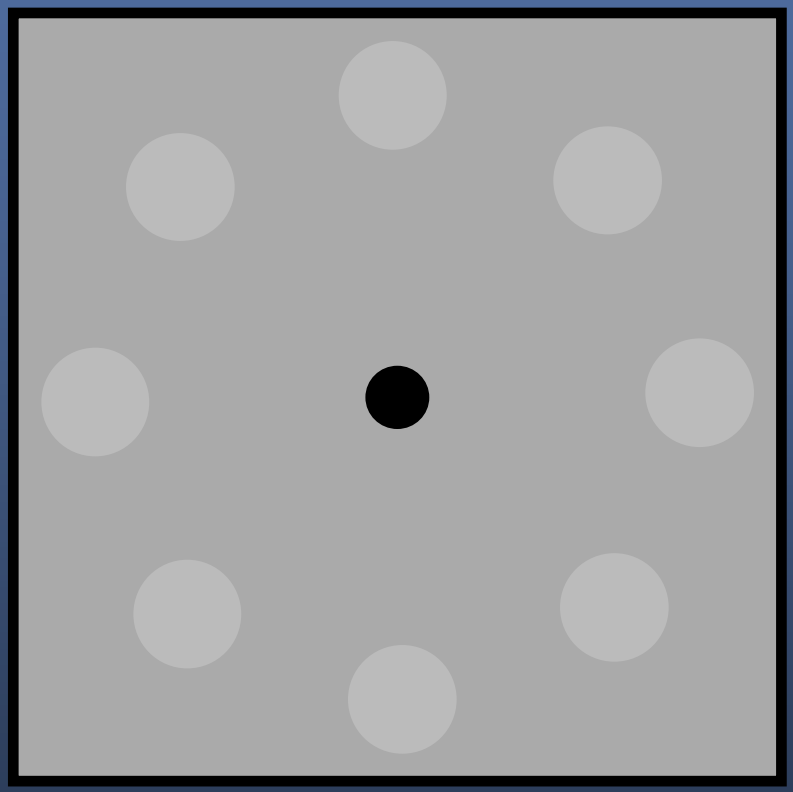
Suppose: **if S=M=L, then WHITE**

Suppose that L gets *tired*?

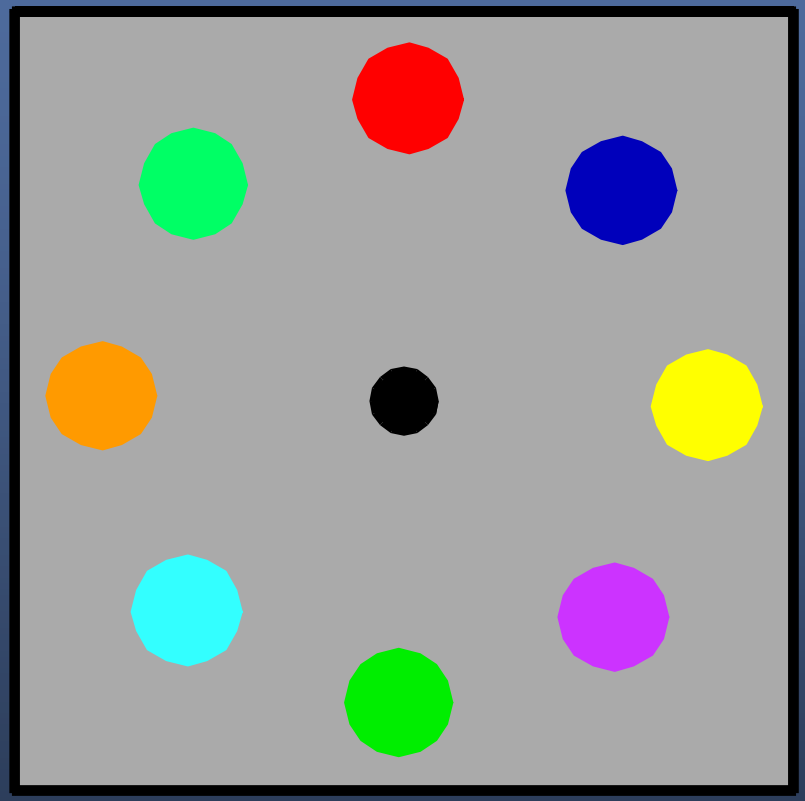


What does S=M>L look like?

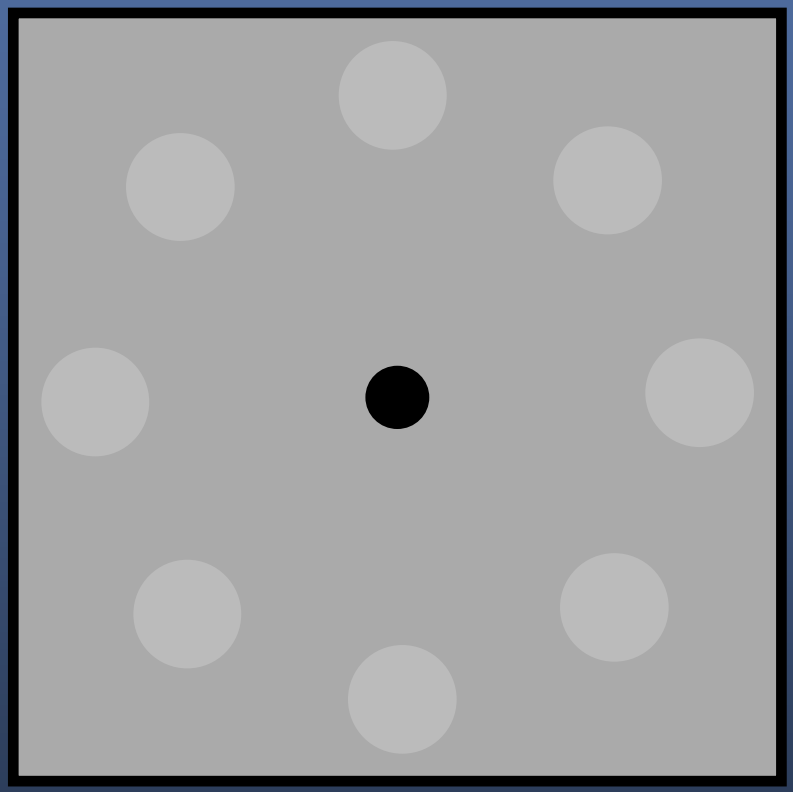
Pretty boring……



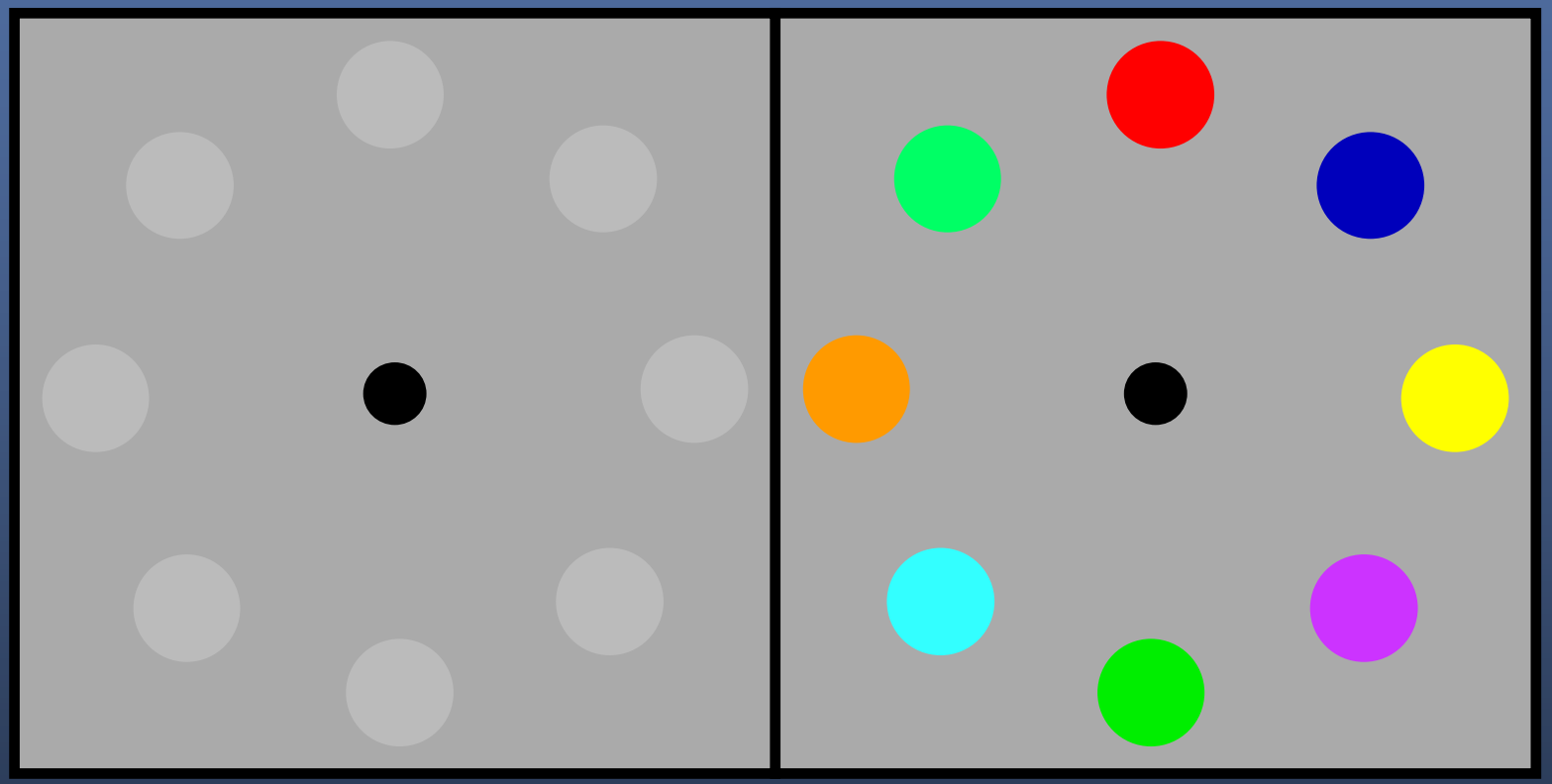
Pretty ……



Pretty, not boring……

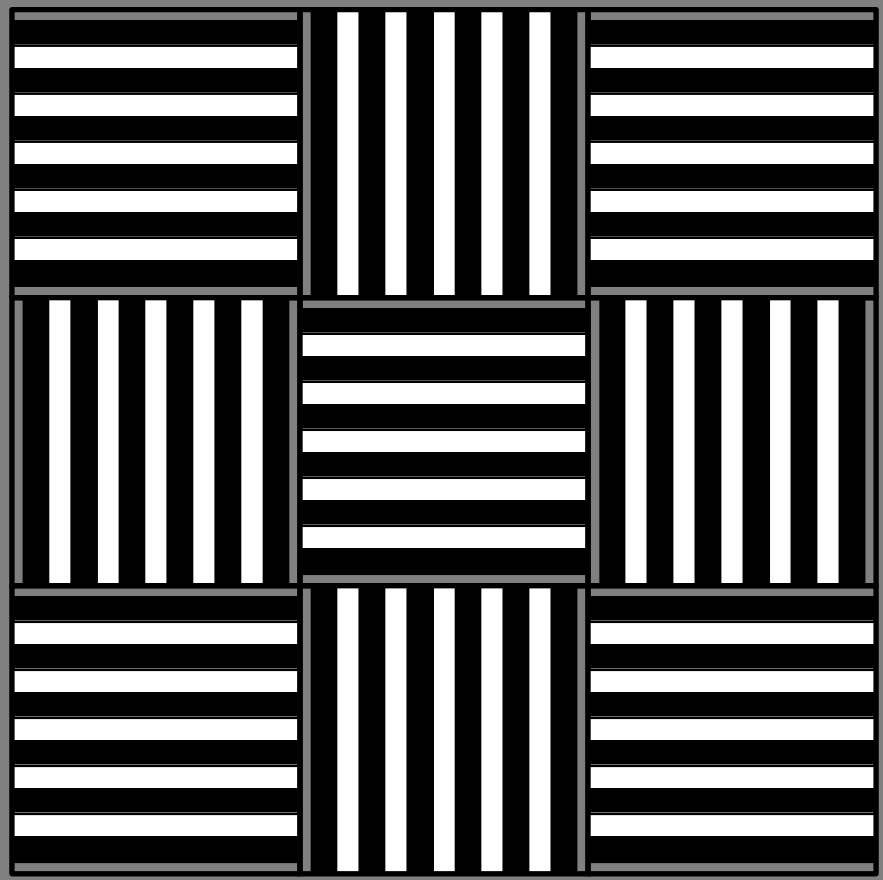


Try this

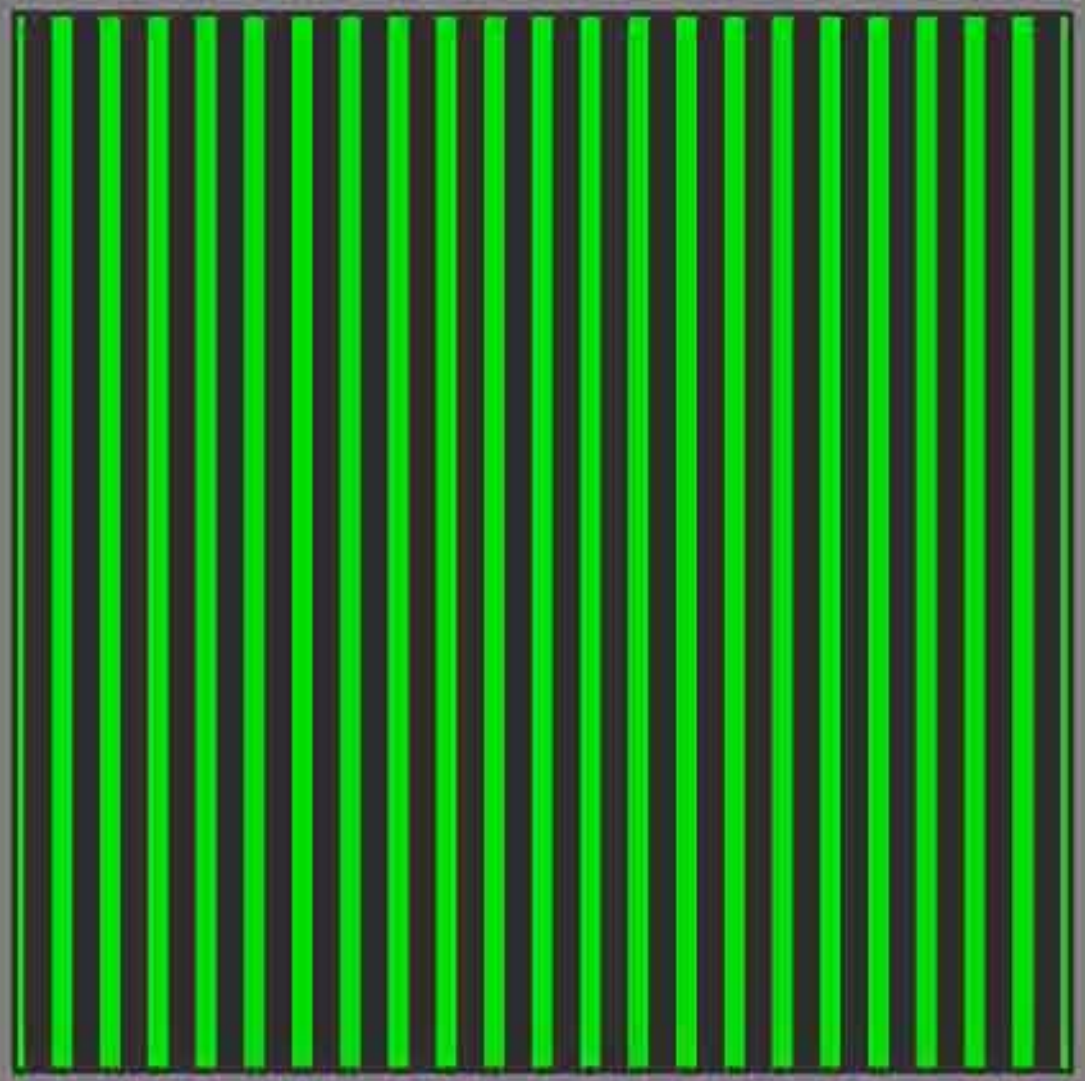


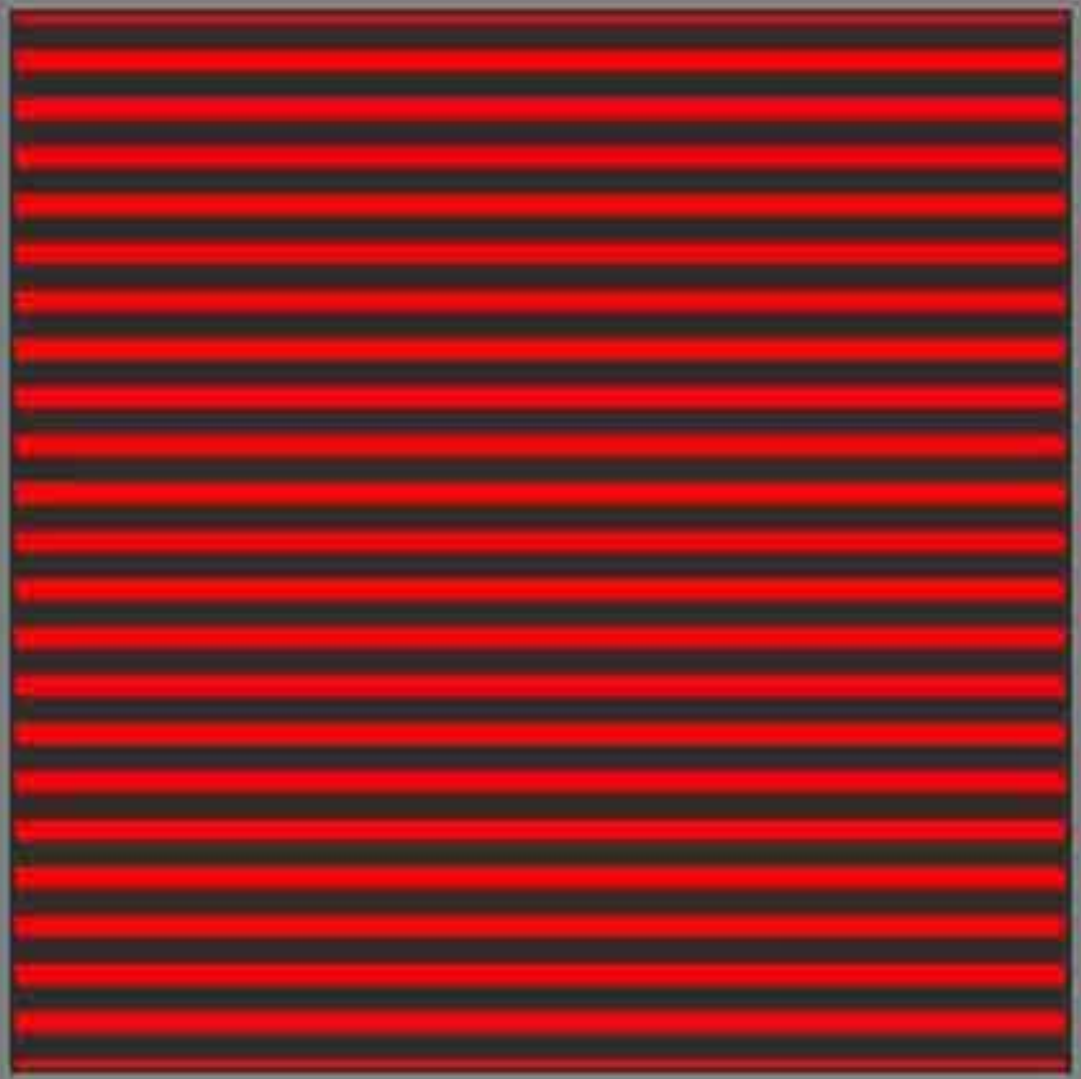
Negative afterimage

Vertical and Horizontal look the same?



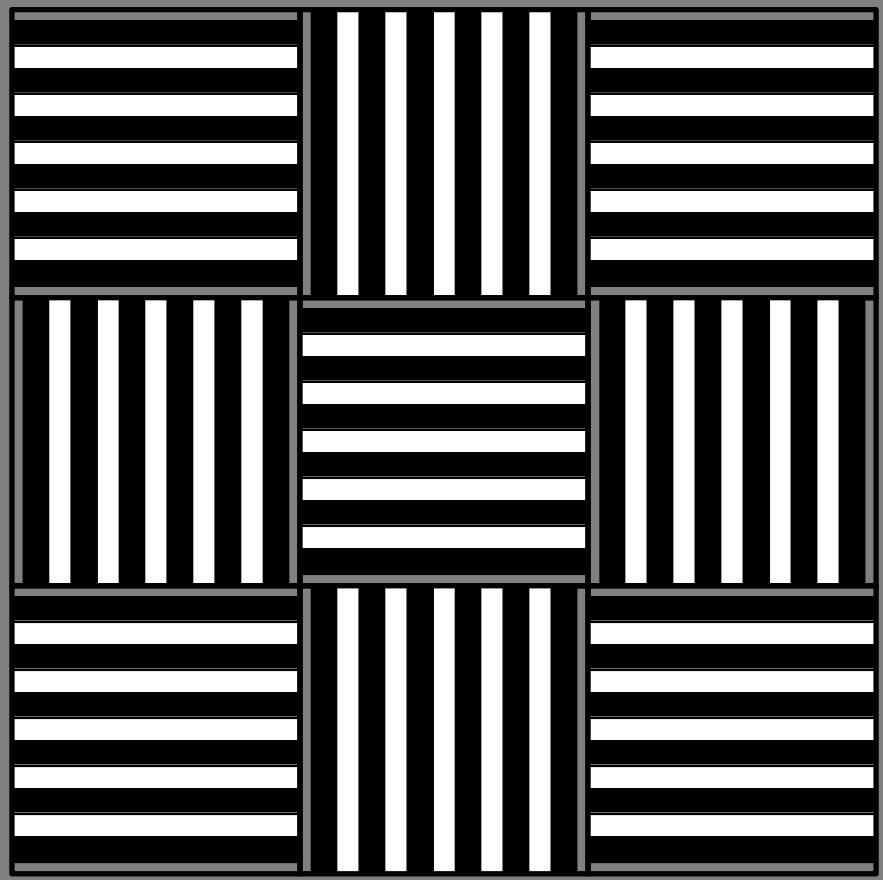
Go forward





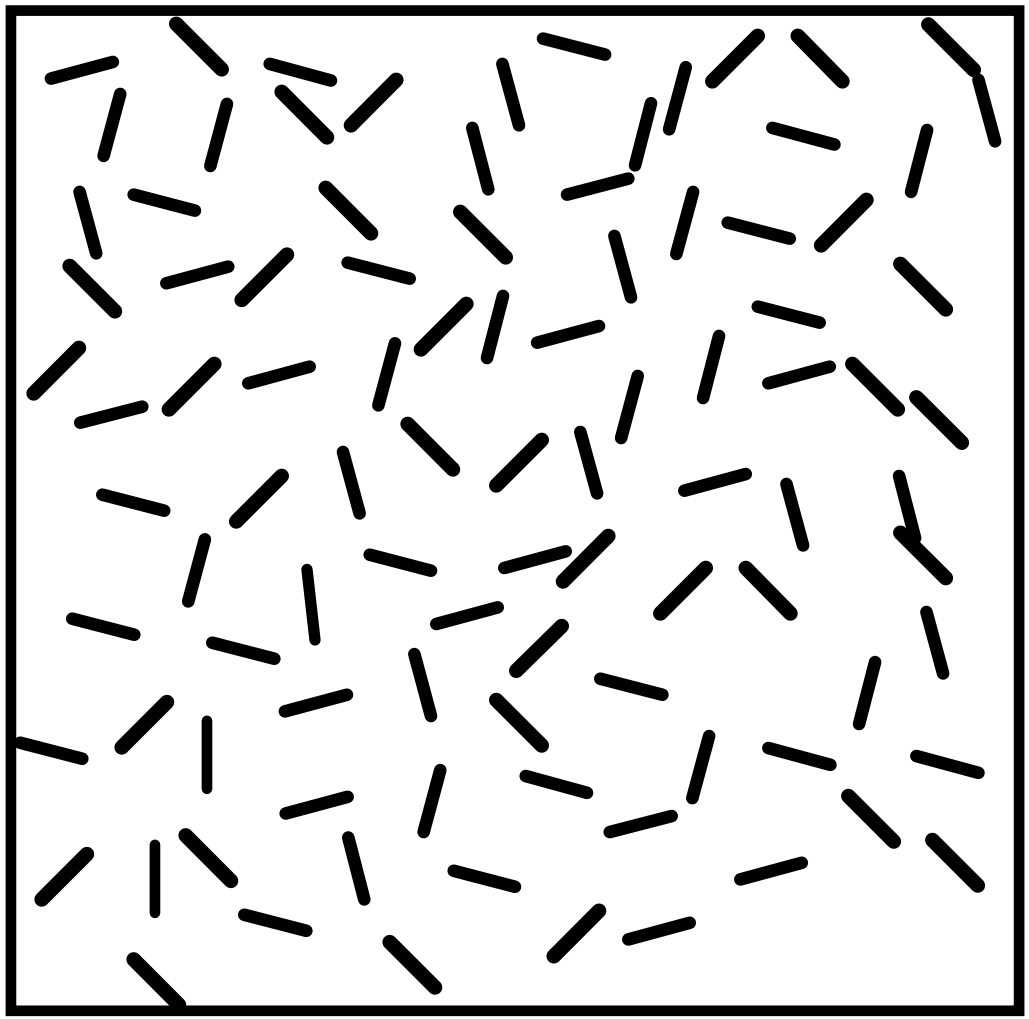
Go back

Vertical and Horizontal look the same?

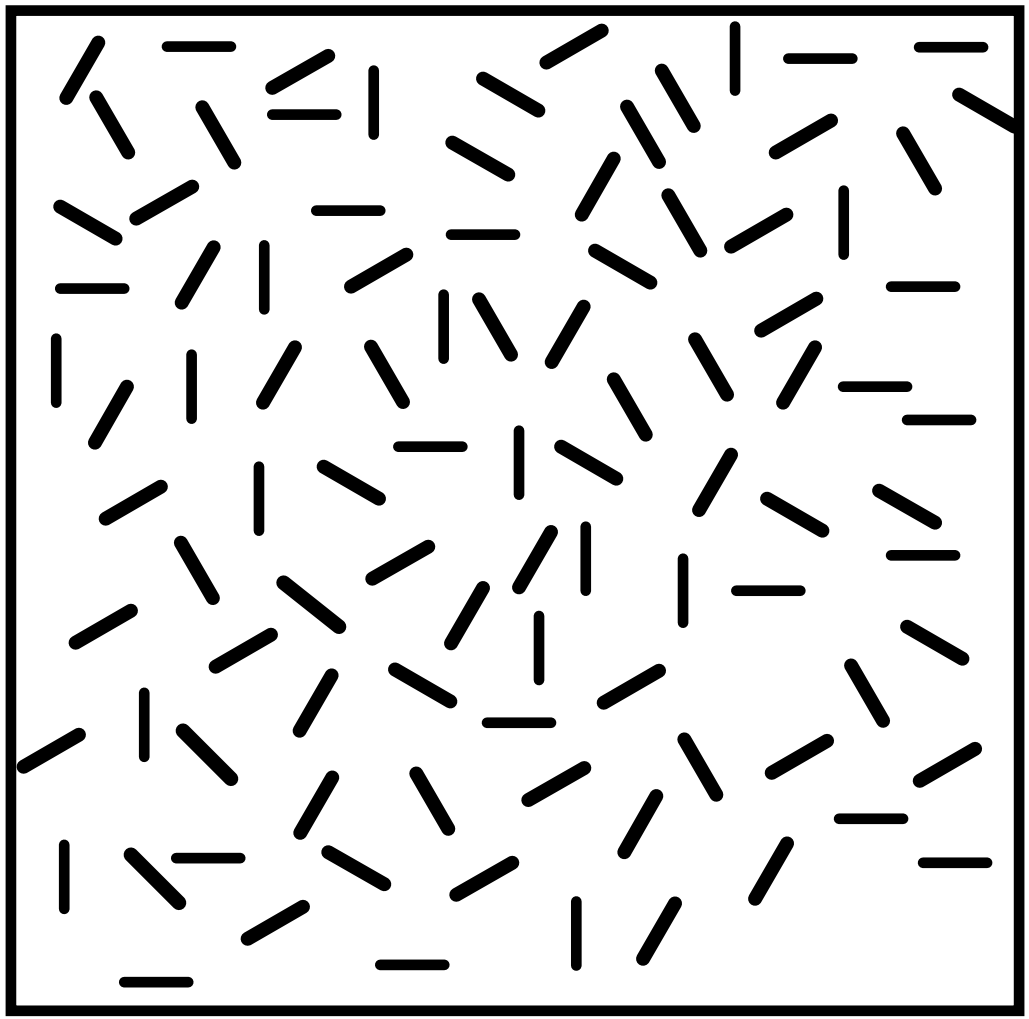


So, you found all these nice features…what is the problem?

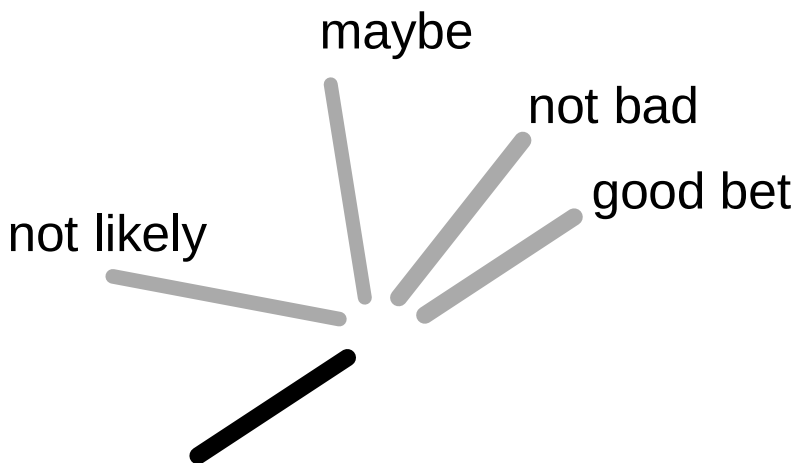
Which lines group together?

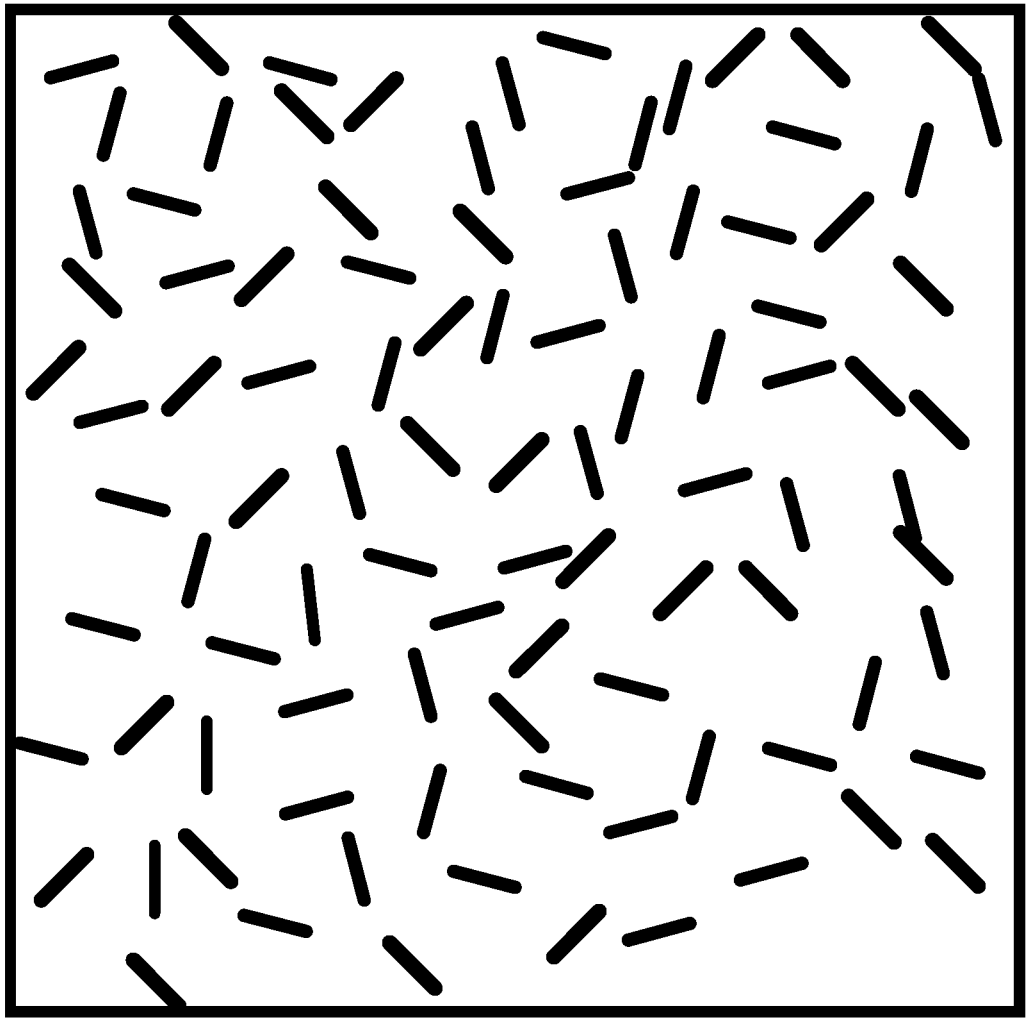


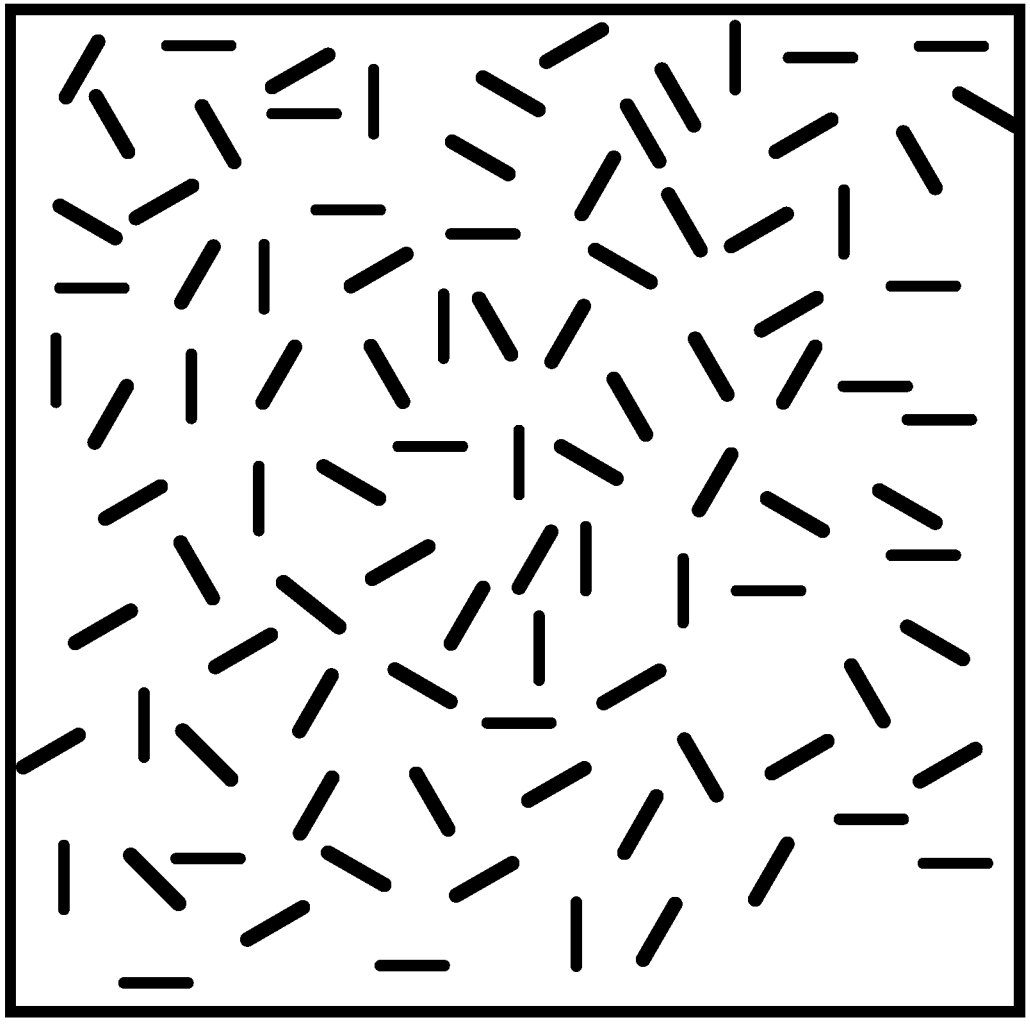
How about here? Why?

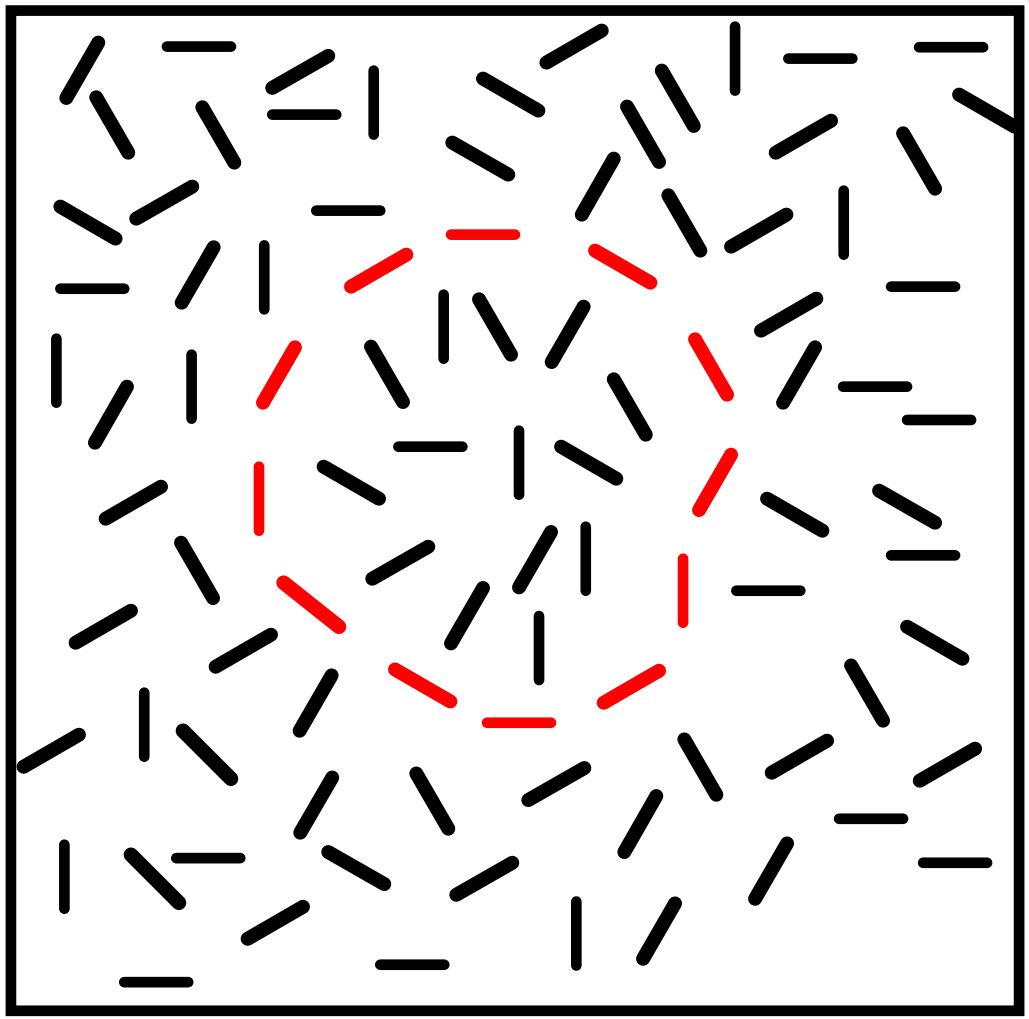


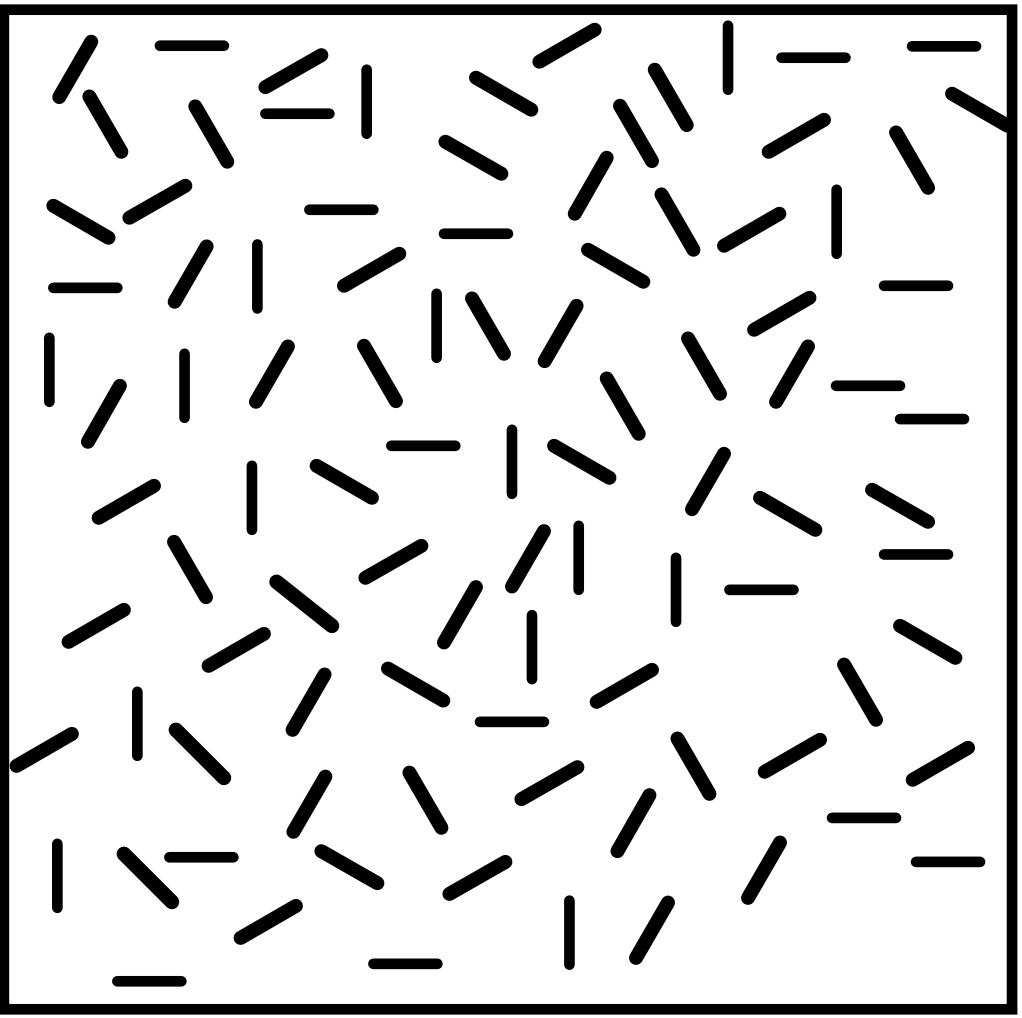
Which gray line is a likely continuation of the black line?











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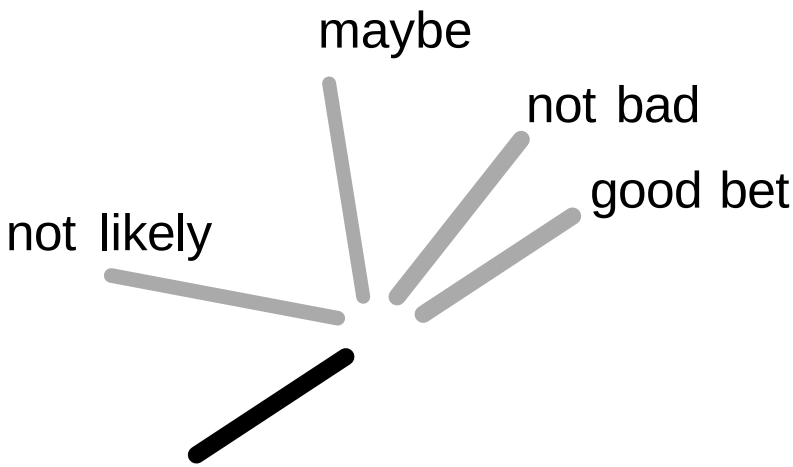
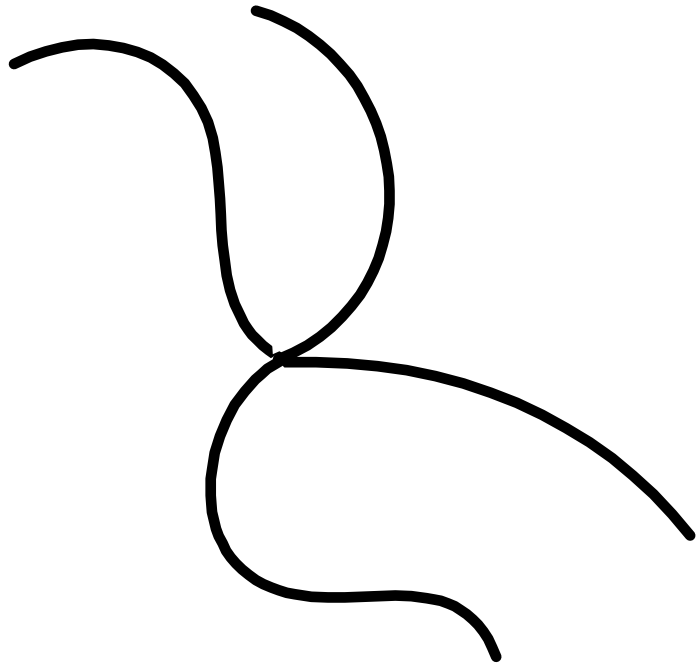
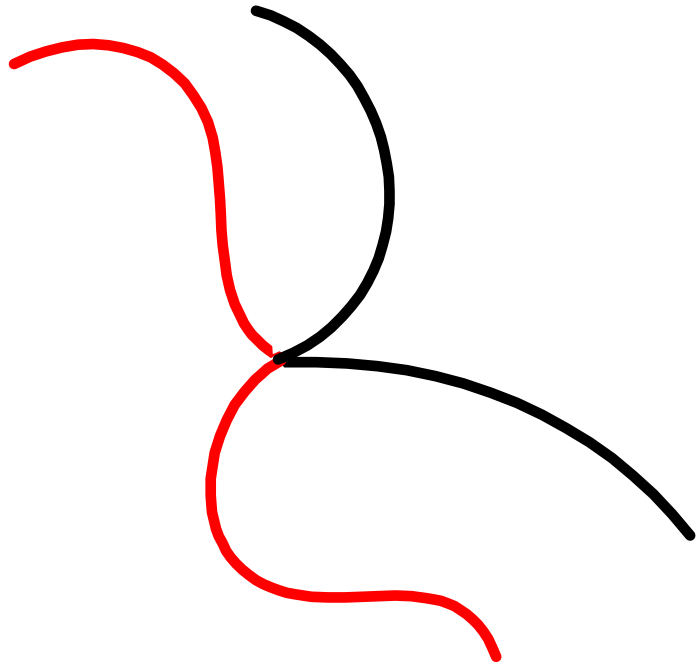


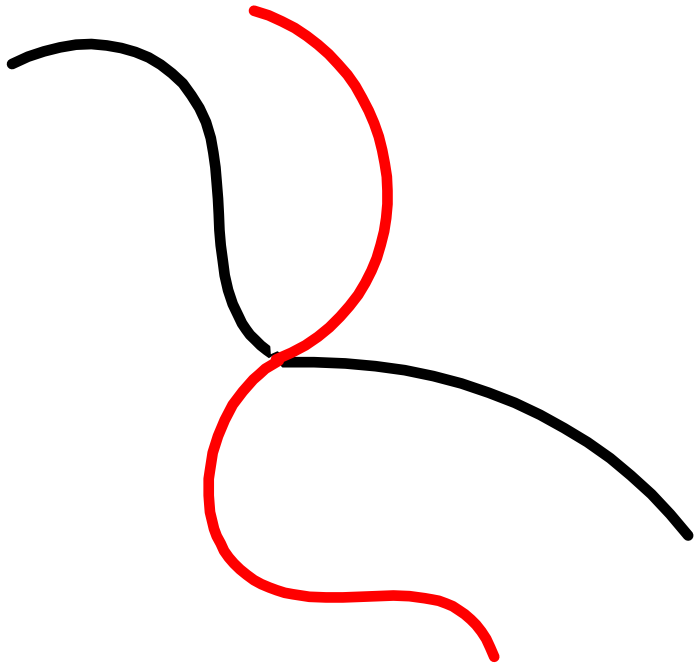
WHAT IS THIS?



Does this seem likely?

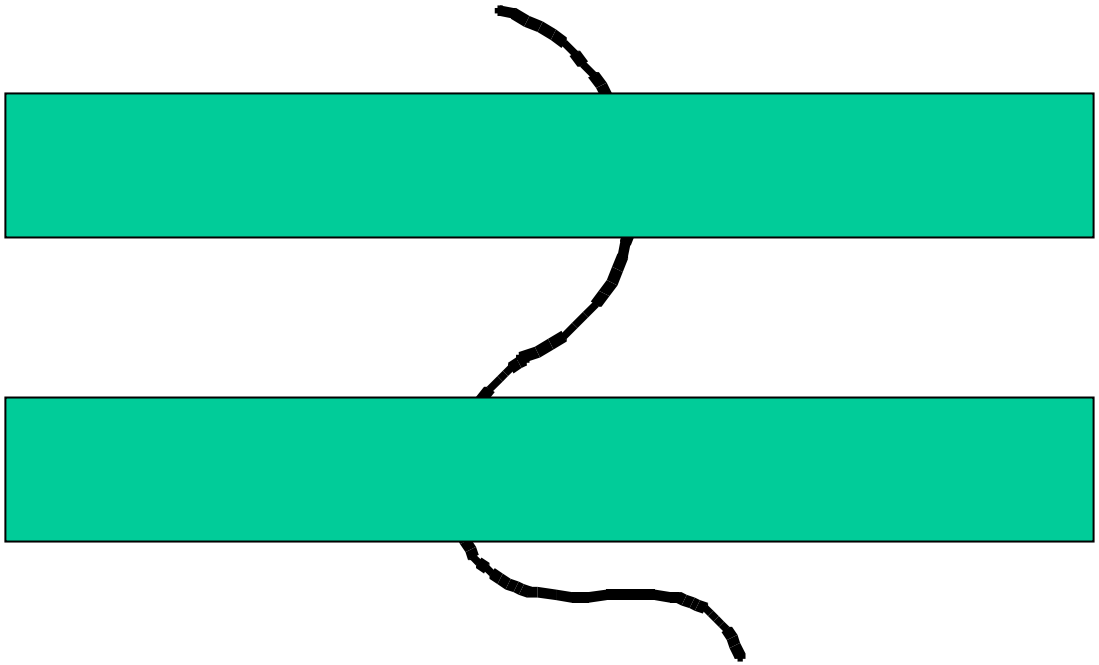


This seems more likely



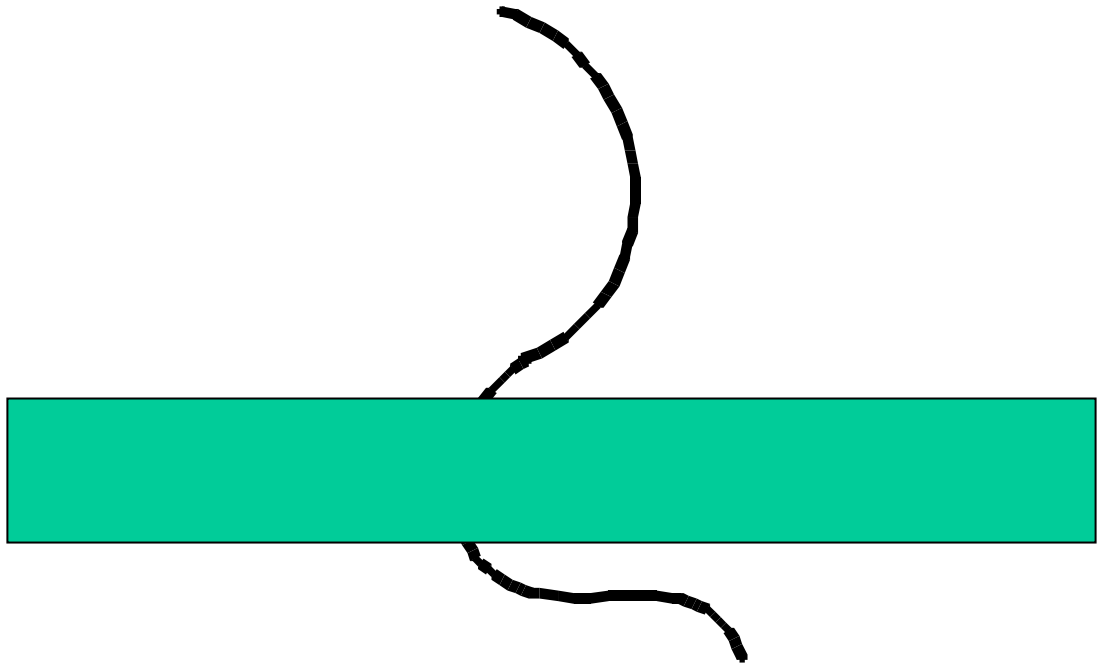
“Good continuation”

One curved line or three?



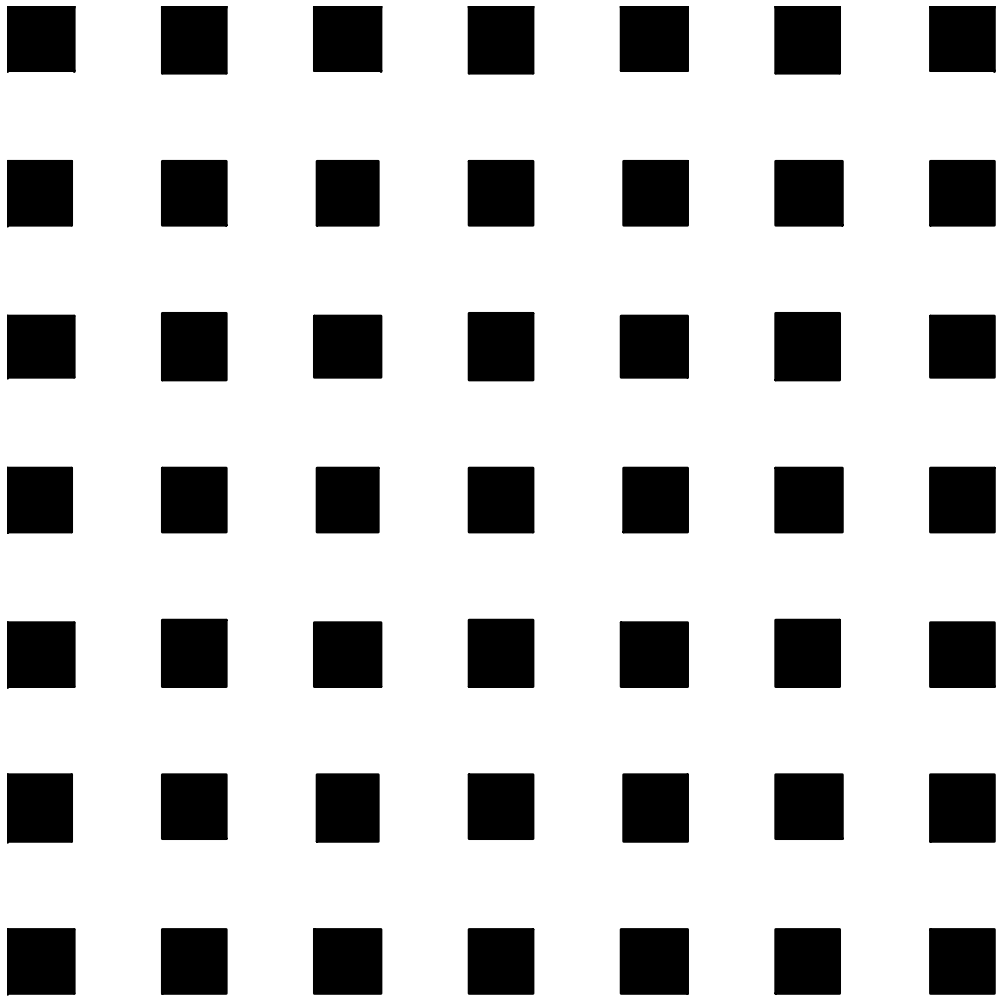
You ‘know’ about occlusion

One curved line or three?

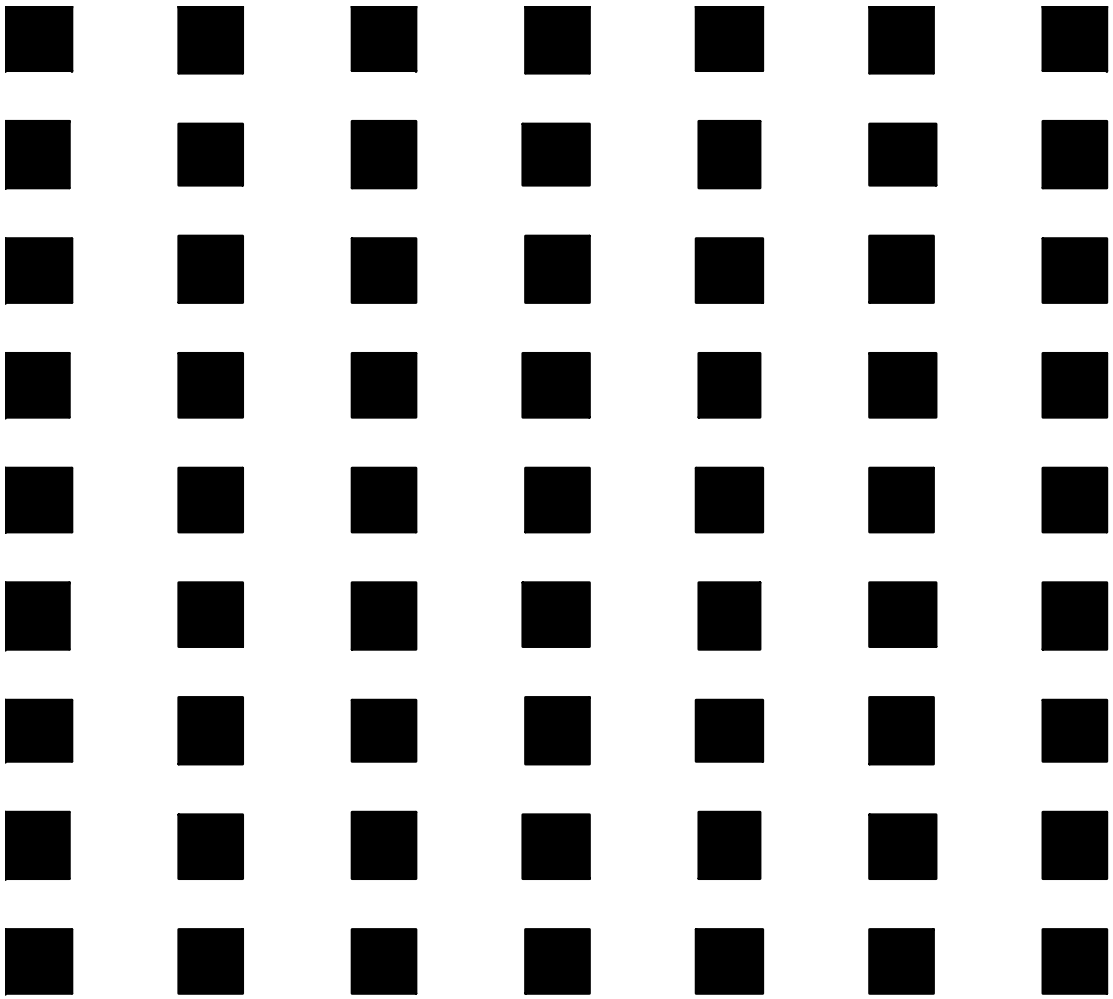


You ‘know’ about occlusion

Organized by columns or rows?

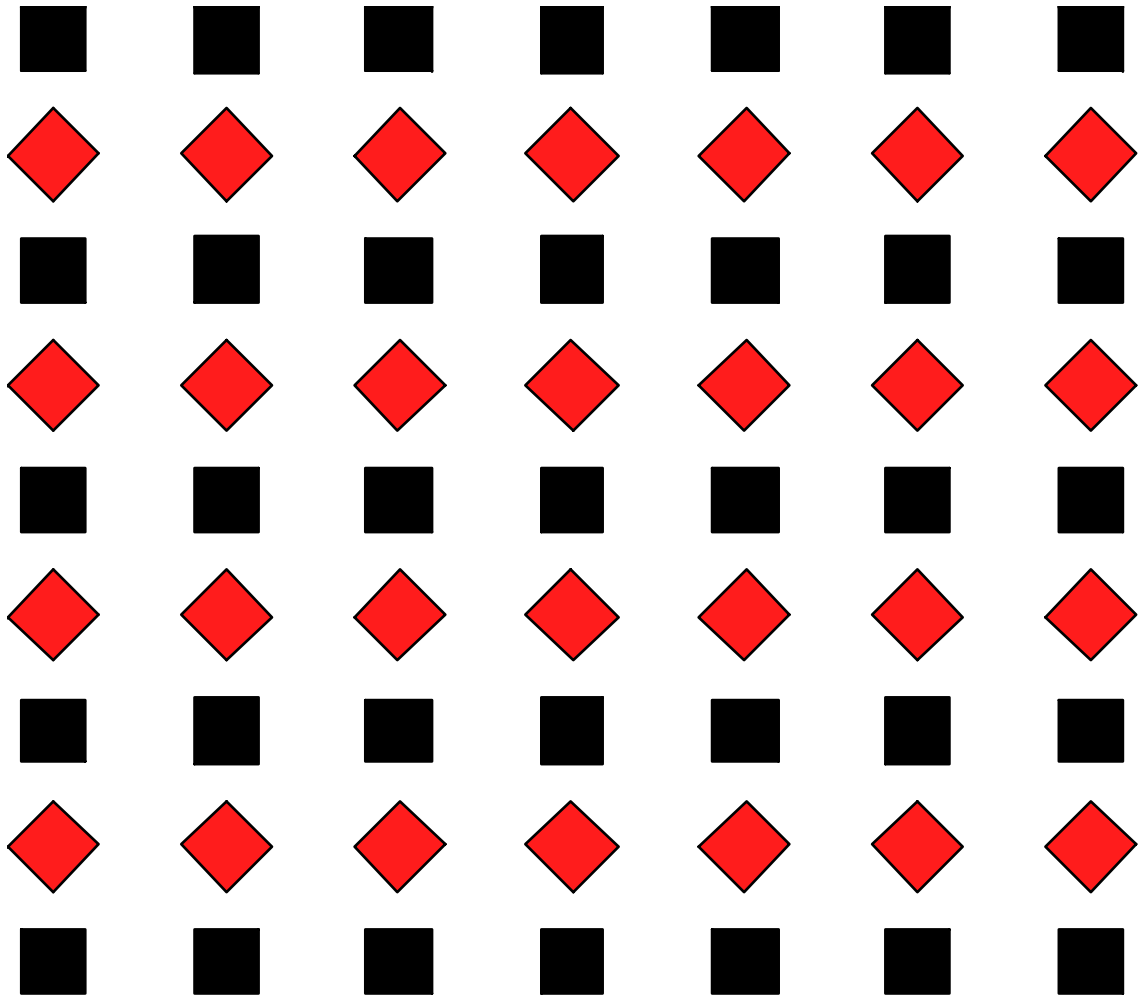


Now? Organized by columns or rows? Why?

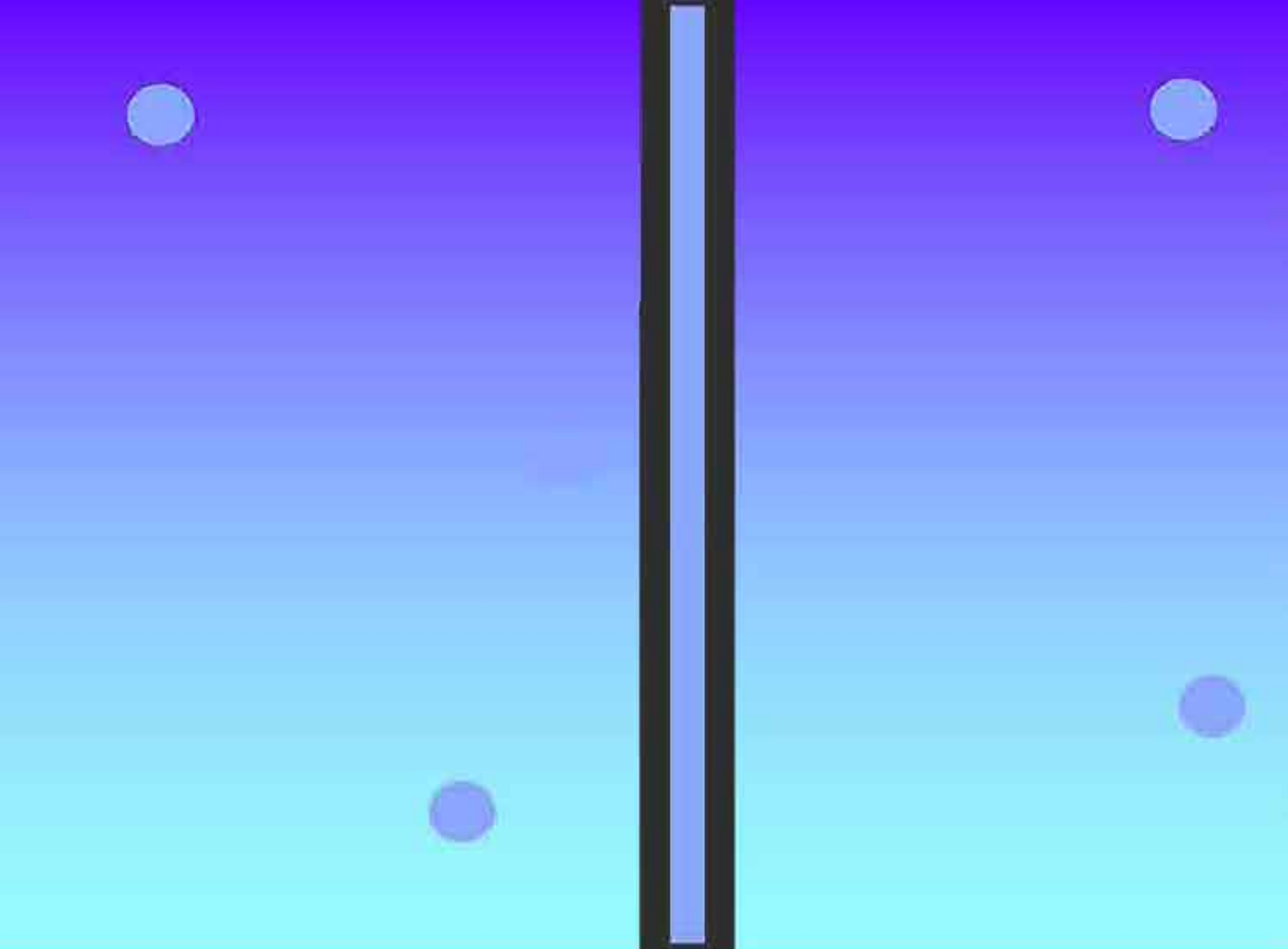


Proximity

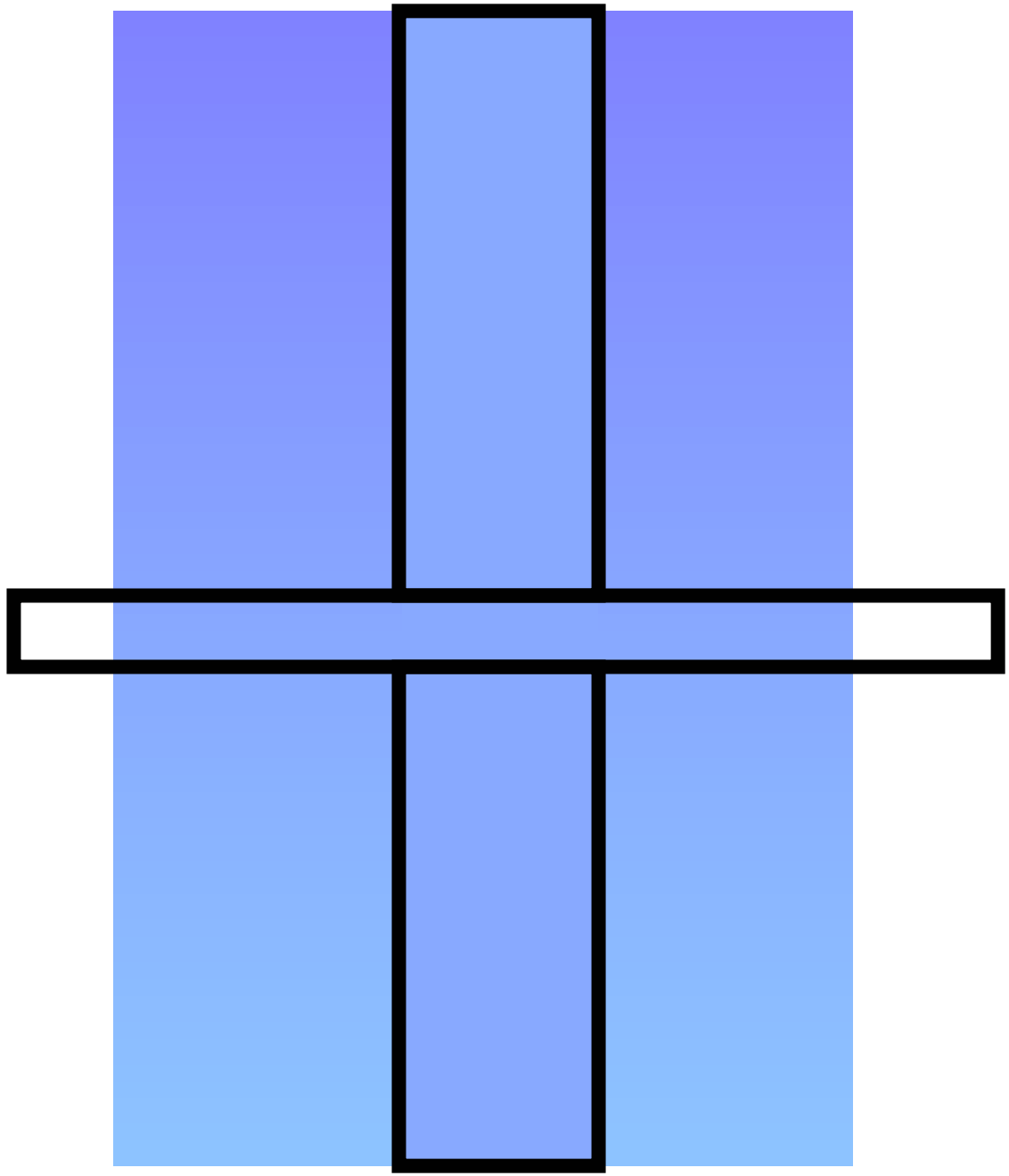
Now? Organized by columns or rows? Why?



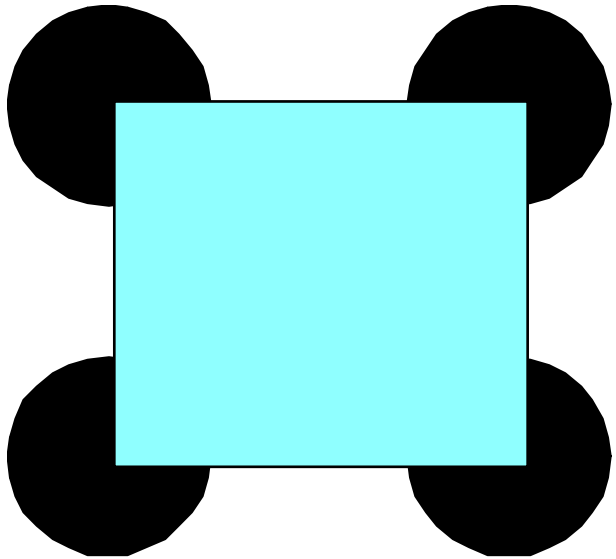
Did Similarity trump Proximity?



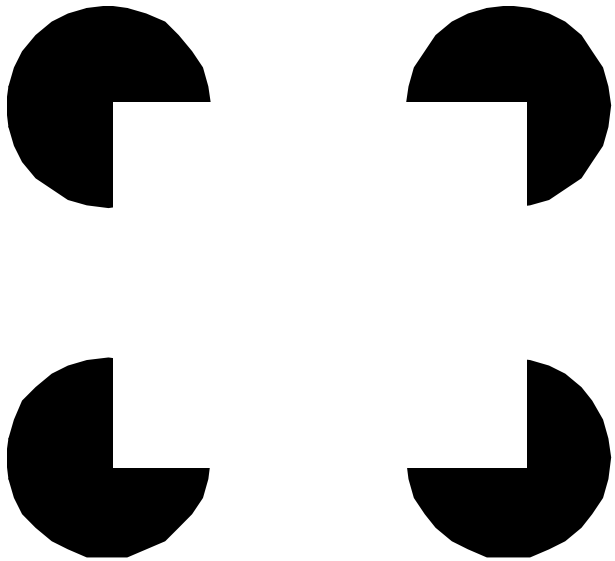
Let’s magnify the critical bit.



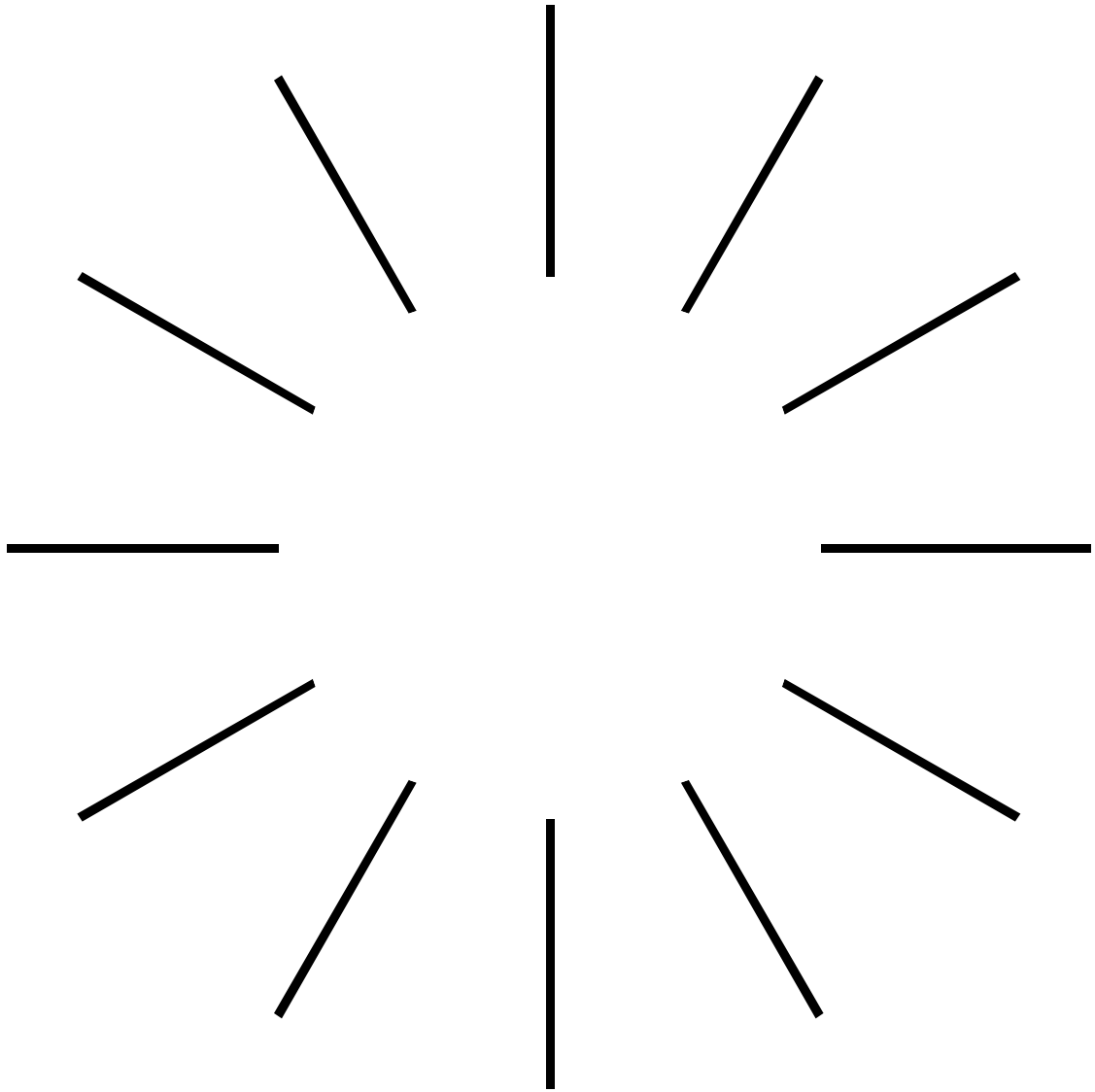
See that rectangle?



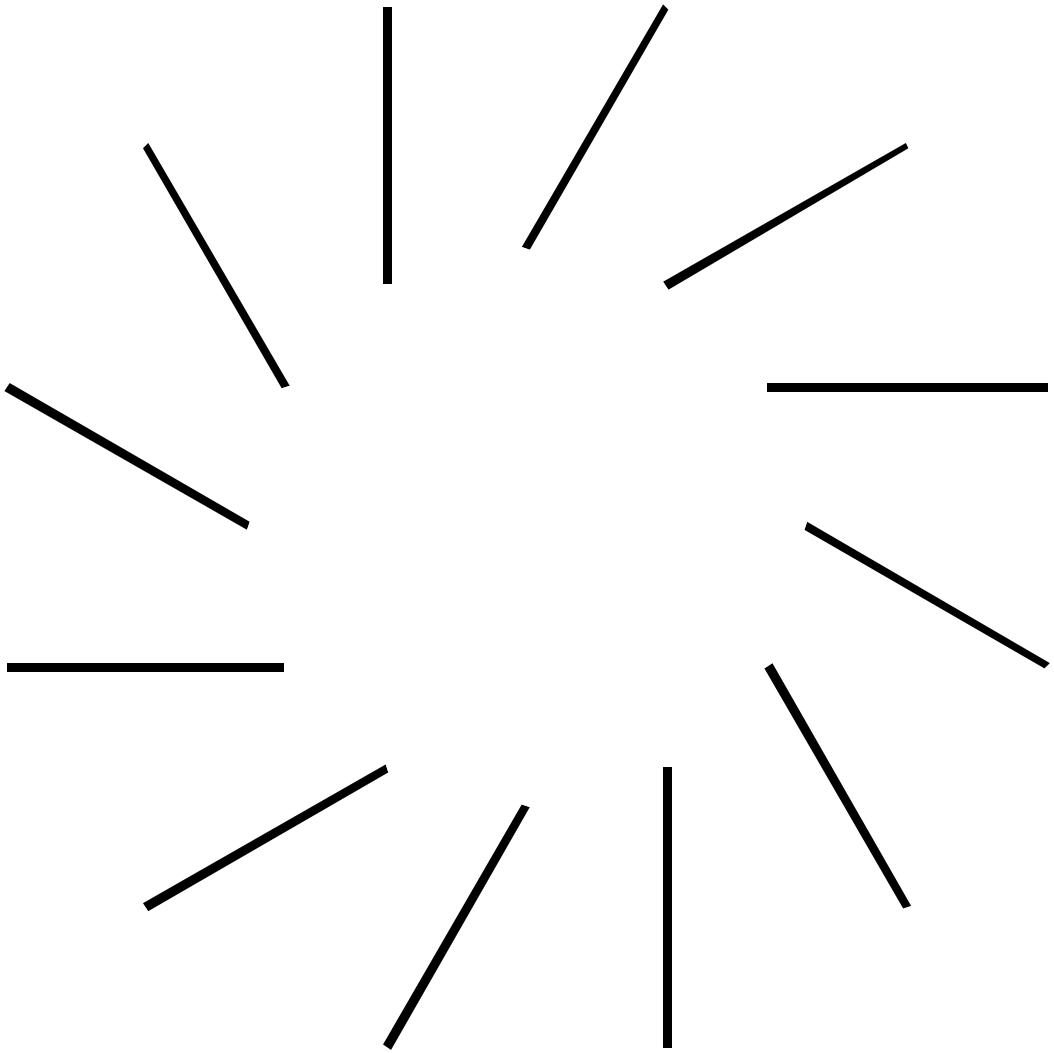
How about that rectangle?



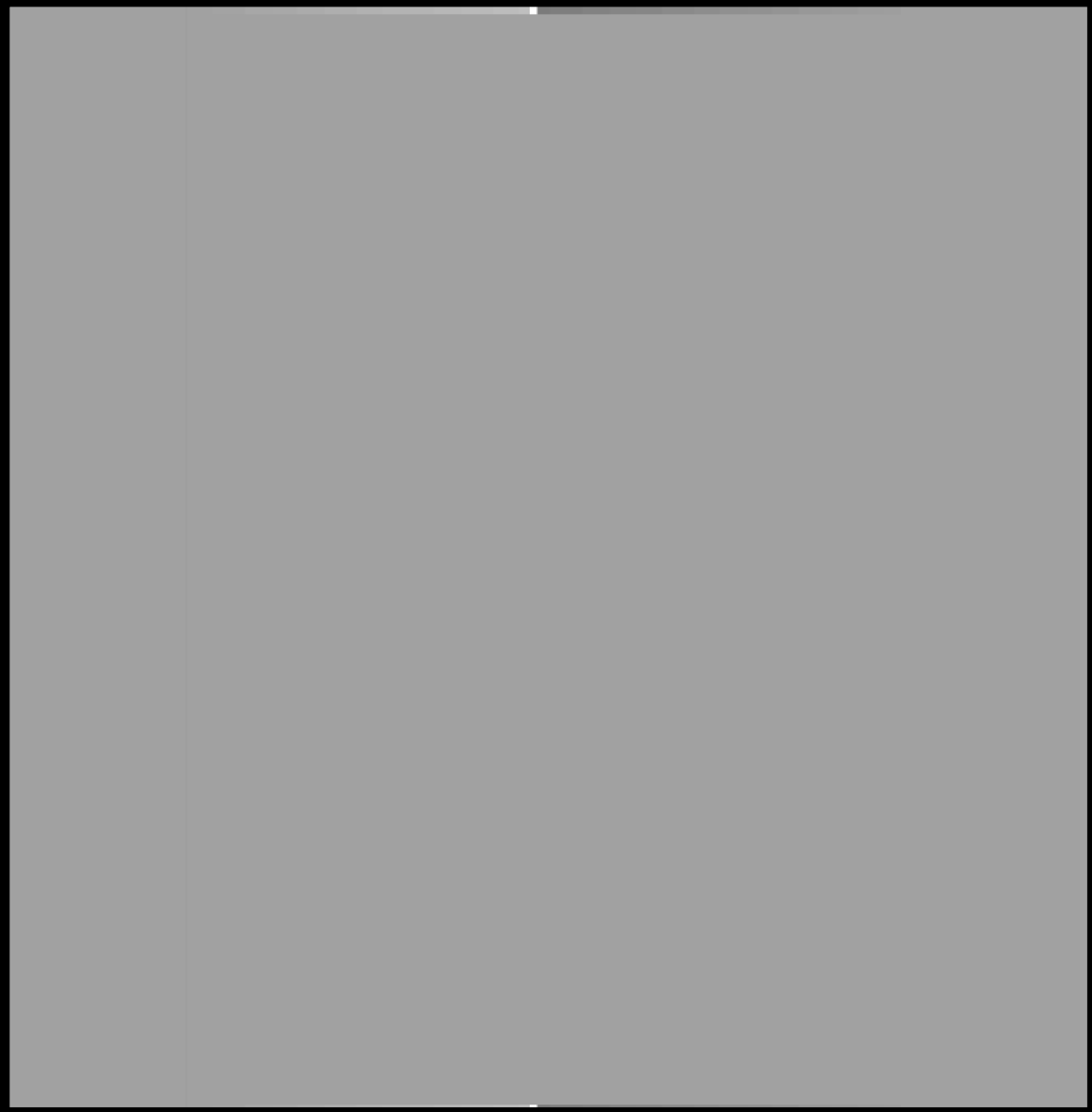
How about that circle?



Not as good?



Edges are important



The visual system distinguishes “real” edges from shadows

Image removed for copyright reasons.

Remember: You want to know about the world, not your retina

cow

Minimal shadow can give you faces

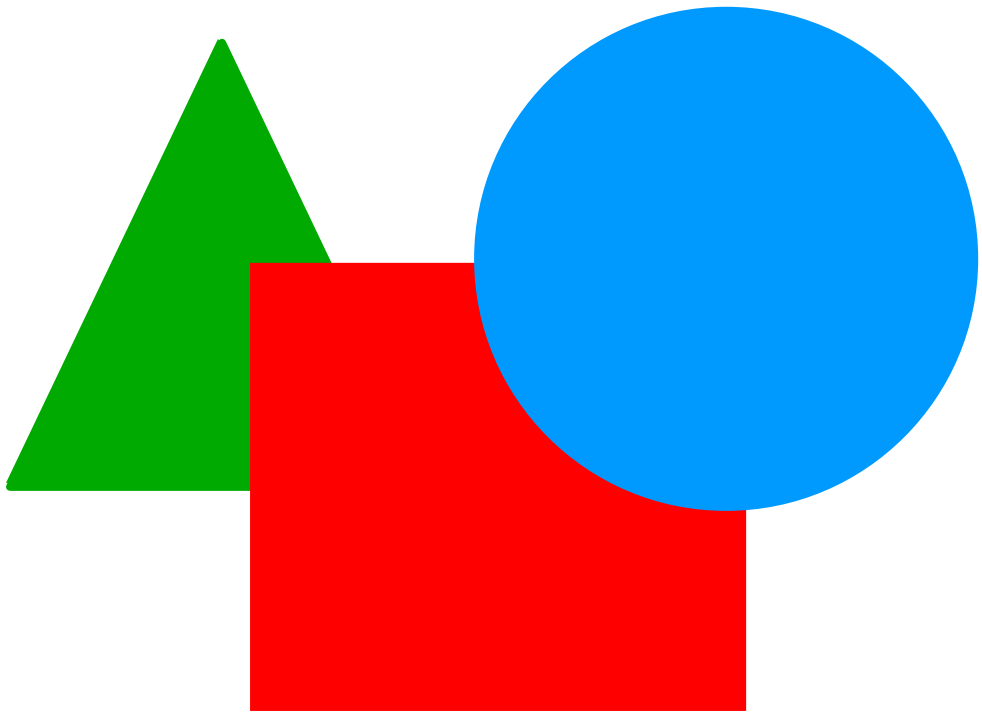
Images removed for copyright reasons.
Faces from University of Bielefeld Cognitive Robot project.

Depth Cues

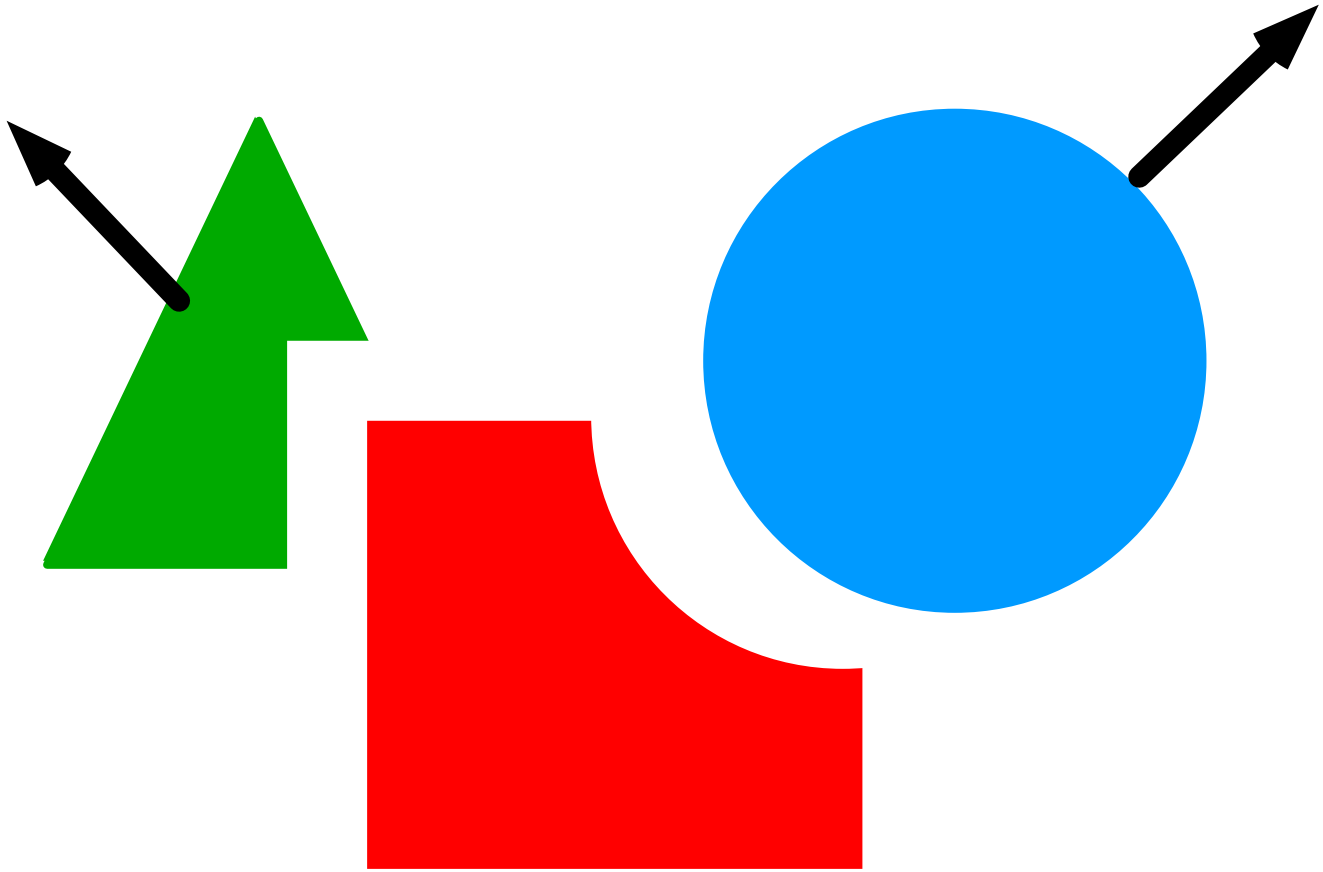
From 2D-3D

Image removed for copyright reasons.

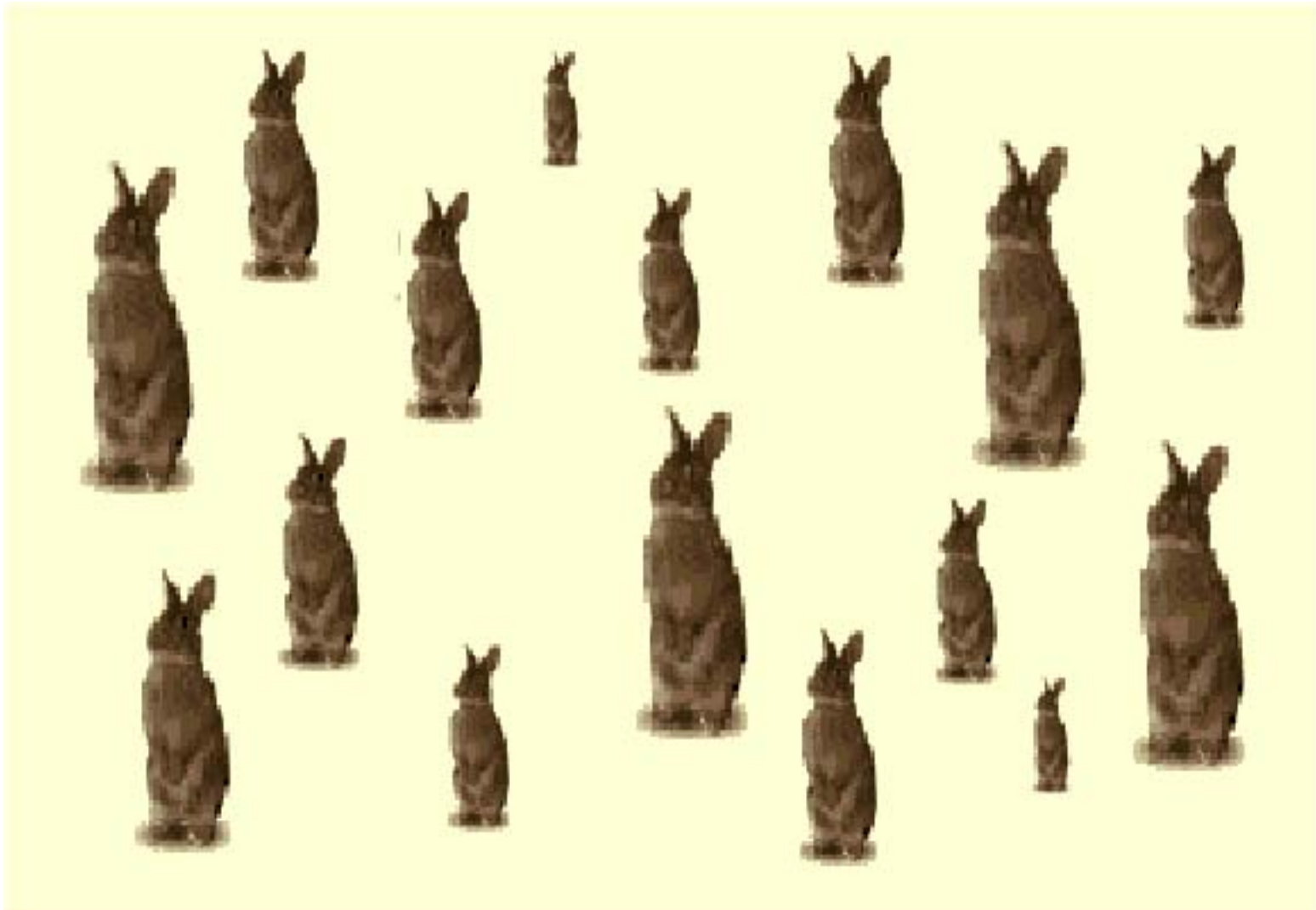
Occlusion



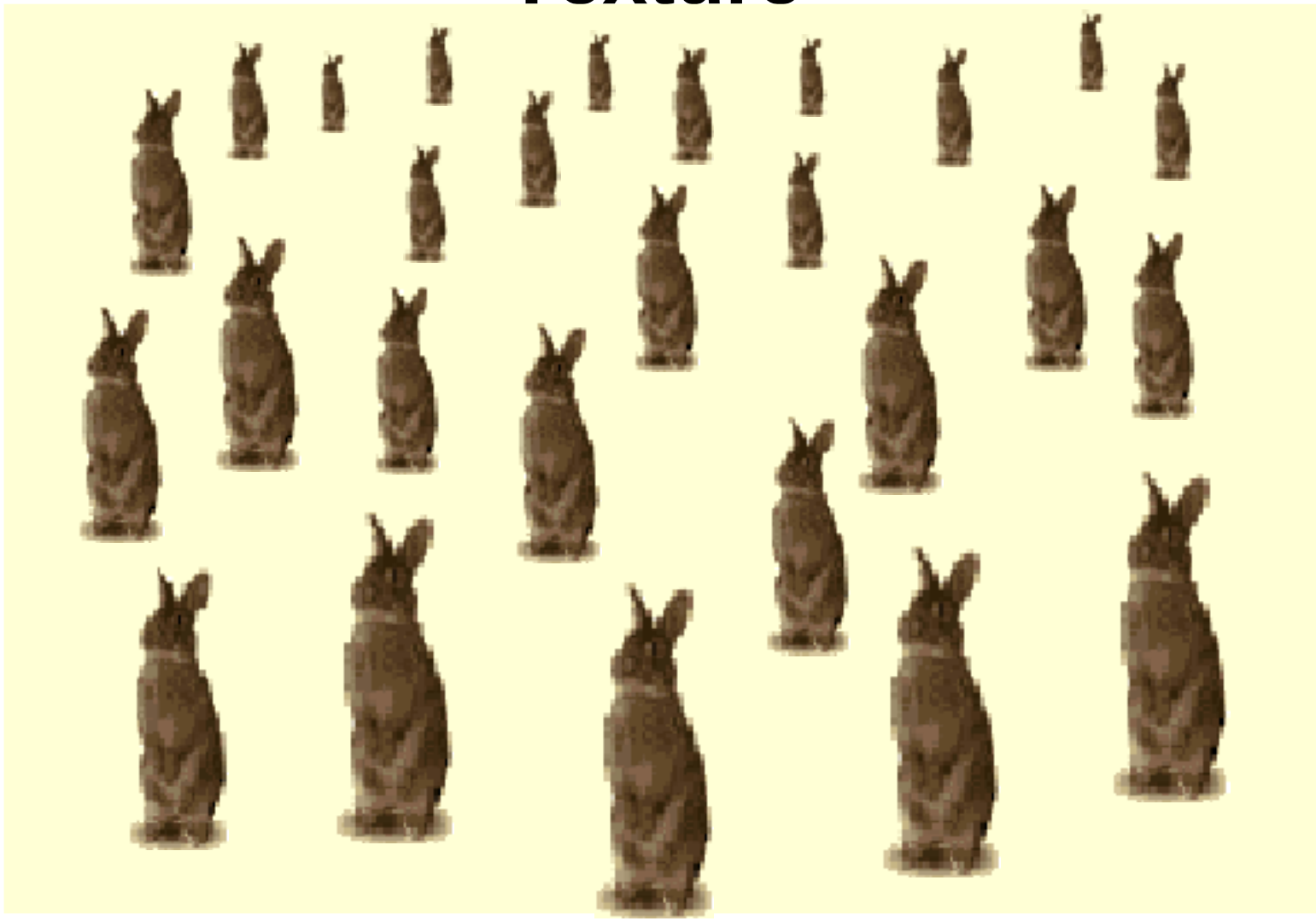
Is this likely?



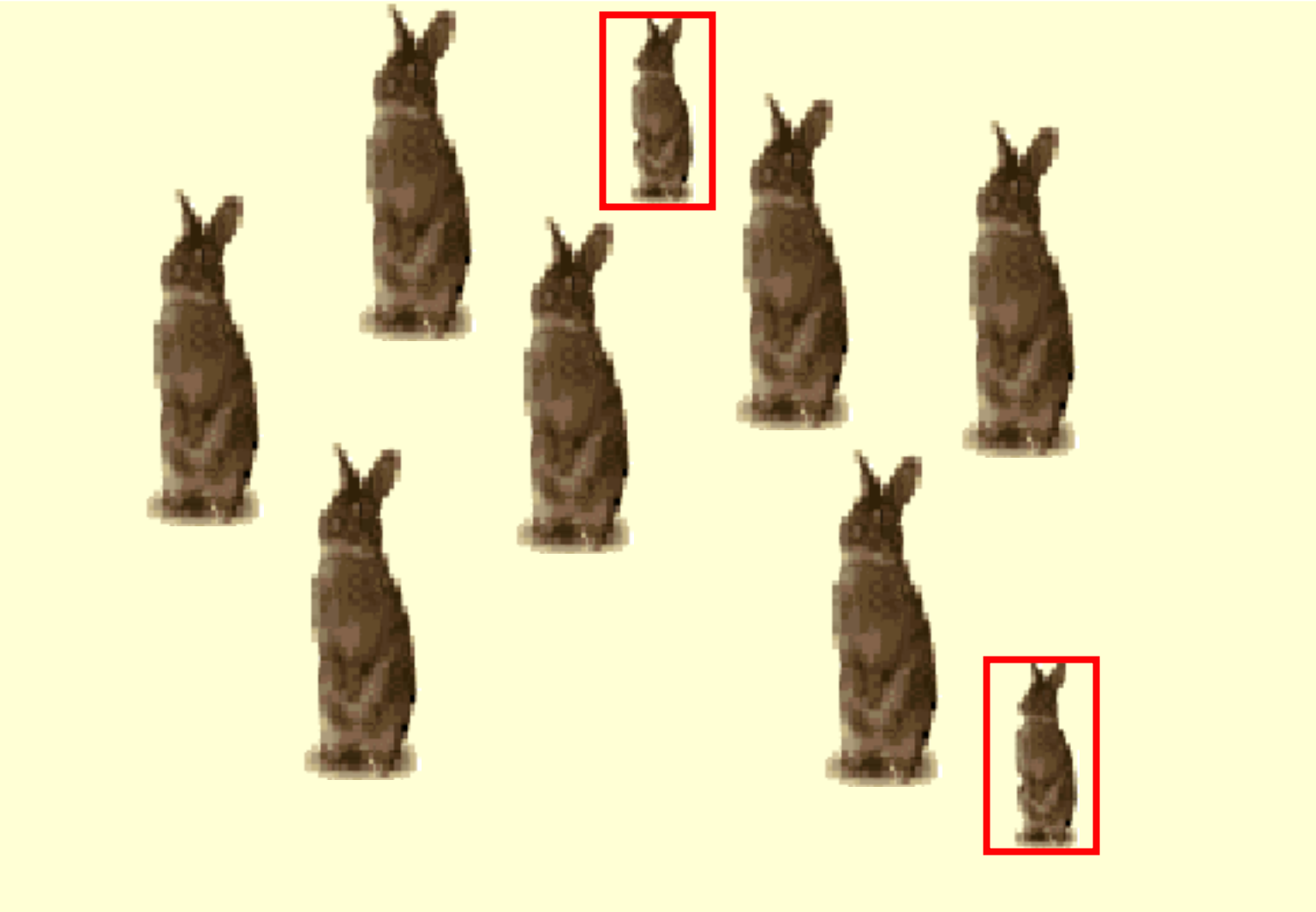
Size



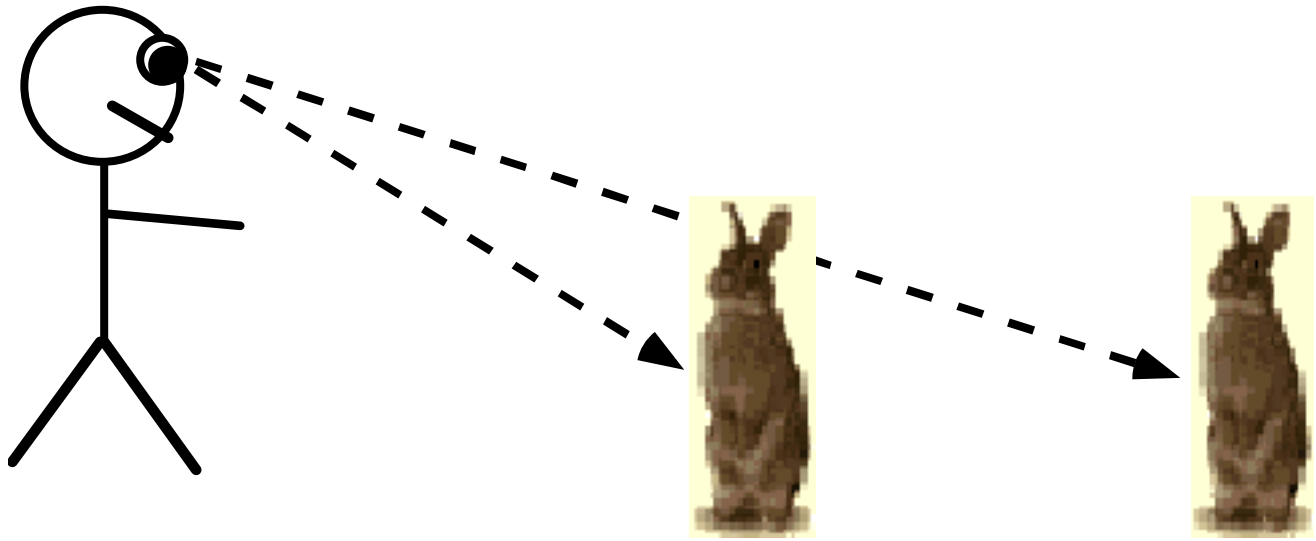
Texture



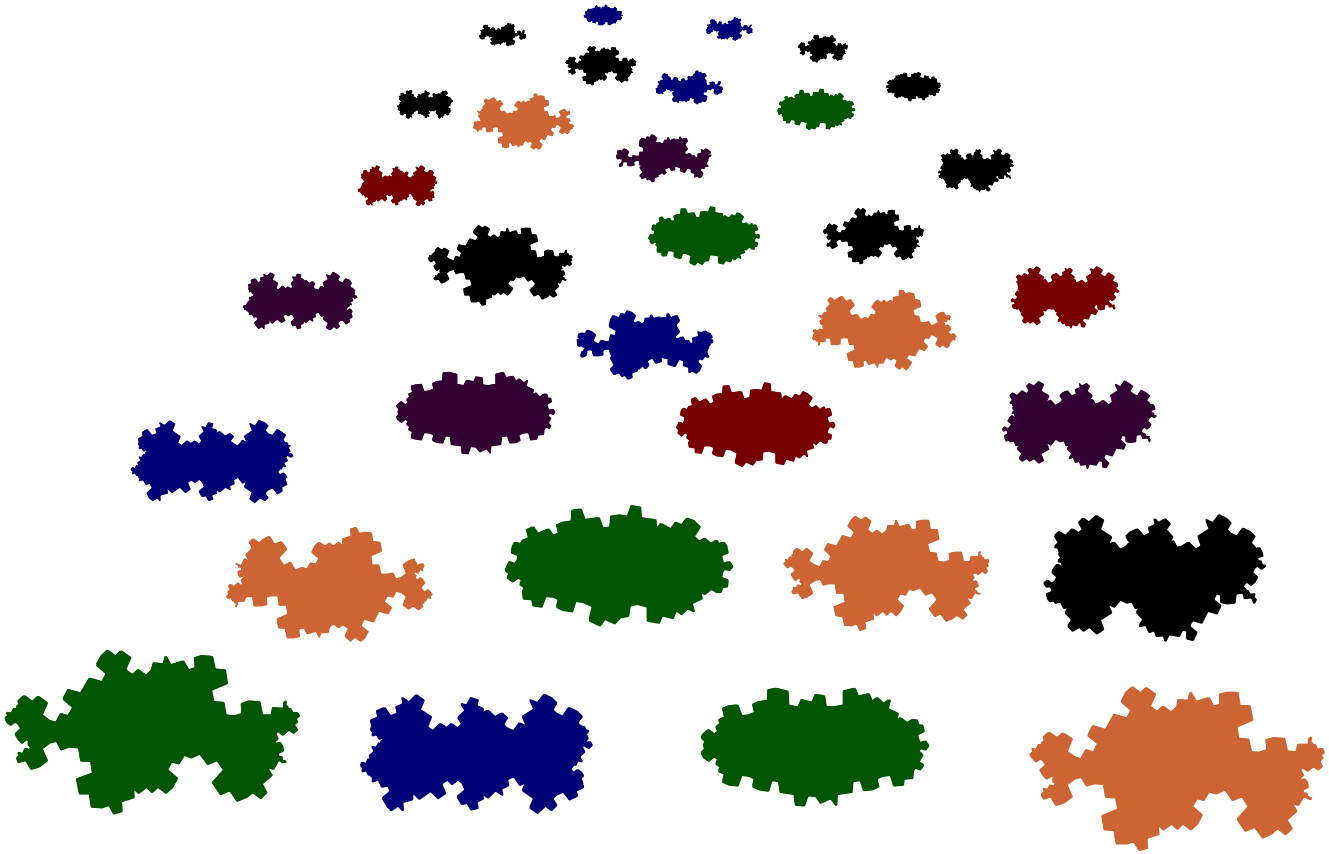
Relative position (height in field)



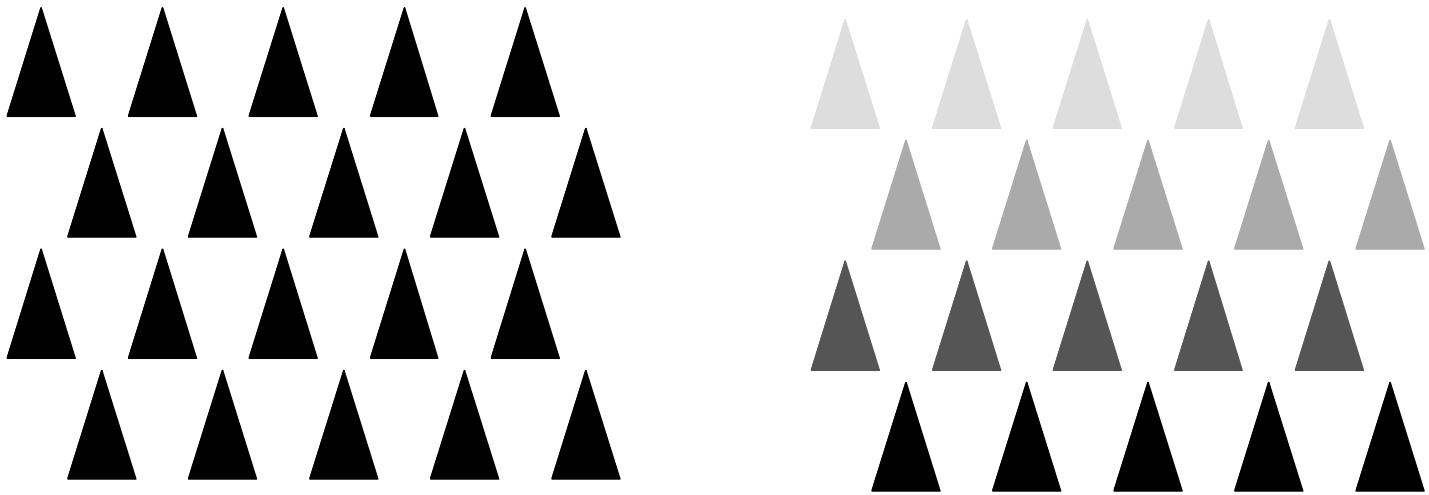
Here is why it works



You don’t need to recognize the objects

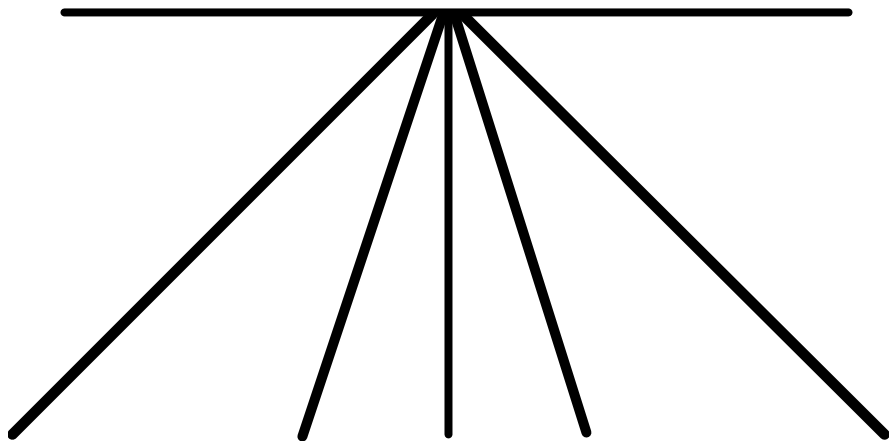


Areal Perspective (haze)



The misty mountains far away

Linear Perspective



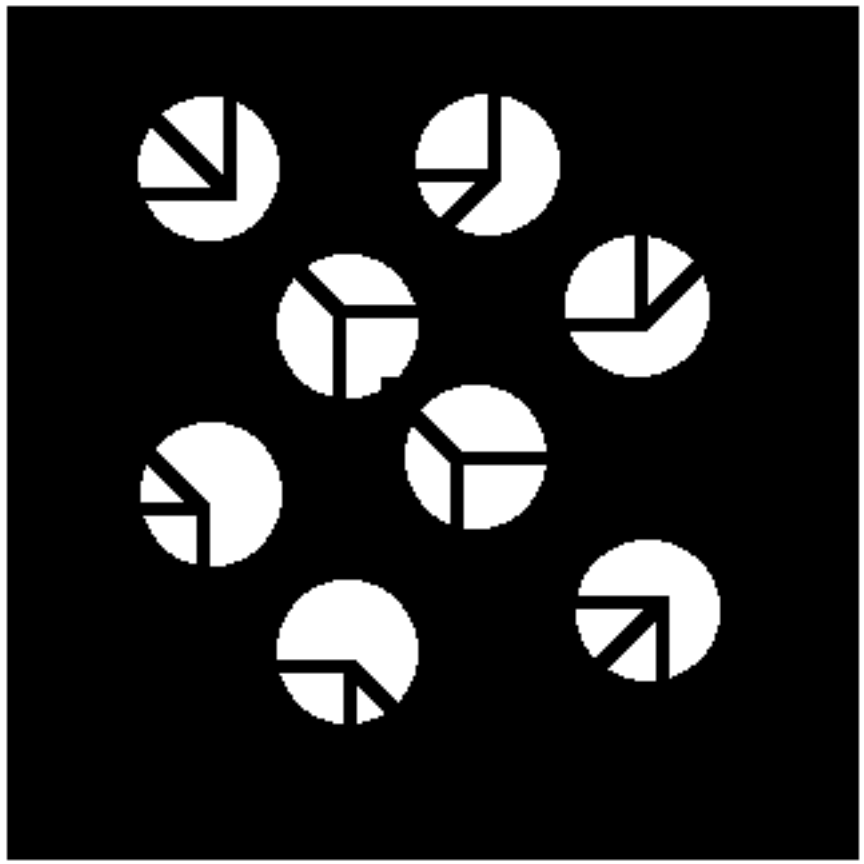
Vanishing point

Linear Perspective?

Image removed for
copyright reasons.

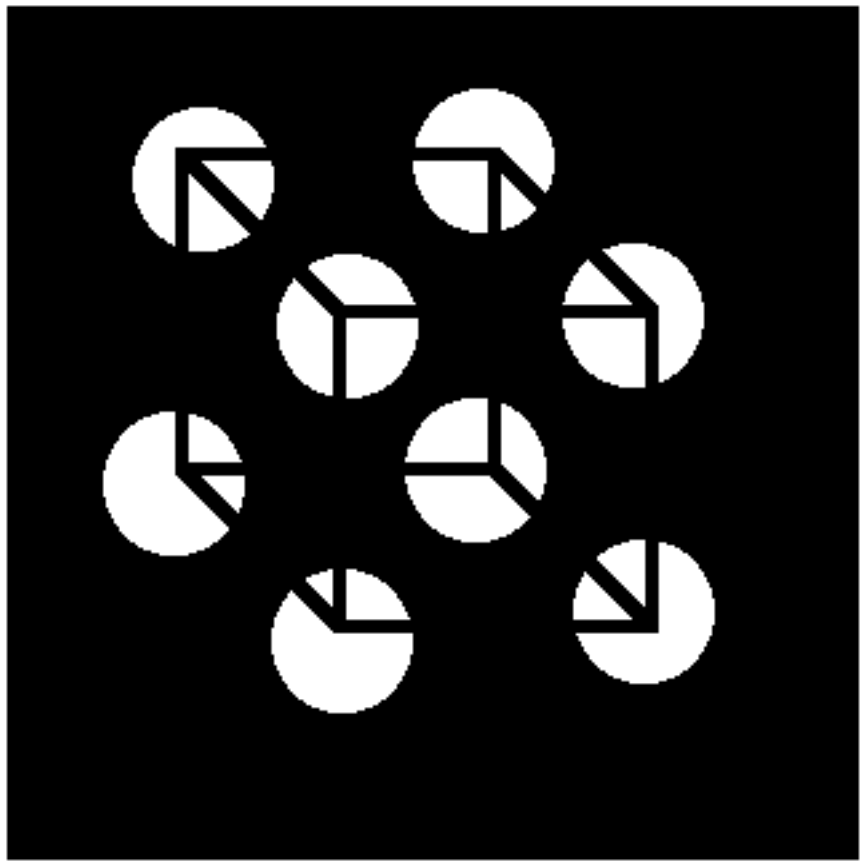
Where is the vanishing point?

Linear Perspective?



These local bits don’t add up

Linear Perspective?



These add up…ambiguously

Shadows

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But where is the sun?

And let’s not forget

Stereopsis,
Vergence,
and
Motion parallax