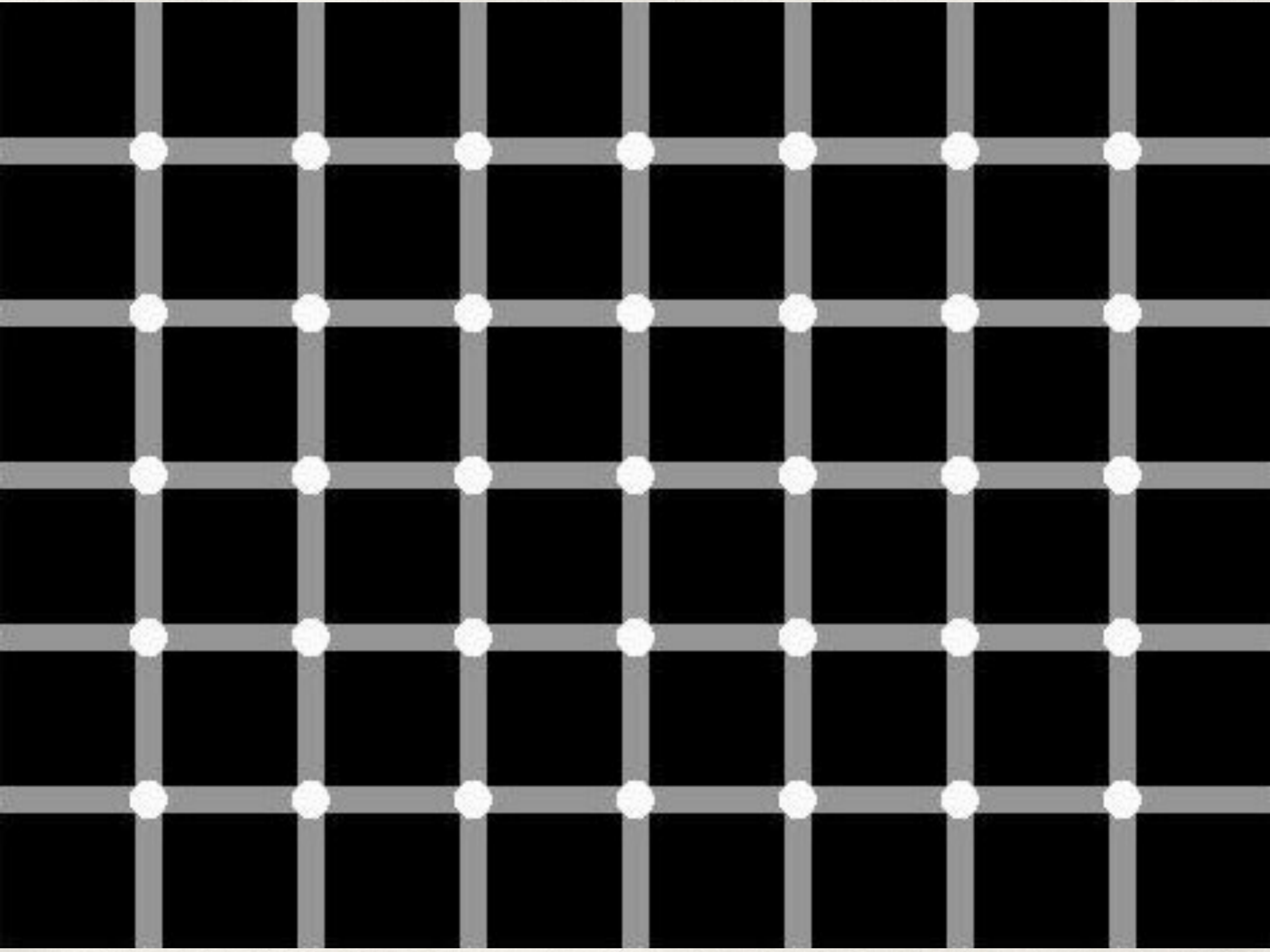


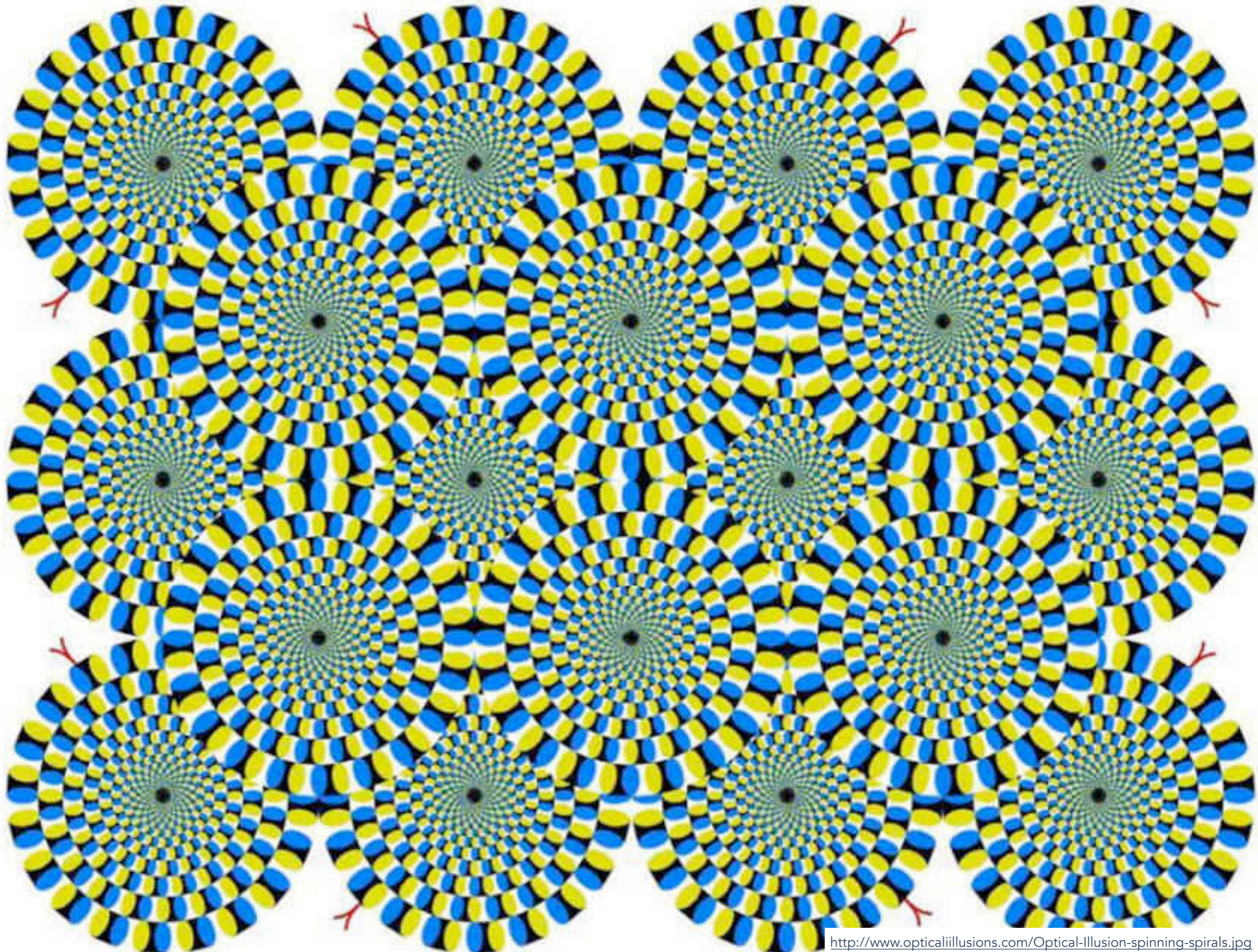
# Perception

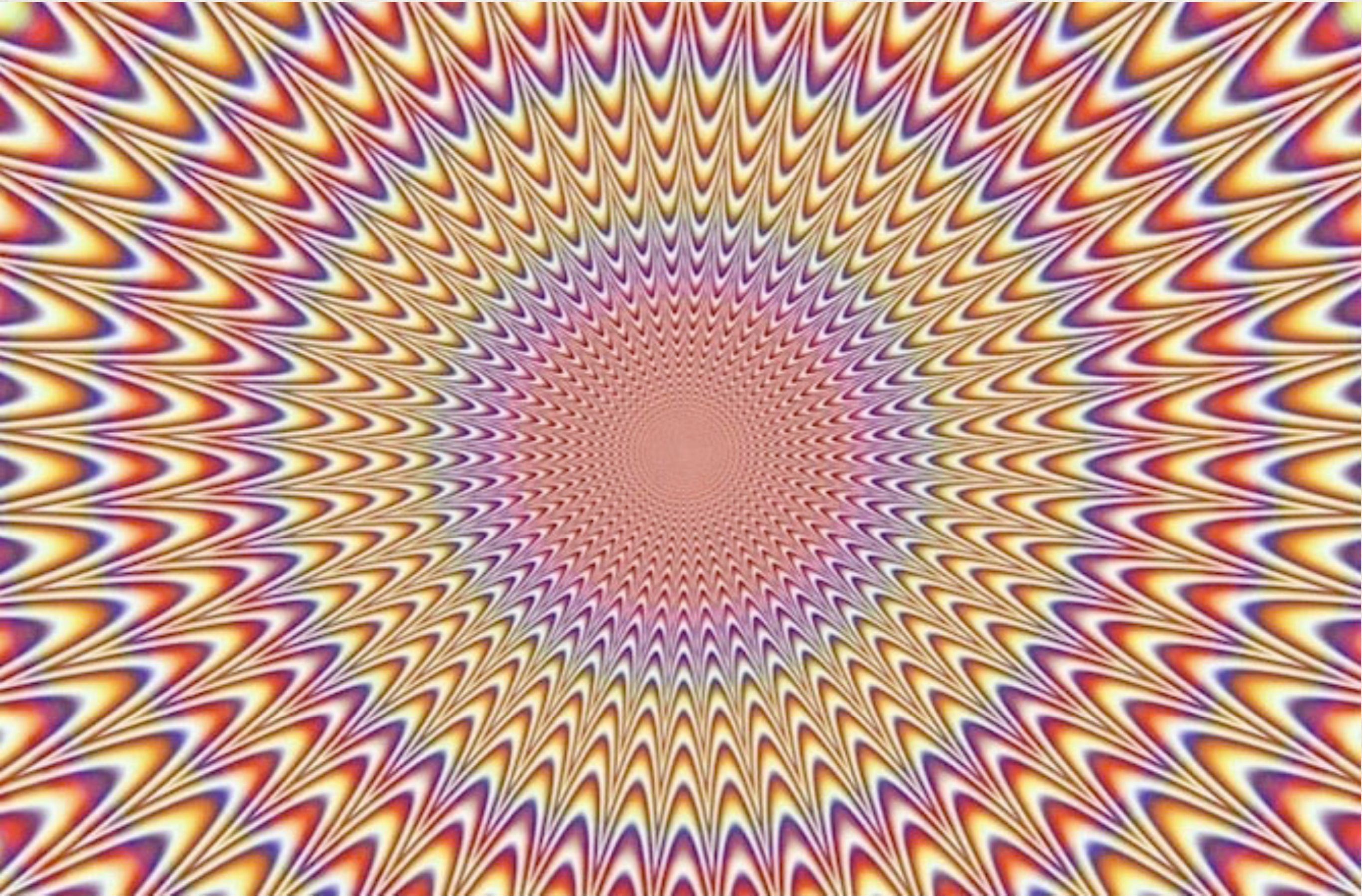
C. Andrews

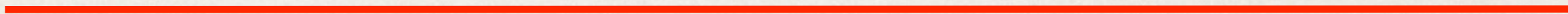
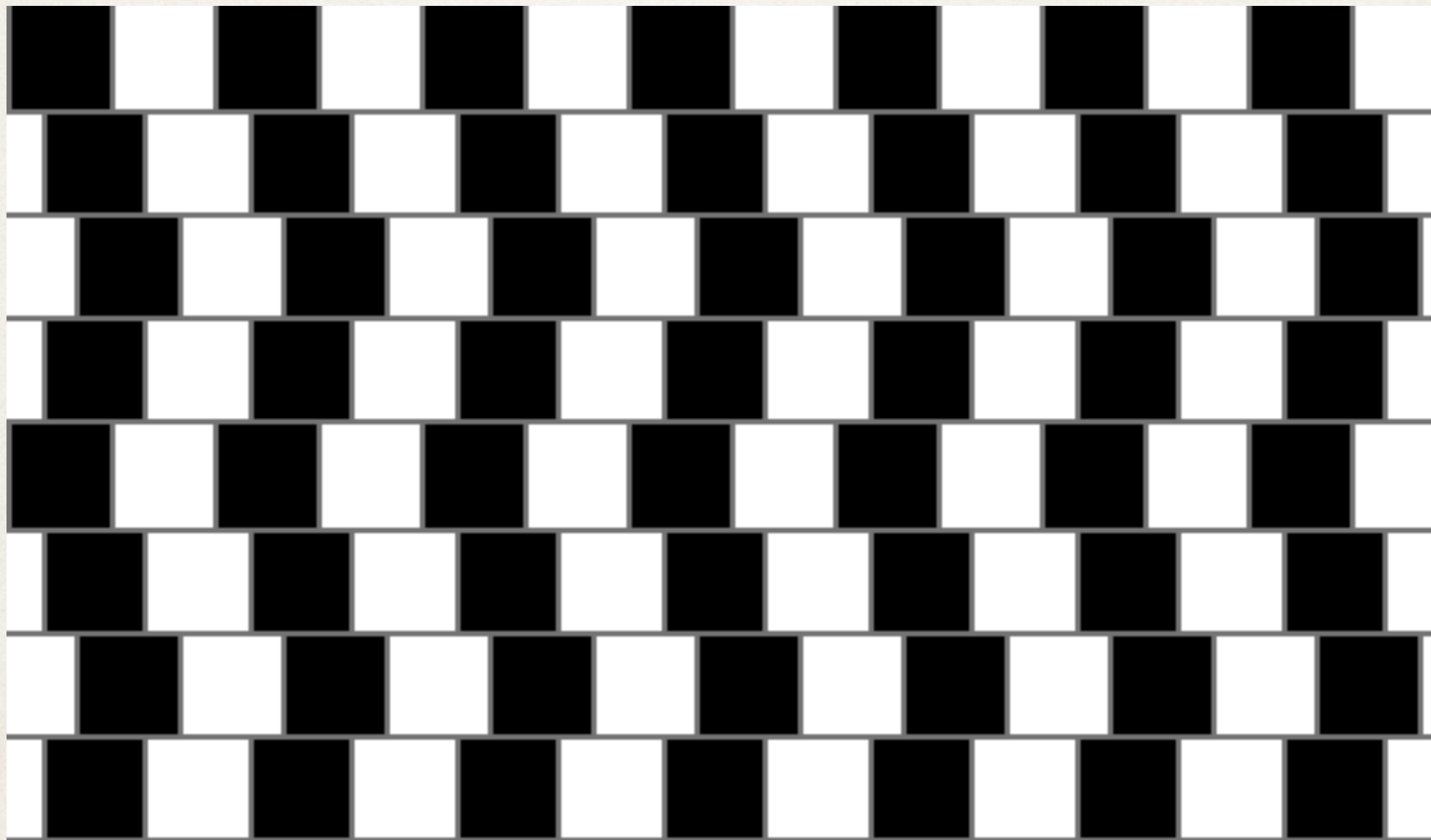
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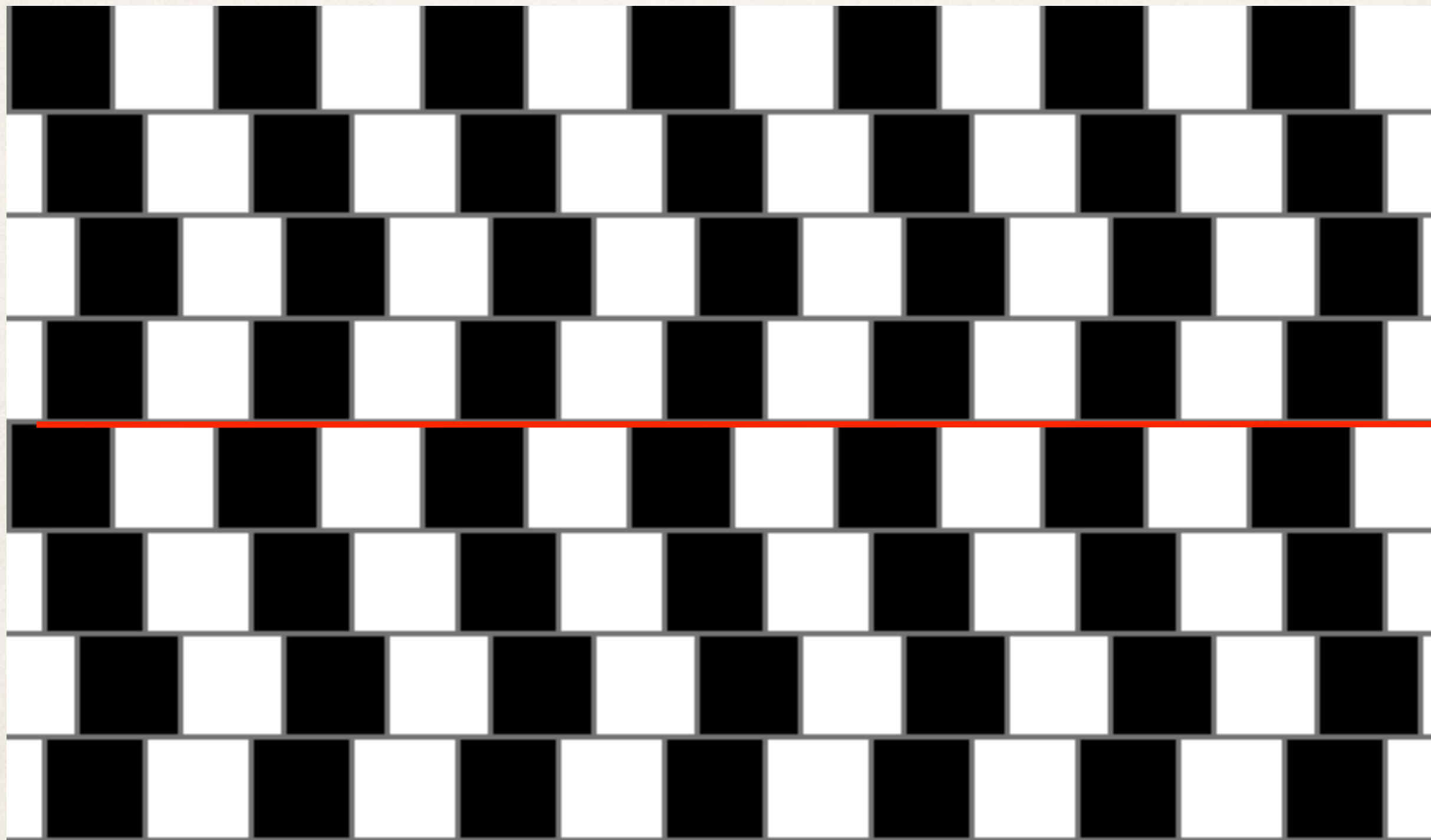
2016-02-22













"My wife and mother in law", W.E. Hill

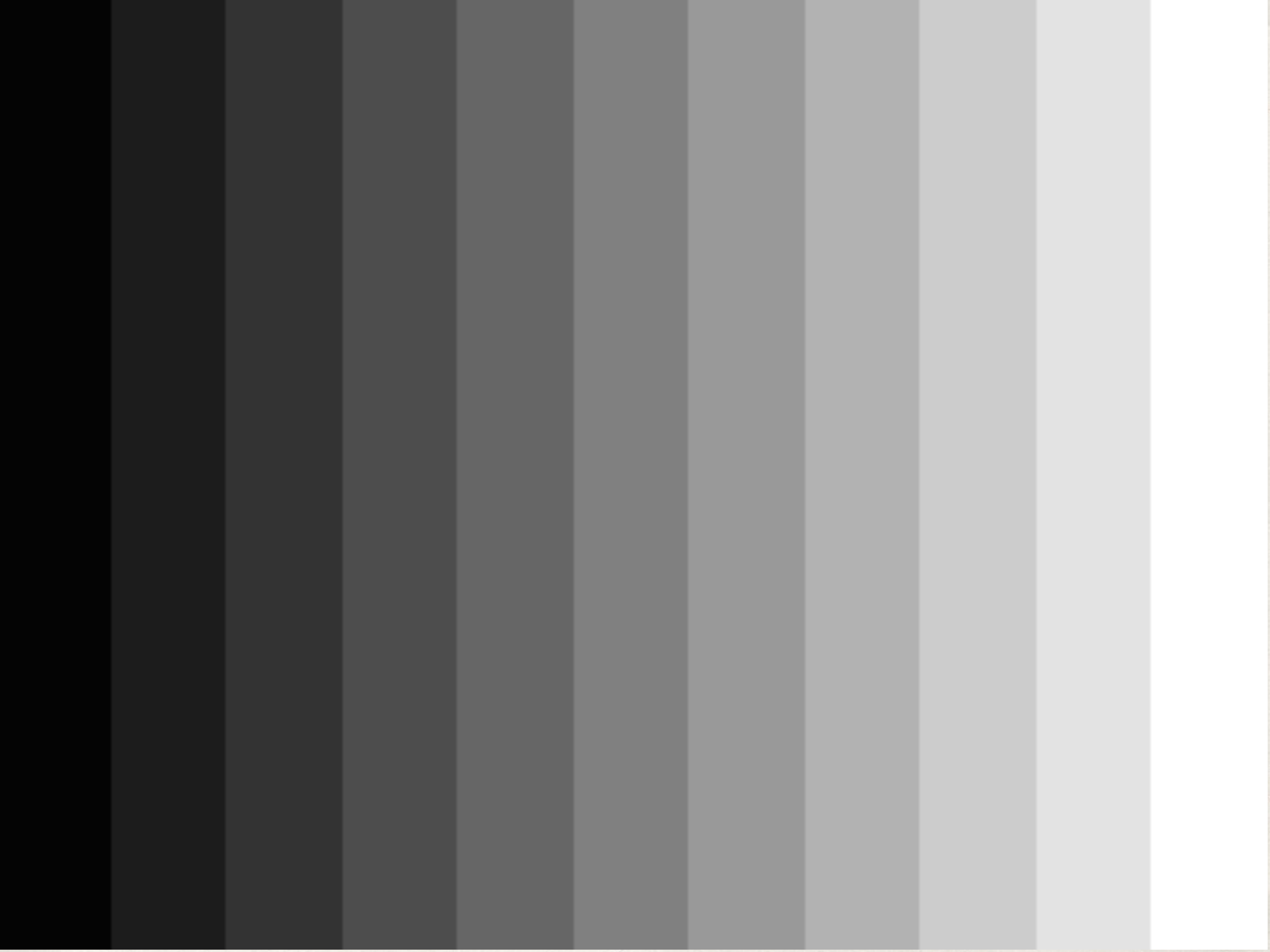


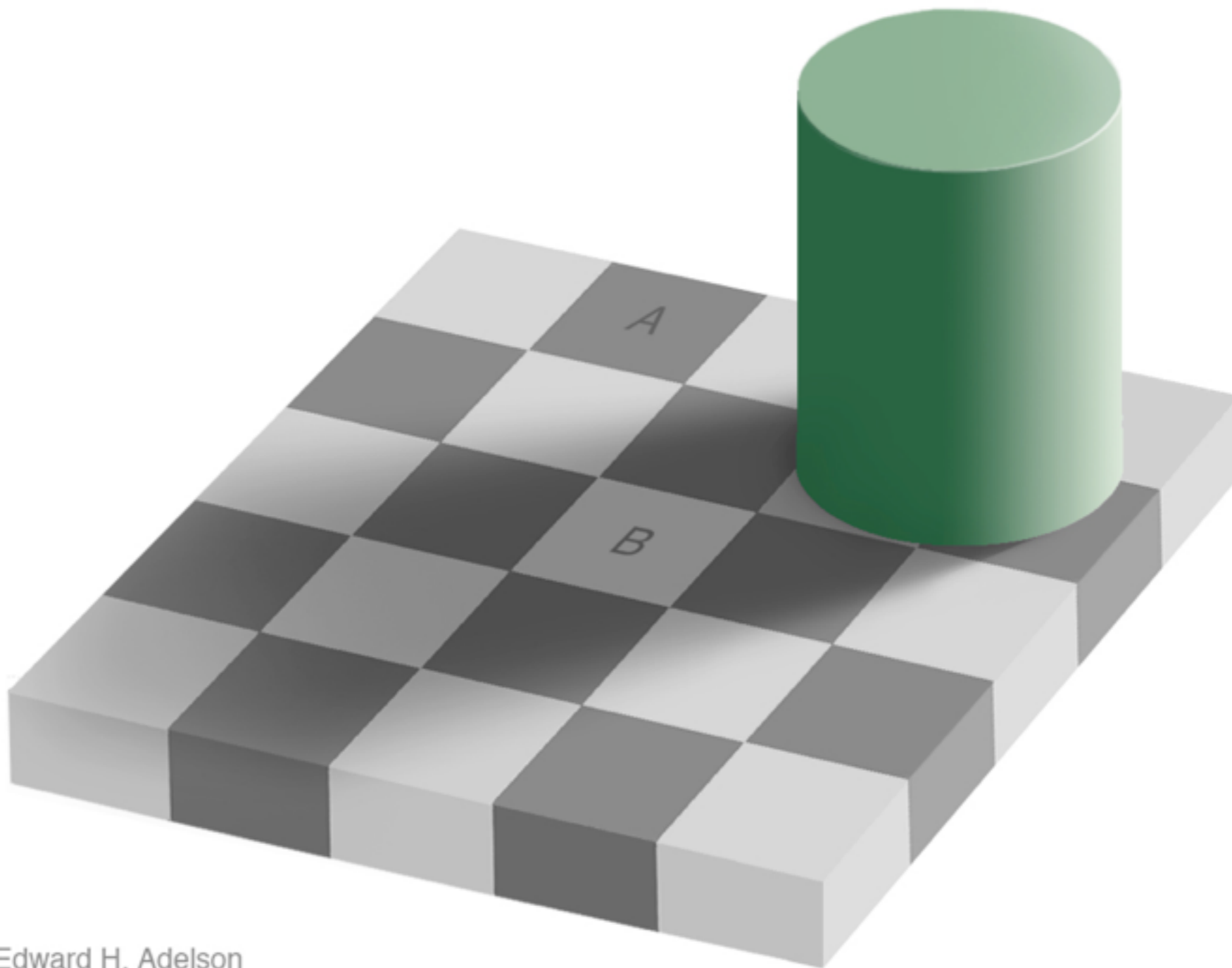
FUNELIXIR.COM



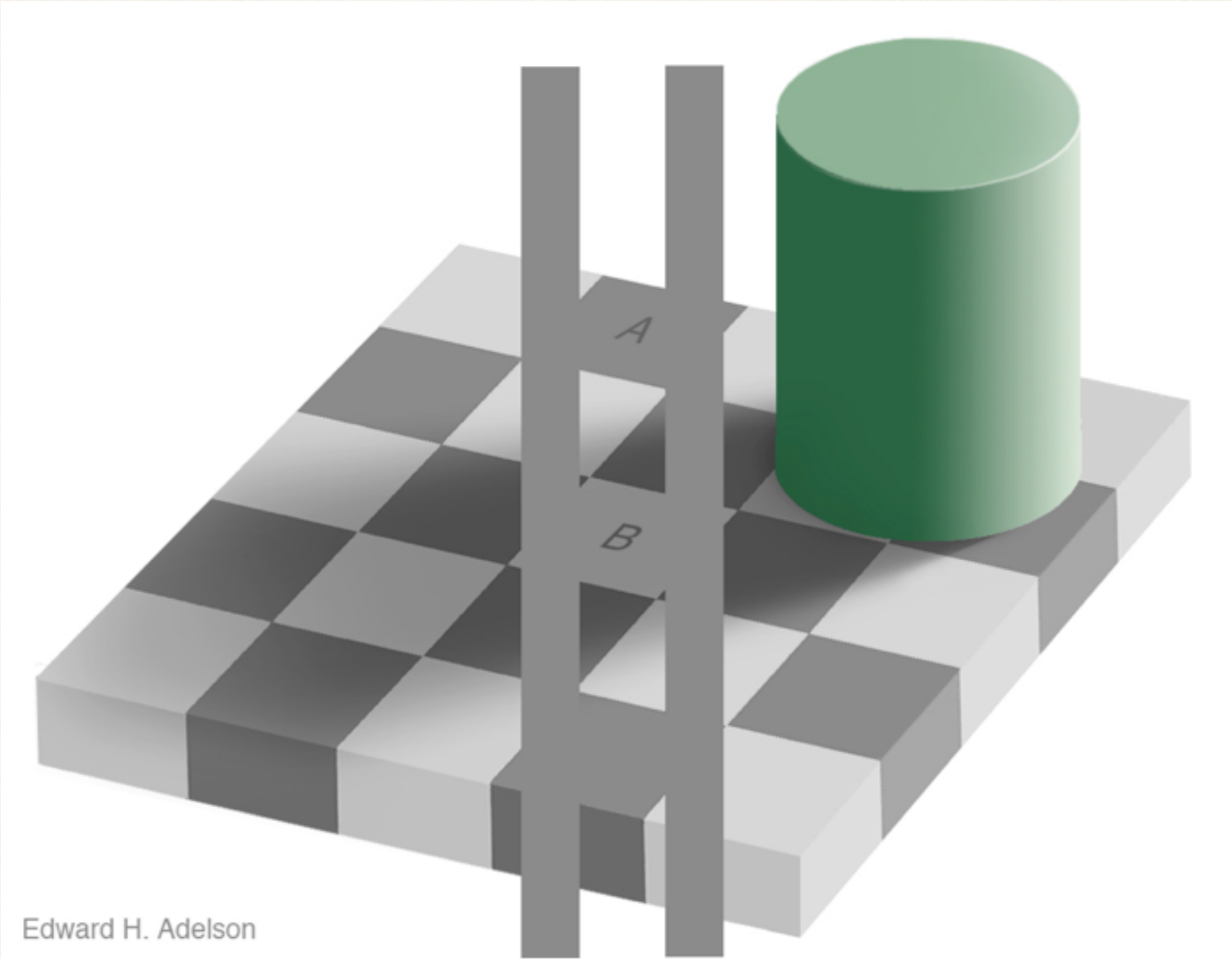


Did you see the dolphin?





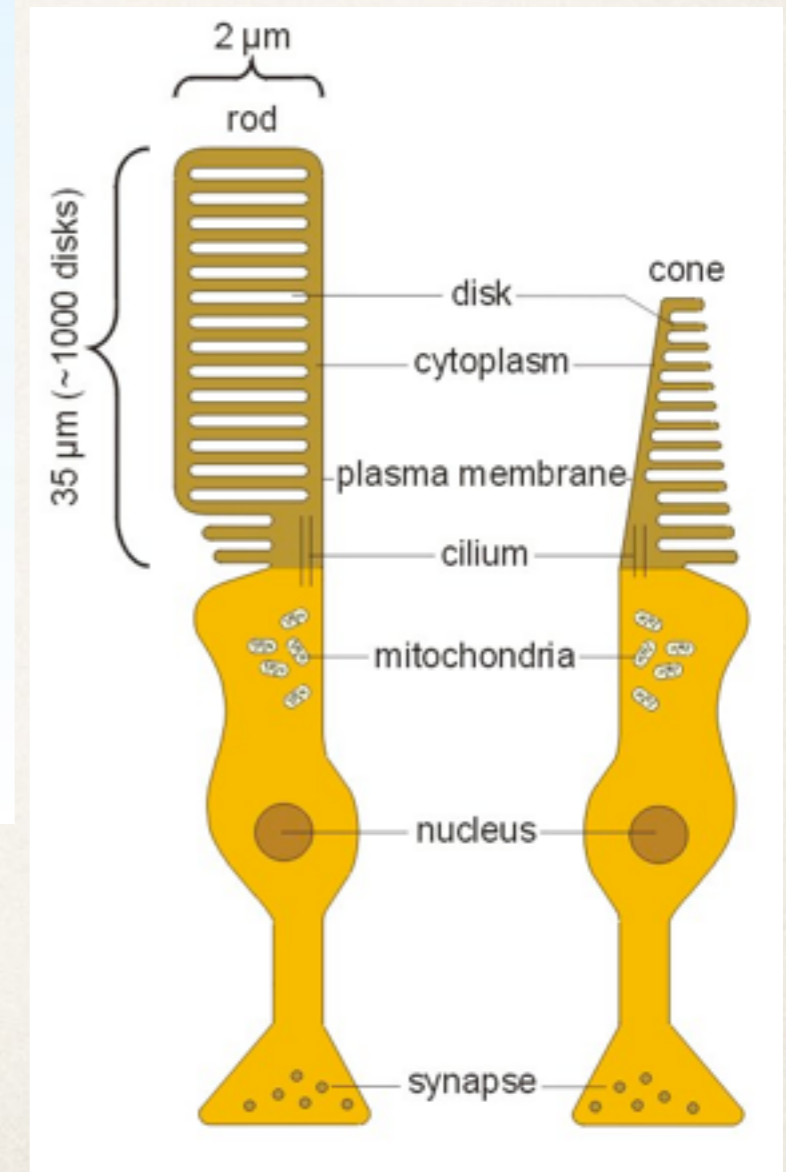
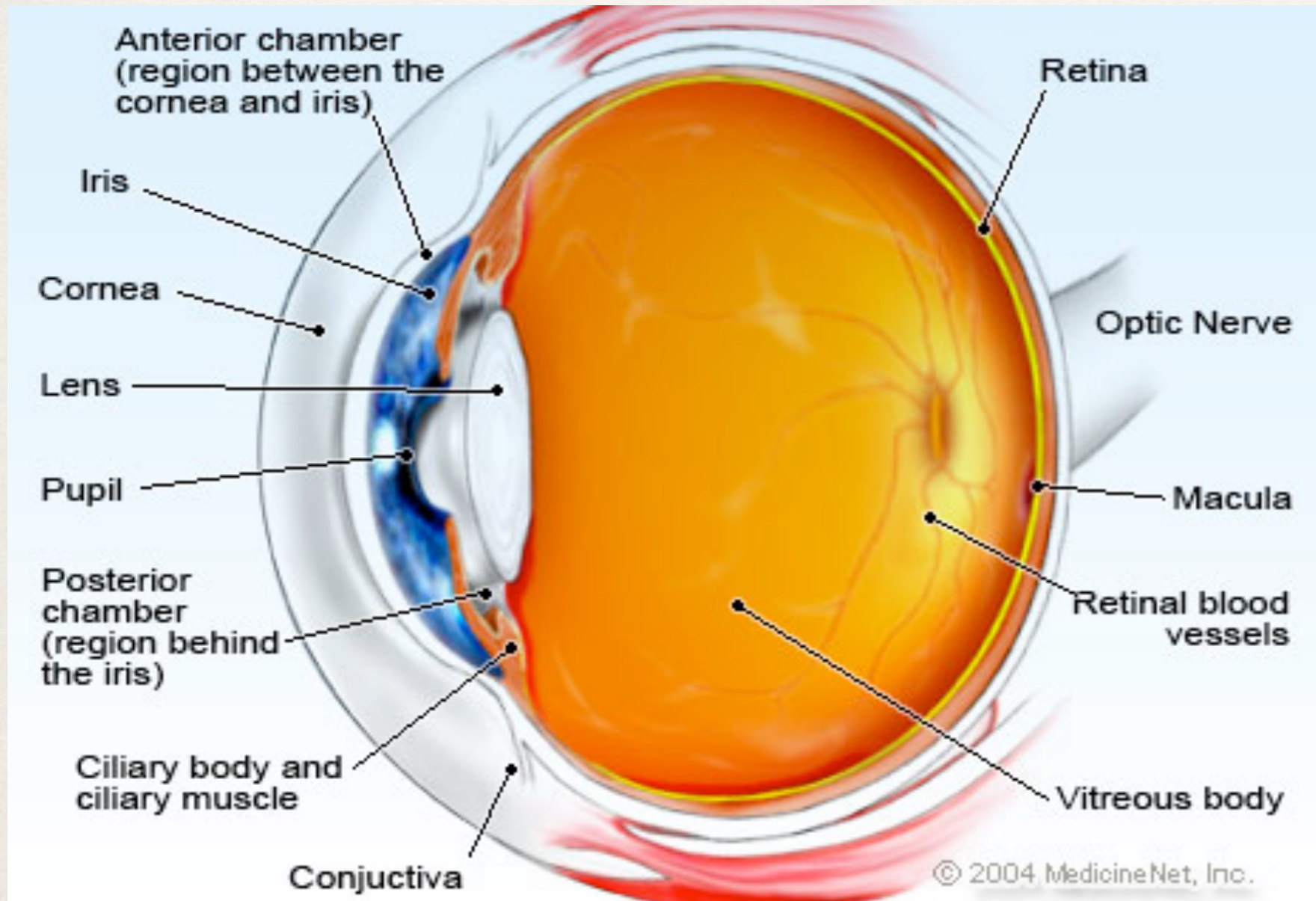
Edward H. Adelson



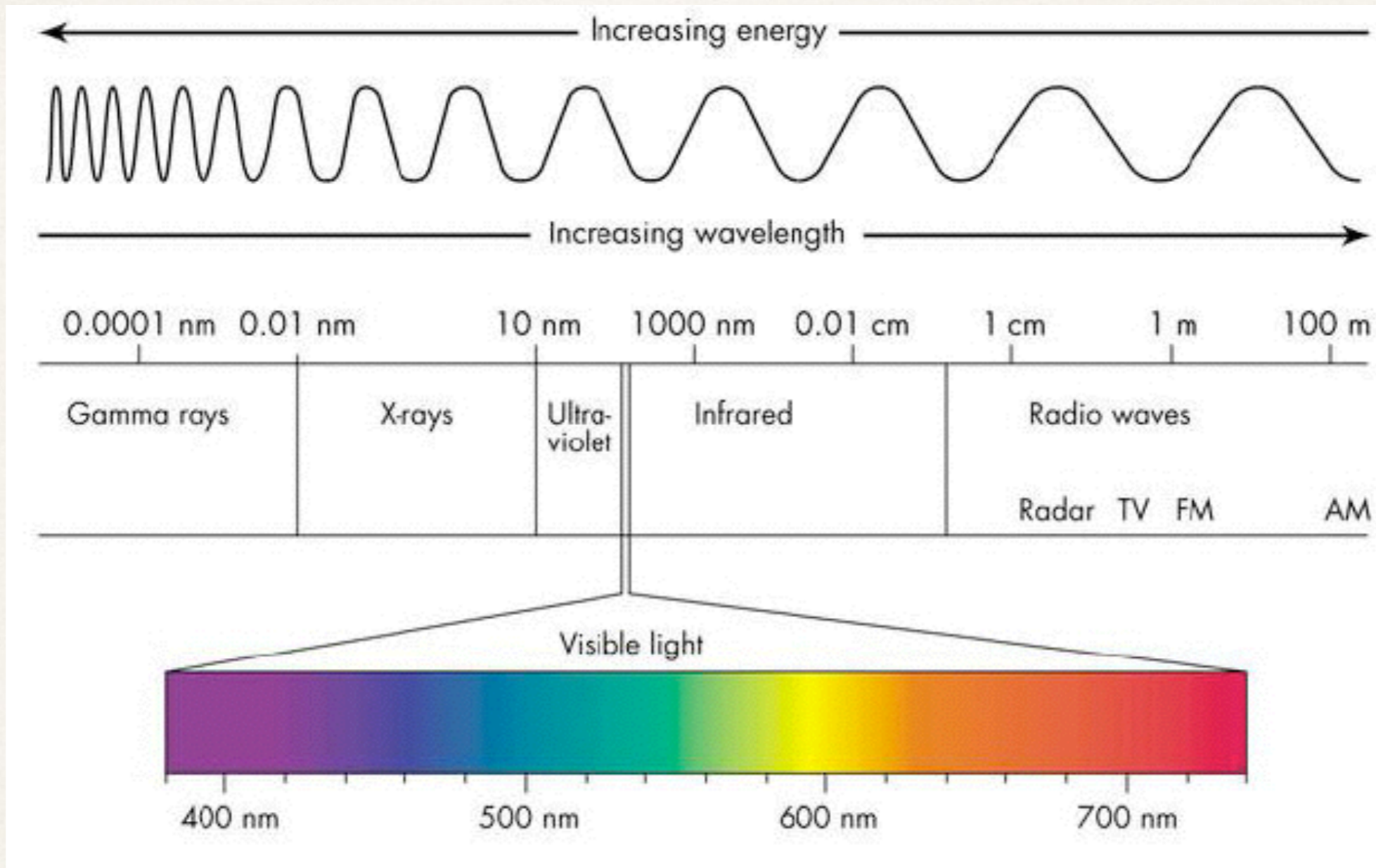
Edward H. Adelson

from:[http://web.mit.edu/persci/people/adelson/checkershadow\\_illusion.html](http://web.mit.edu/persci/people/adelson/checkershadow_illusion.html)

# Human eye

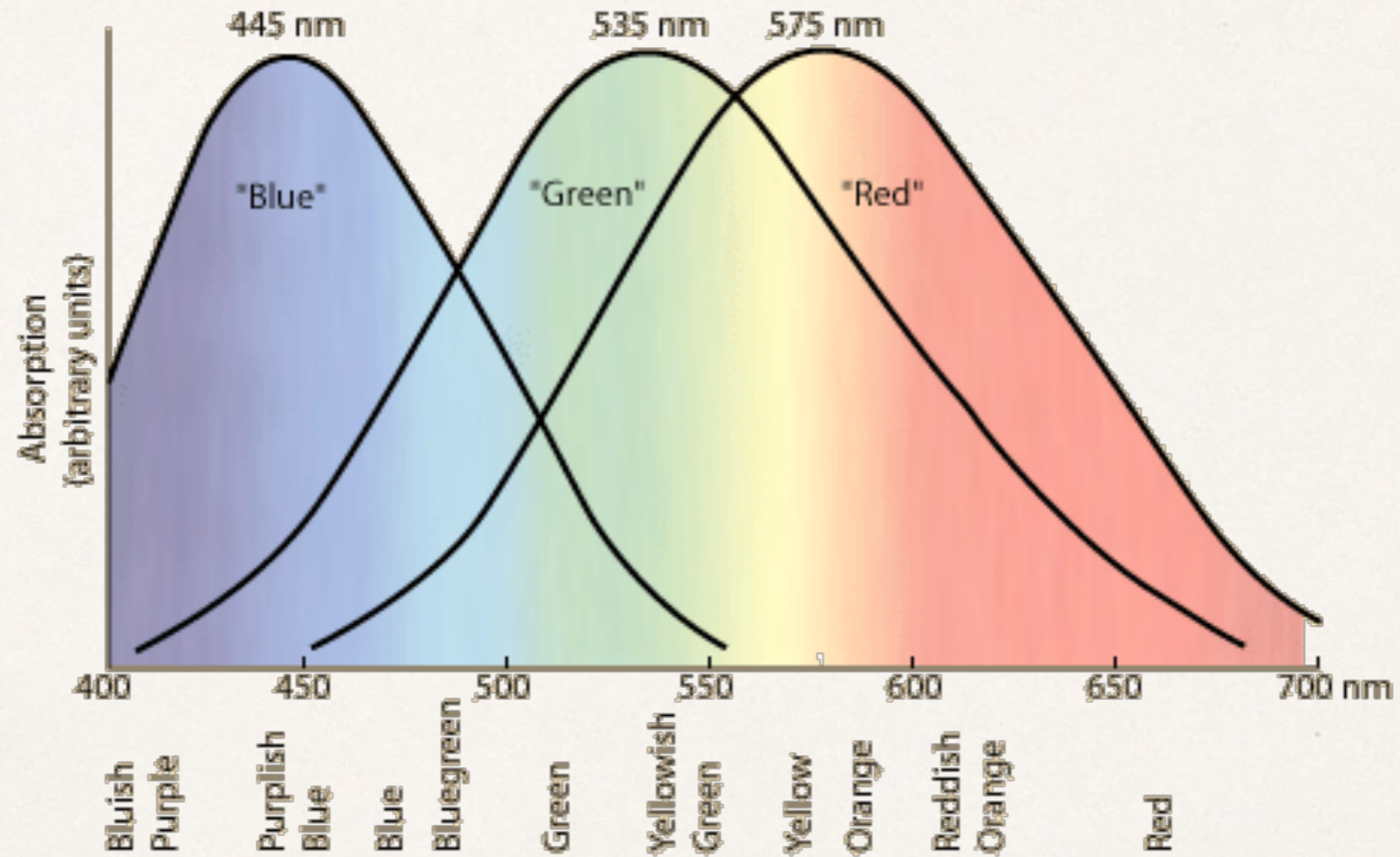


# Visible light spectrum



from: <http://lumenistics.com/what-is-full-spectrum-lighting/>

# Human sensitivity to color



from: <http://hyperphysics.phy-astr.gsu.edu/hbase/vision/colcon.html>

# Eye movement

## Conjugate eye movements

also called *pursuit* movements

eyes maintain the same angle from a normal to the face

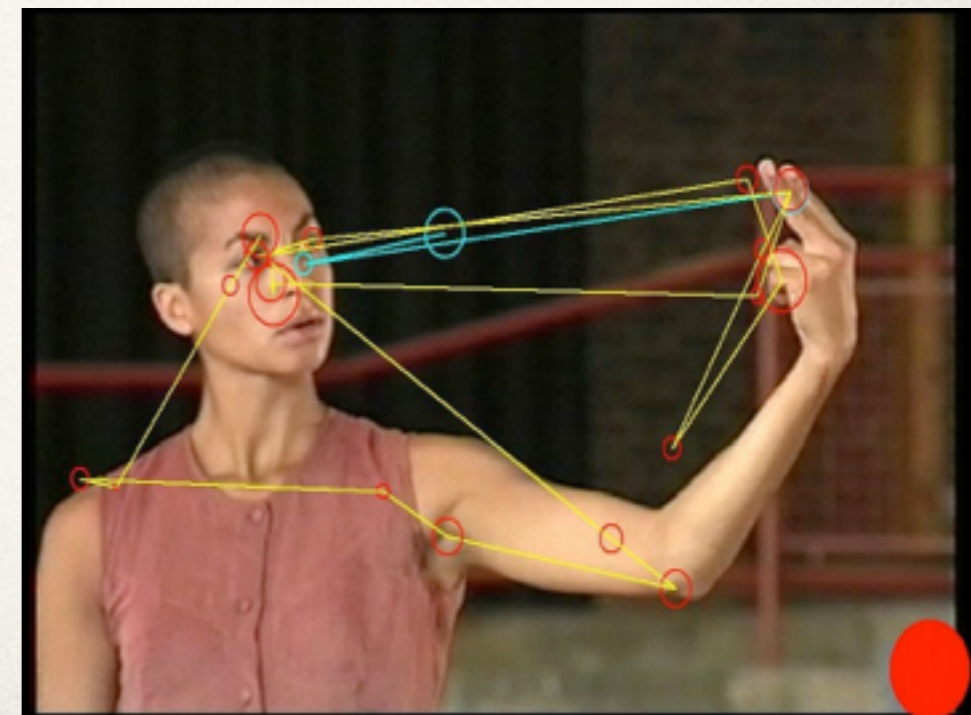
## Vergence eye movements

eyes move at different angles (going cross-eyed)

## Saccadic eye movements

fast movement to switch targets (25 ms to move)

suppression occurs between targets





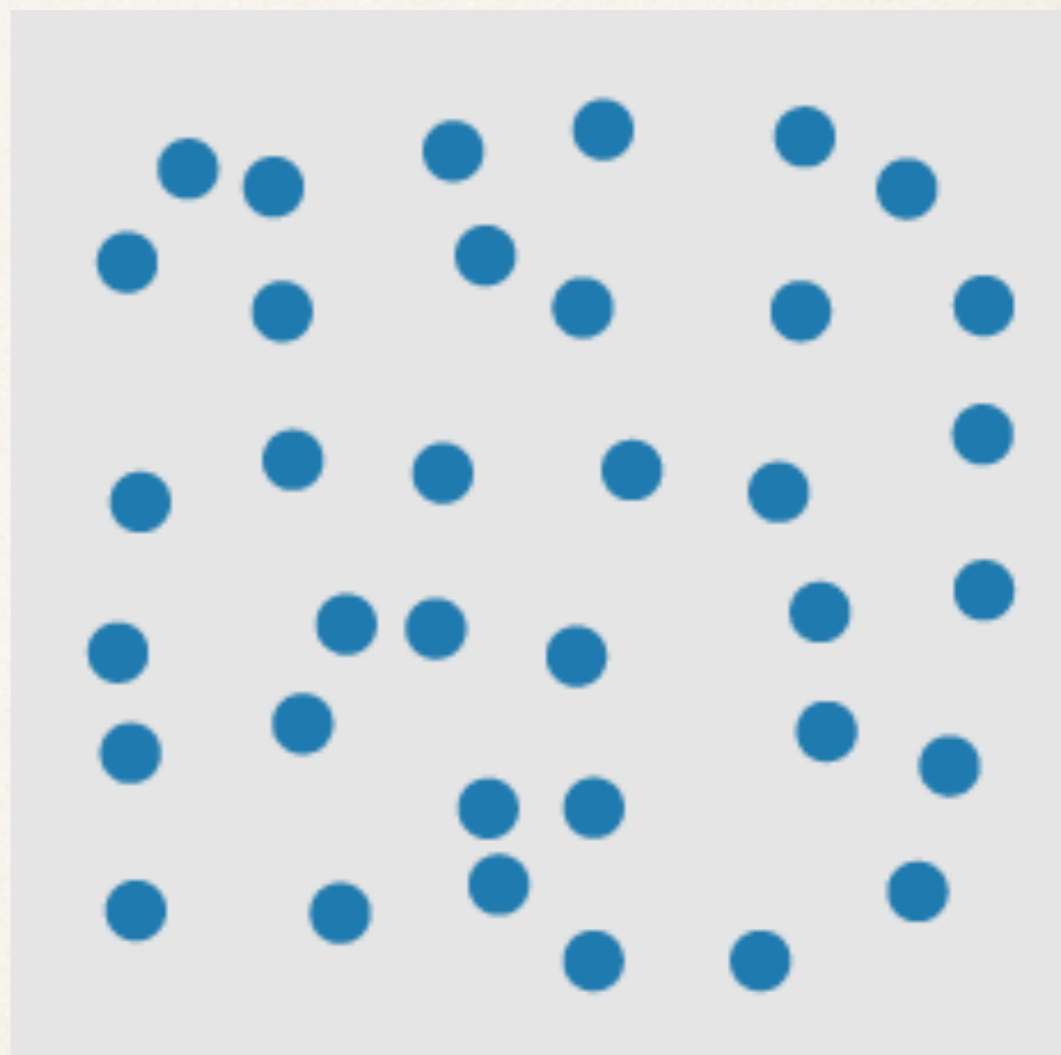
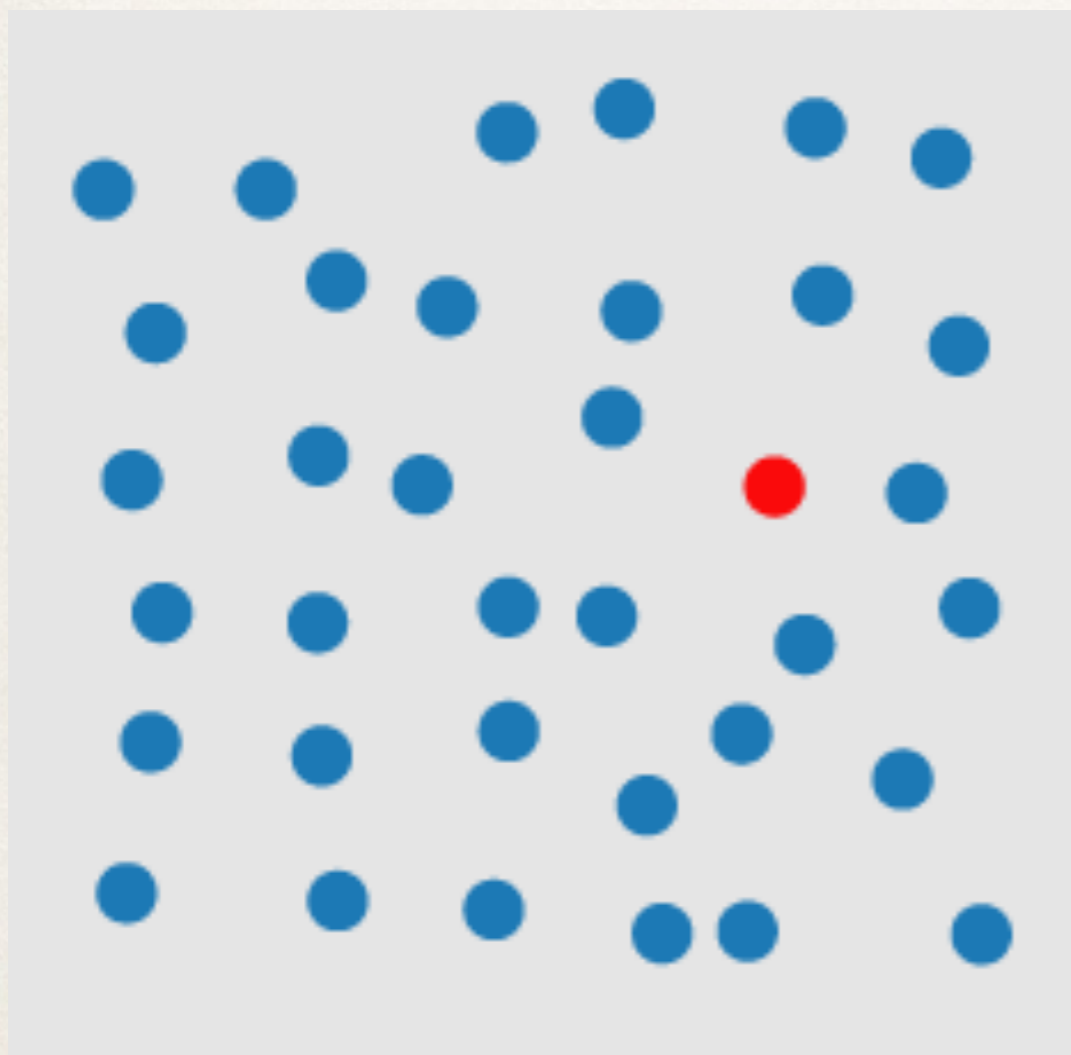
# How many threes?

45929078059772098775972655665110049836645  
27107462144654207079014738109743897010971  
43907097349266847858715819048630901889074  
25747072354745666142018774072849875310665

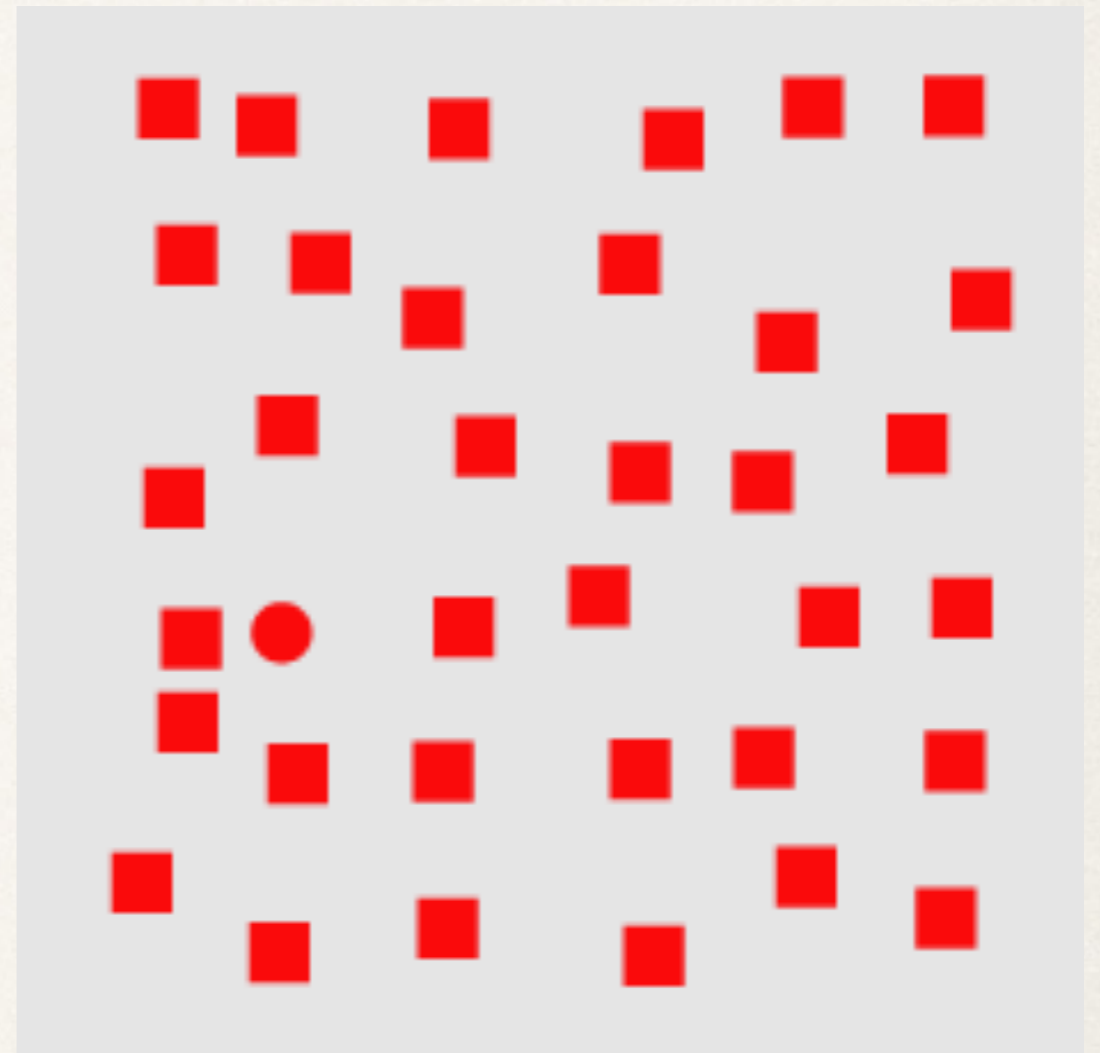
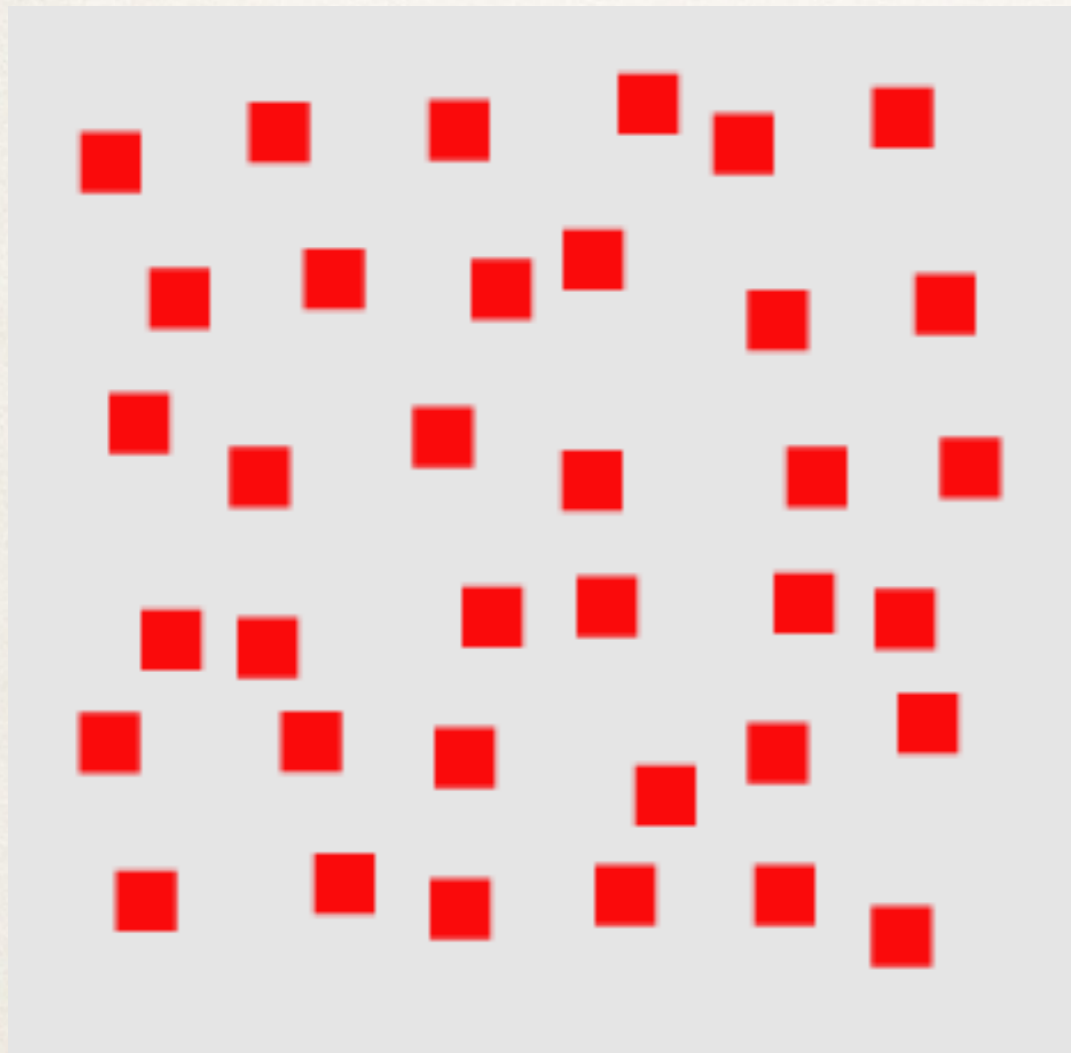
# How many threes?

459290780597720987759726556651100498**3**6645  
271074621446542070790147**3**810974**3**897010971  
4**3**907097**3**492668478587158190486**3**0901889074  
25747072**3**54745666142018774072849875**3**10665

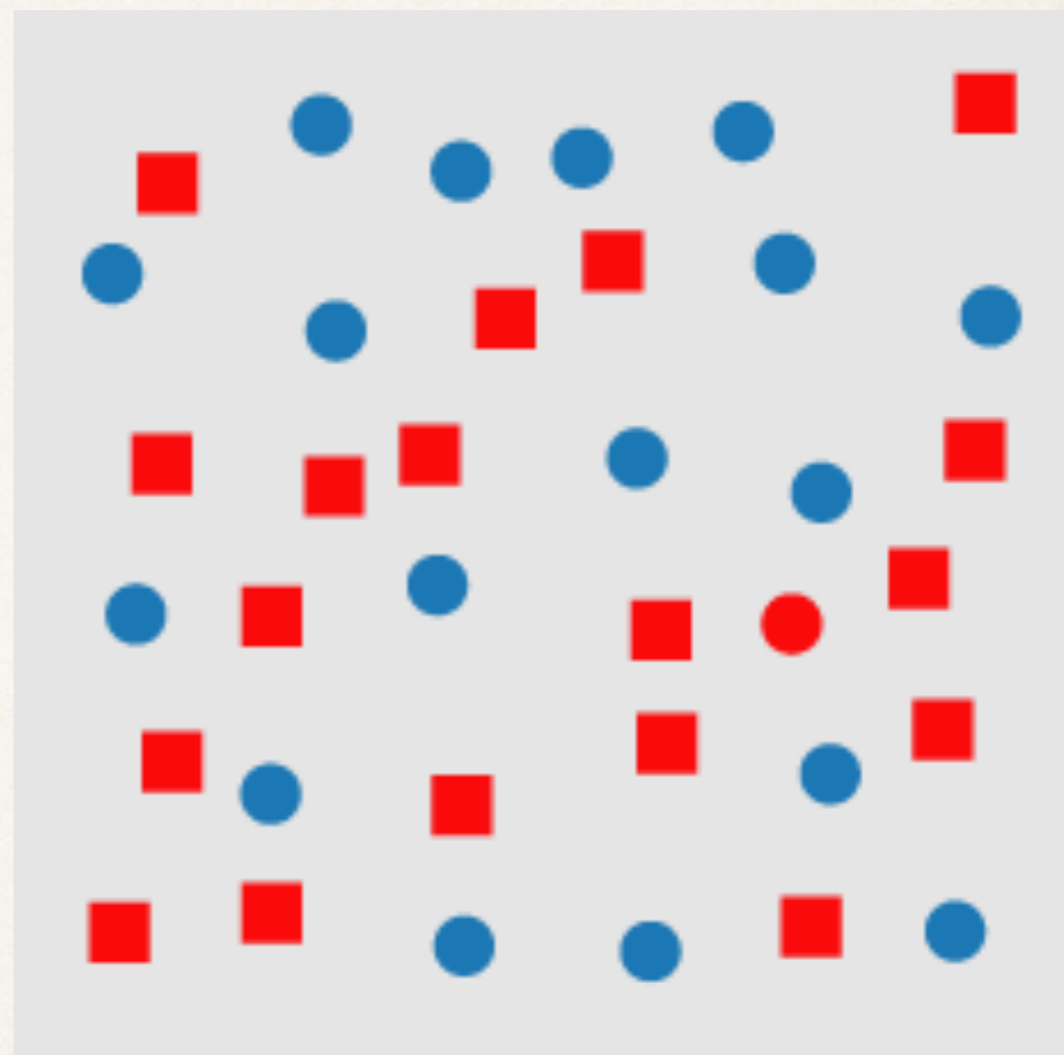
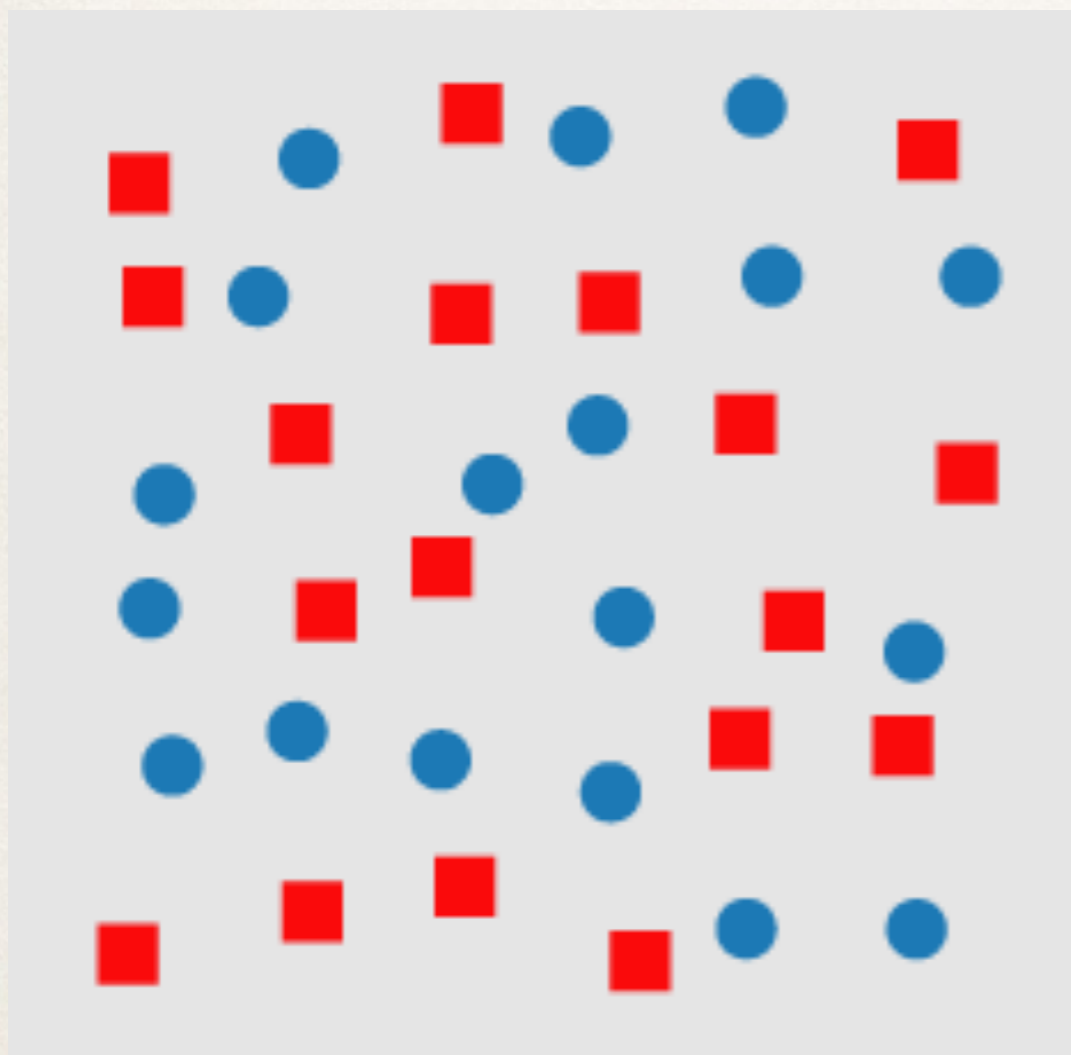
# Is there a red circle?



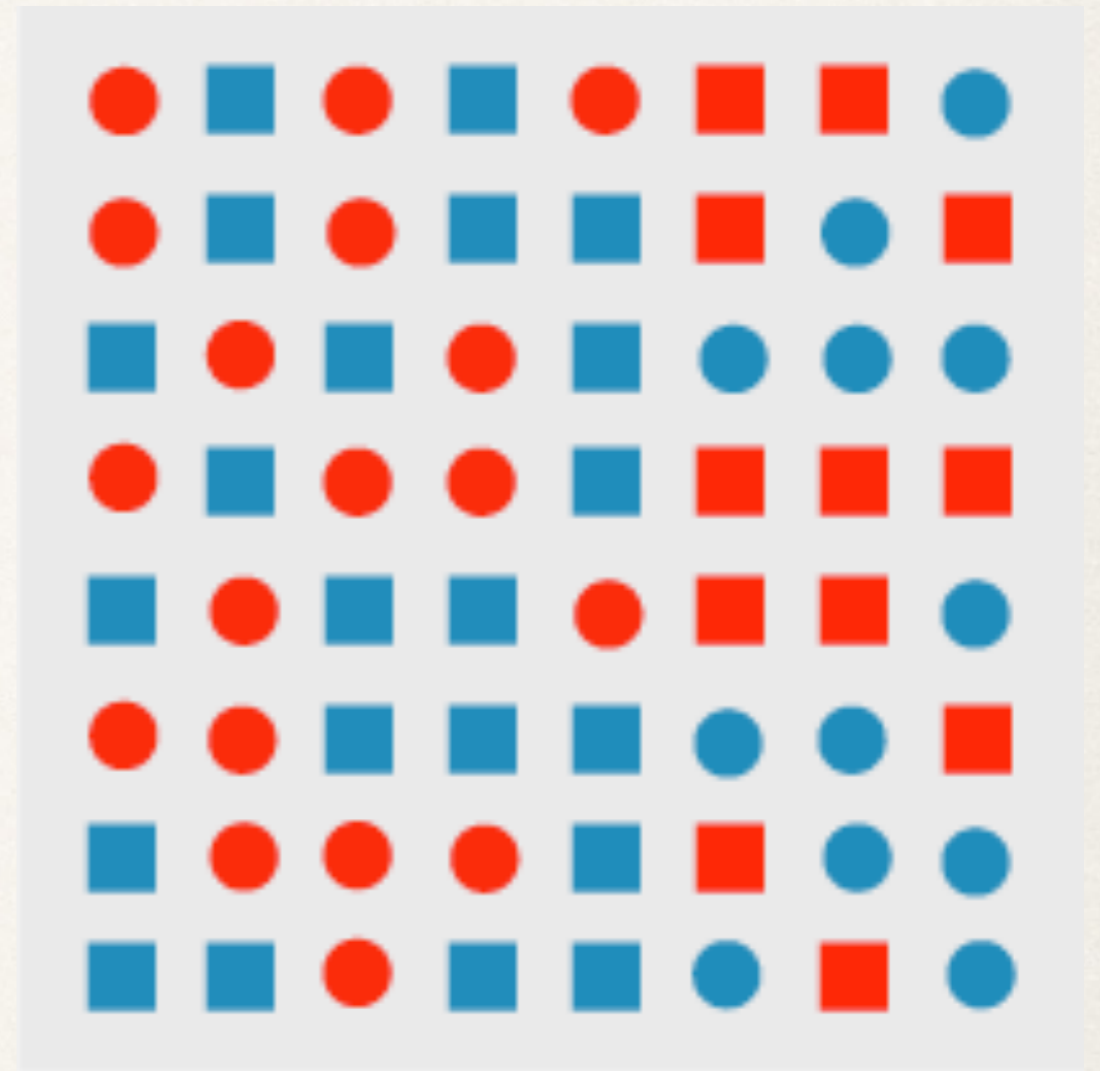
# Is there a red circle?



# Is there a red circle?



# Is there a boundary?



# Preattentive vs Attentive

## pre-attentive

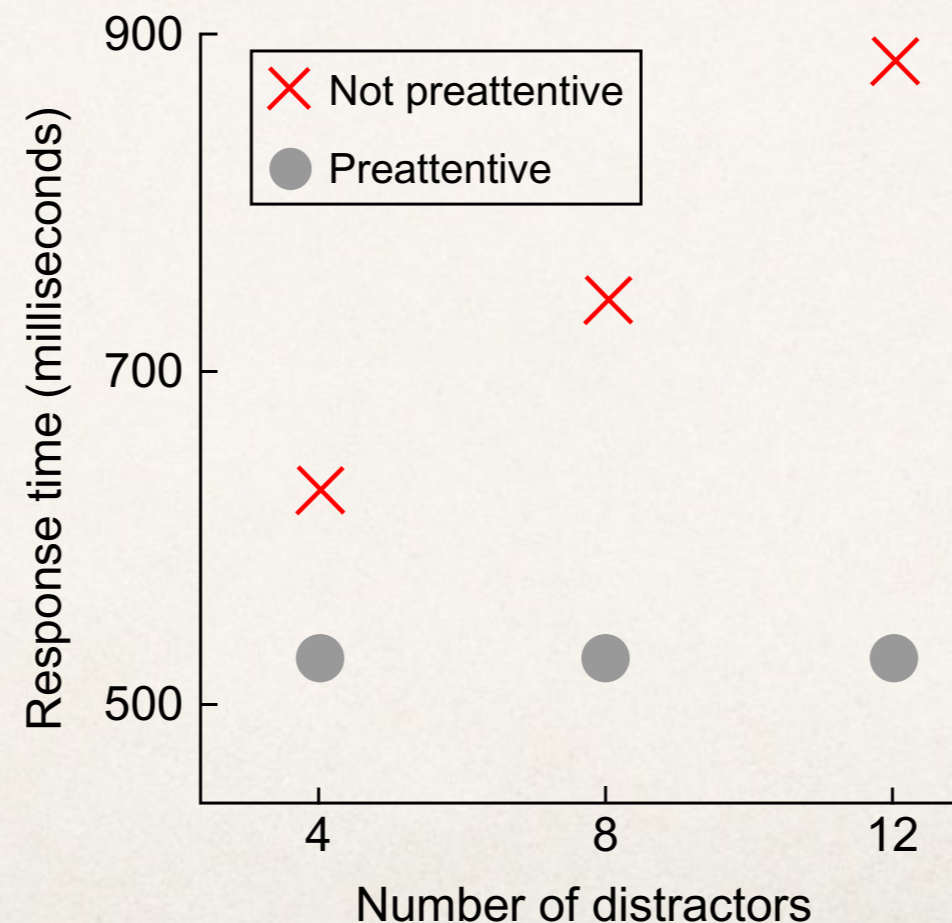
$\leq 250$  ms

parallel

## attentive

$> 250$  ms

serial



# Uses for preattentive processing

**target detection:** is a target present? where is it?

**counting:** count the number of targets

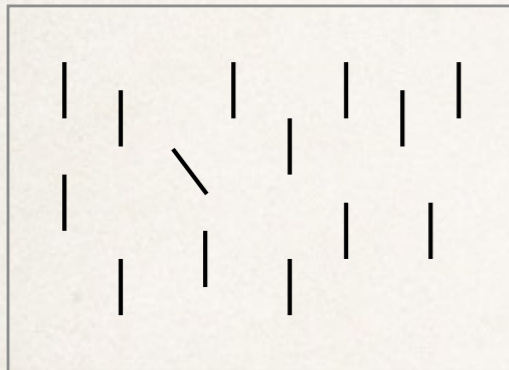
**boundary detection:** identify regions where the elements have a common visual property

**tracking:** following a target as it moves in time and space

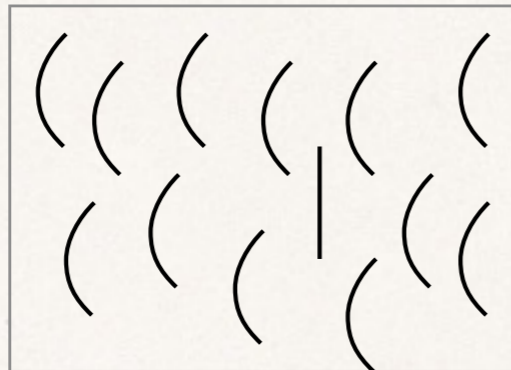


# Preattentive features

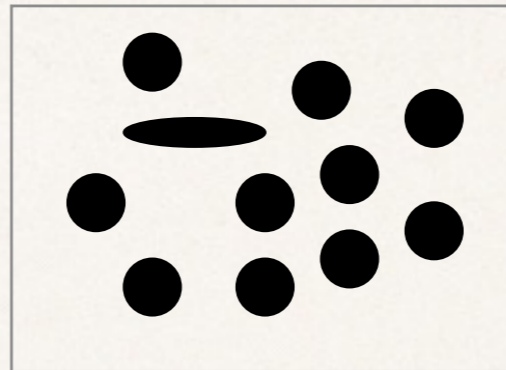
Orientation



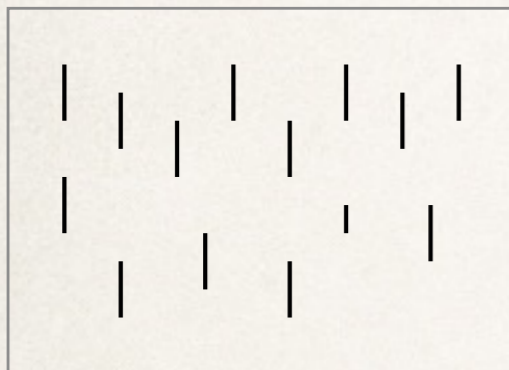
Curved/straight



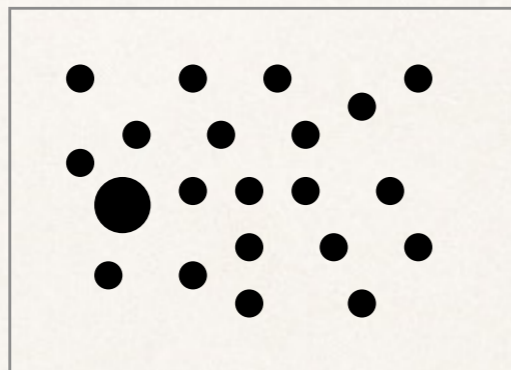
Shape



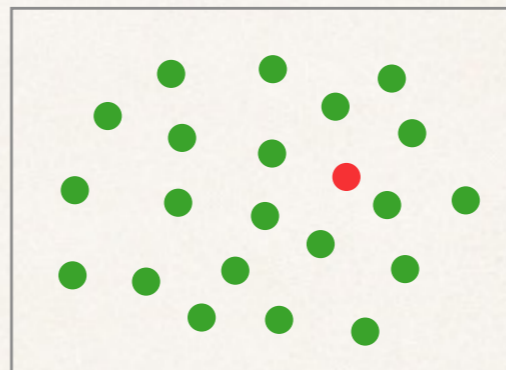
Shape



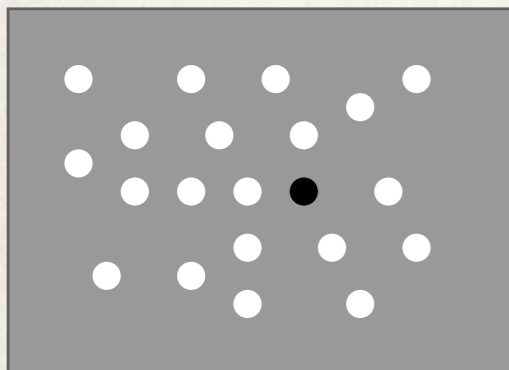
Size



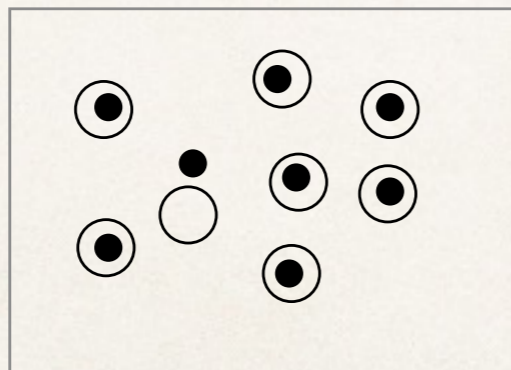
Color



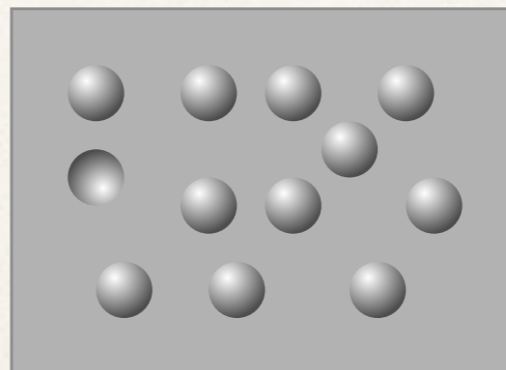
Light/dark



Enclosure



Convex/concave



## Others

spatial position

intensity

closure

intersection

3D depth cues

flicker

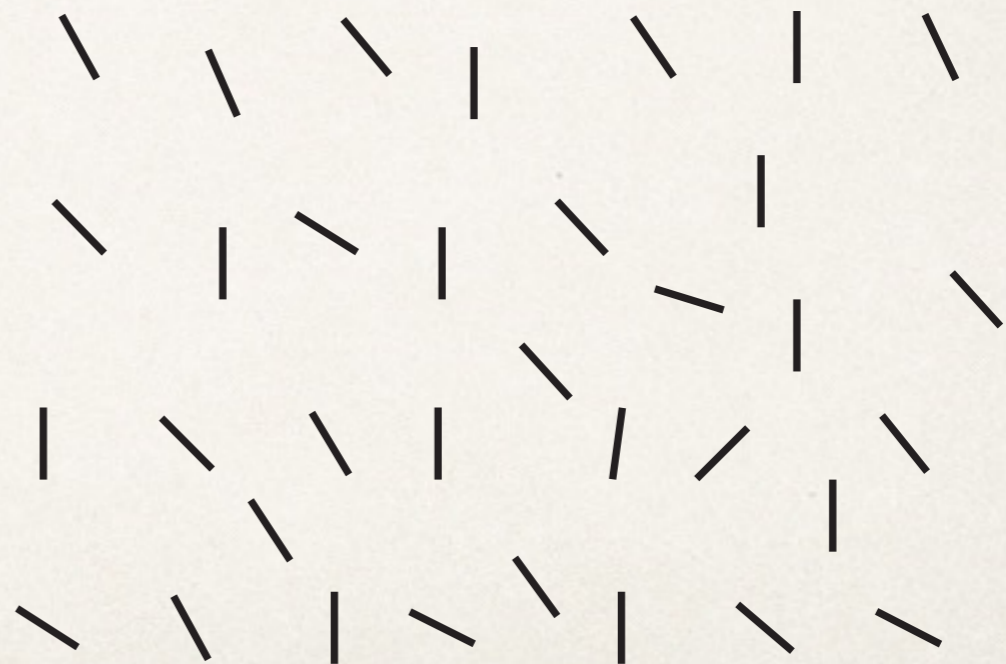
motion direction

motion velocity

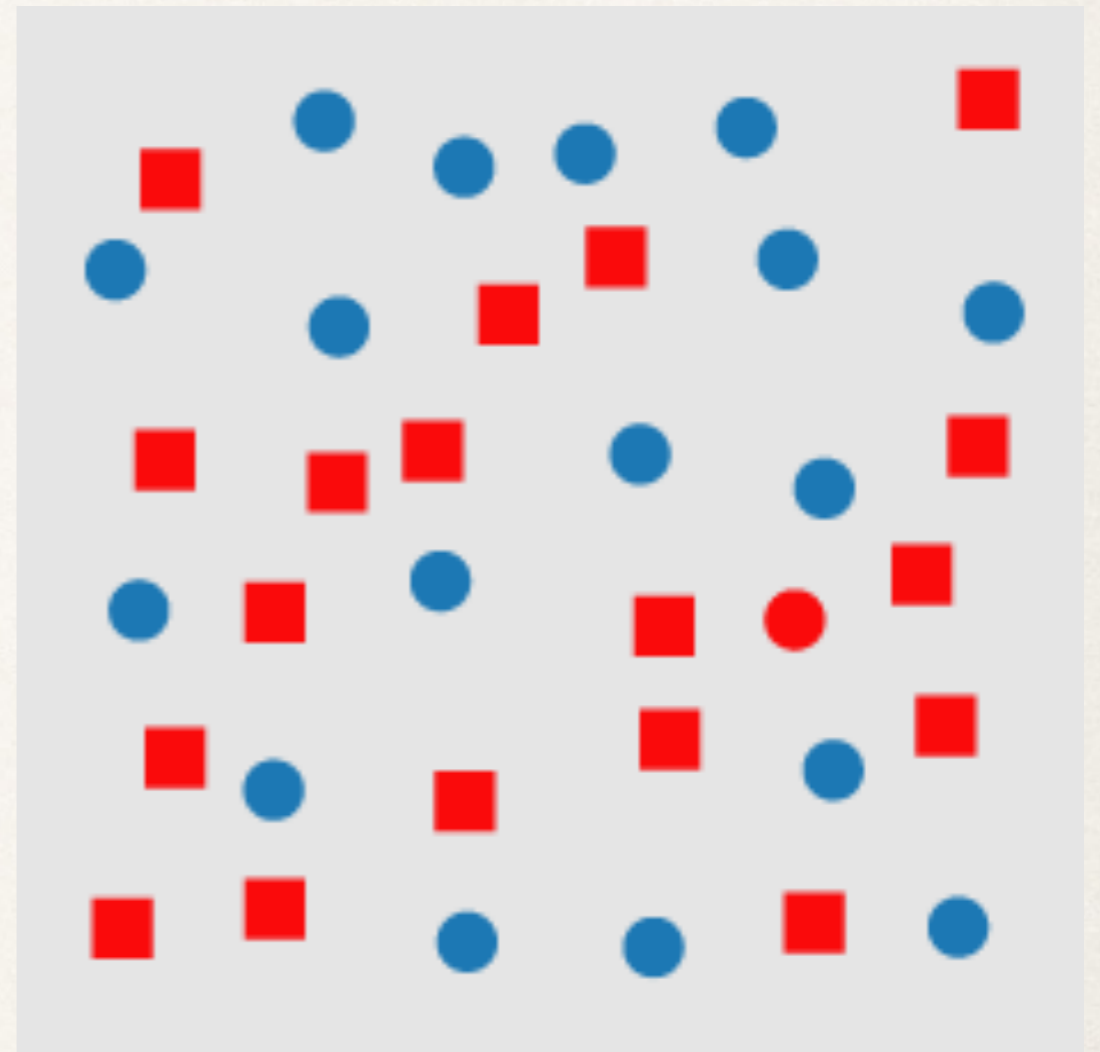
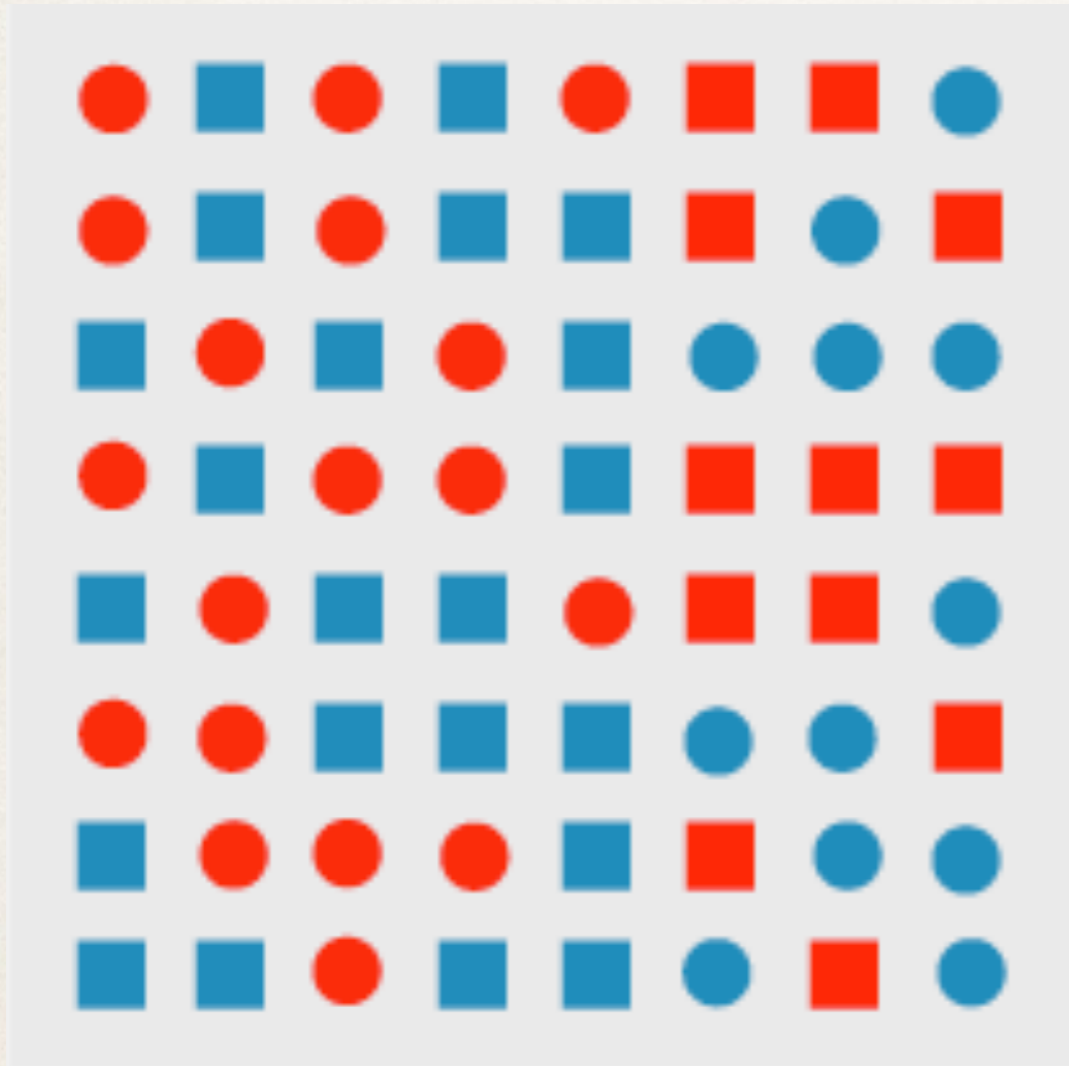
lighting direction

3D orientation

# Impact of distractors

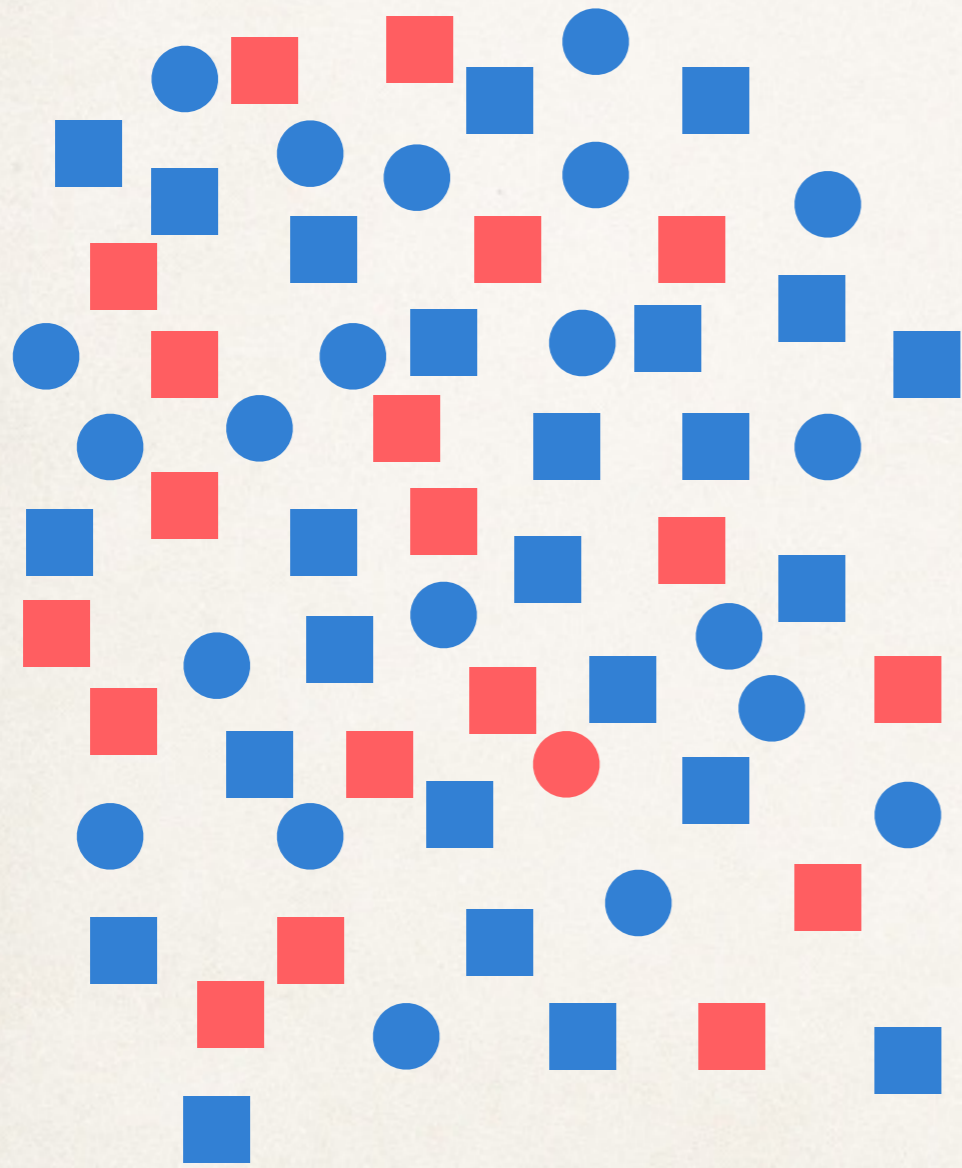


# Preattention conjunctions

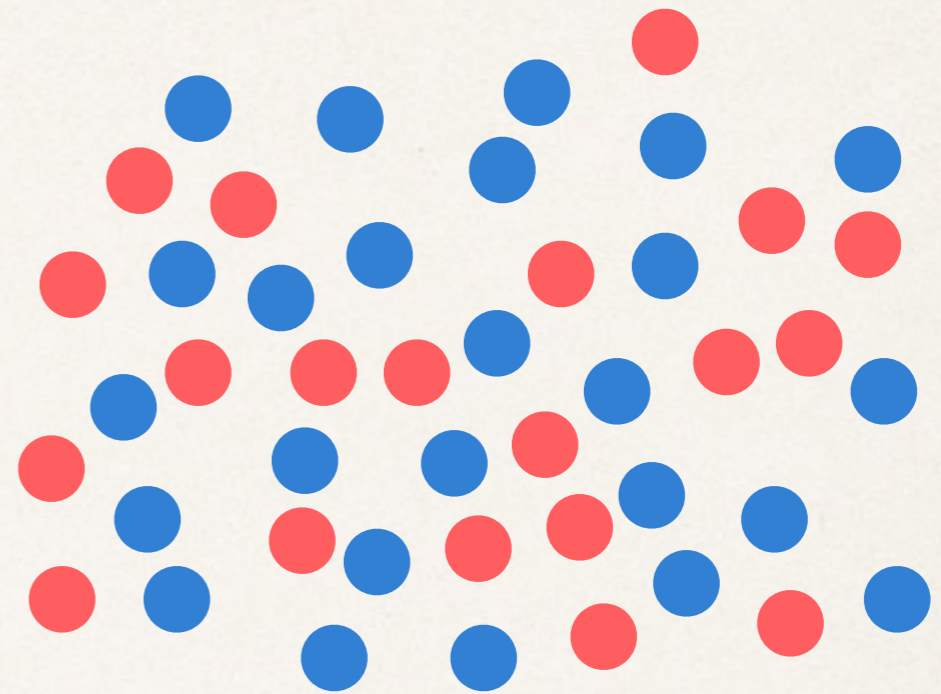


Most conjunctions are not preattentive

# Preattention conjunctions

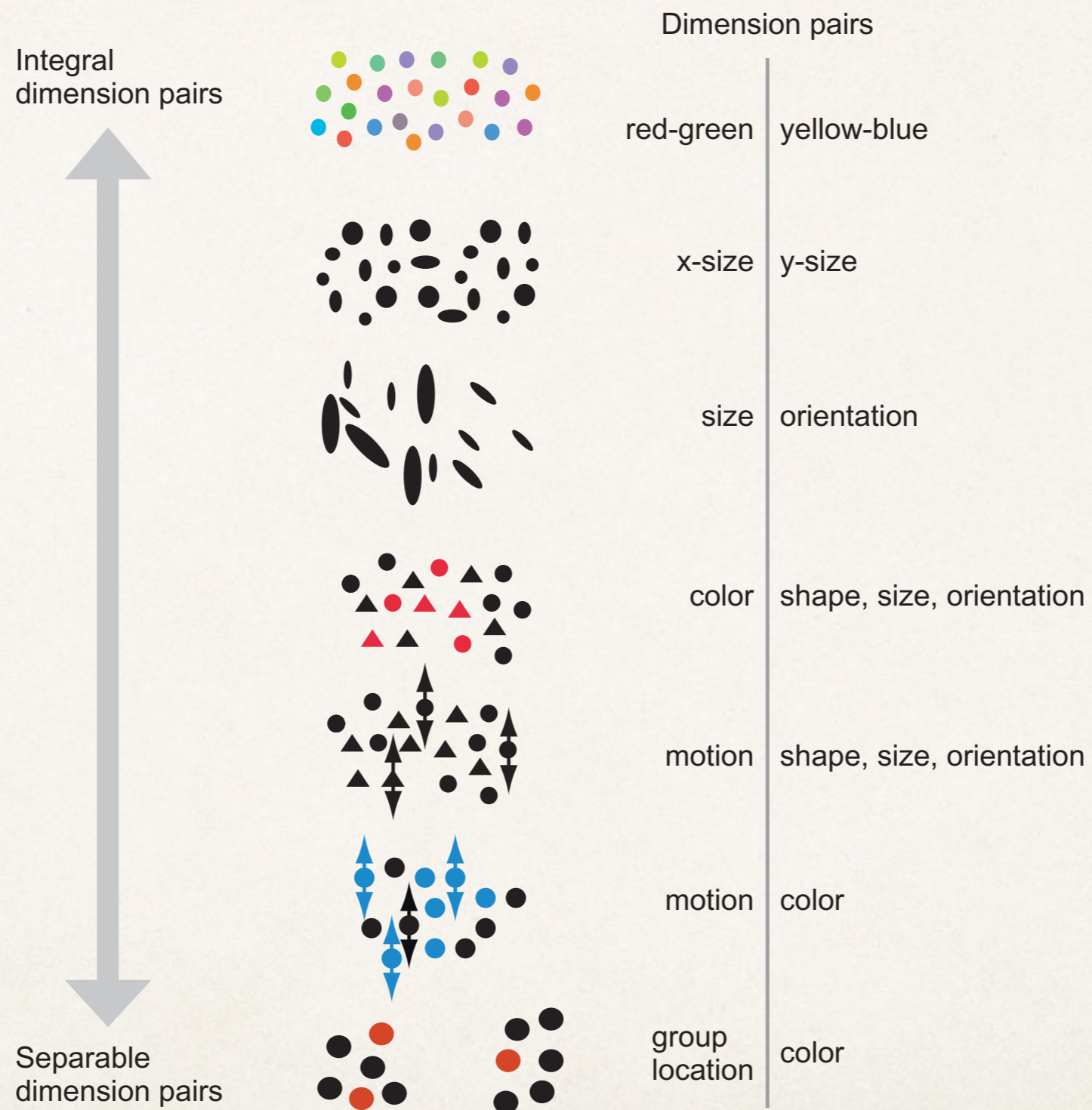


Color and shape



Color and position

# Integral - Separable attributes



# Preattention conjunctions

## Conjunctions that can be preattentive

space + color

motion + shape

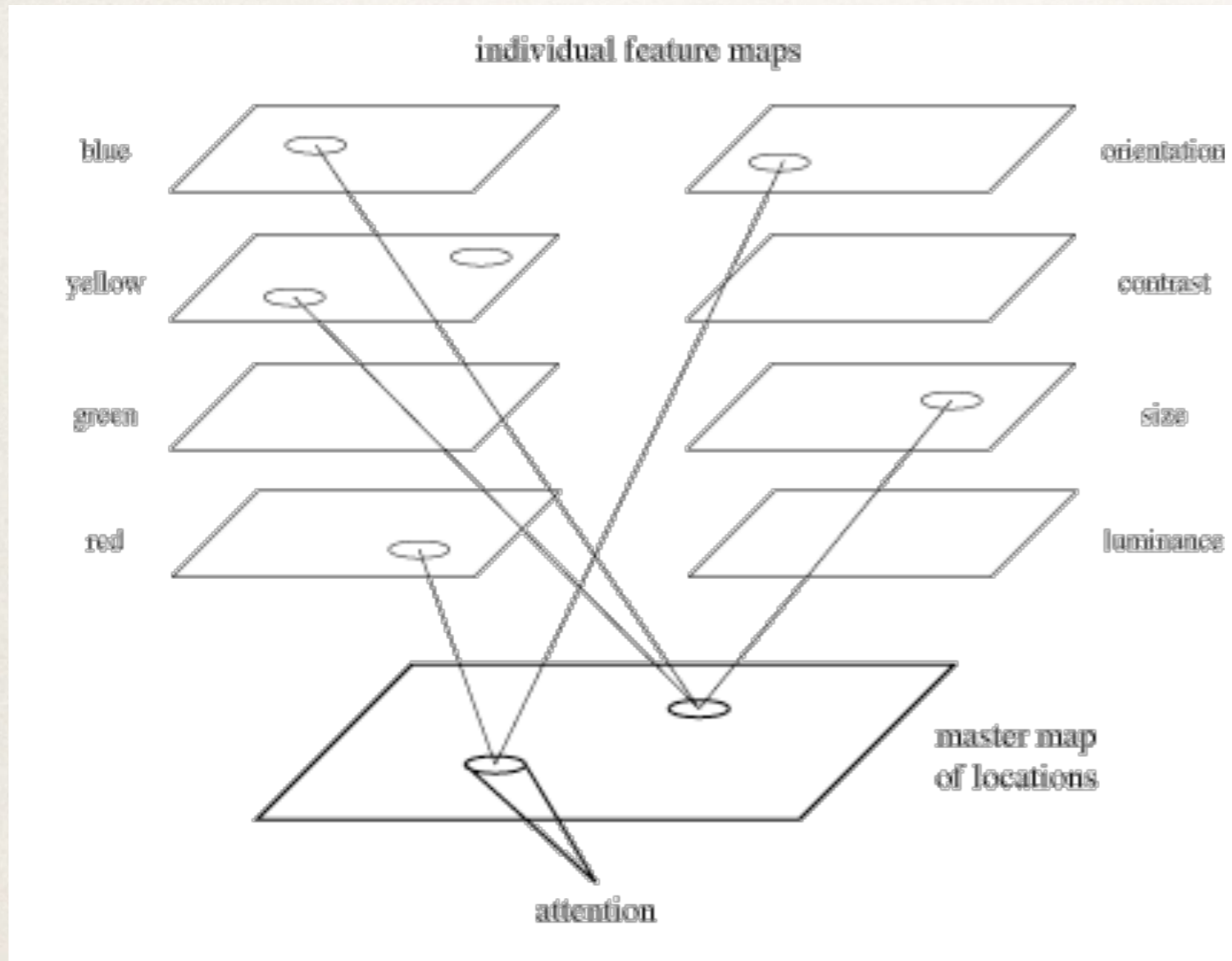
motion + color

stereoscopic depth + color

convexity/concavity + color

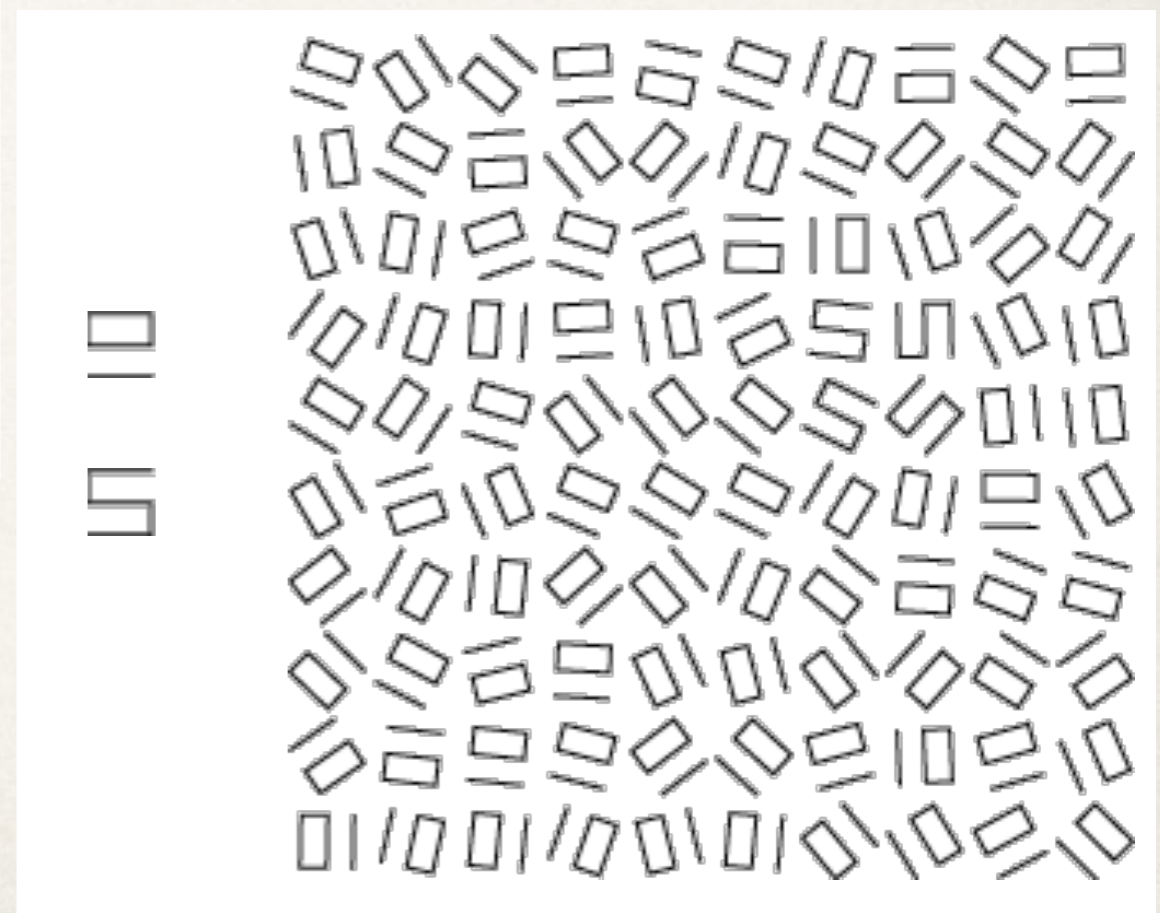
light direction + color

# Preattention theories

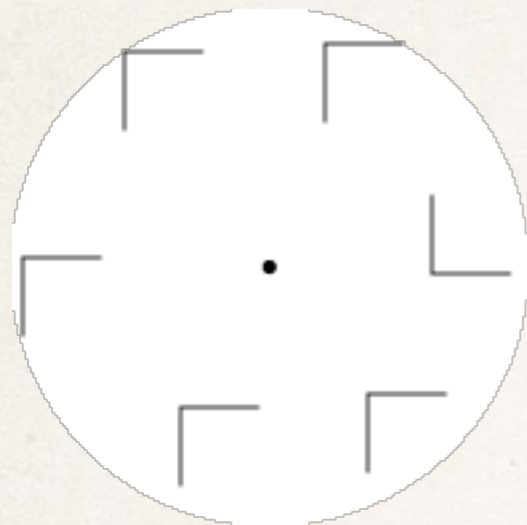


## Feature Integration Theory

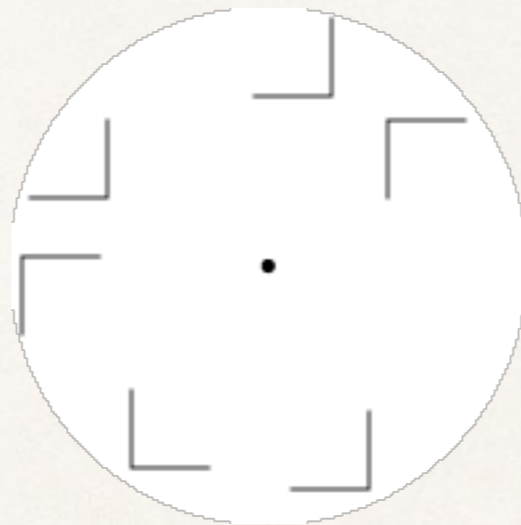
## Texton Theory



# Preattention theories



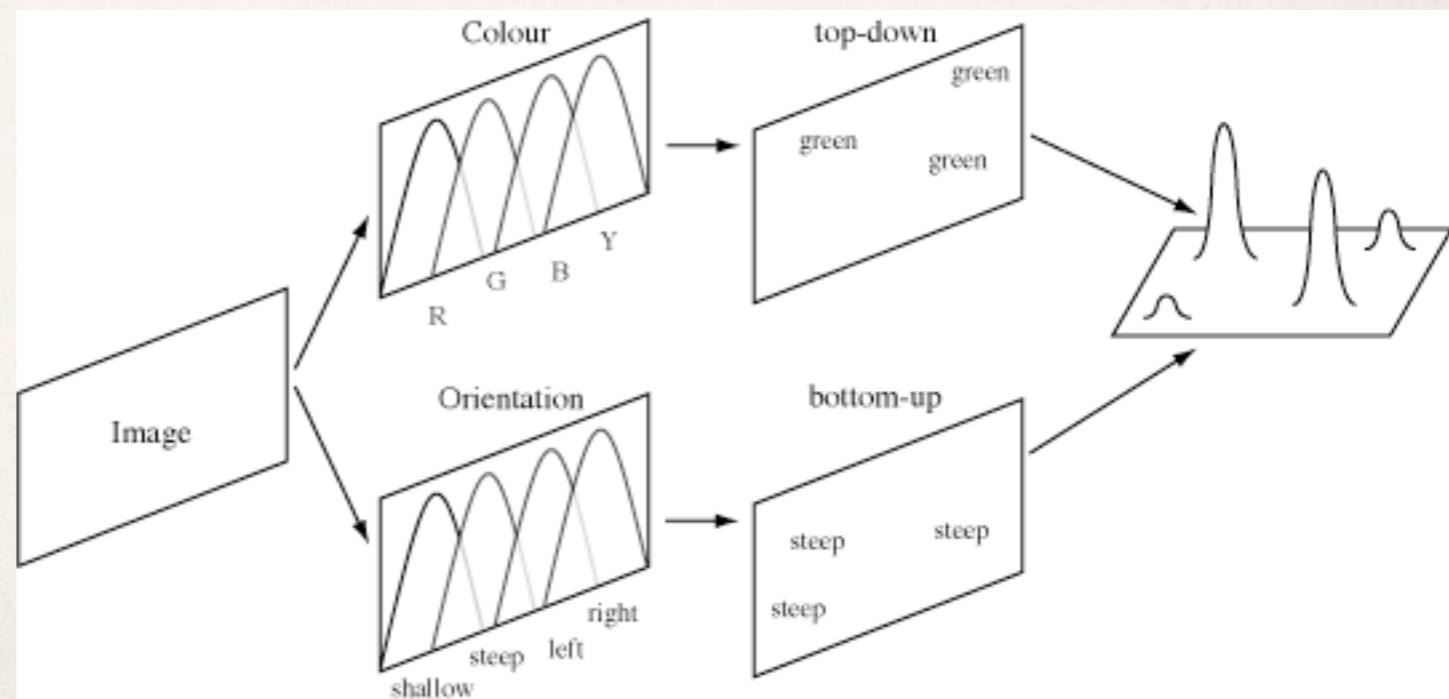
high N-N similarity



low N-N similarity

## Similarity Theory

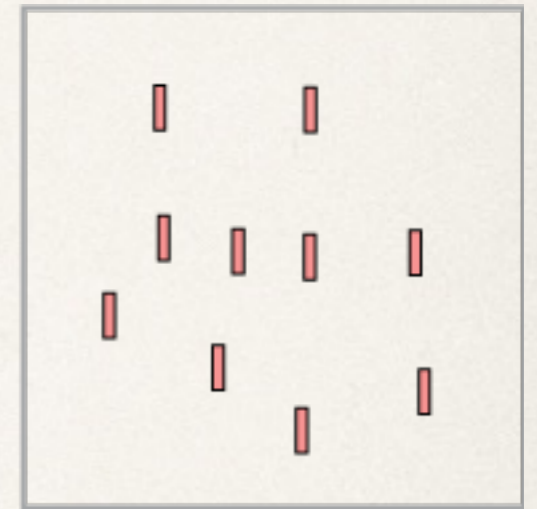
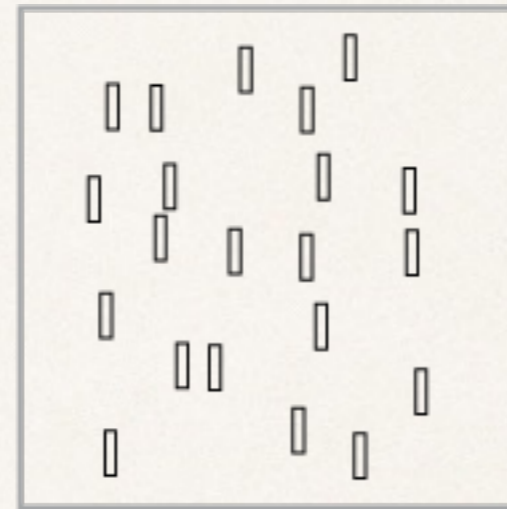
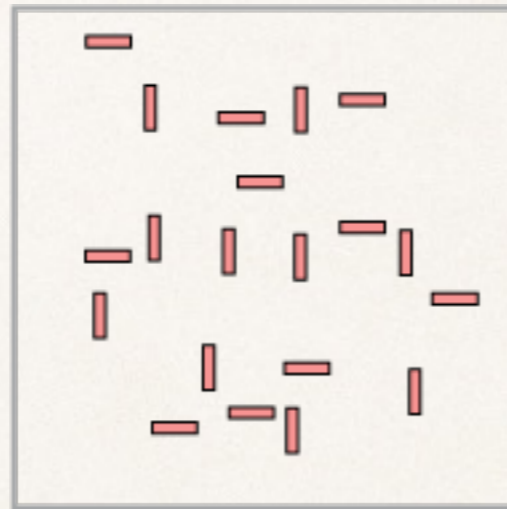
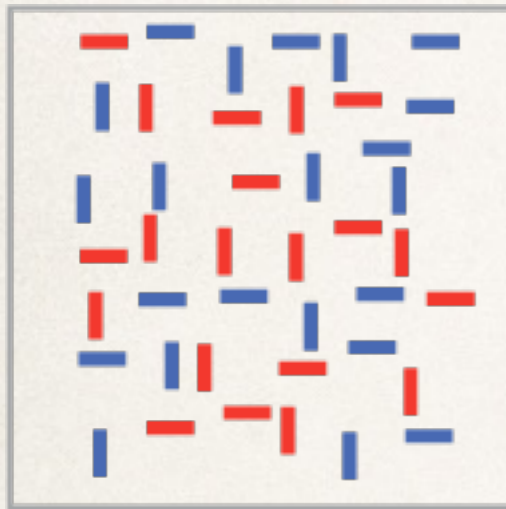
## Guided Search Theory





# Preattention theories

## Boolean Map Theory



# Preattention theories

## Boolean Map Theory



# Preattention theories

## Boolean Map Theory



# Preattention theories

## Boolean Map Theory

All colors differ



Only two colors differ



# Change blindness



# Selective attention

<http://www.youtube.com/watch?v=Ahg6qcgoy4>

<http://www.youtube.com/watch?v=ubNF9QNEQLA>

# Gestalt laws of grouping

**Proximity:** things that are close to one another are grouped

**Similarity:** similar objects are seen as belonging together

**Connectedness:** physical connections to form relationships

**Continuity:** we construct visual entities from smooth, continuous visual elements

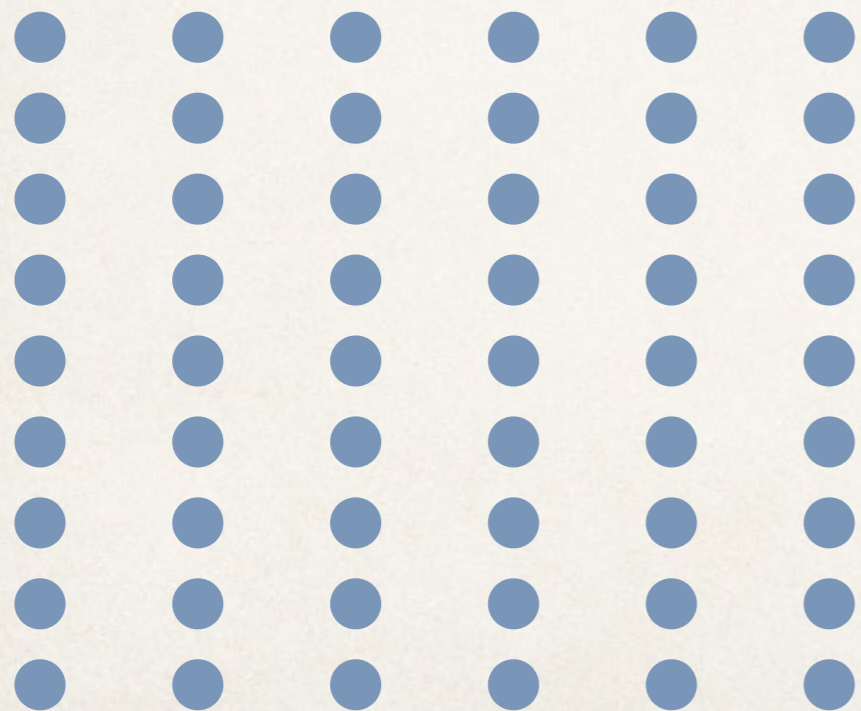
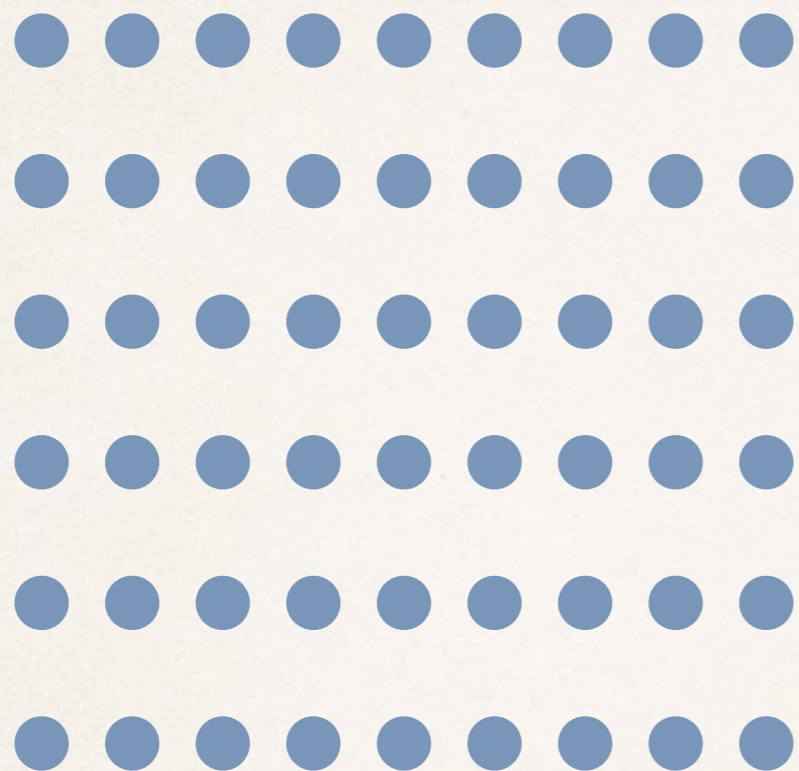
**Symmetry:** symmetric objects are perceived as being part of a whole

**Closure:** a closed contour is seen as an object

**Relative size:** smaller components of a pattern are perceived as objects

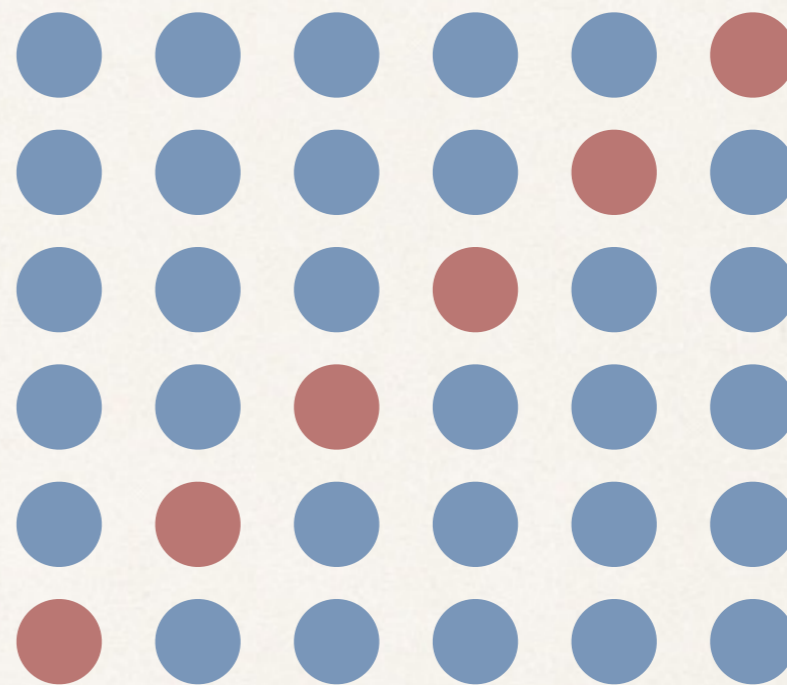
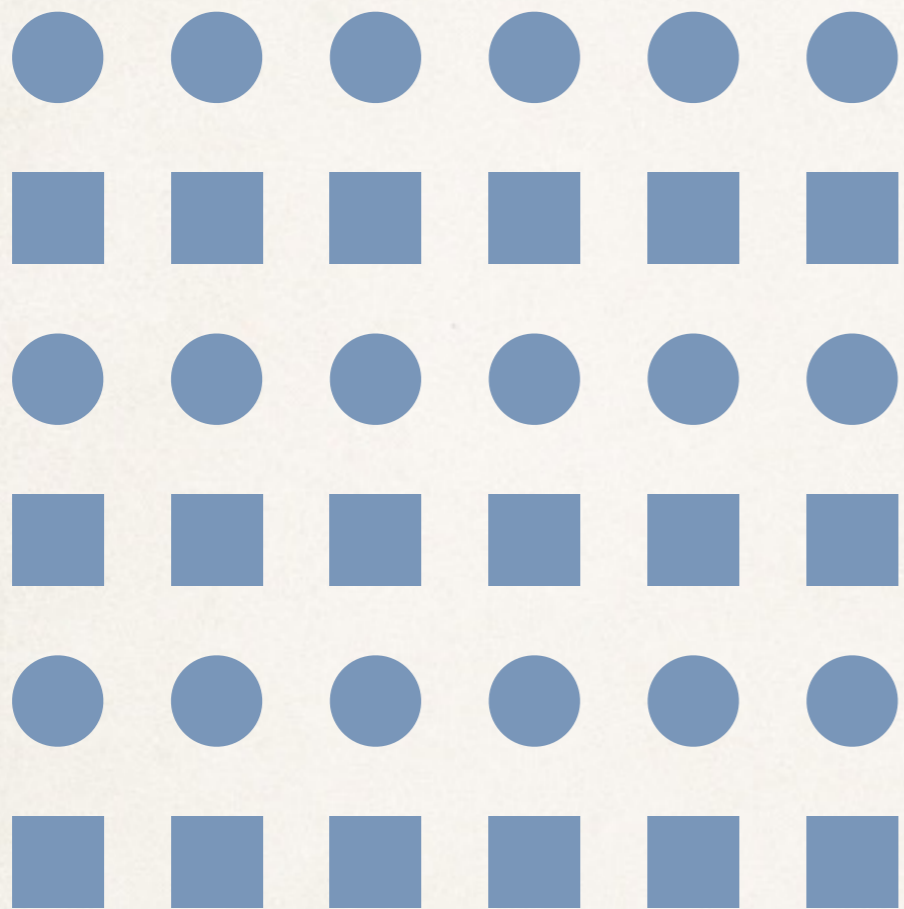
**Common fate:** objects that move together are perceived as being

# Gestalt laws - proximity

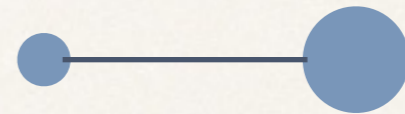




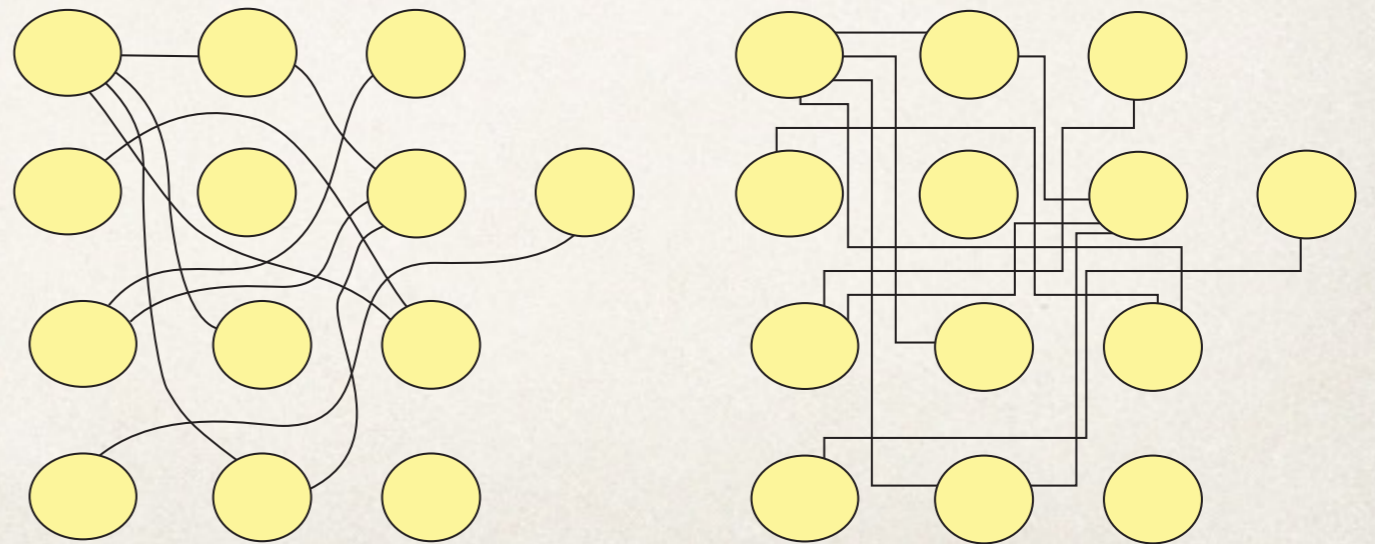
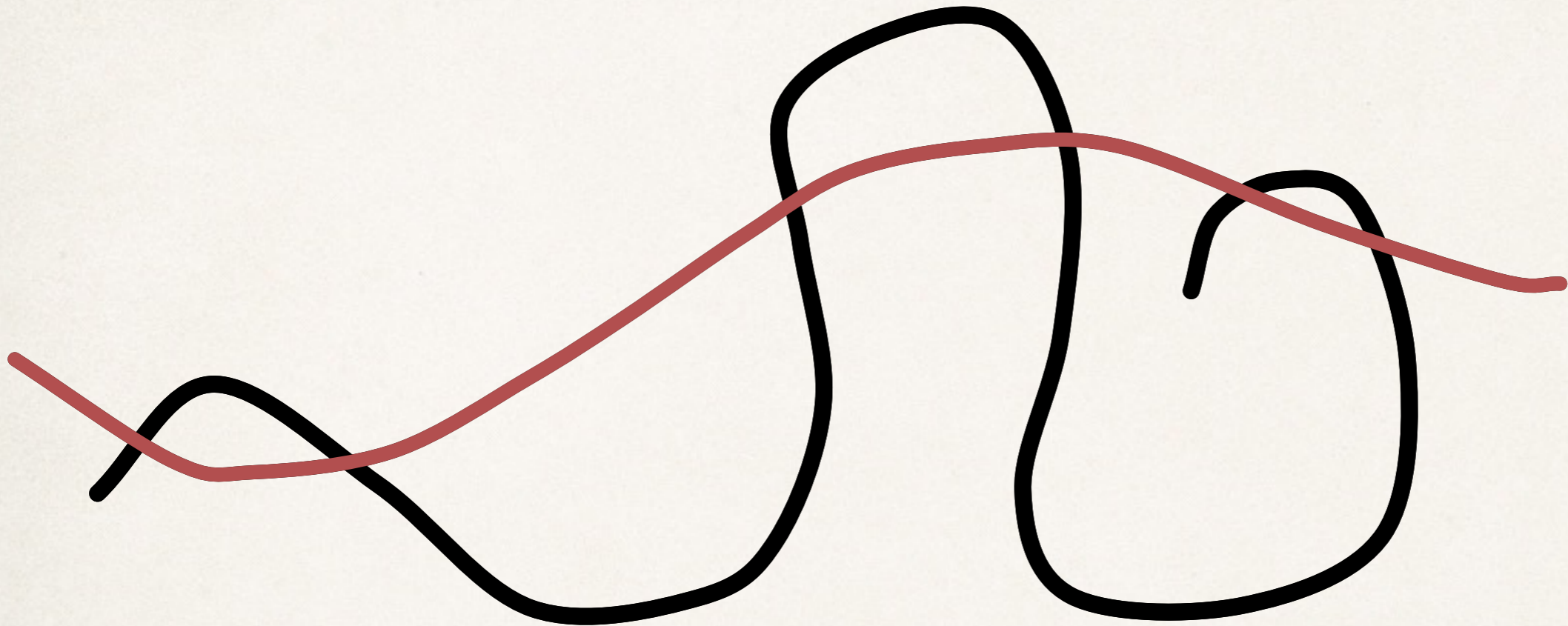
# Gestalt laws - similarity



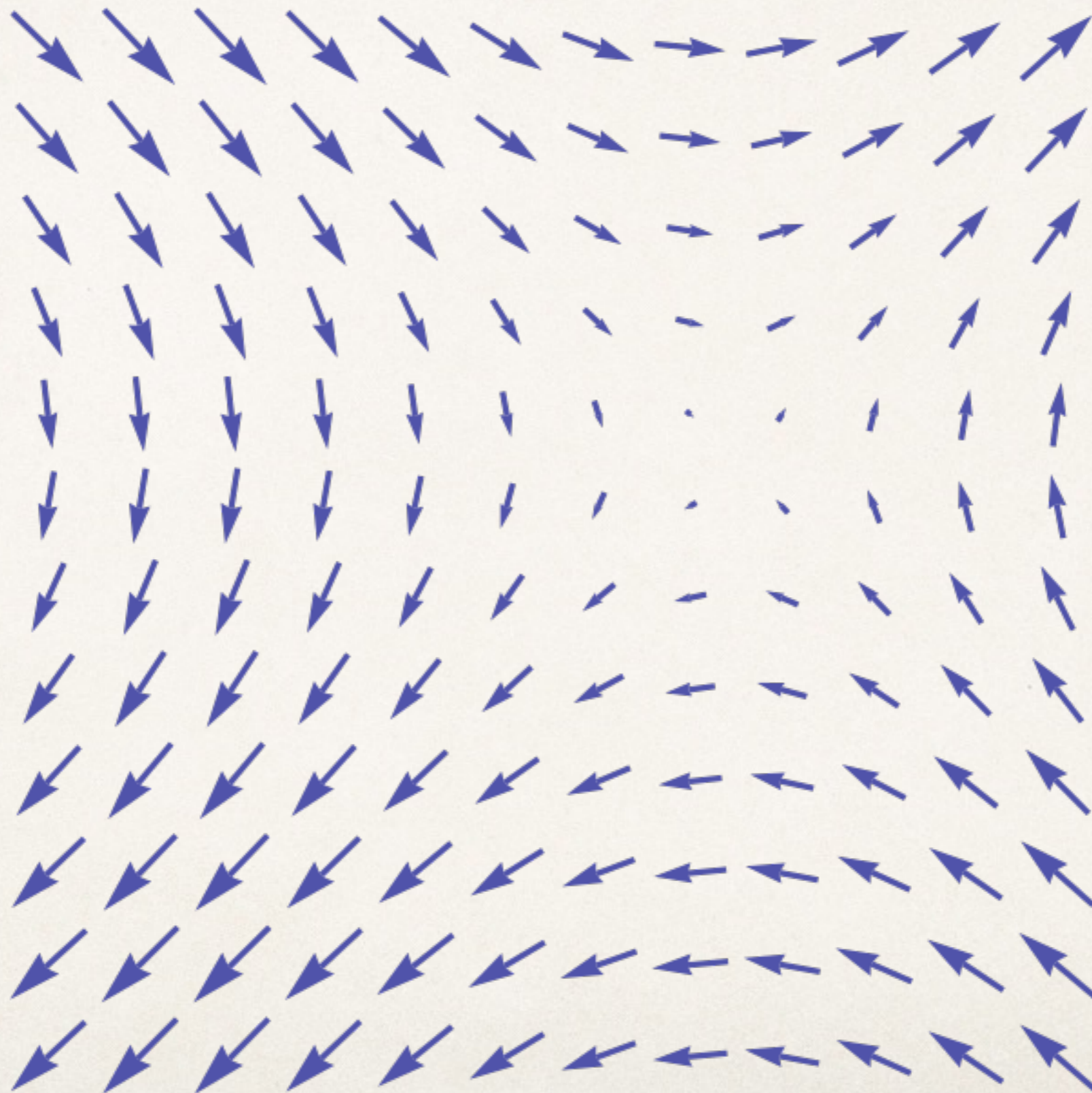
# Gestalt laws - connectedness



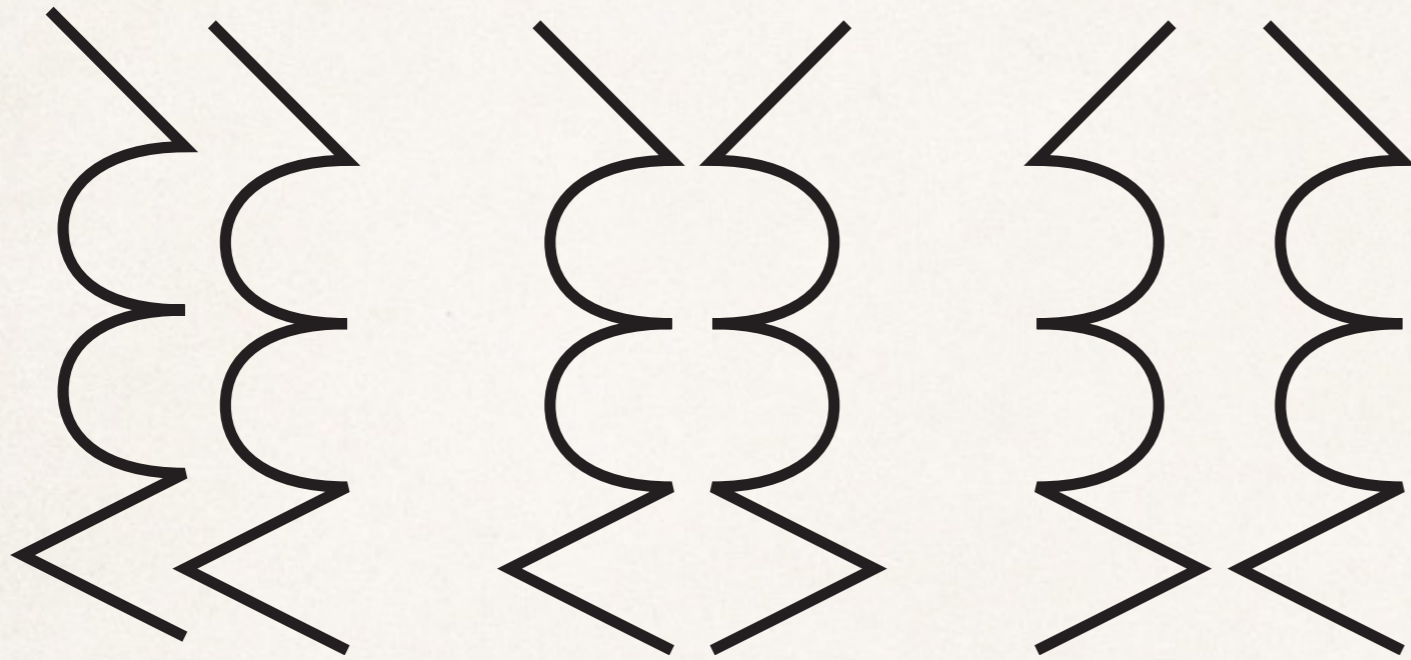
# Gestalt laws - continuity



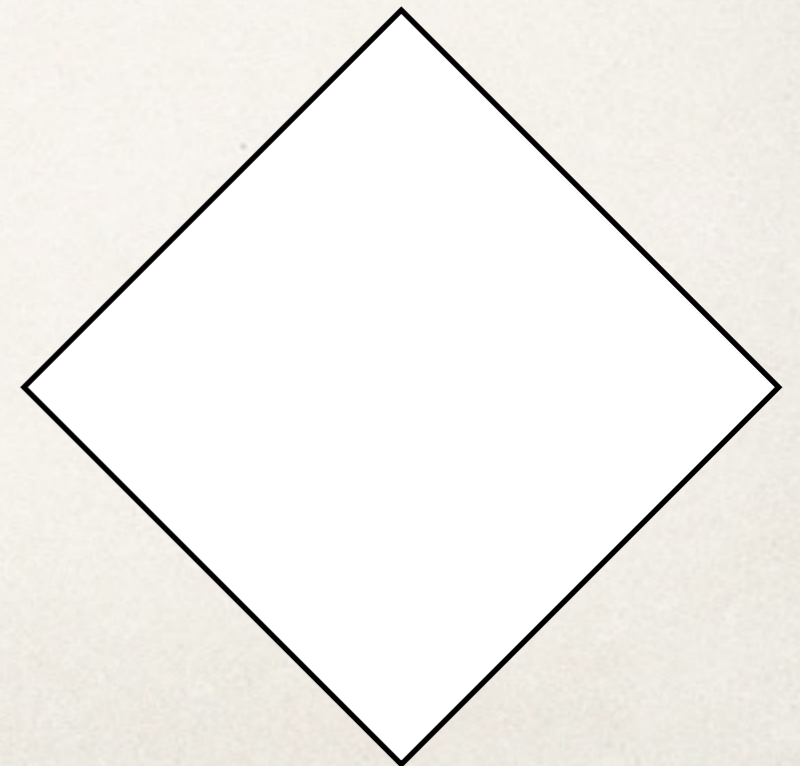
# Gestalt laws - continuity



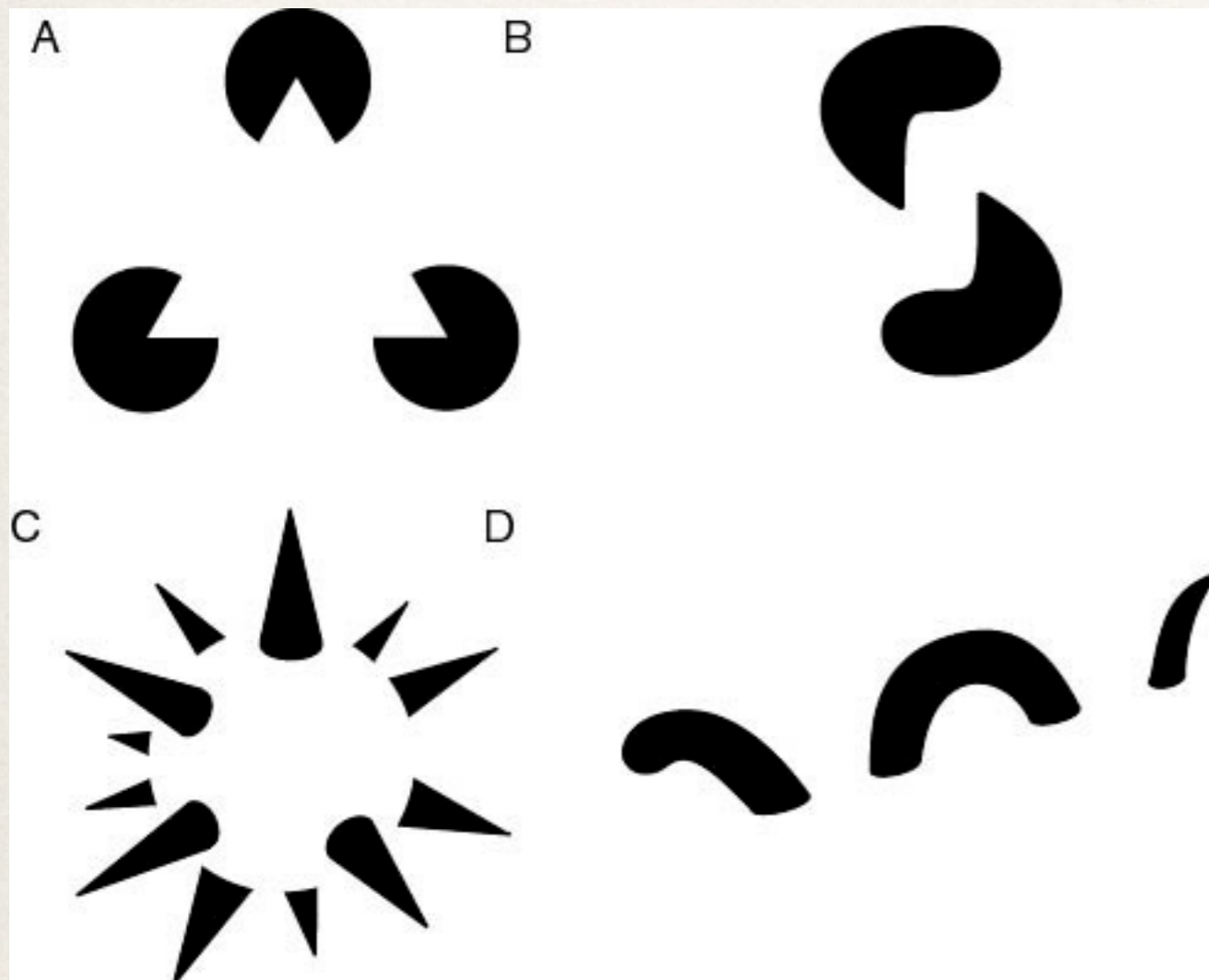
# Gestalt laws - symmetry



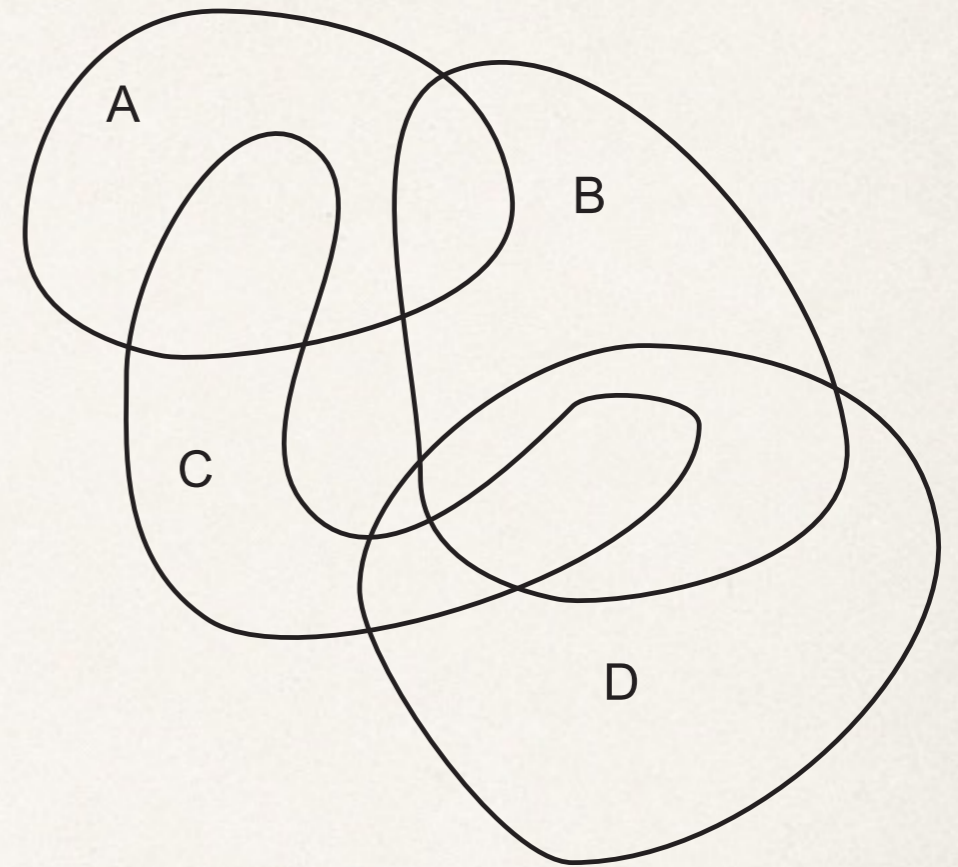
Ware, "Information Visualization: Perception for Design"



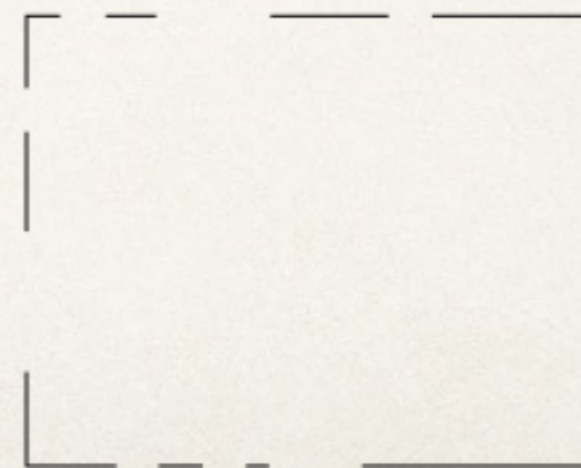
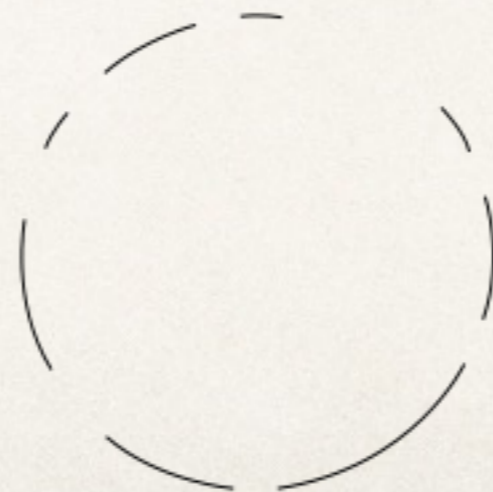
# Gestalt laws - closure



Wikimedia Commons

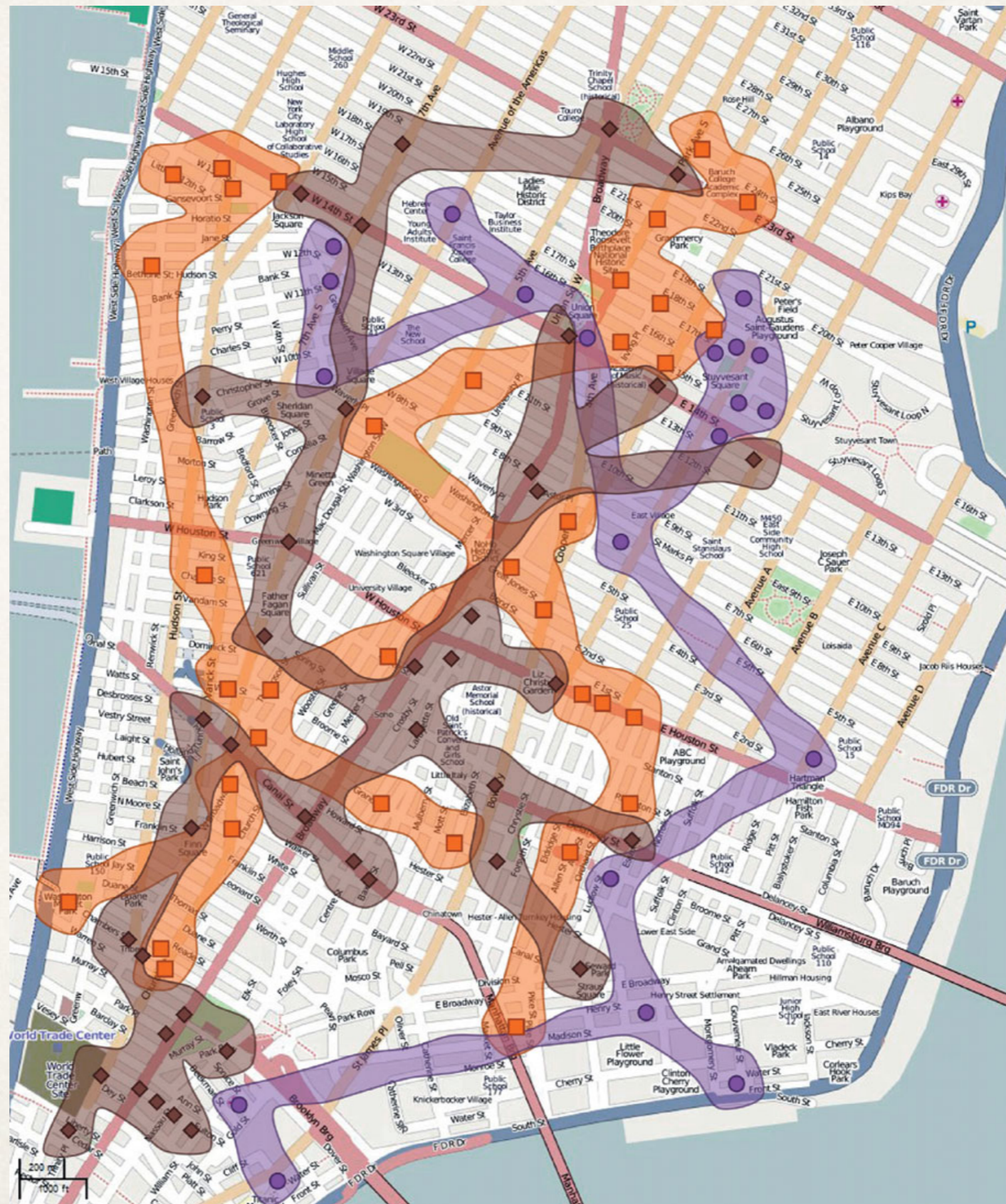


Ware, "Information Visualization: Perception for Design"



Wikimedia Commons

# Gestalt laws - closure



# Gestalt laws - relative size

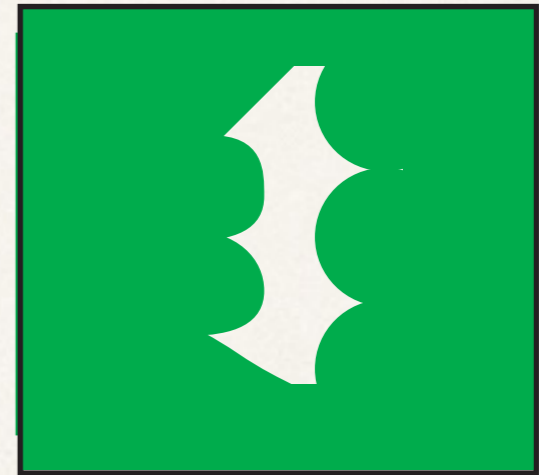
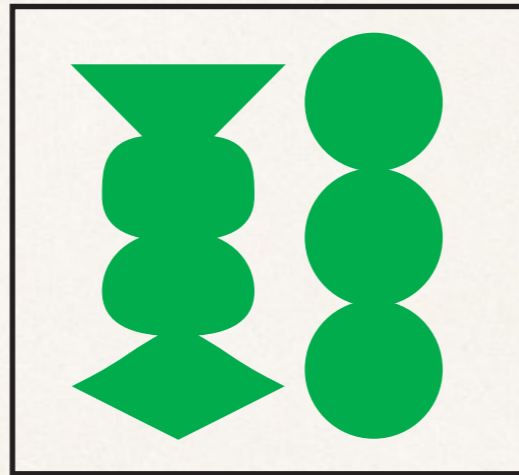
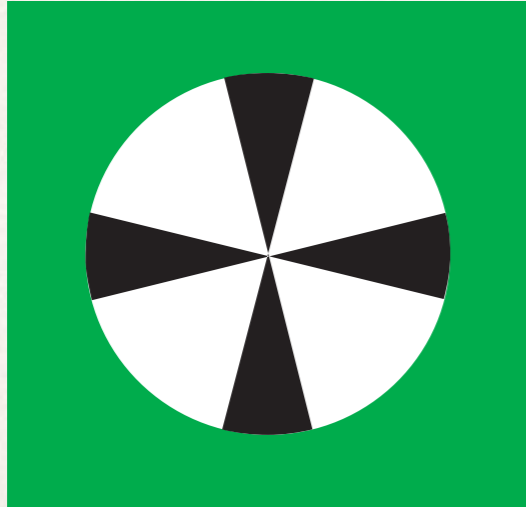


Figure vs ground



# Gestalt laws - shared fate



# Gestalt laws - shared fate

