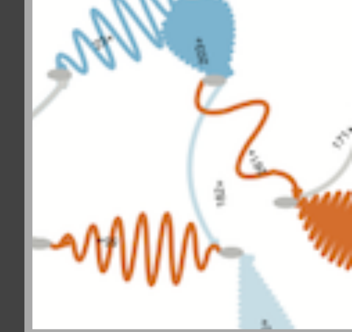
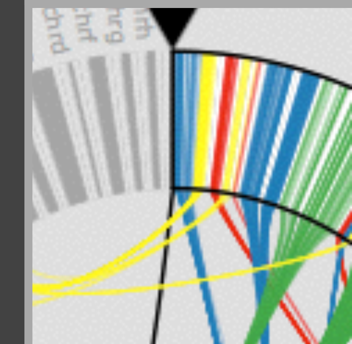
cs6630 | September 2 2014

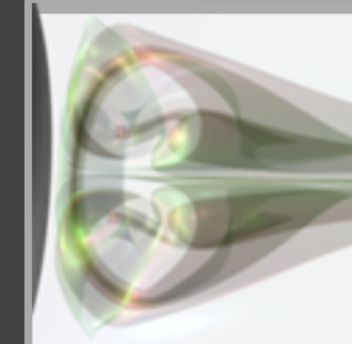
# PERCEPTION

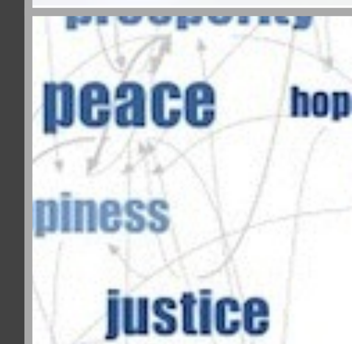

Miriah Meyer

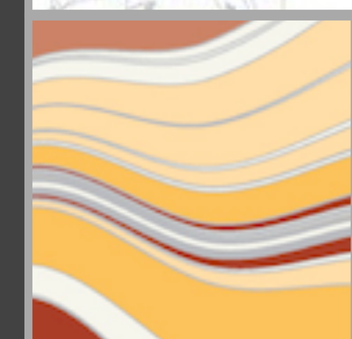
*University of Utah*

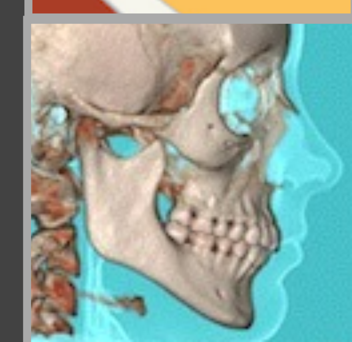











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# PERCEPTION

**Miriah Meyer**
*University of Utah*

***slide acknowledgements:***
Hanspeter Pfister, Harvard University
Bang Wong, Broad Institute

administrivia . . .

- design critiques start this week
    - *please include the visualization in the post*

- first assignment goes out Thursday

last time . . .

# Tufte's integrity principles

Clear, detailed, and thorough labeling should be used to defeat graphical distortion and ambiguity.

The representation of numbers, as physically measured on the surface of the graphic itself, should be directly proportional to the numerical quantities represented.

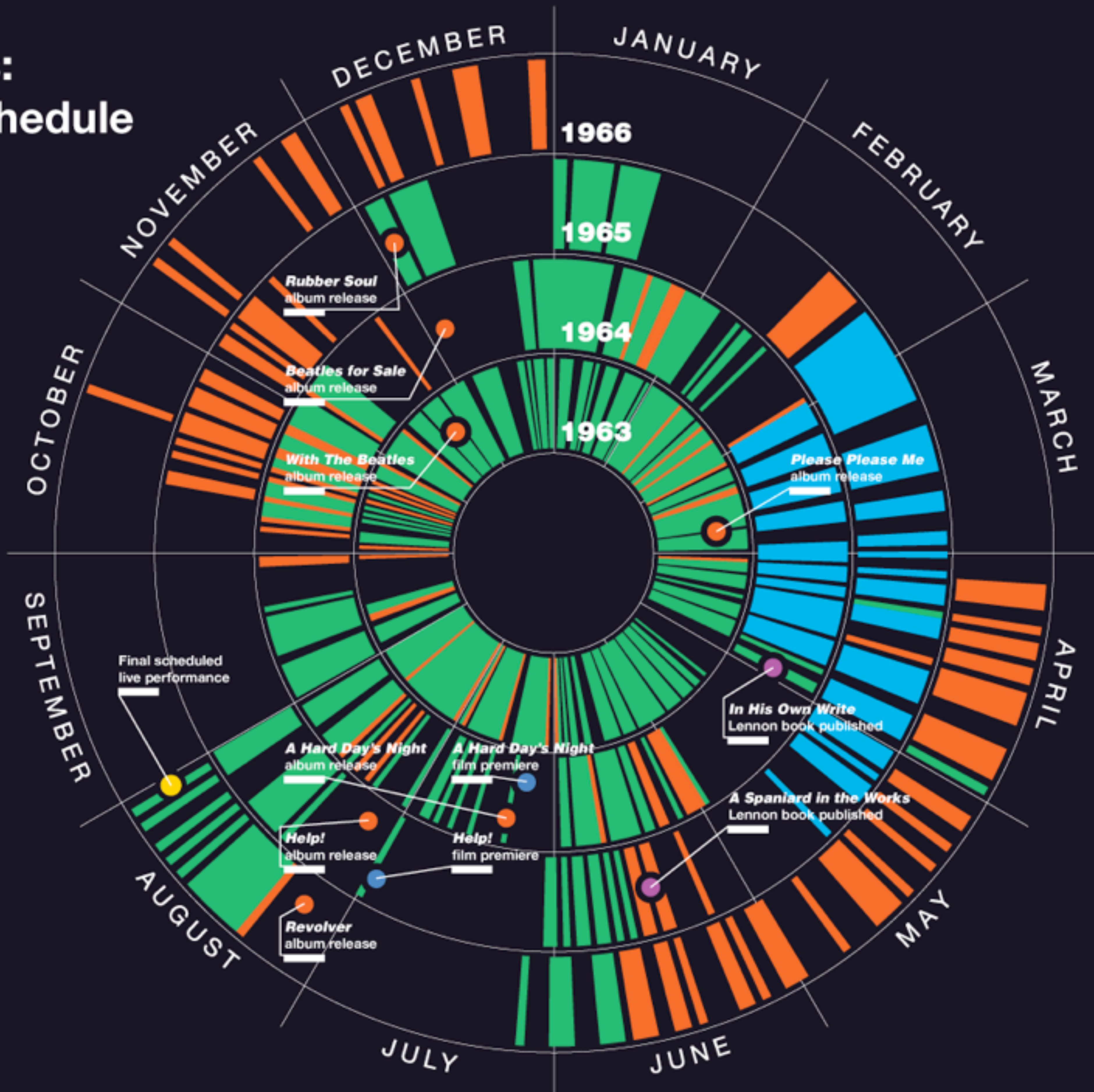
Show data variation, not design variation.

# Tufte's design principles

- maximize the data-ink ratio
- avoid chart junk (***sometimes***)
- use multifunctioning elements
- layer information
- maximize the data density
  - *shrink the graphics*
  - *maximize the amount of data shown* (***sometimes***)

# The Beatles: Working Schedule

1963 - 1966




Recording

Filming movie

Performing and touring

http://www.mikemake.com/72772/Charting-the-Beatles today . . .

- the eye
- edge detection
- relativity of perception
- things that pop
- gestalt principles

- the eye
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- relativity of perception
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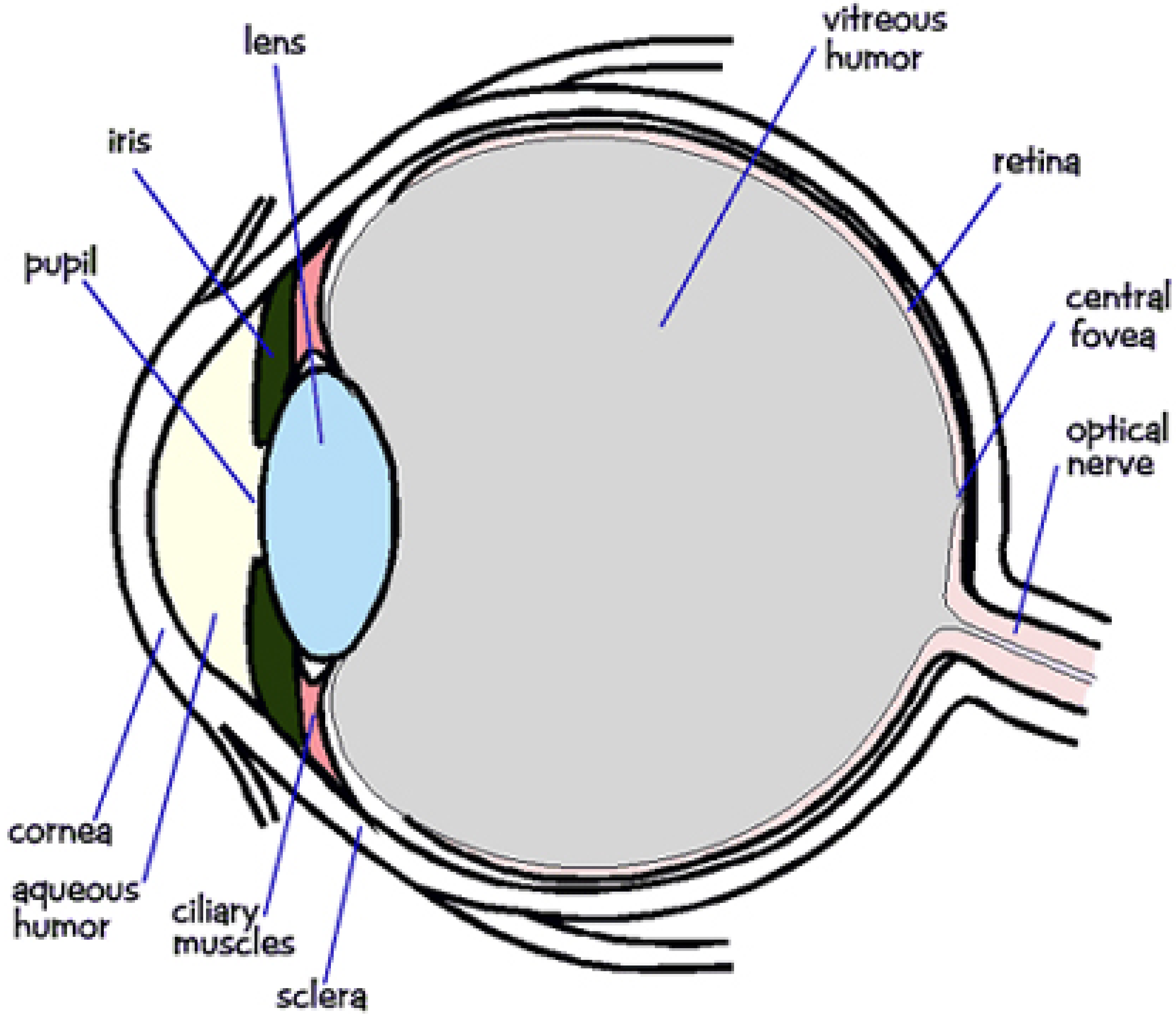
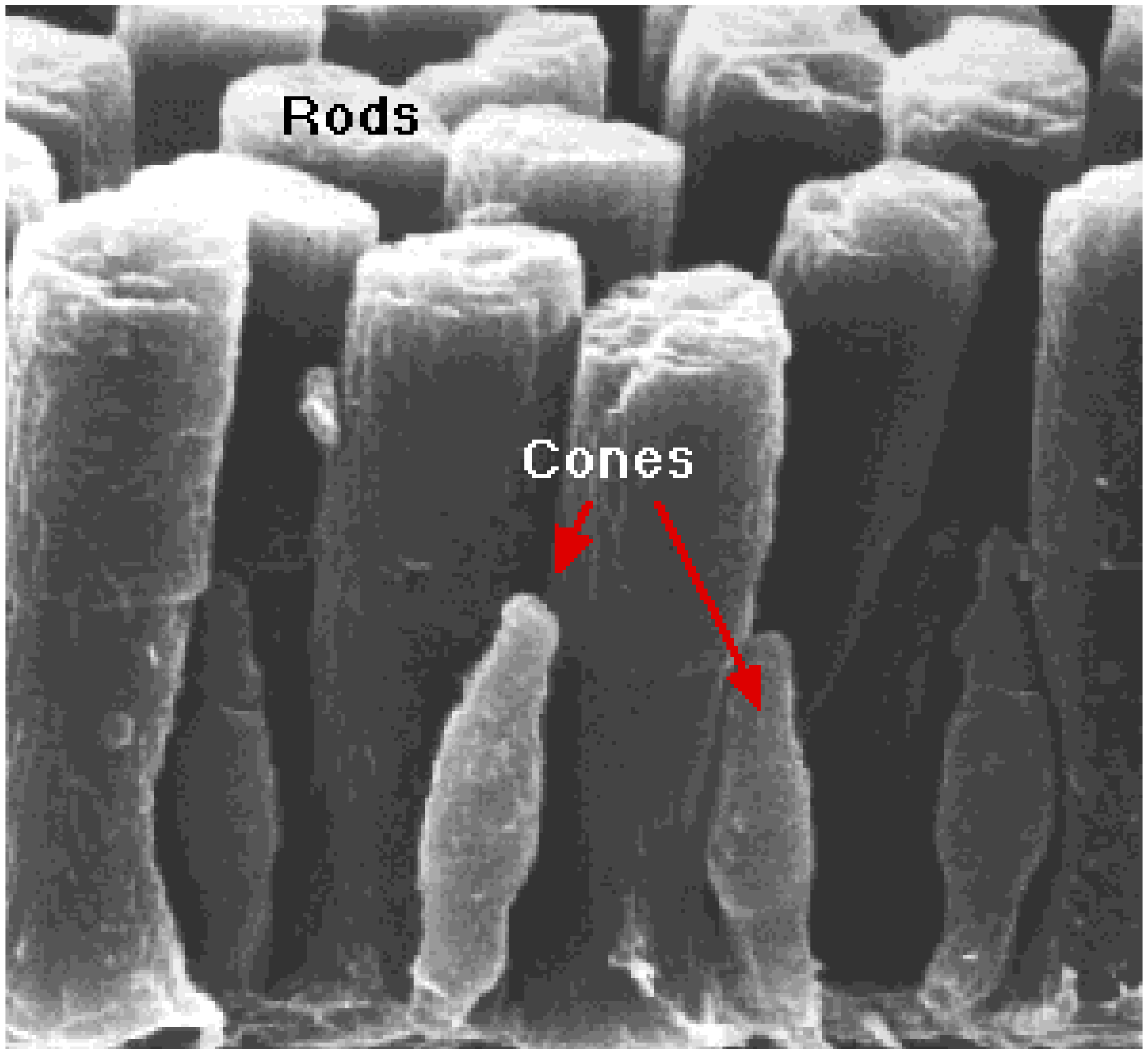
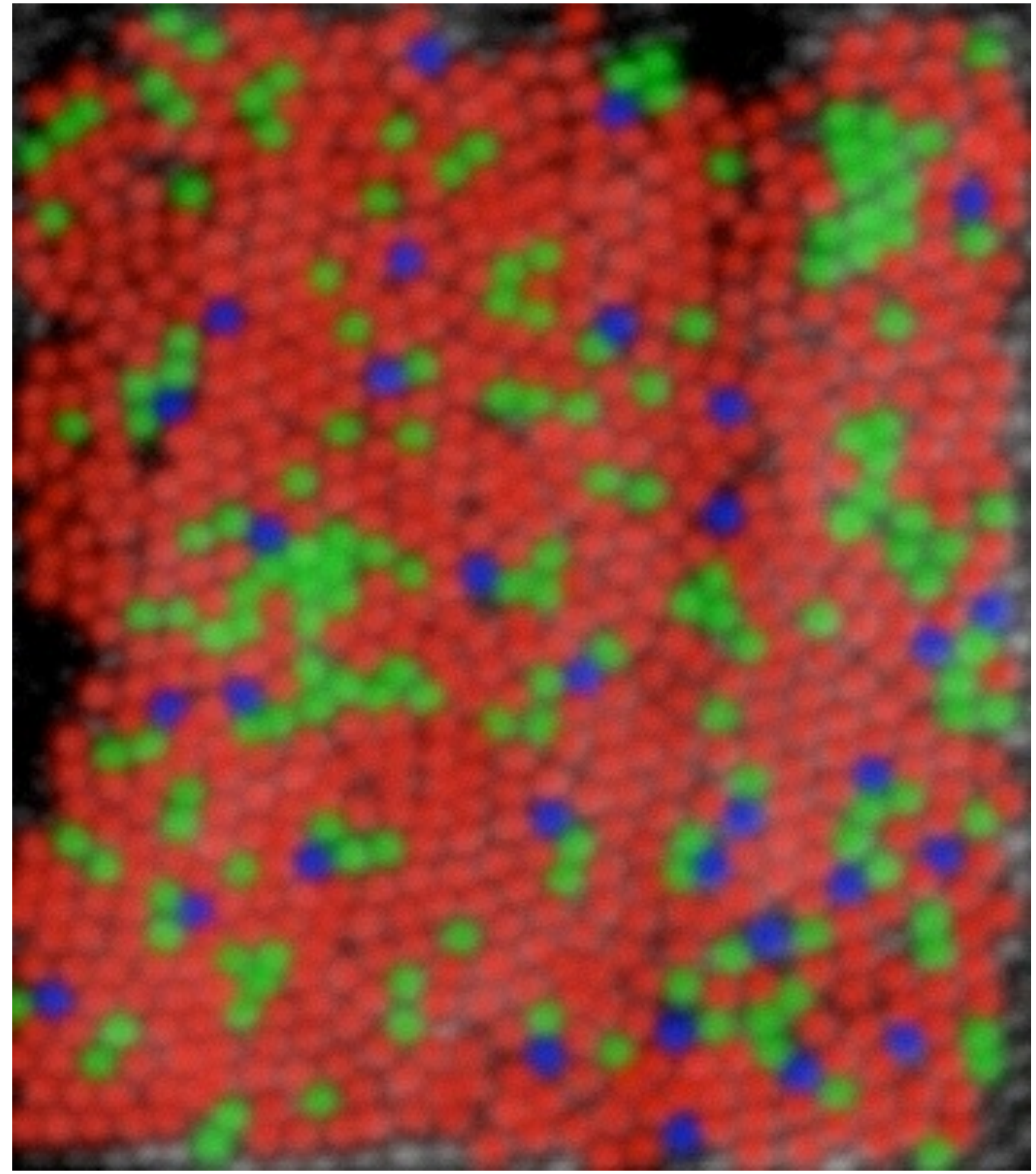
- gestalt principles


lens
vitreous humor
iris
retina
pupil
central fovea
optical nerve
cornea
aqueous humor
ciliary muscles
sclera



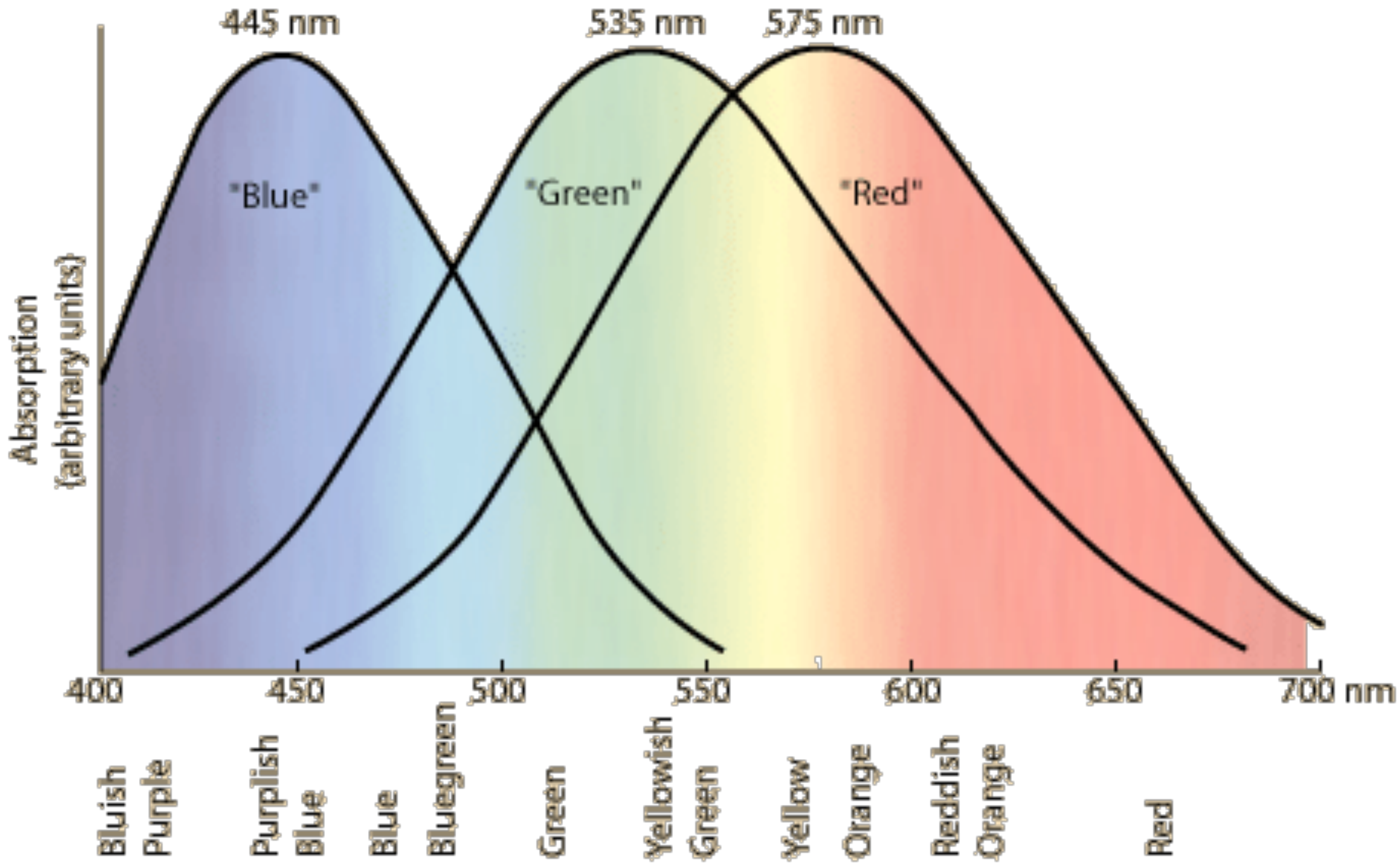

120 million rods



5-6 million cones

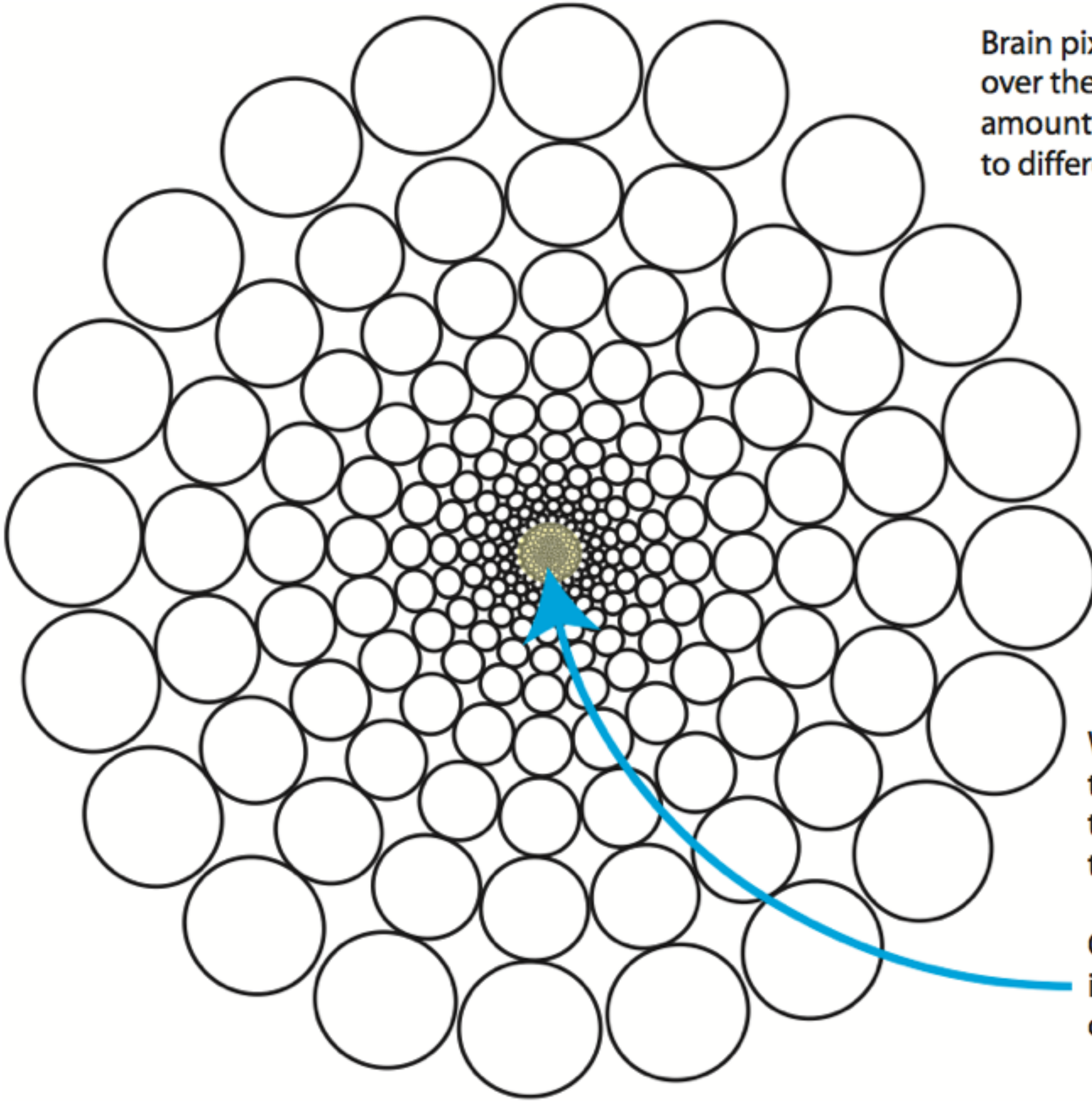
Wandell, "Foundations of Vision" (left)
David R. Williams, Univ. of Rochester (right)

# Cone Response






HyperPhysics, Georgia State University

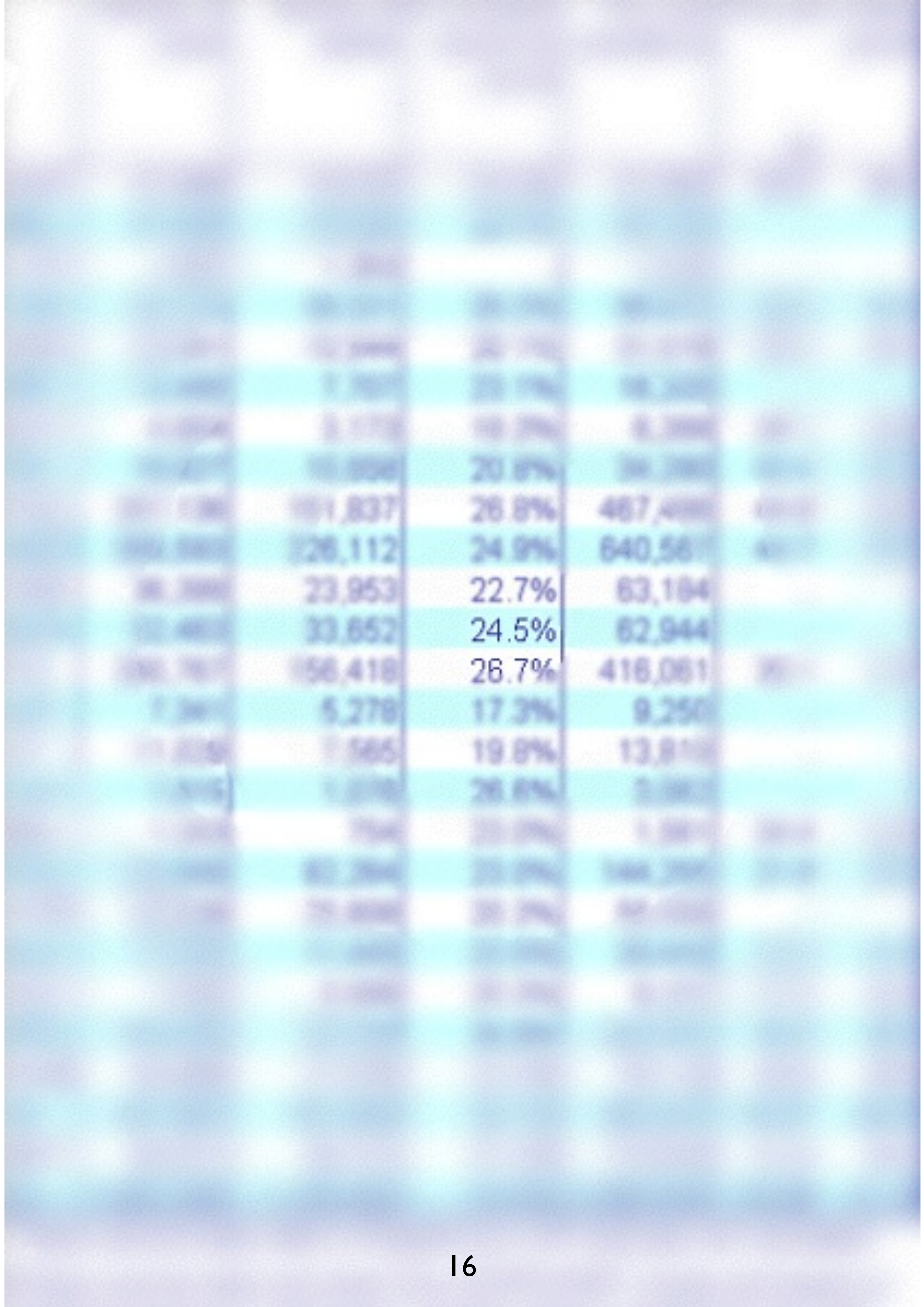


Brain pixels vary enormously in size over the visual field. This reflects differing amounts of neural processing power devoted to different regions of visual space.

At the edge of the visual field we can only barely see something the size of a fist at arm's length.

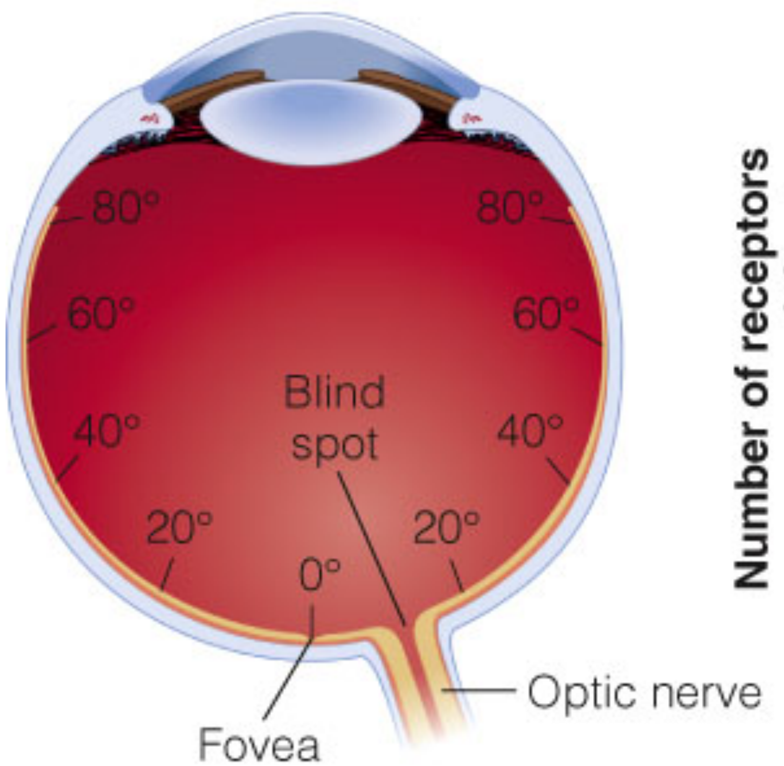
We can resolve about 100 points on the head of a pin held at arm's length in the very center of the visual field called the fovea.

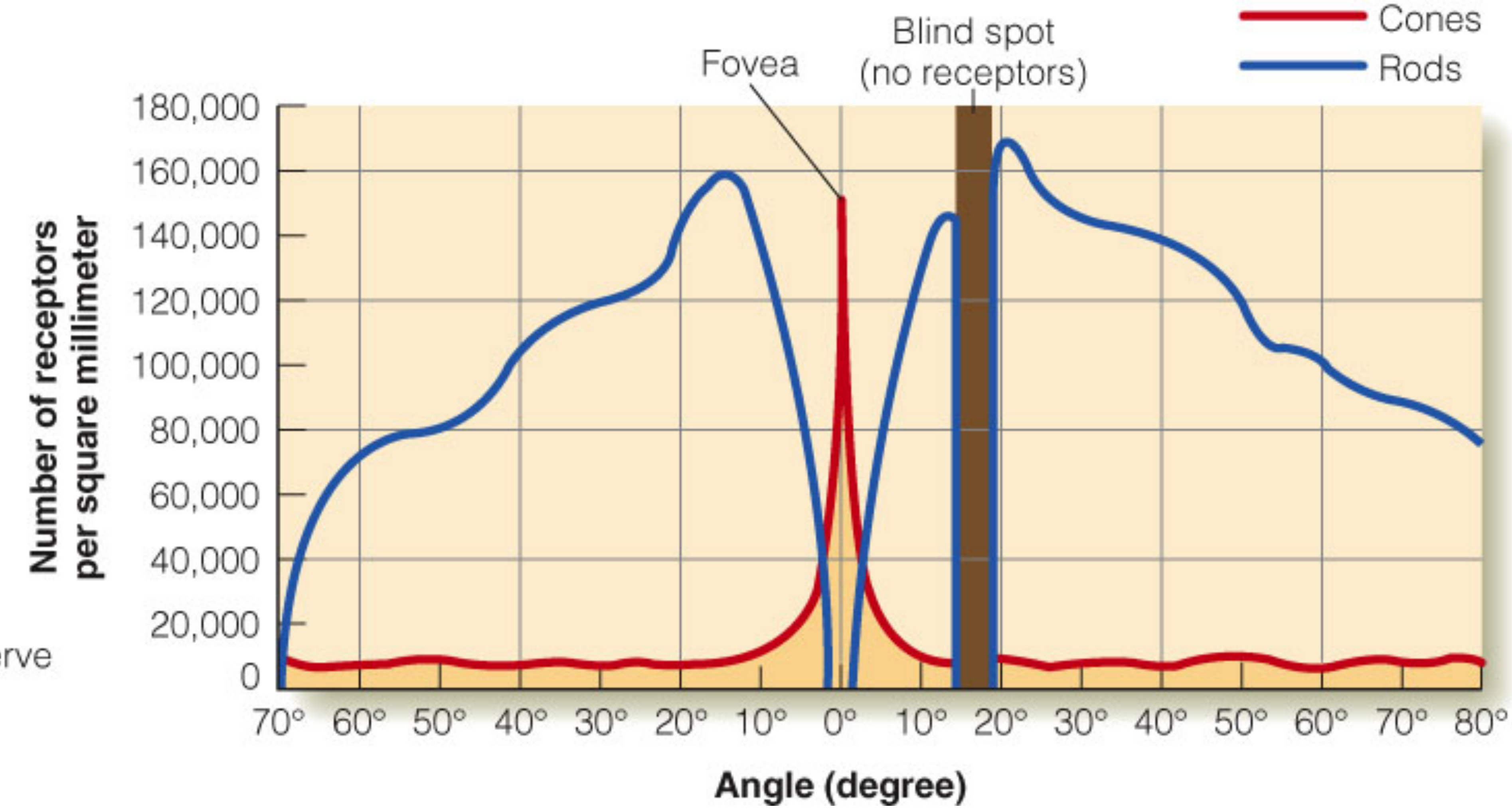
Over half of our visual processing power is concentrated in a slightly larger area called the parafovea.






C. Ware, "Visual Thinking for Design"



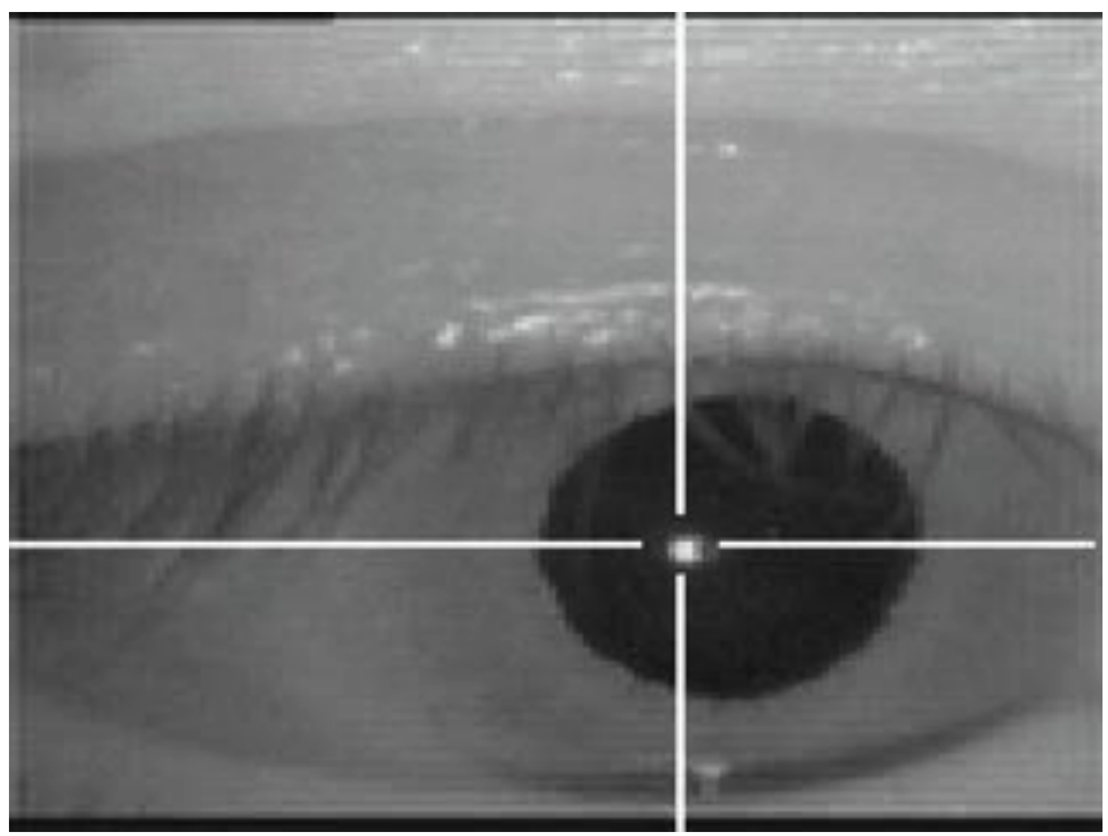






E. B. Goldstein "Sensation and Perception"
(Adapted from Lindsay & Norman, 1977)

# Saccadas

- **rapid involuntary eye movements**
  - moving: 20-100 ms
  - fixations: 200-600 ms



 http://vision.arc.nasa.gov/personnel/jbm/home/projects/osa98/osa98.html

# Saccadas

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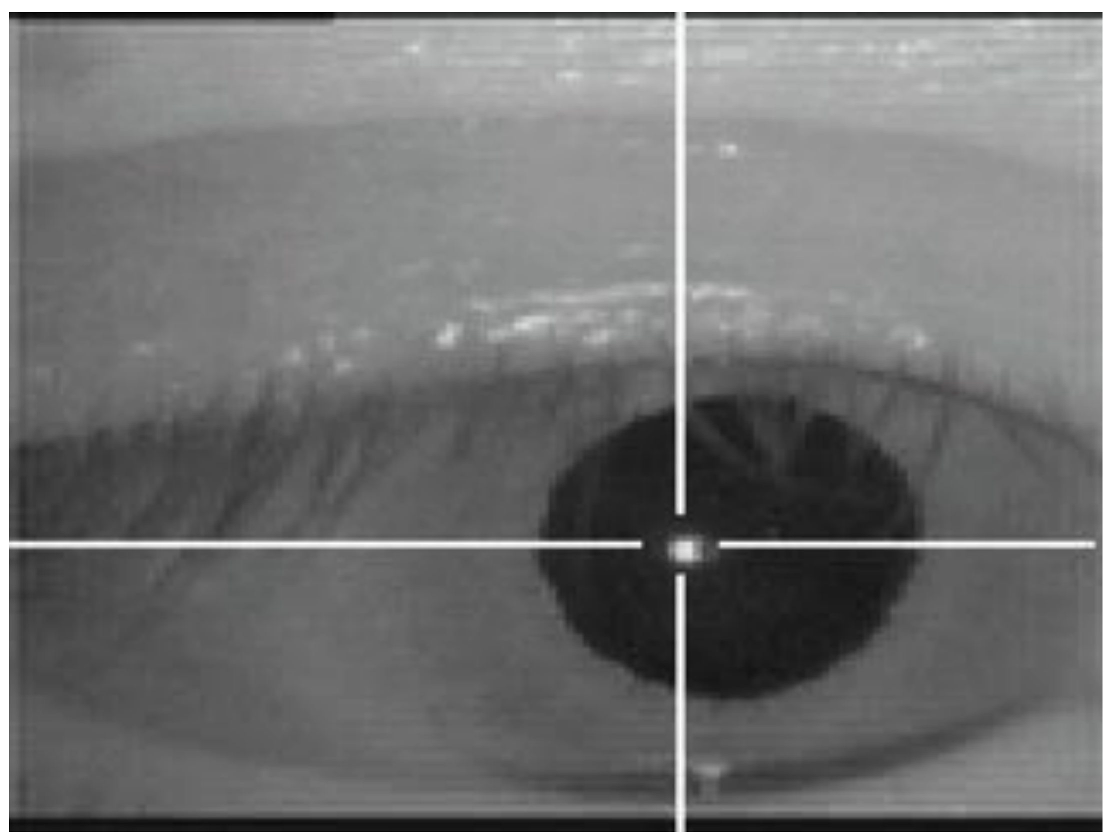


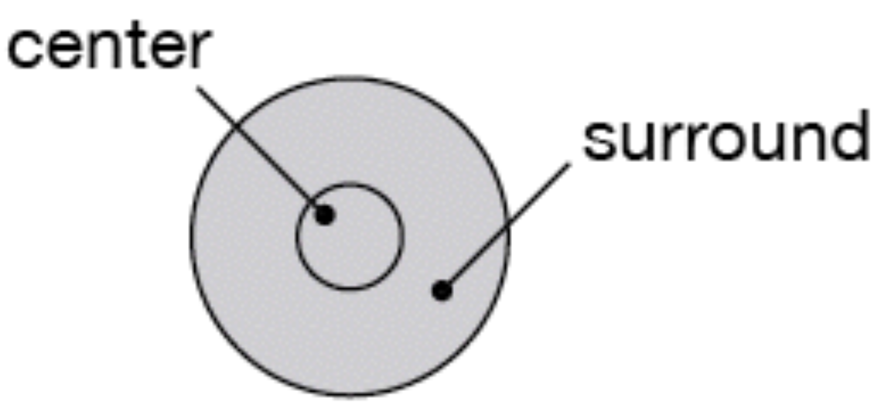


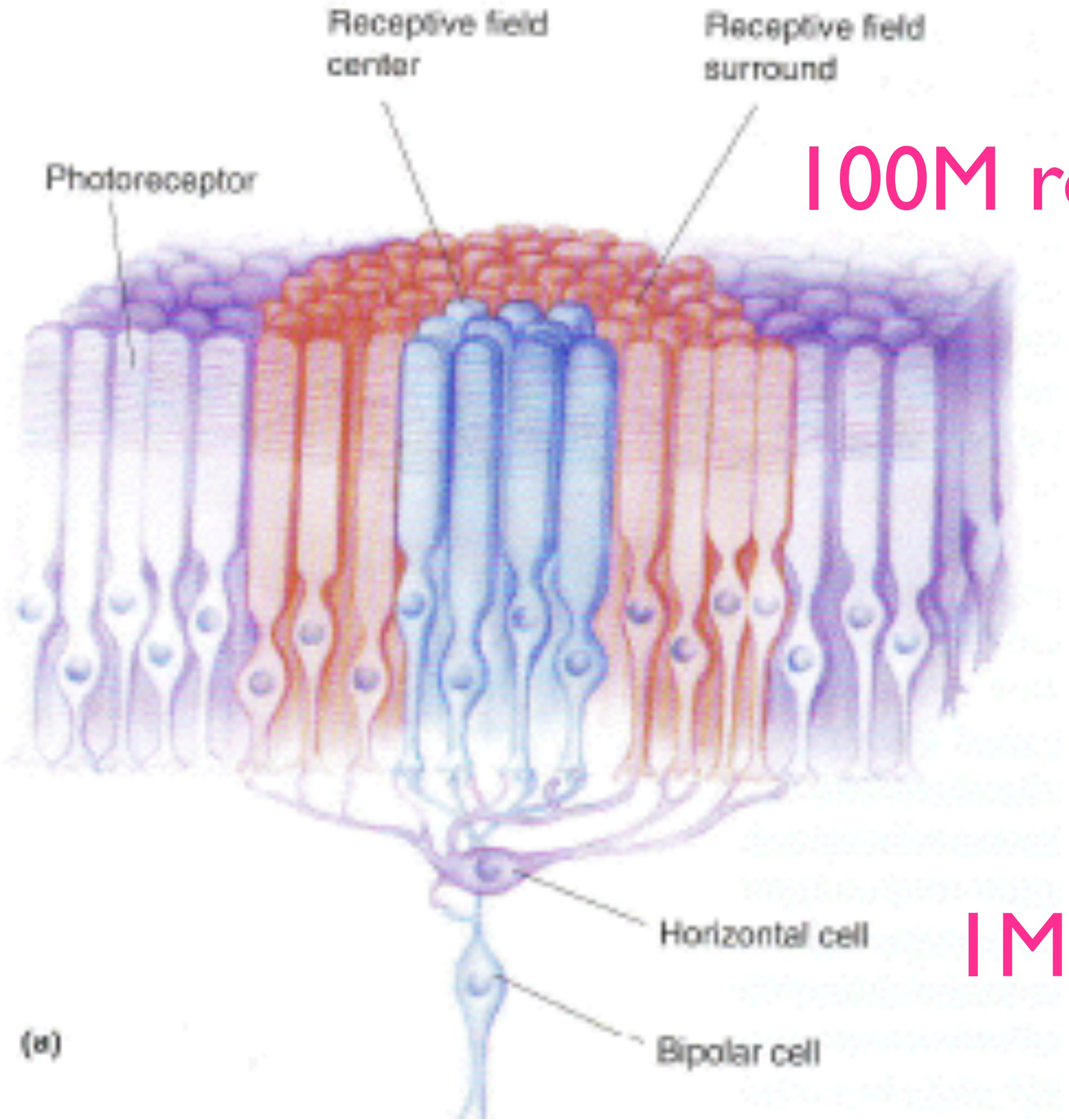
http://vision.arc.nasa.gov/personnel/jbm/home/projects/osa98/osa98.html

- the eye
- **edge detection**
- relativity of perception
- things that pop
- gestalt principles

# center surround

# receptive field



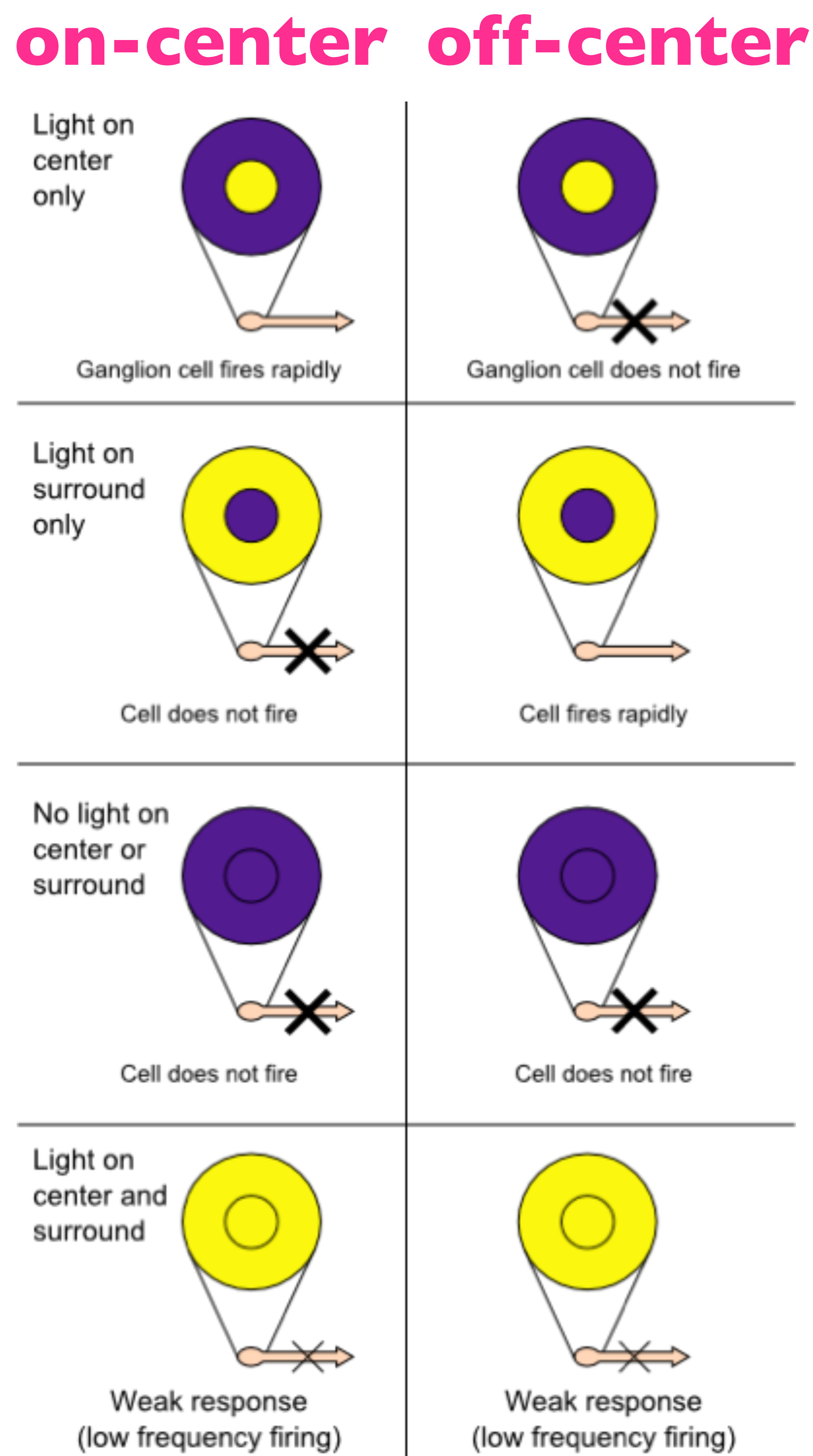




100M rods and cones

1M ganglion cells

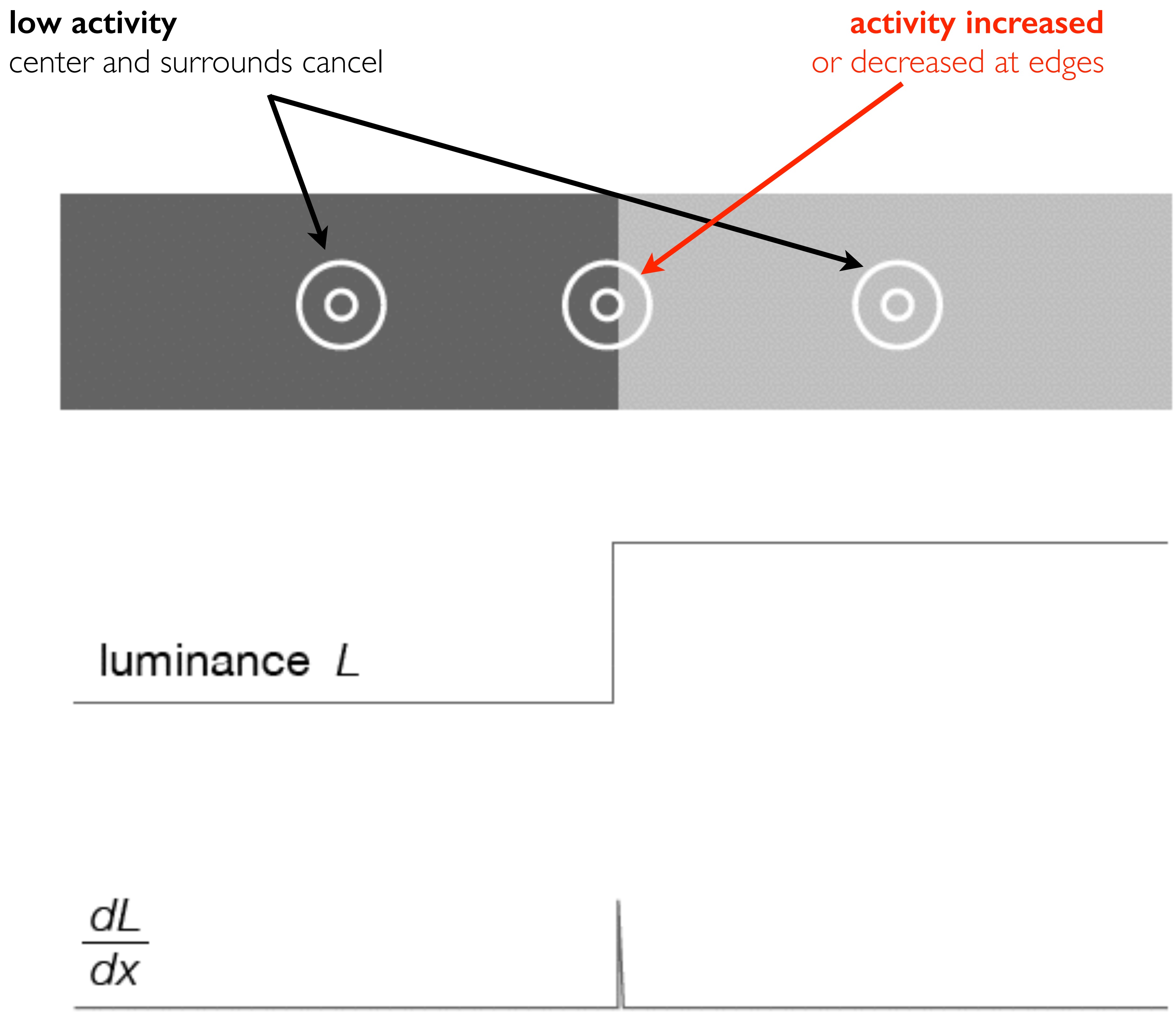
Bear, Connors, Paradiso, "Neuroscience"

# retinal ganglion cells

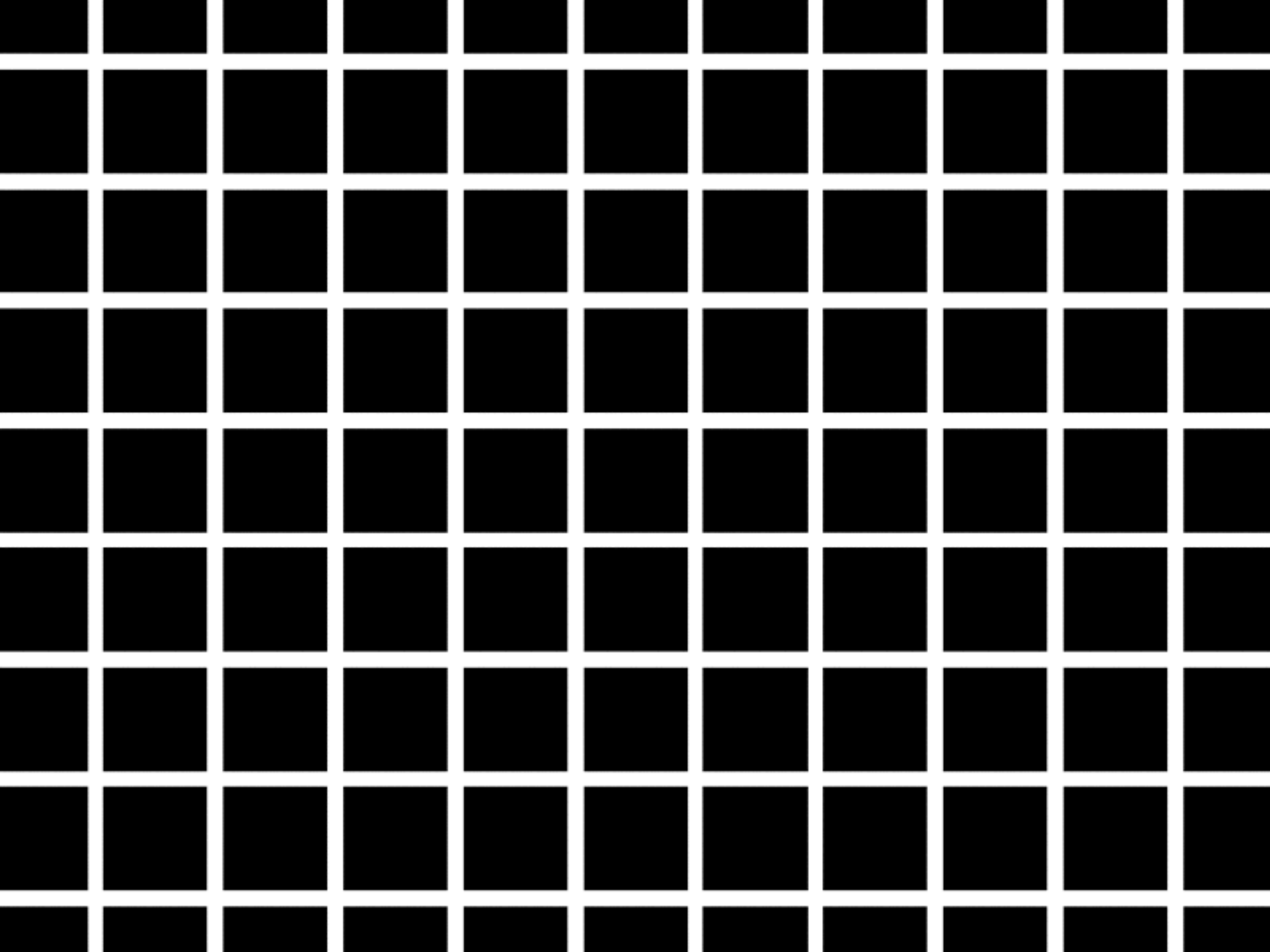



source: wikipedia

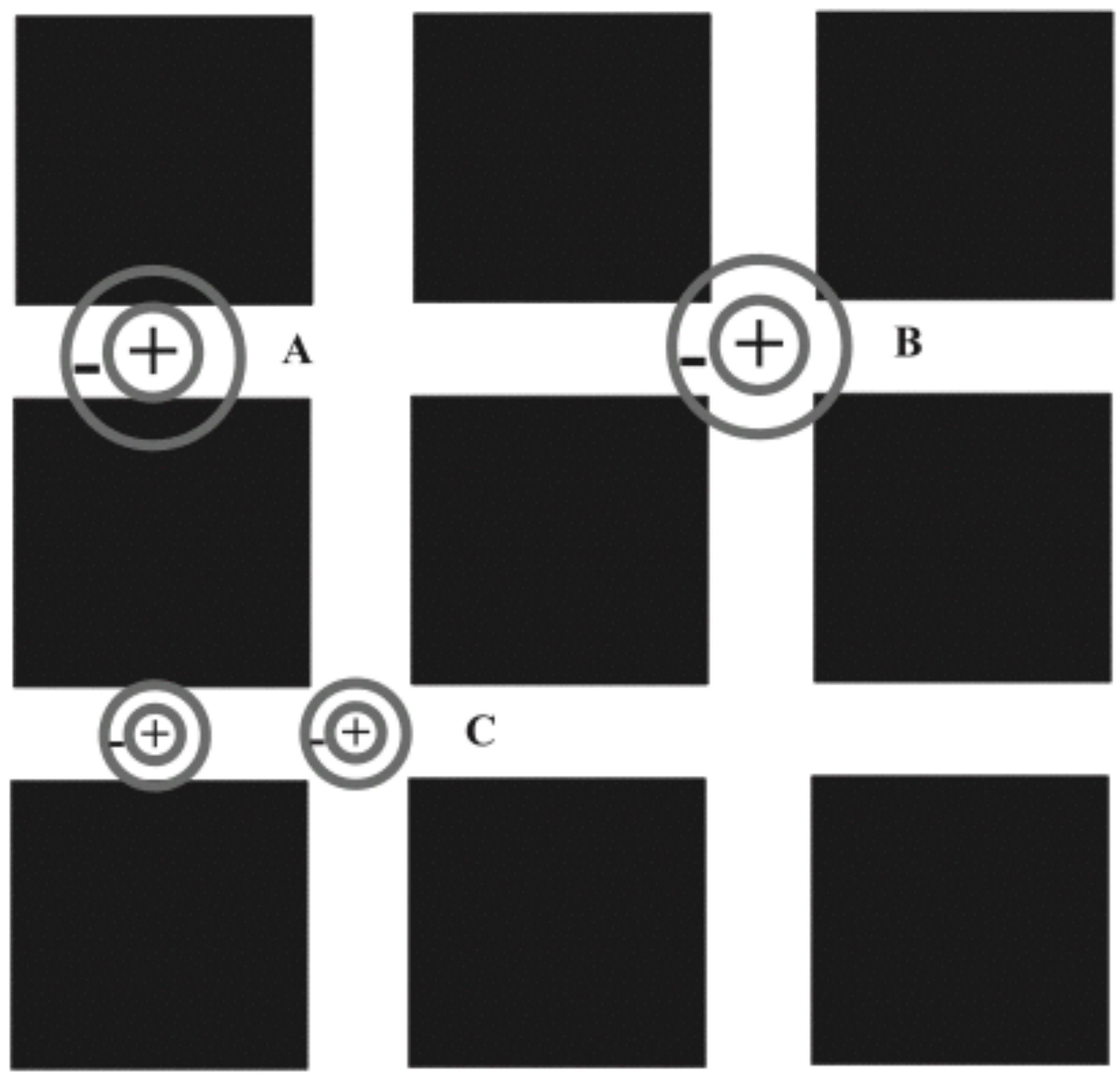
luminance $L$
$\frac{dL}{dx}$



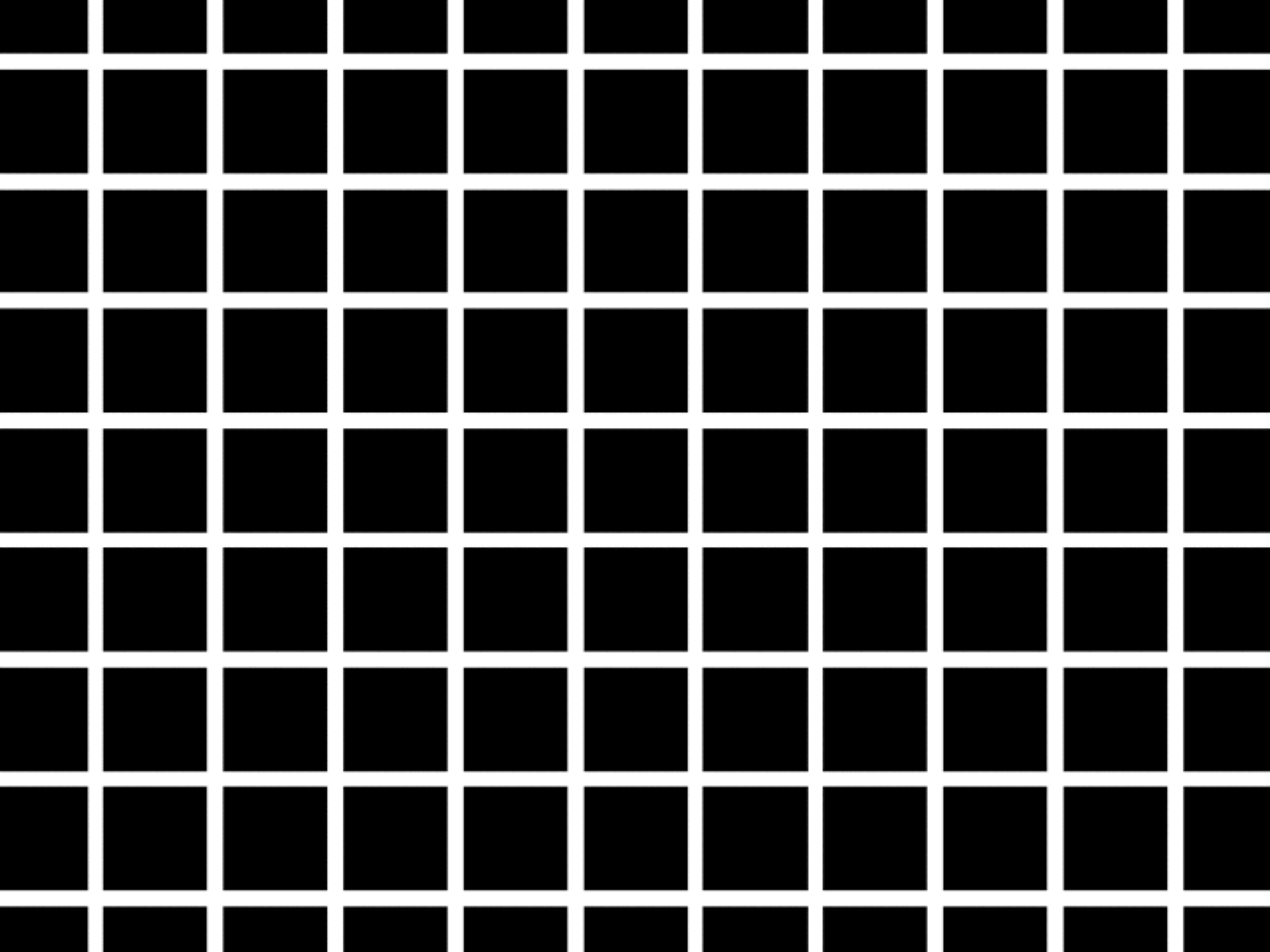
**low activity**
center and surrounds cancel
**activity increased**
or decreased at edges
luminance $L$
$\frac{dL}{dx}$



# Hermann grid effect




Annie Prud’homme-Généreux



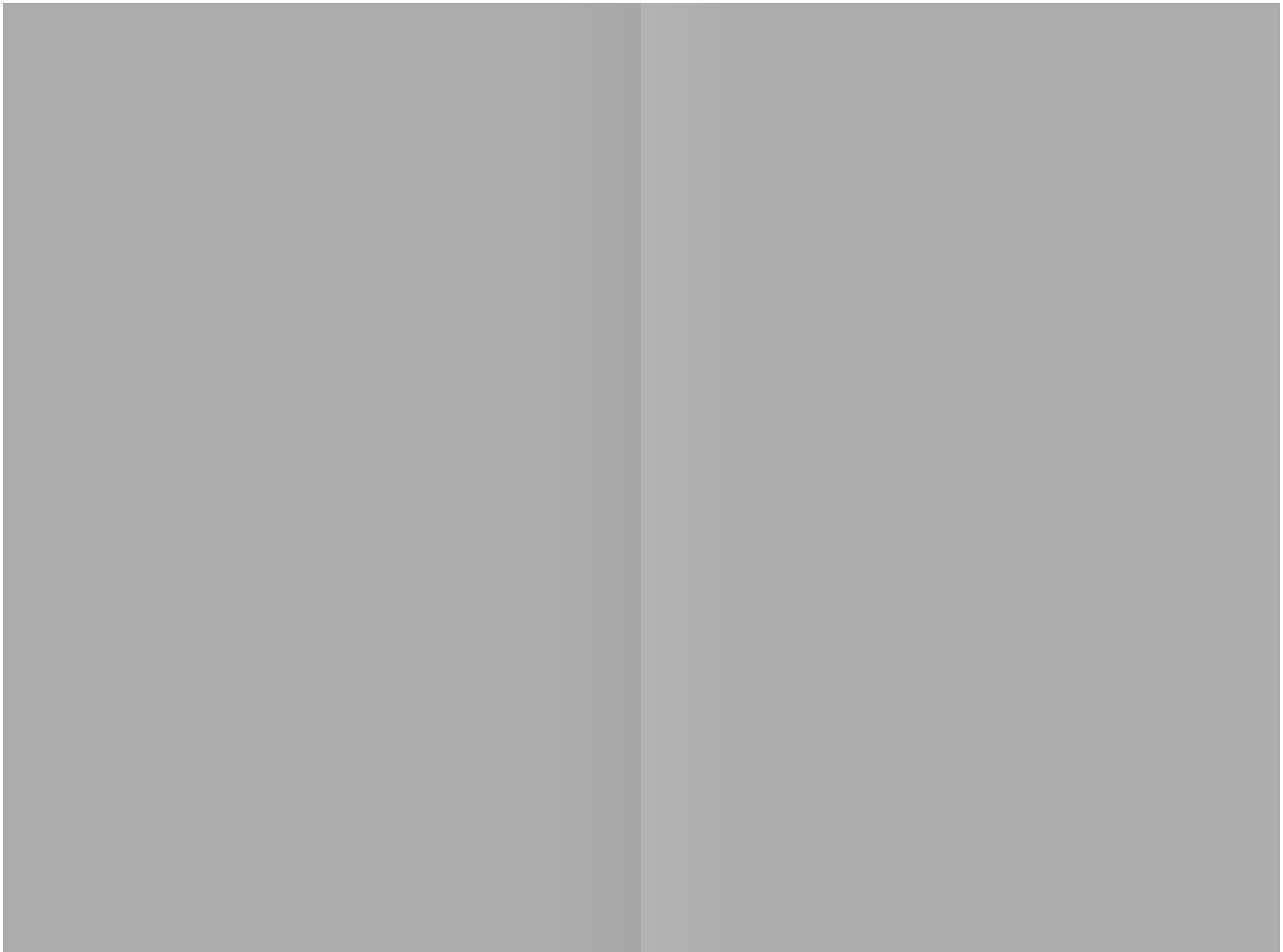
# Takeaway

Our visual system sees differences, not absolute values, and is attracted to edges.

**Maximize the contrast with the background if the outlines of shapes are important.**

# consequences of edge extraction

# Cornsweet Illusion



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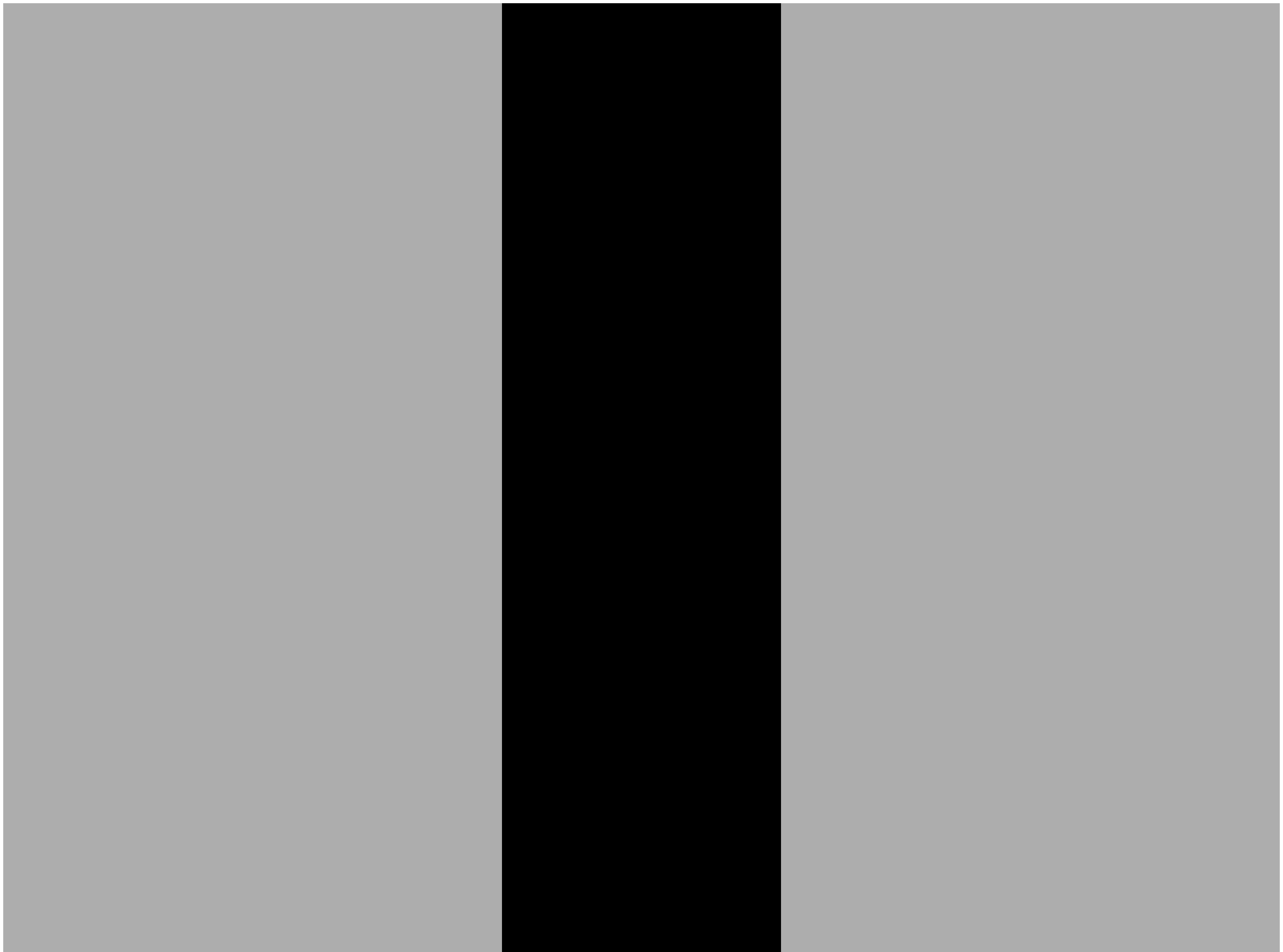
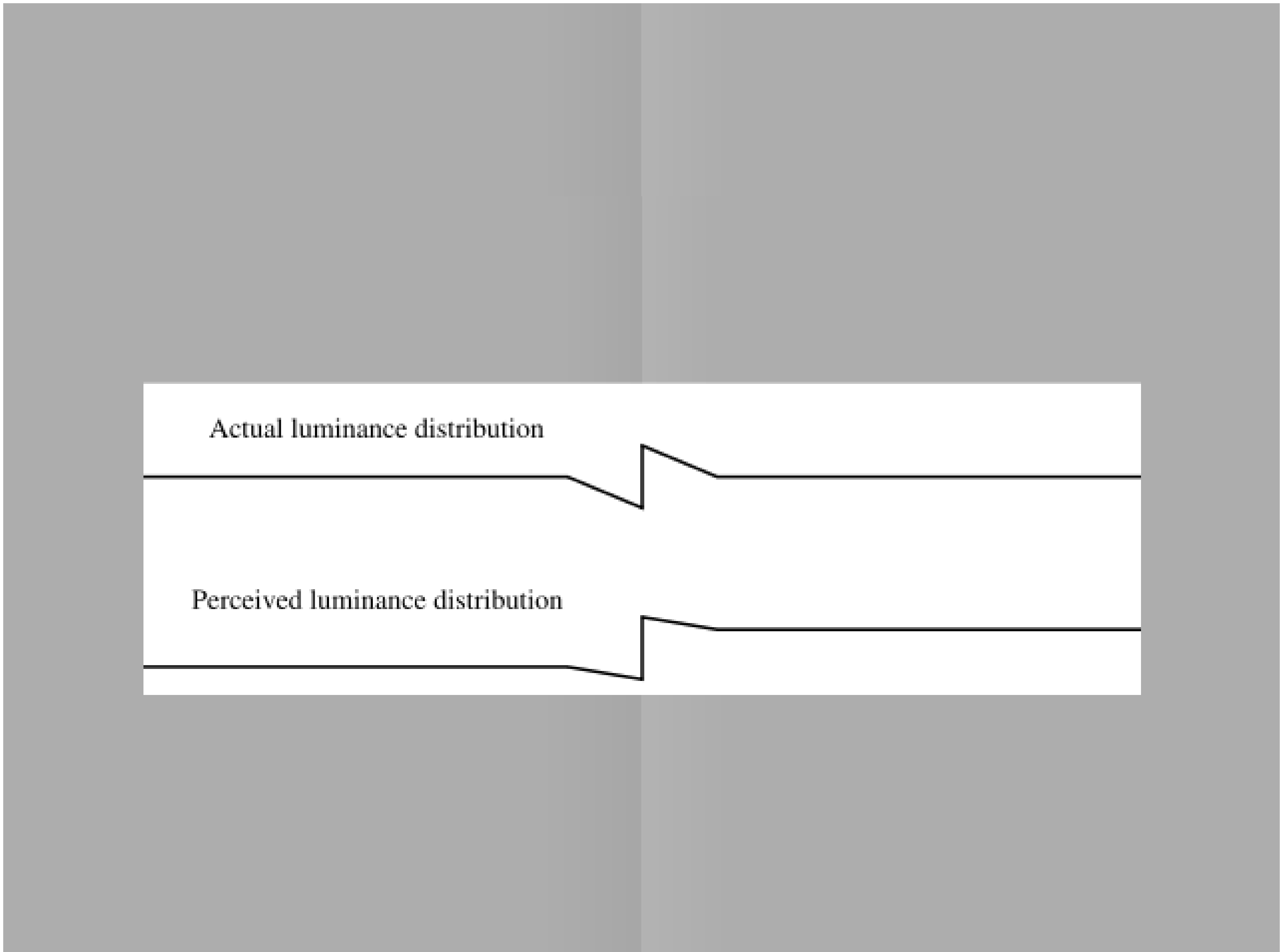


# Cornsweet Illusion



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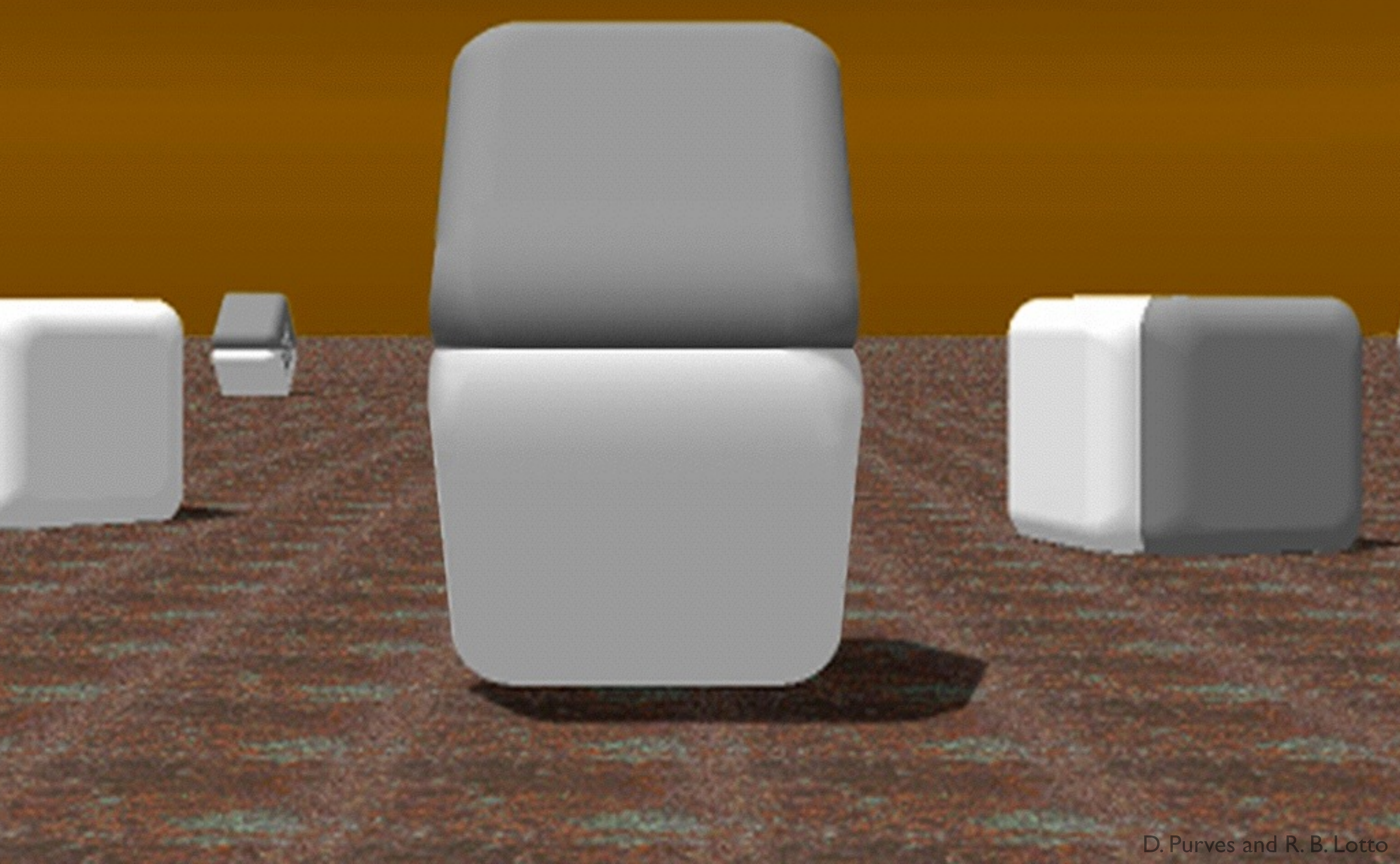

D. Purves and R. B. Lotto

# Cornsweet Illusion

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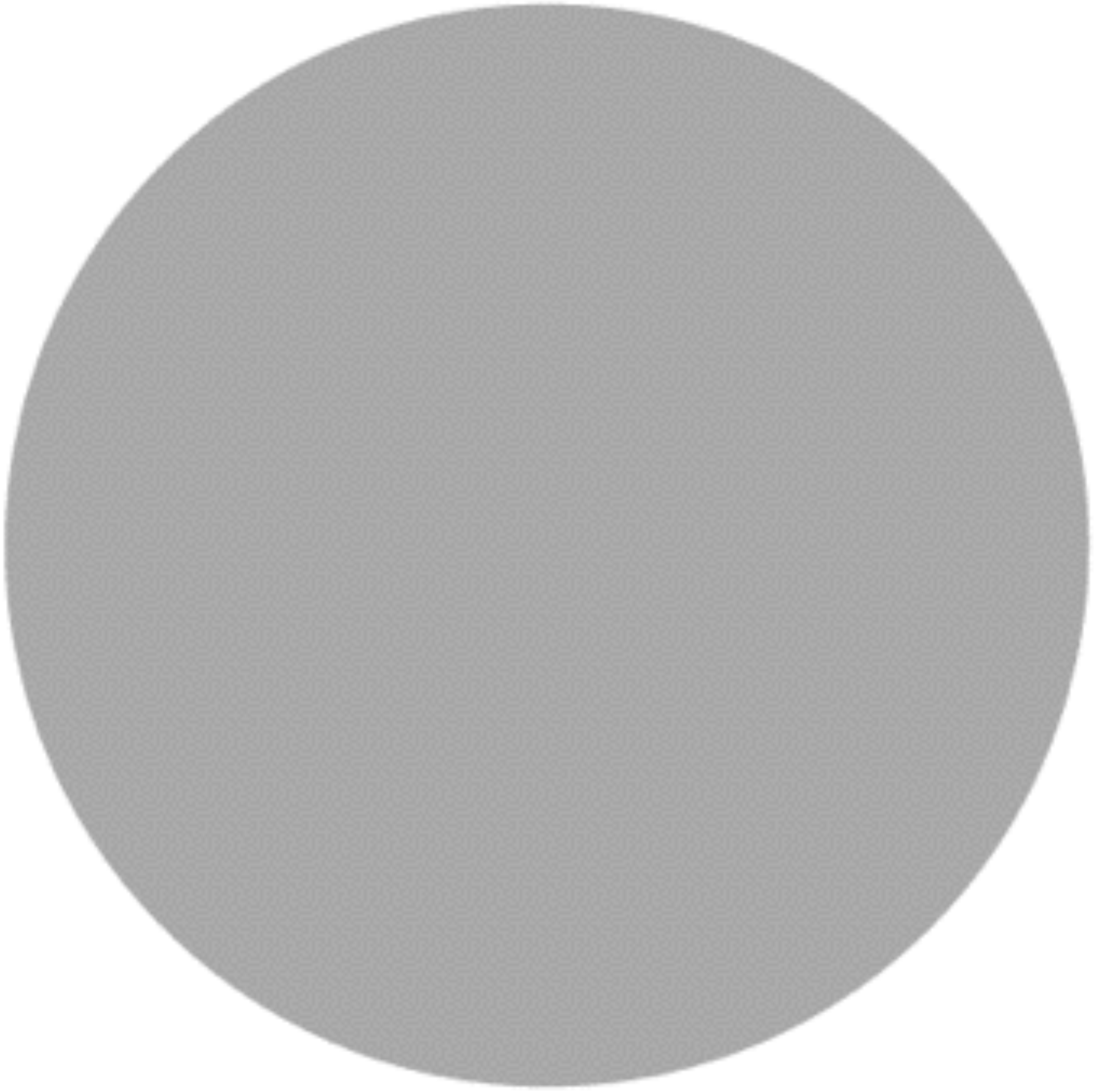
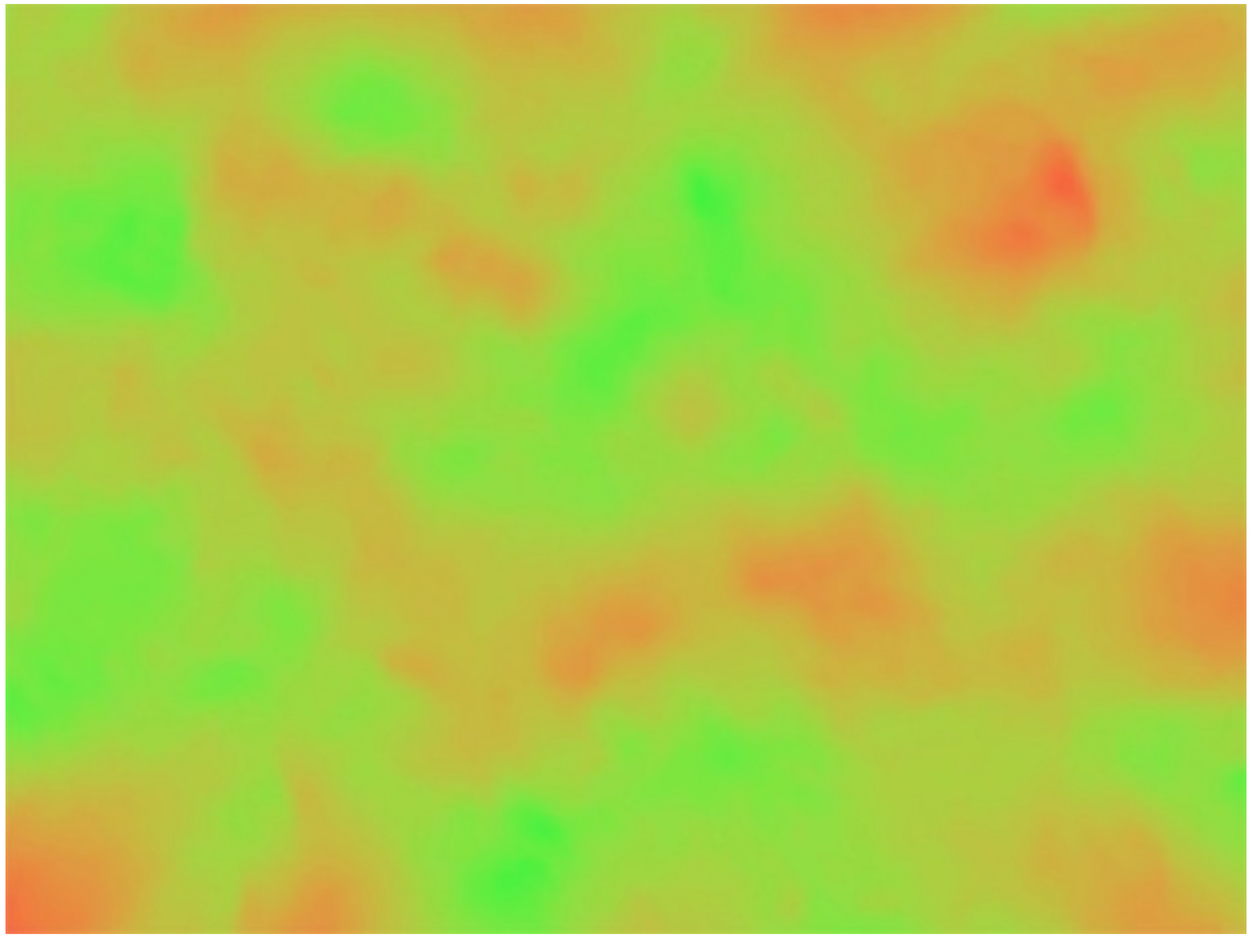
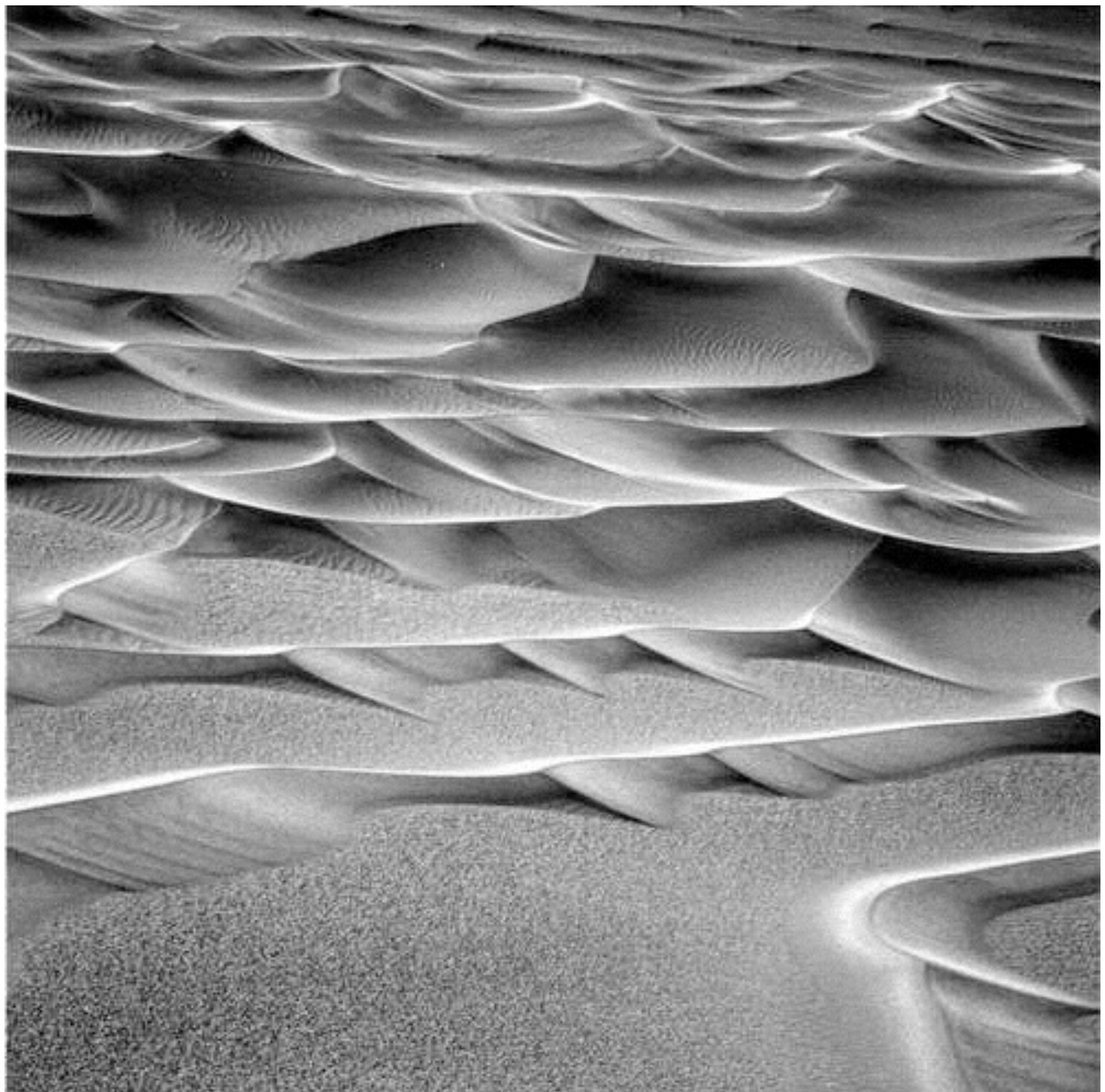


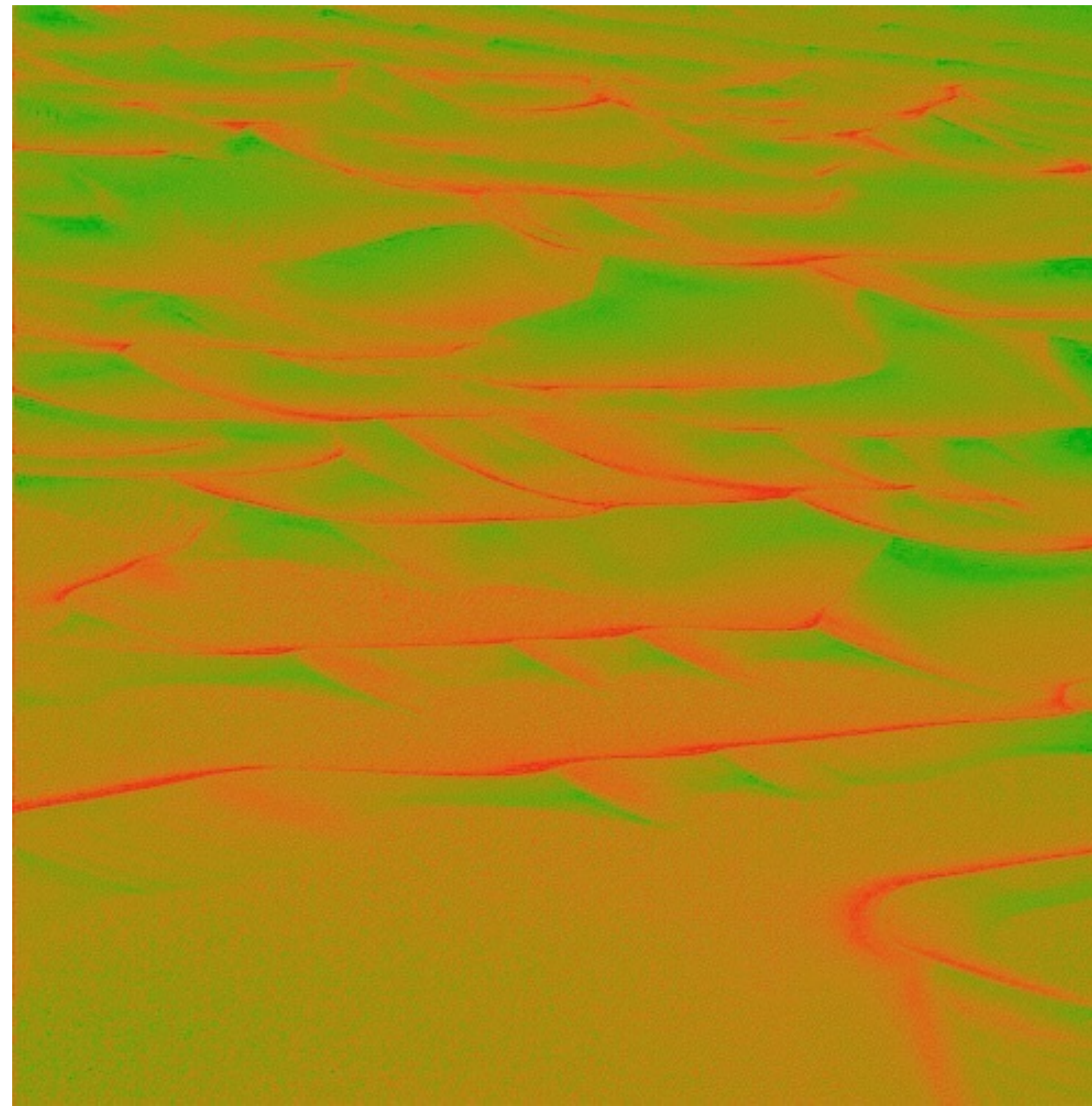
# Contrast Sensitivity



C. Ware, "Visual Thinking for Design"

# Contrast Sensitivity





C. Ware, "Visual Thinking for Design"

# Takeaway

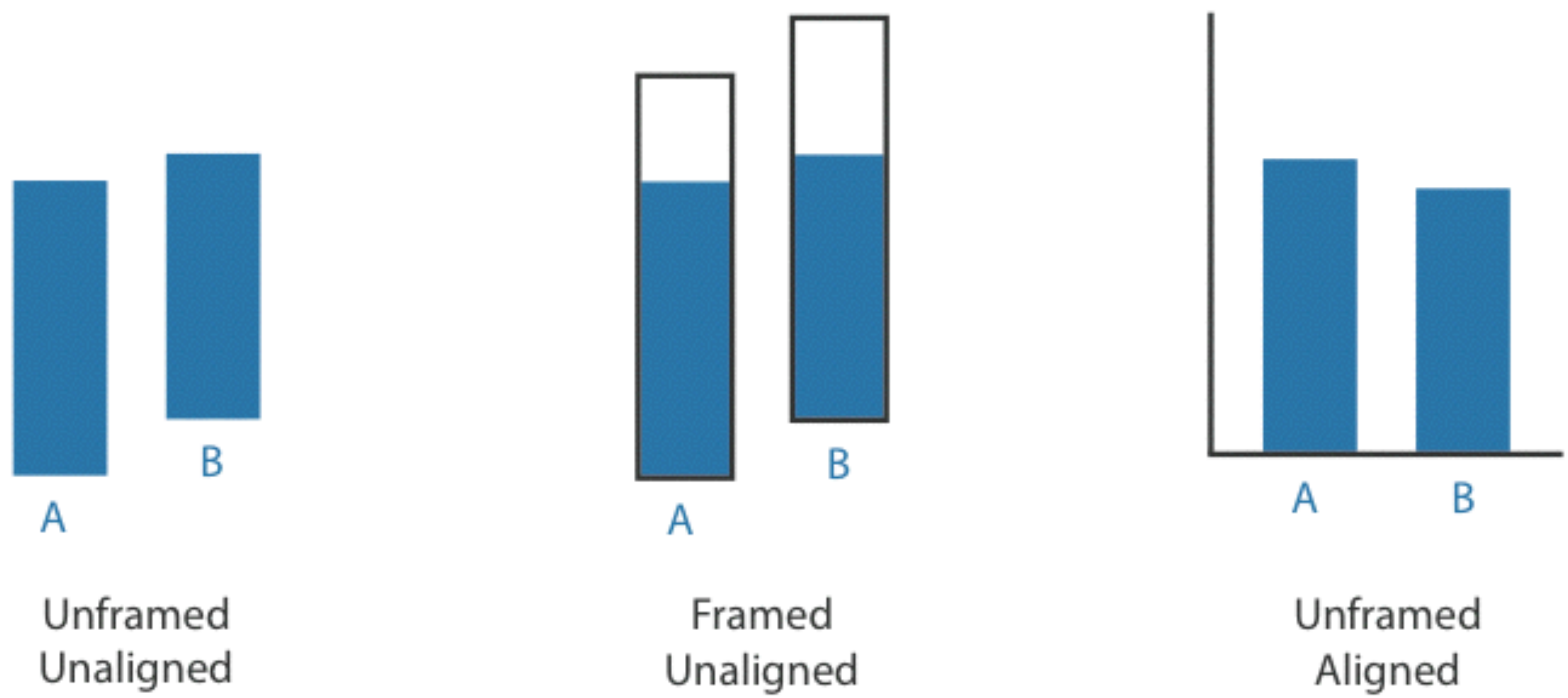
The brain constructs surface color based largely on edge contrast information.

**We have higher contrast sensitivity in the luminance than in the chrominance channel.**

- the eye
- edge detection
- **relativity of perception**
- things that pop
- gestalt principles

# WEBER'S LAW

we judge based on relative, not absolute, differences



# RELATIVE DIFFERENCES

# AXIS OF ALIGNMENT

# AXIS OF ALIGNMENT

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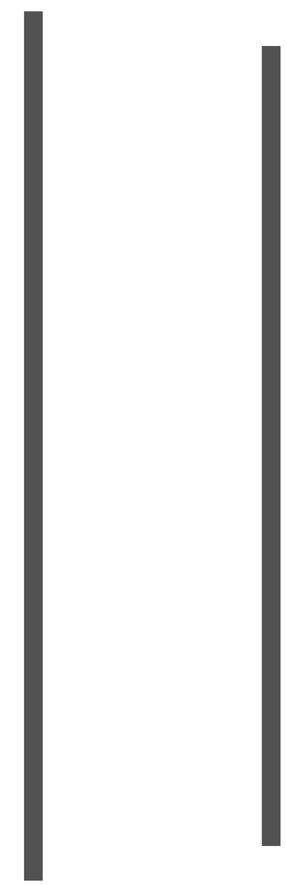
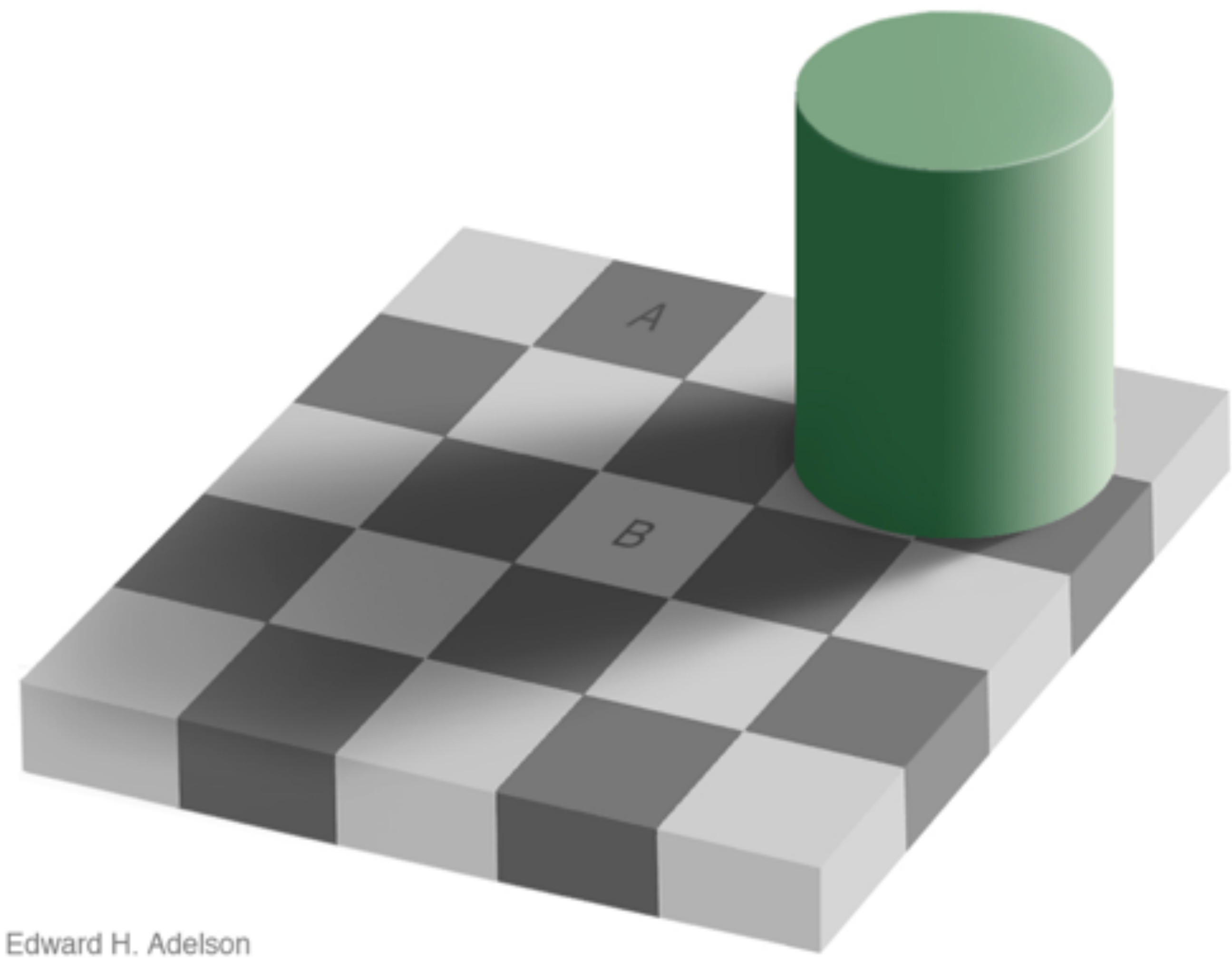


# SIMULTANEOUS CONTRAST




http://persci.mit.edu/_media/gallery/checkershadow_double_full.jpg

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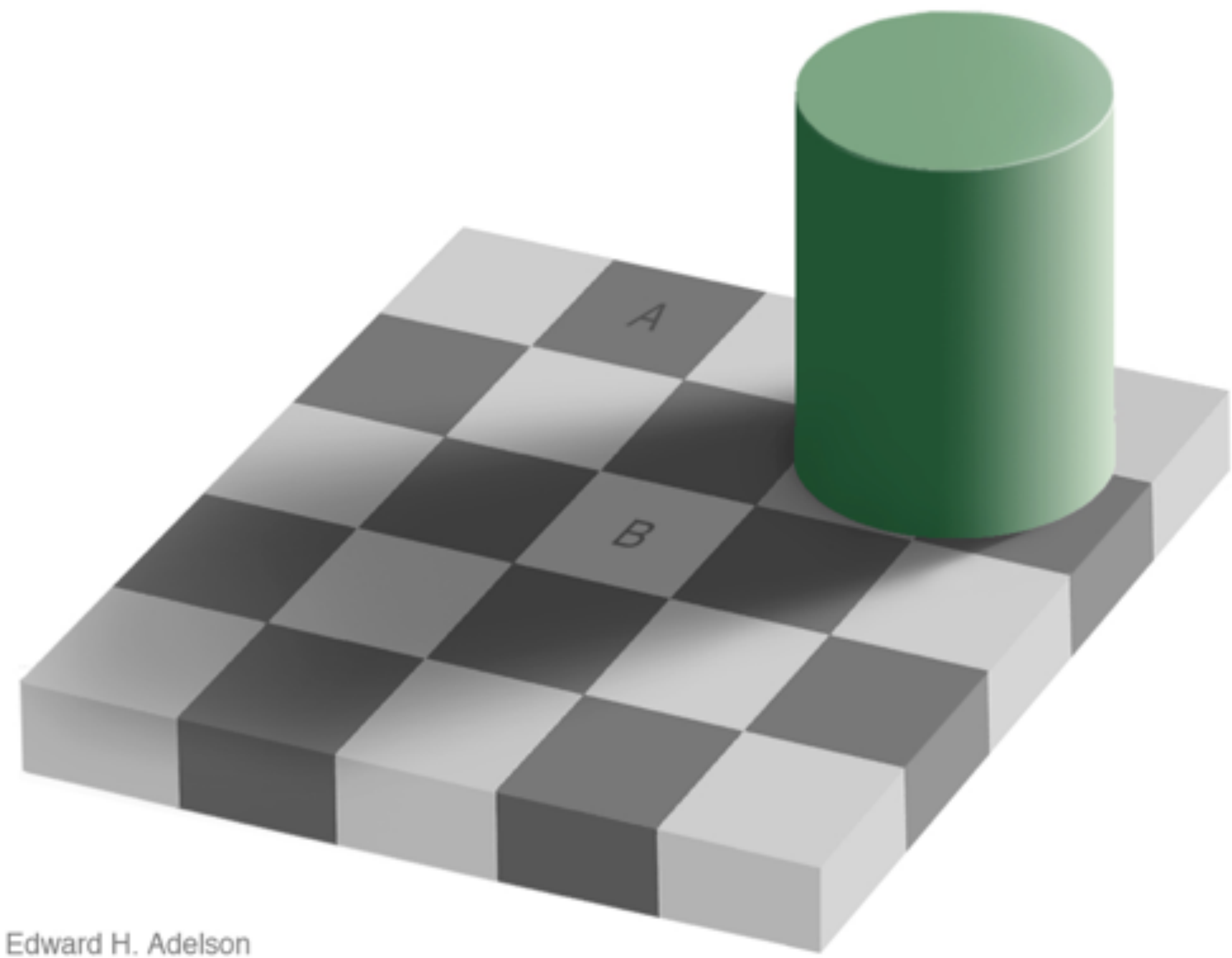


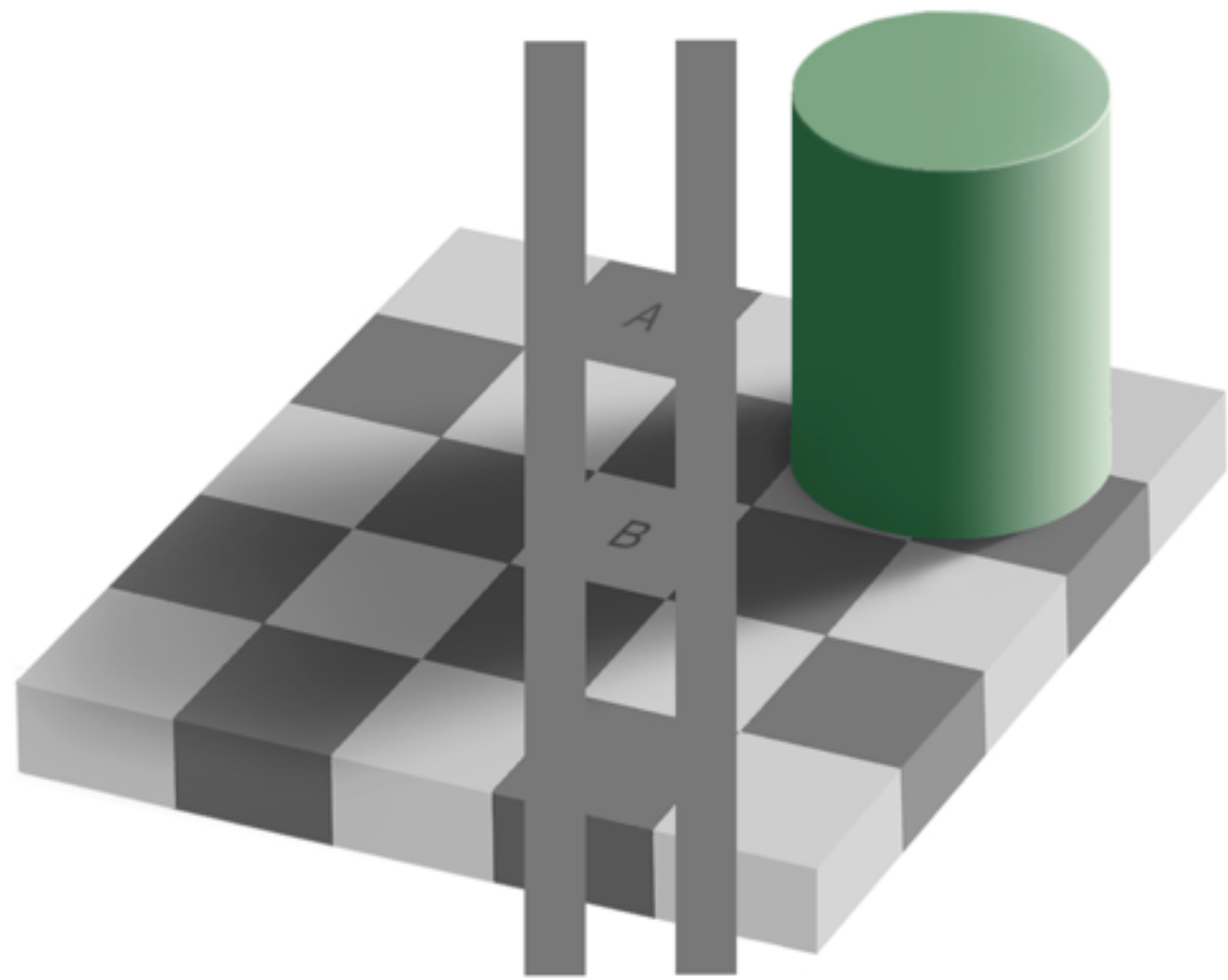


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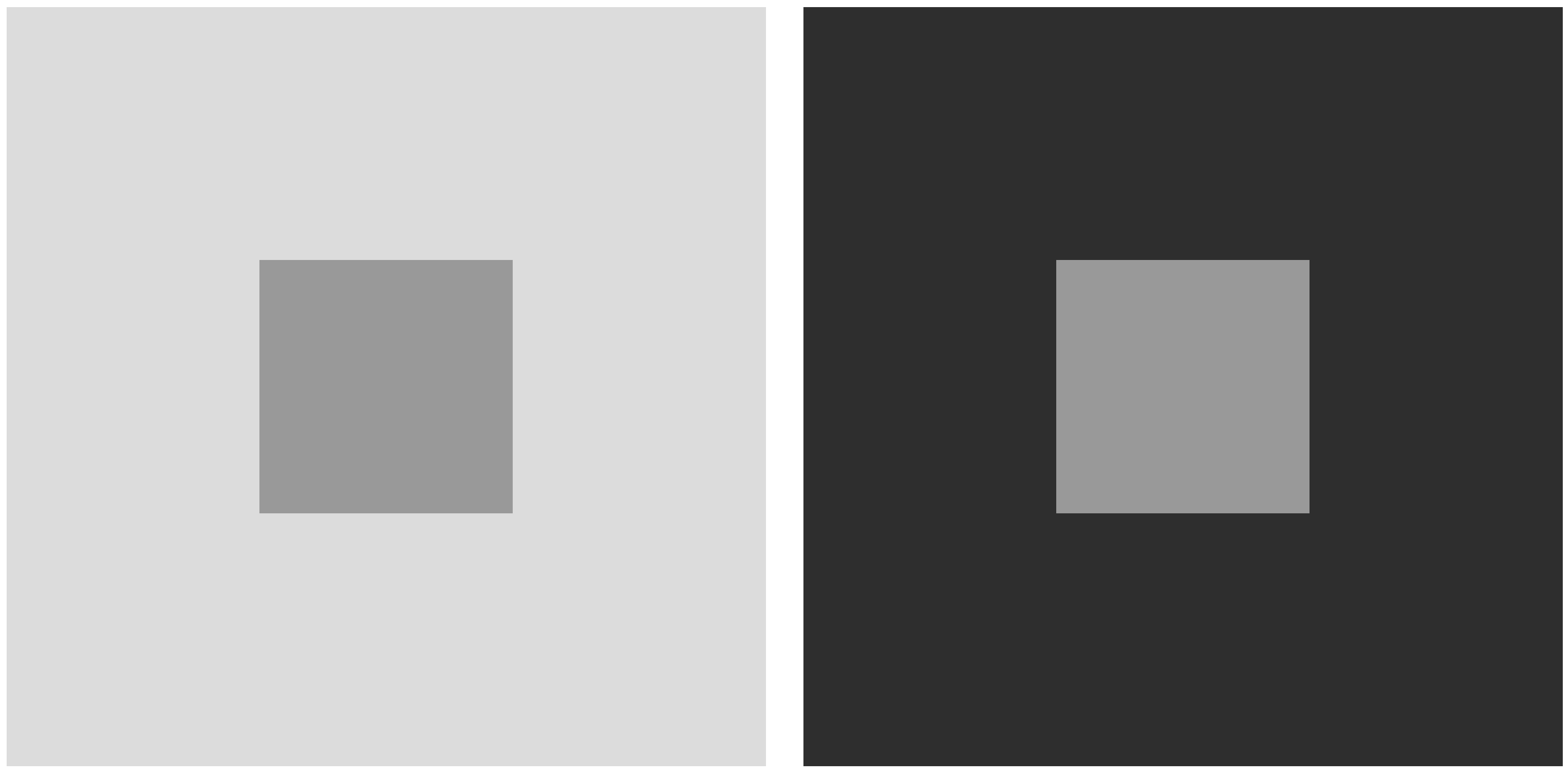

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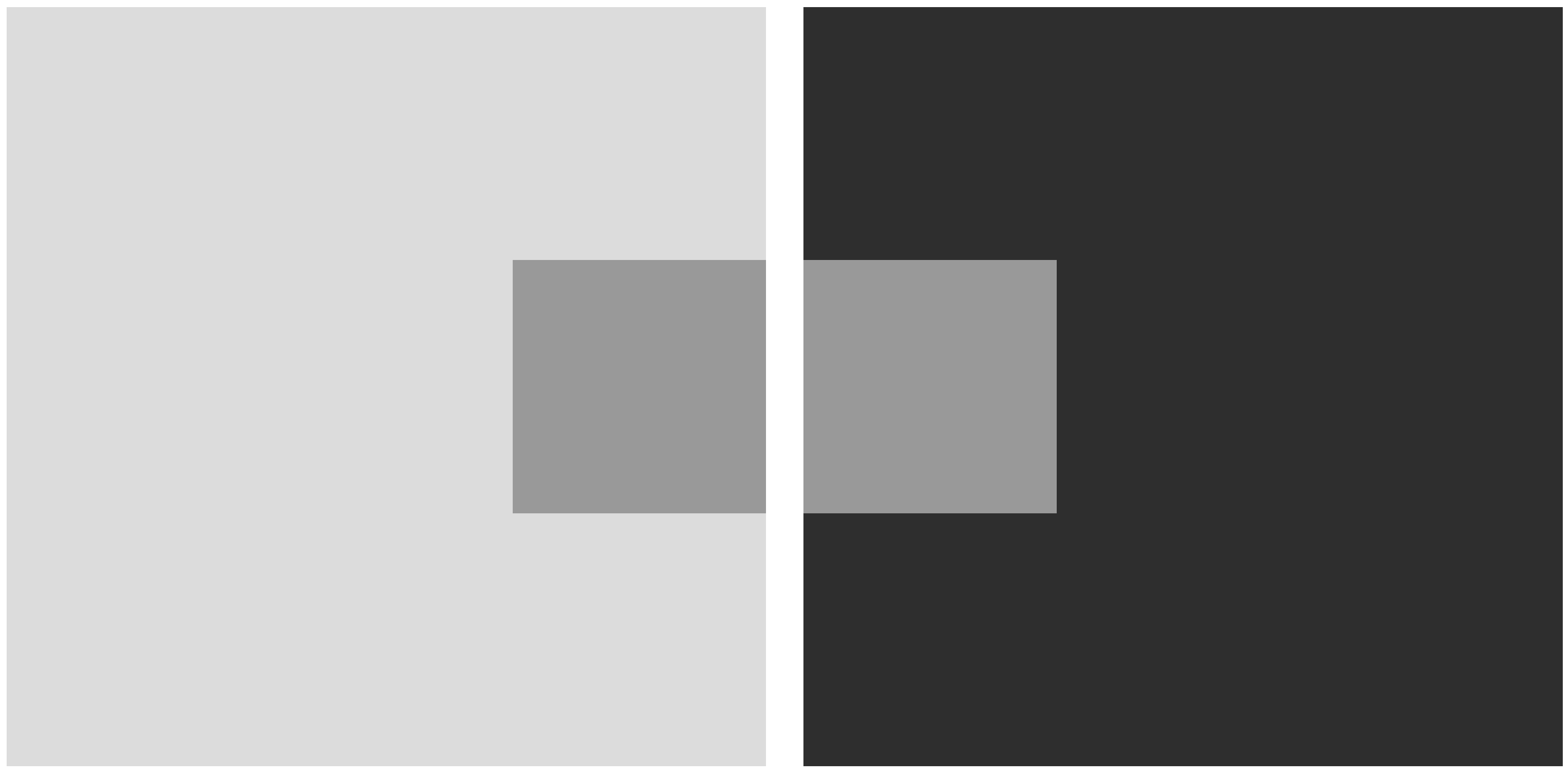

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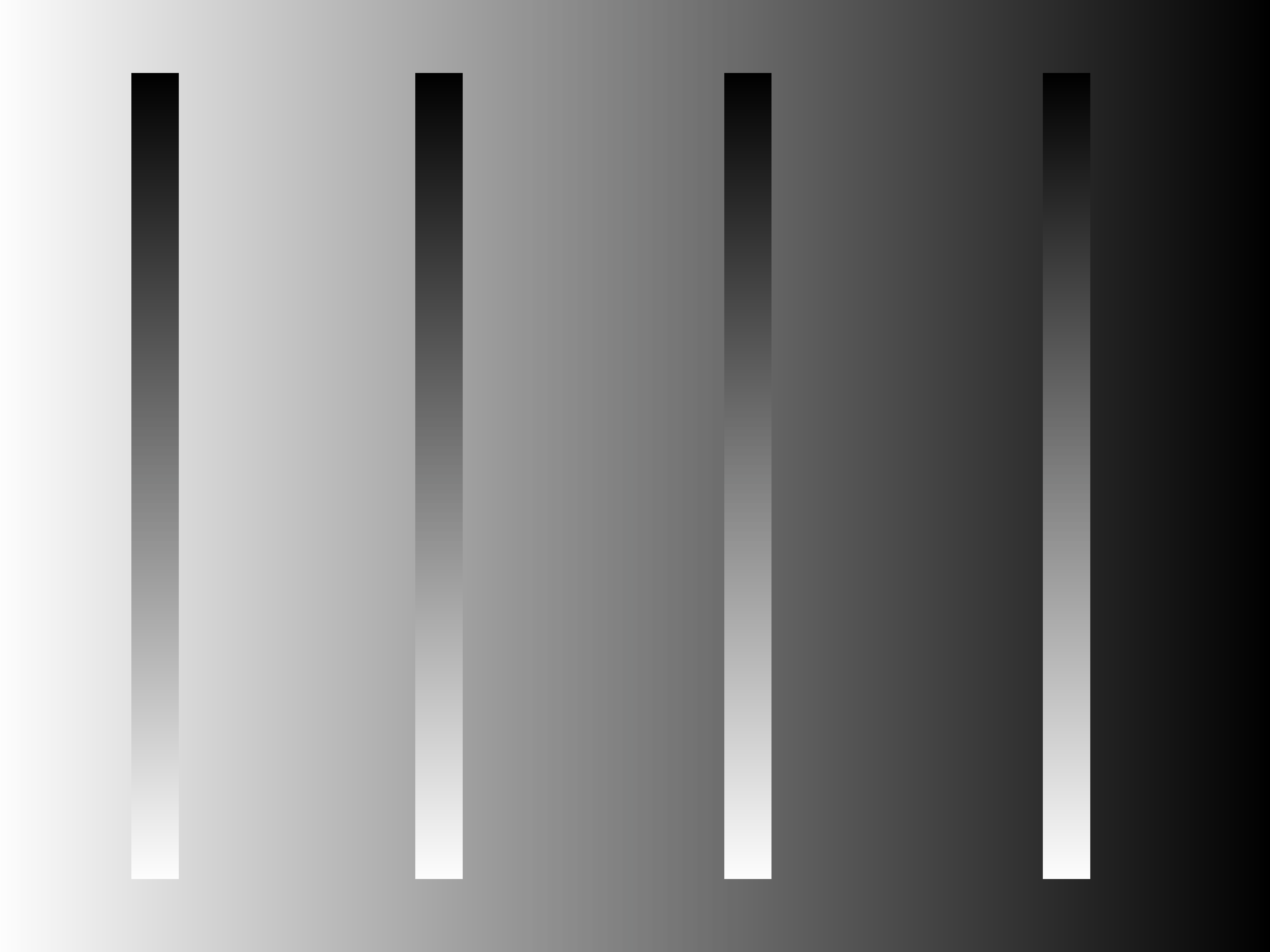
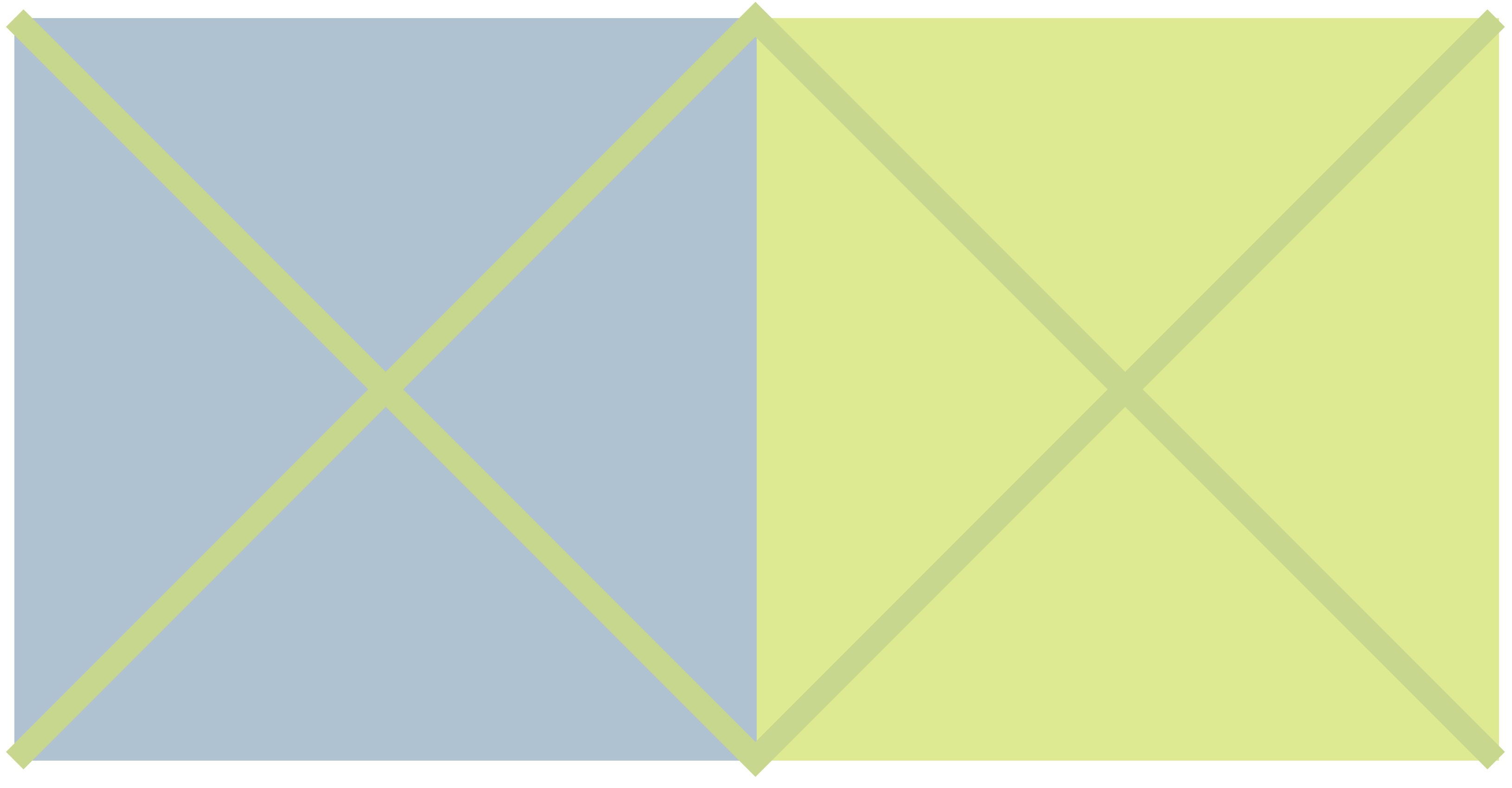


# INTERACTION OF COLOR



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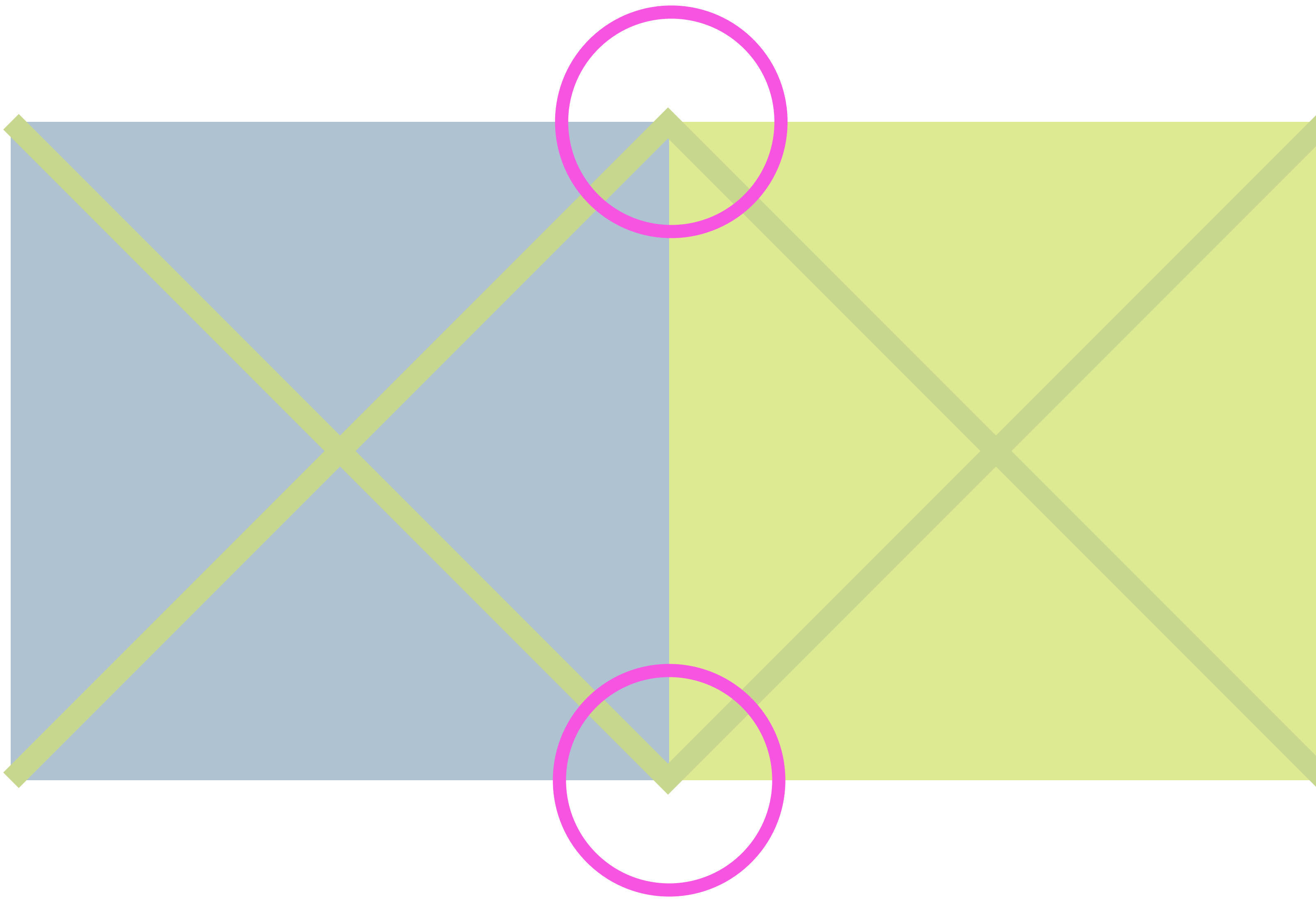

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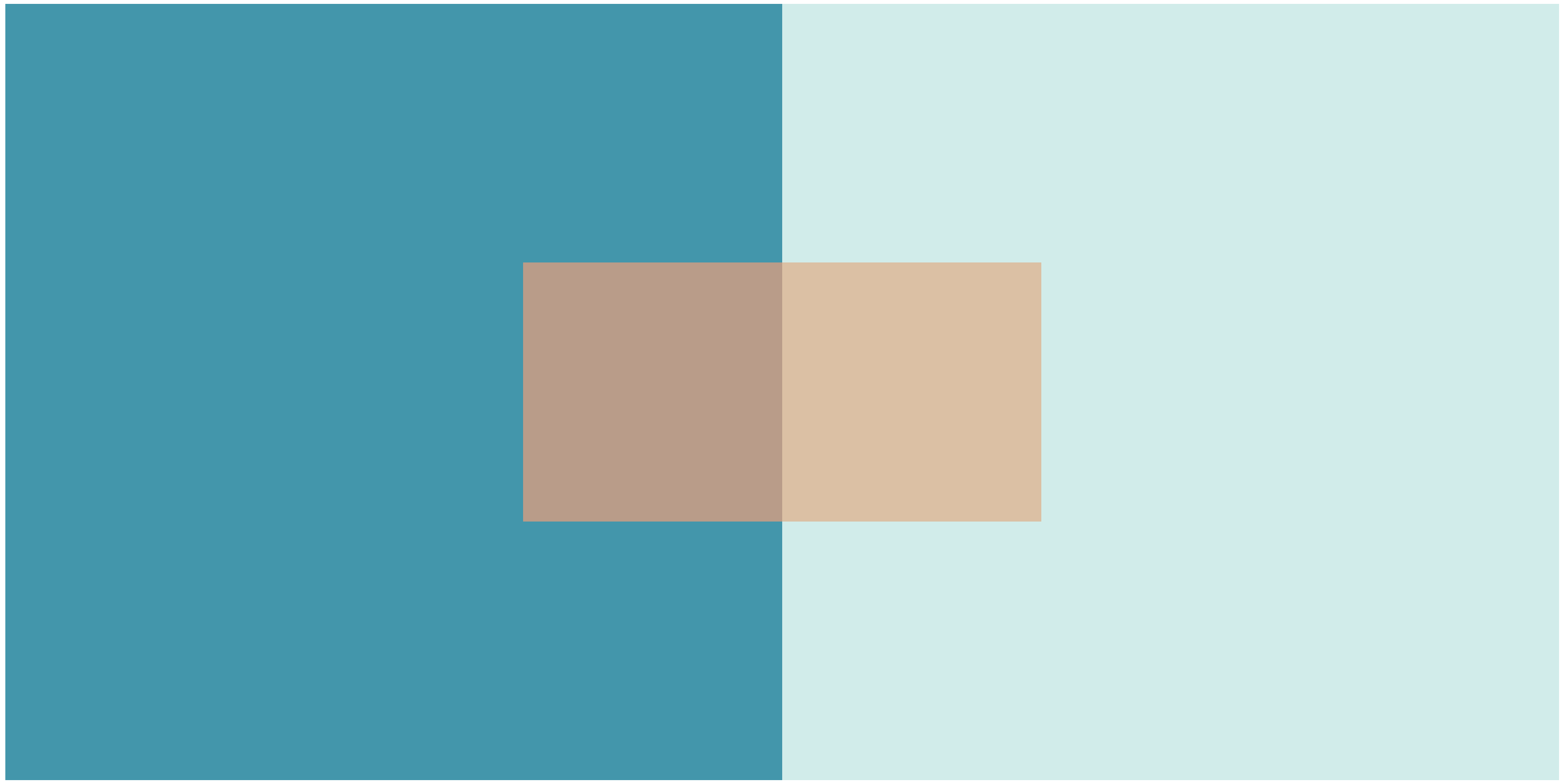

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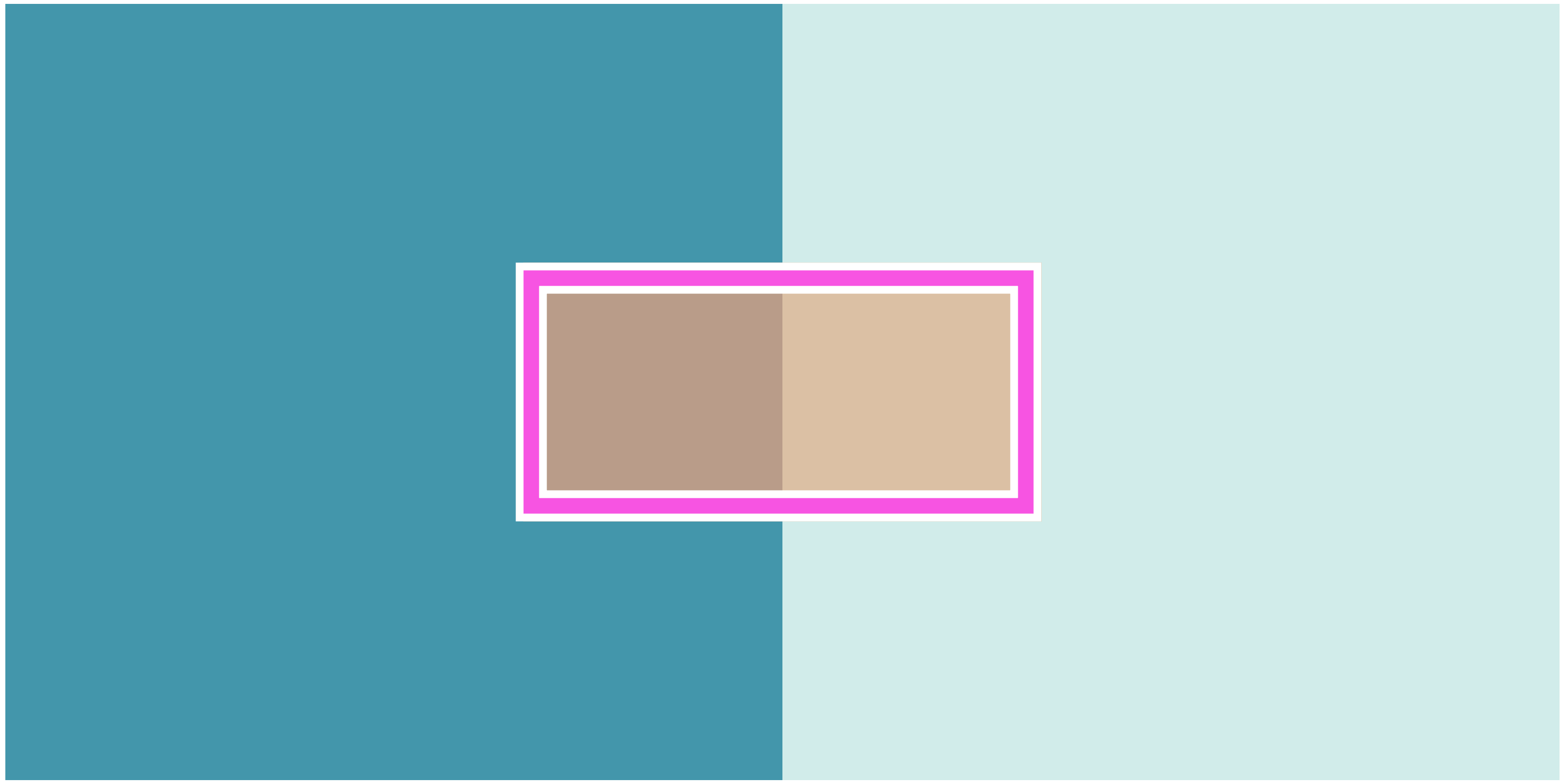

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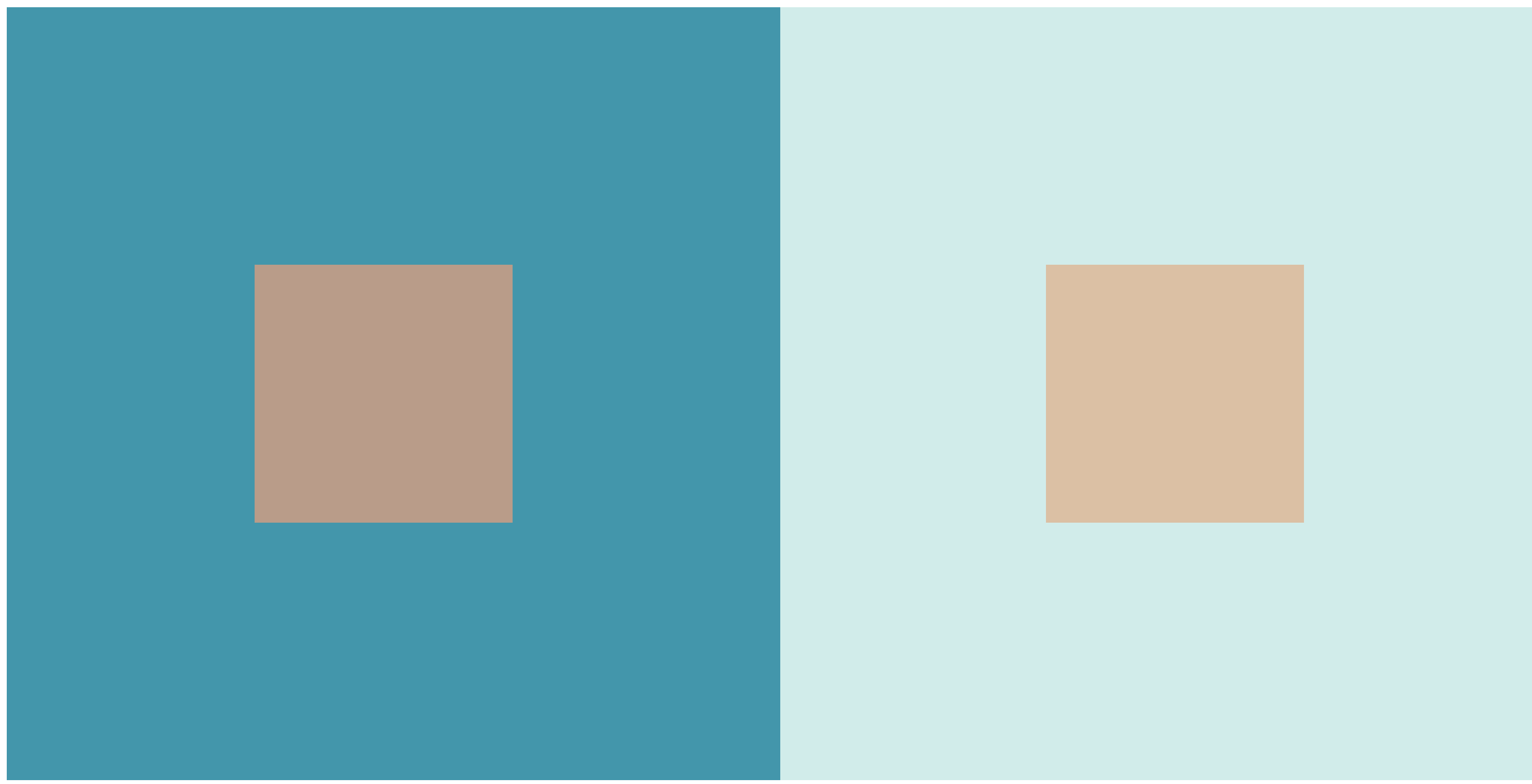

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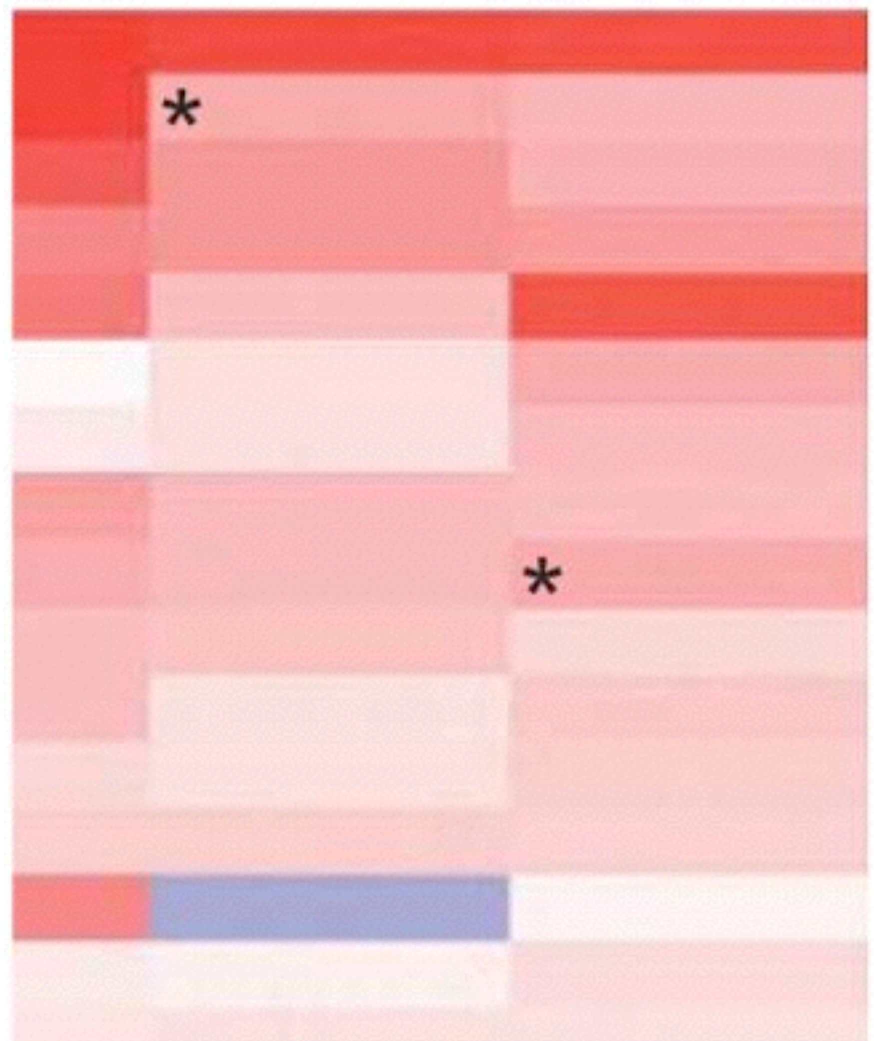
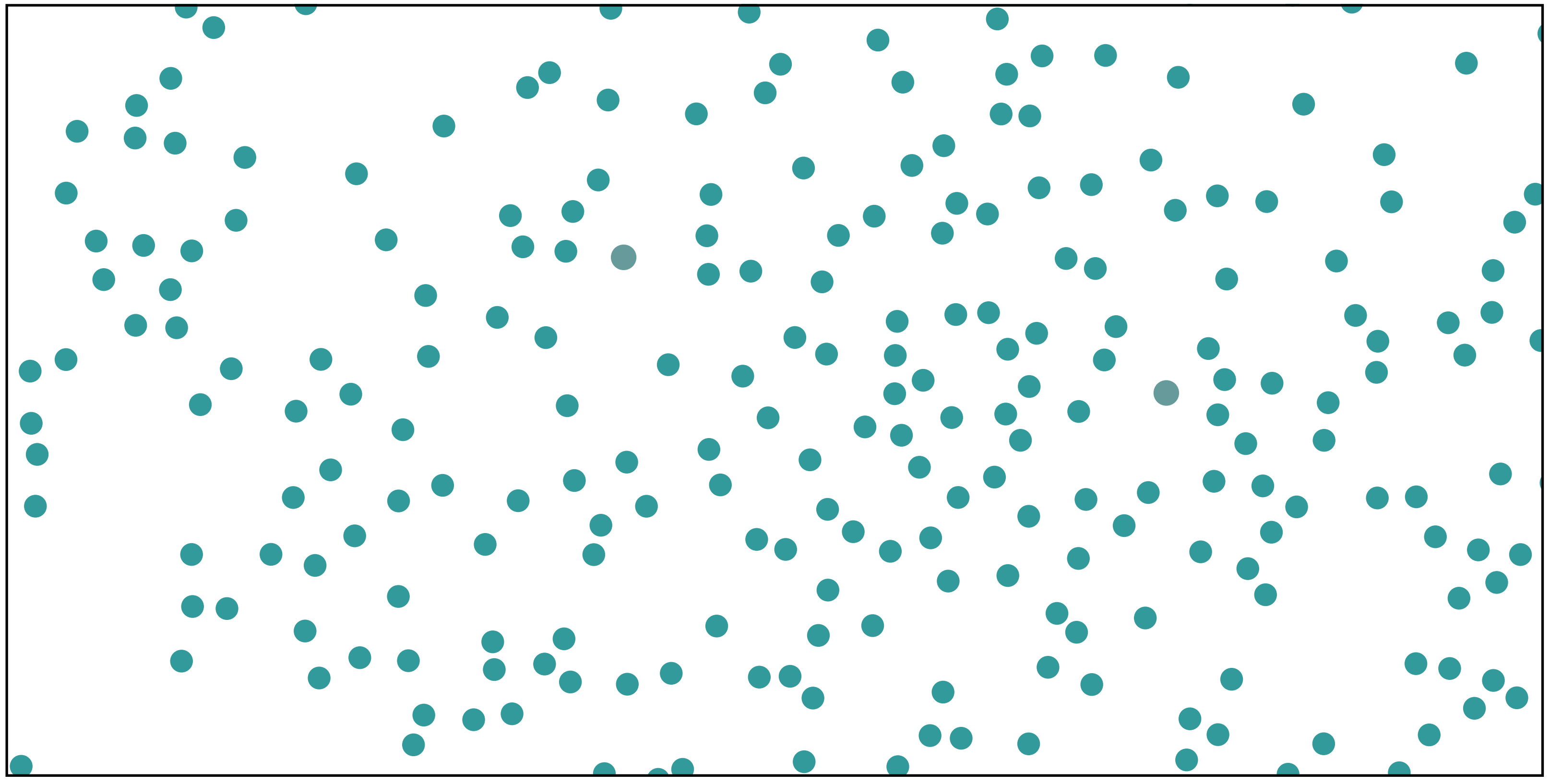



Wong 2010

- the eye
- edge detection
- relativity of perception
- **things that pop**
- gestalt principles

# POPOUT



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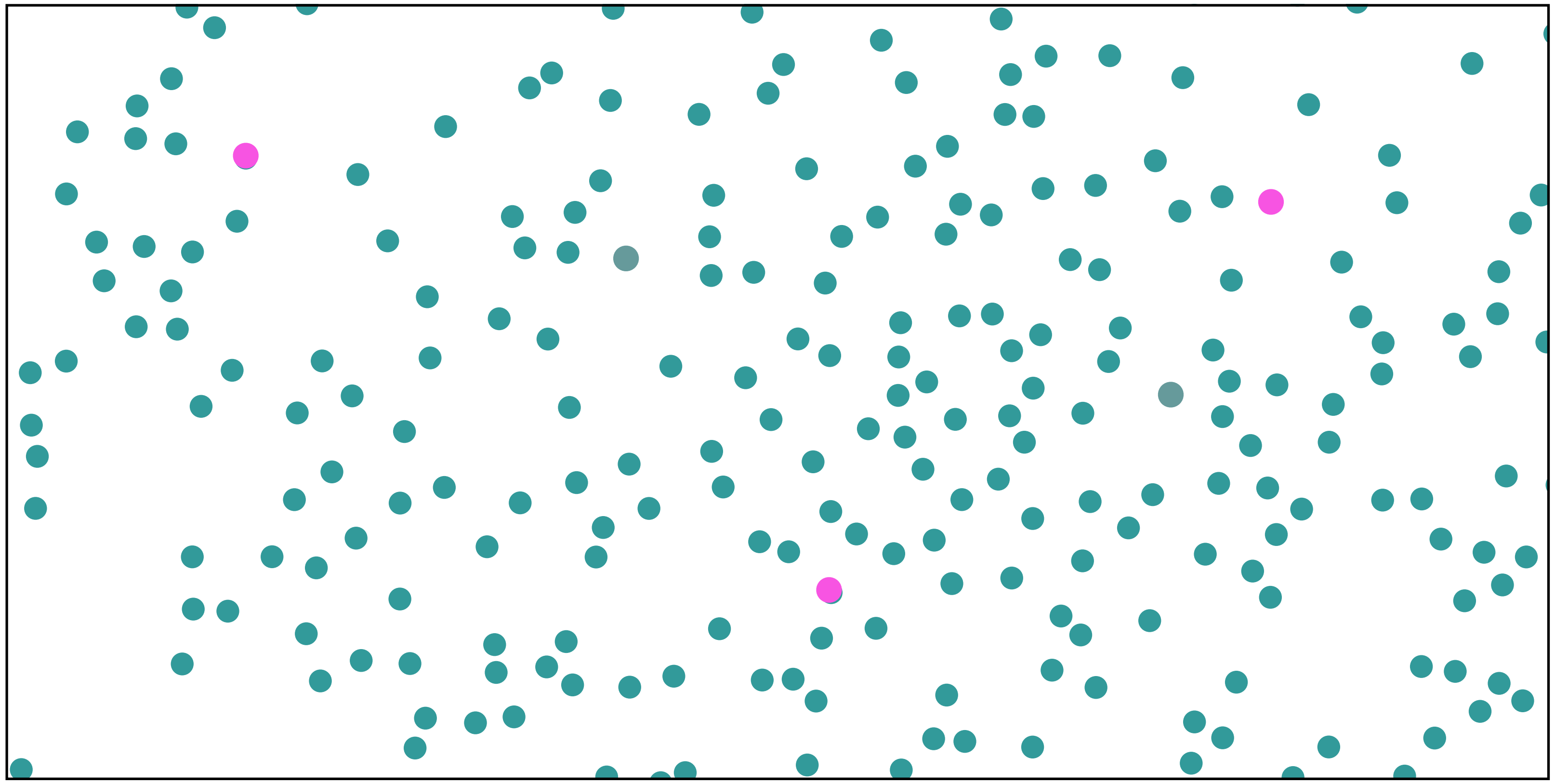

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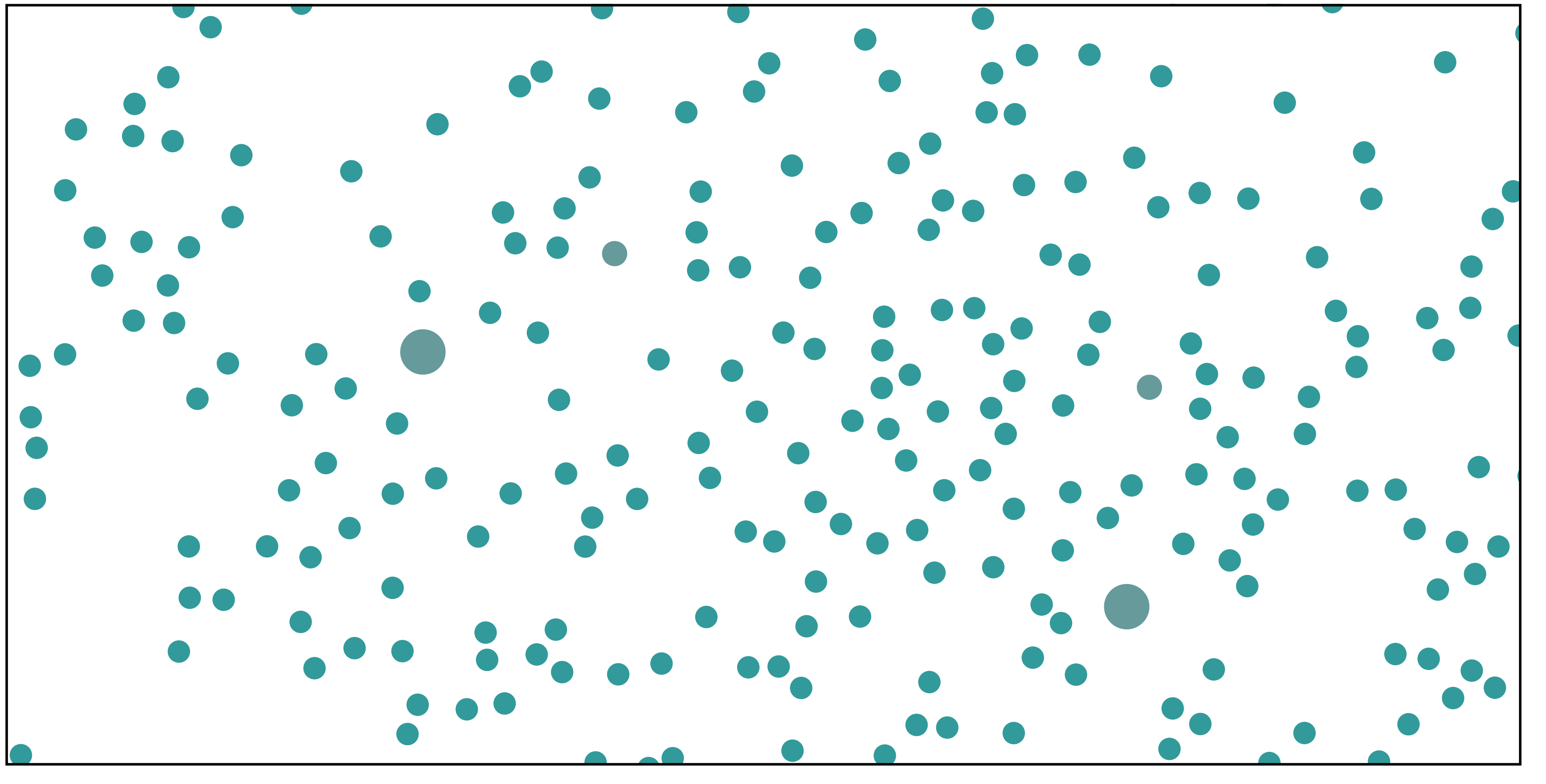

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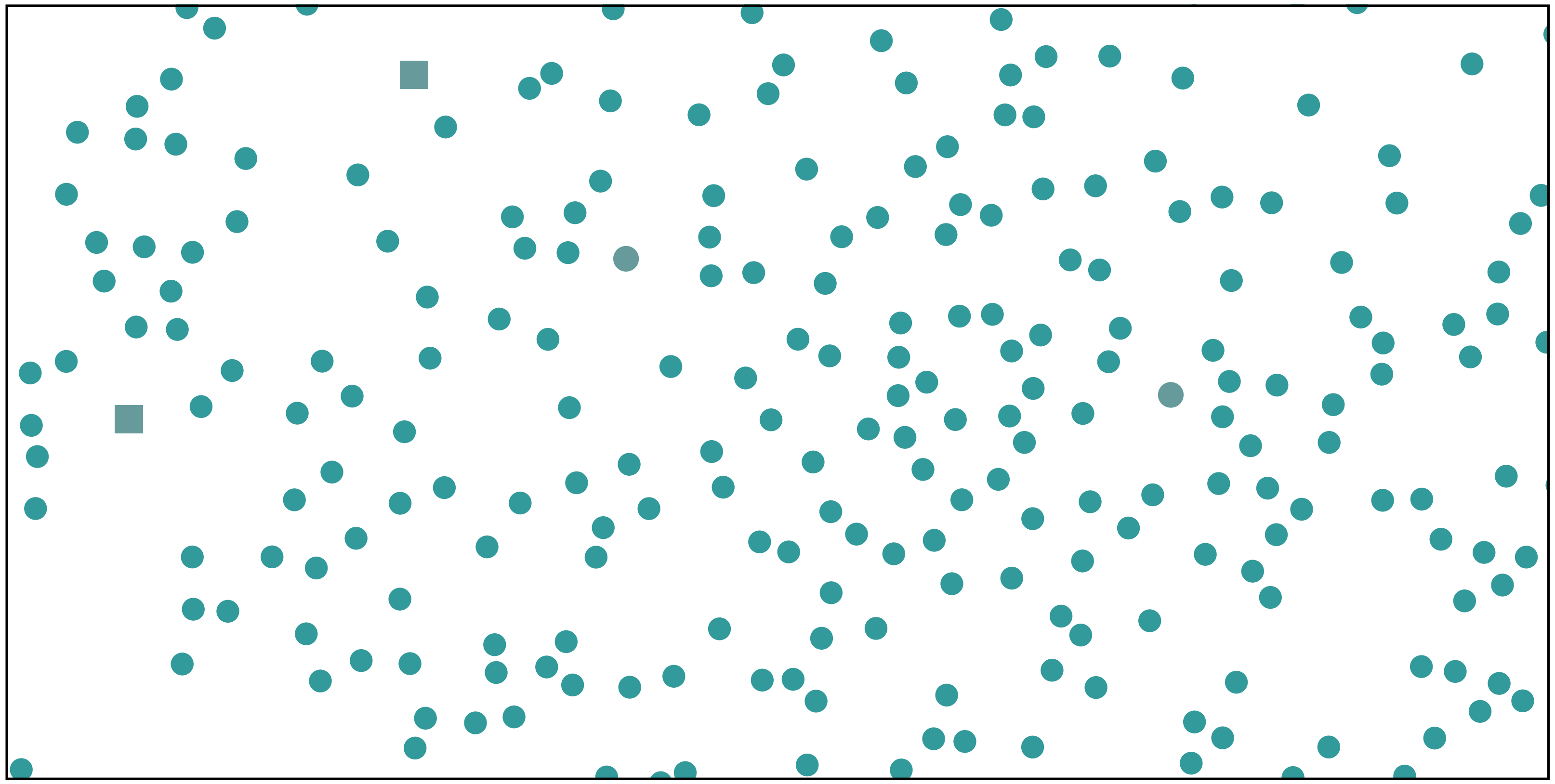

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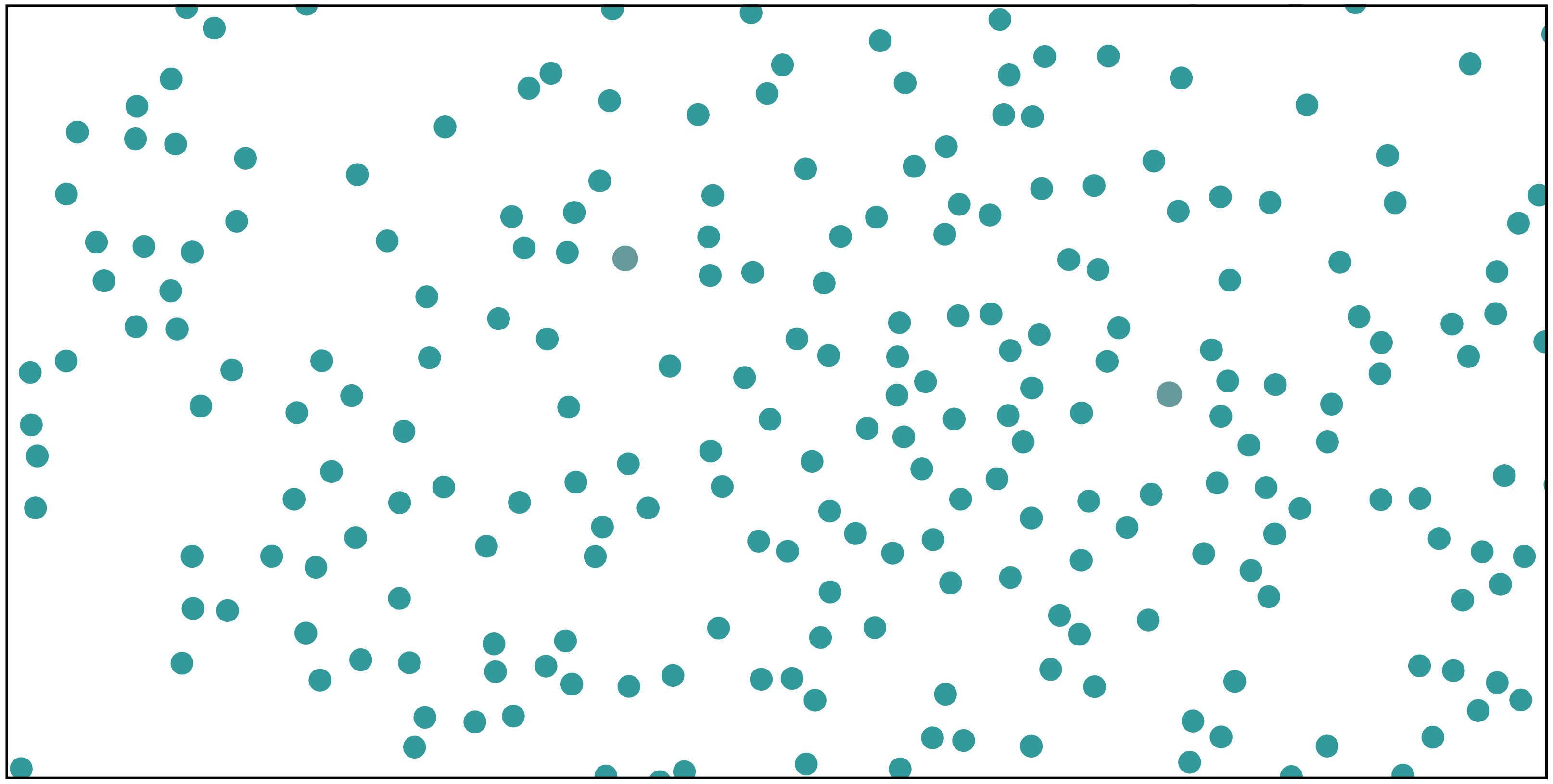
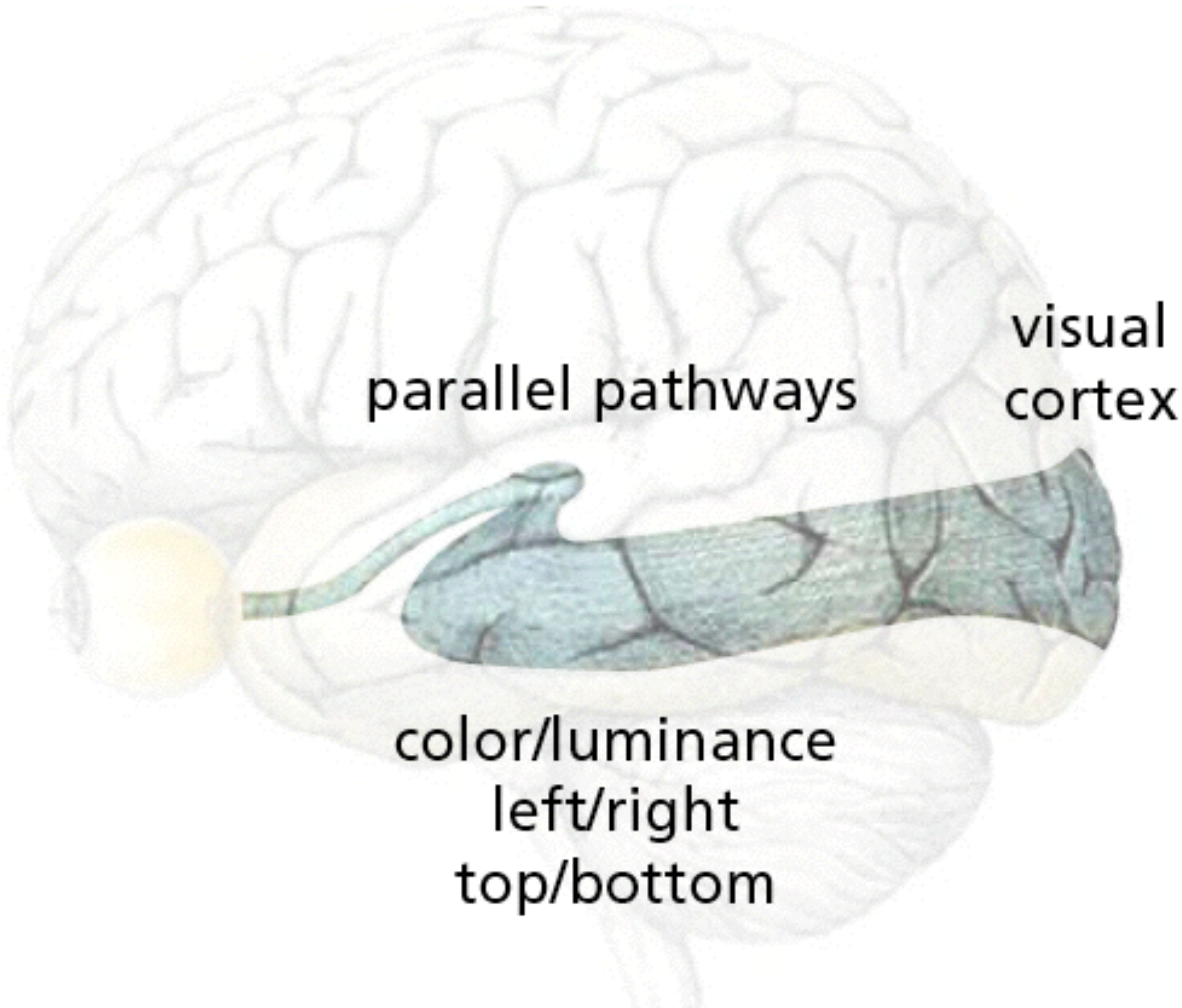


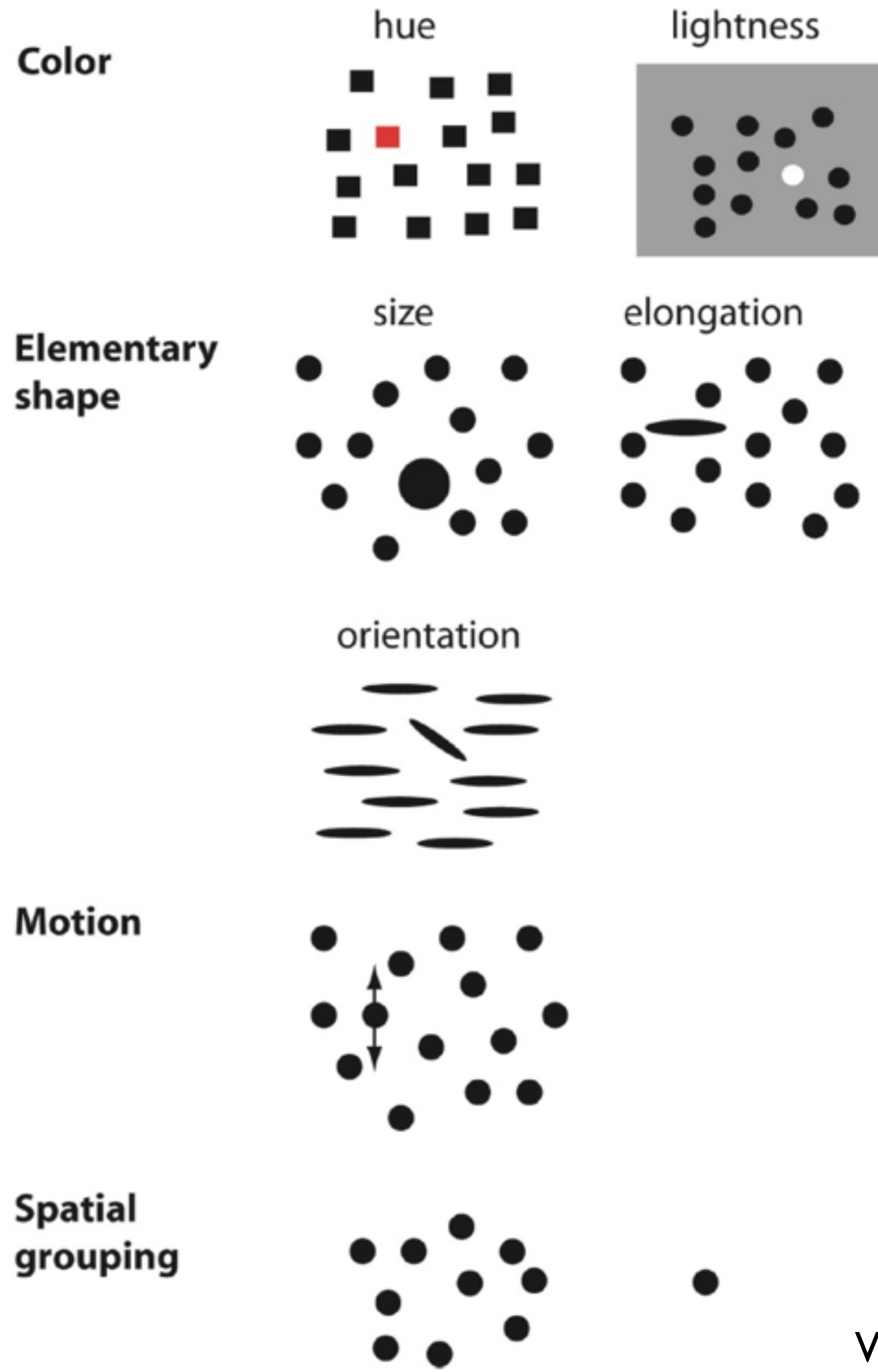



Based on slide from Mazur

# PRE-ATTENTIVE PROCESSING

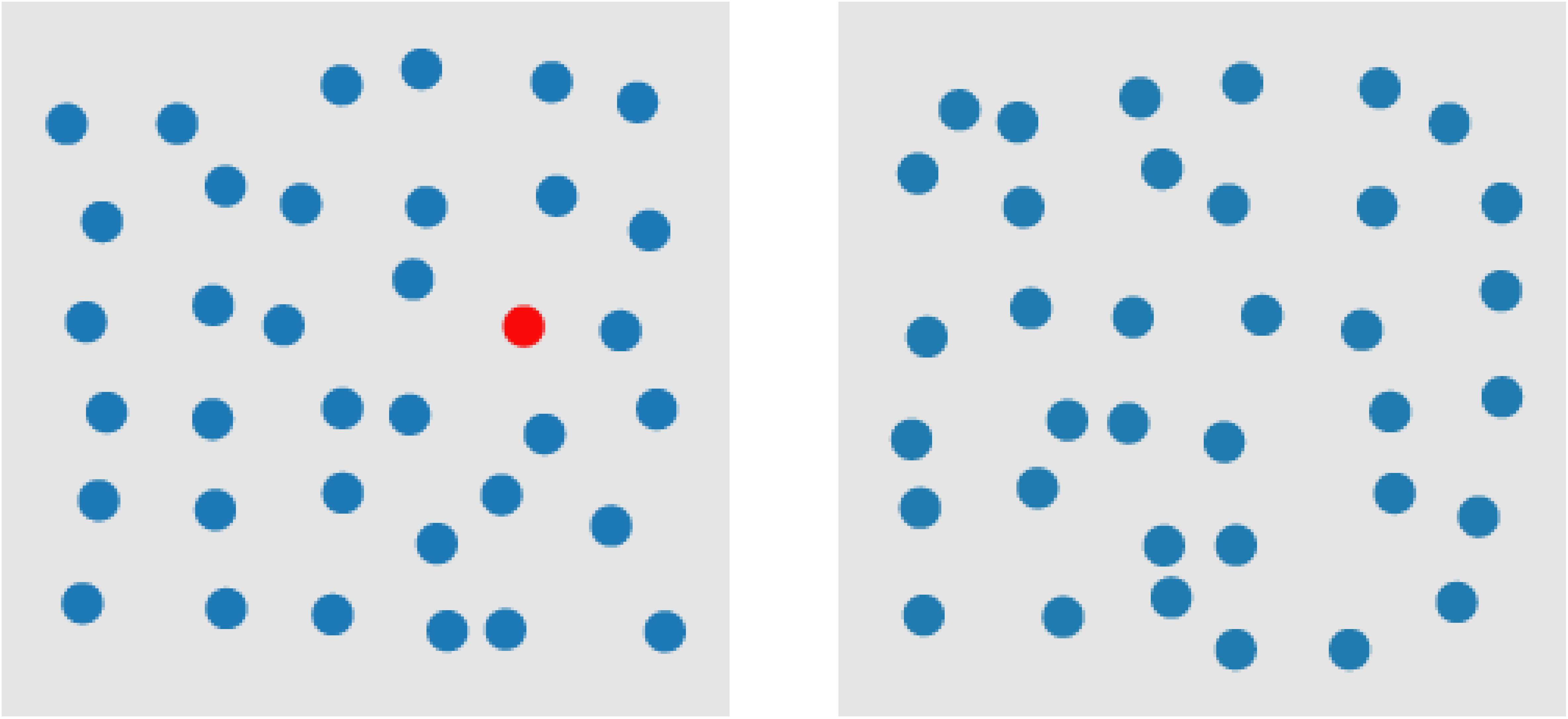
- requires attention, despite name
- very fast: <200 ms
- what matters most is contrast between features

# BASIC POPOUT CHANNELS

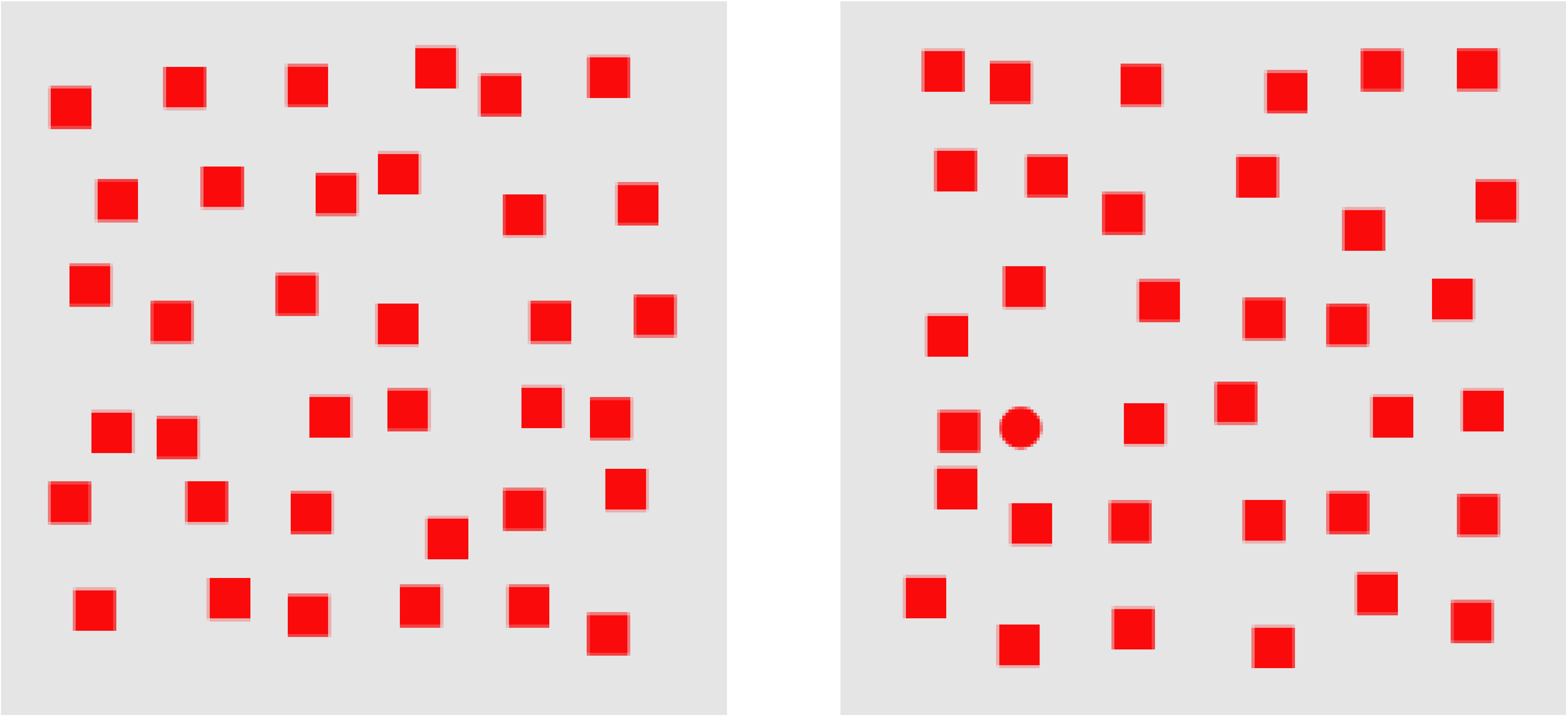



Ware 2008

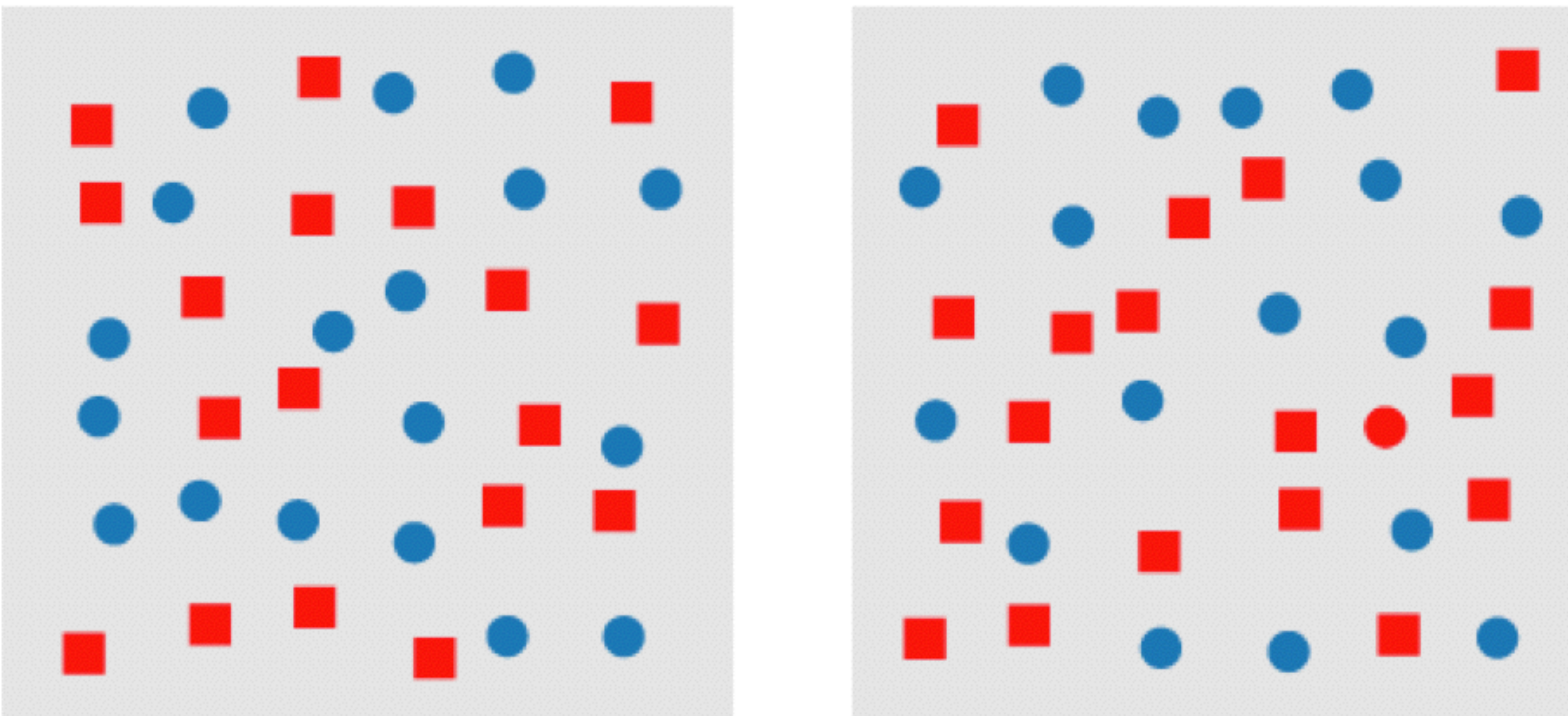
which side has the outlier?



Healy 2007

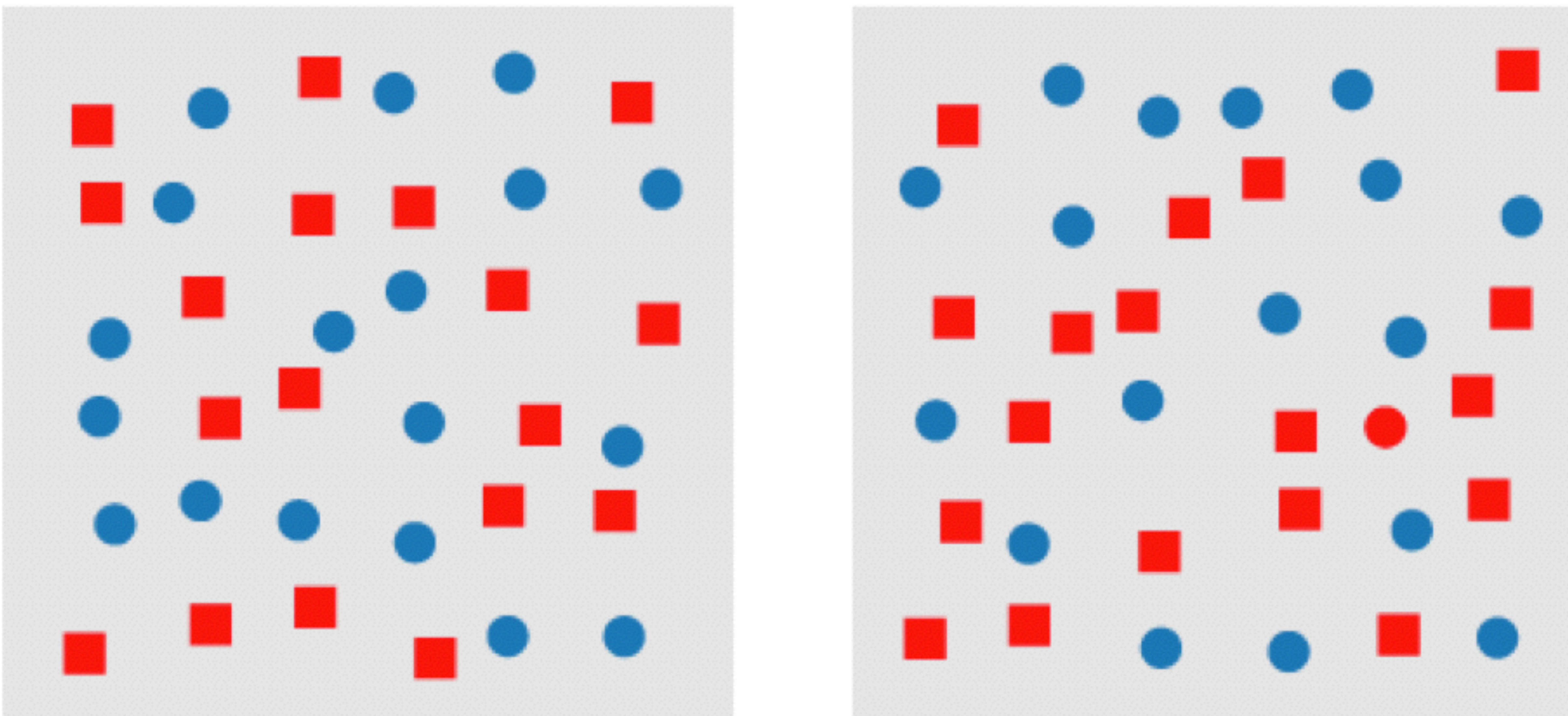


Healy 2007



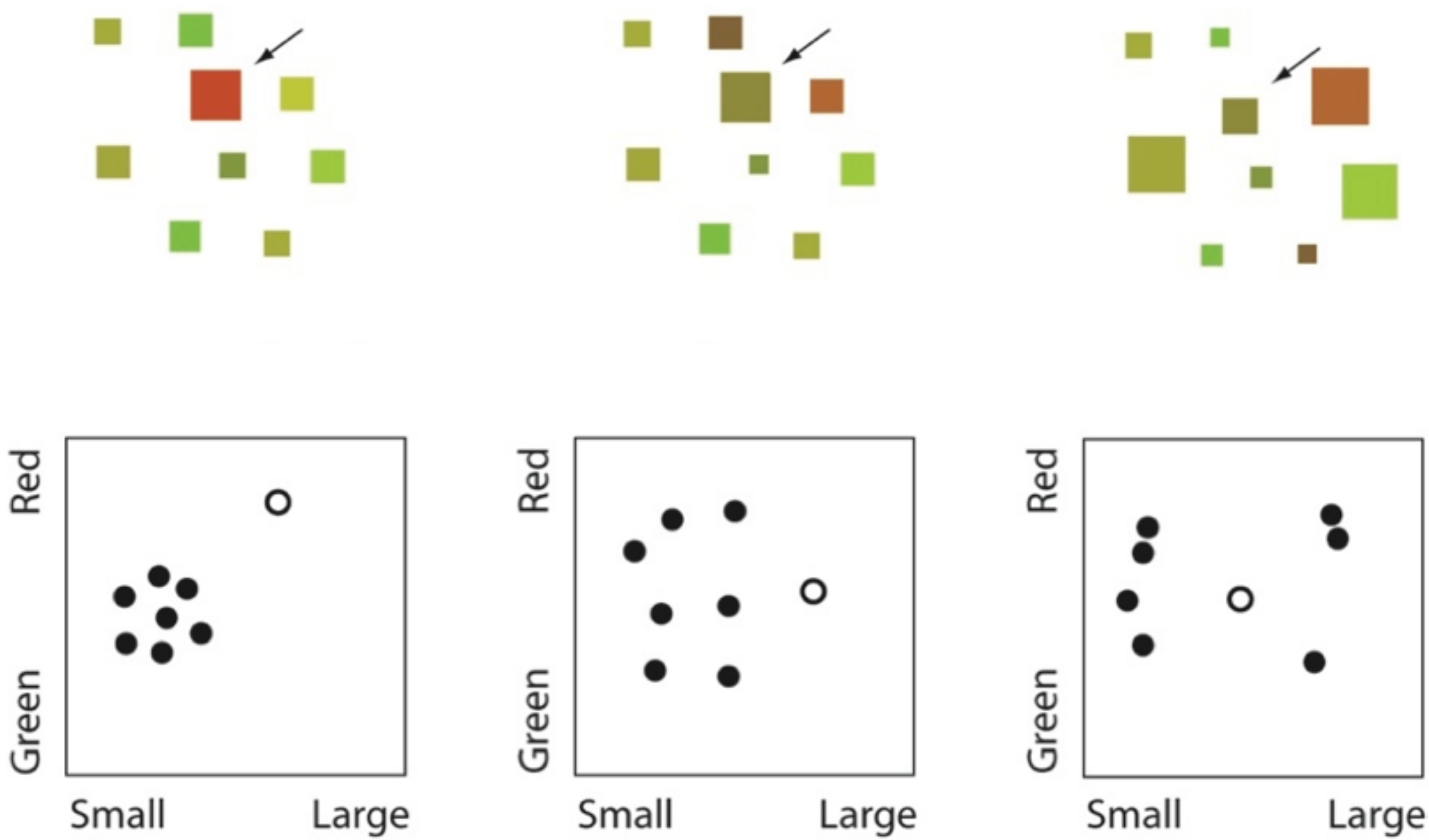
Healey 2007

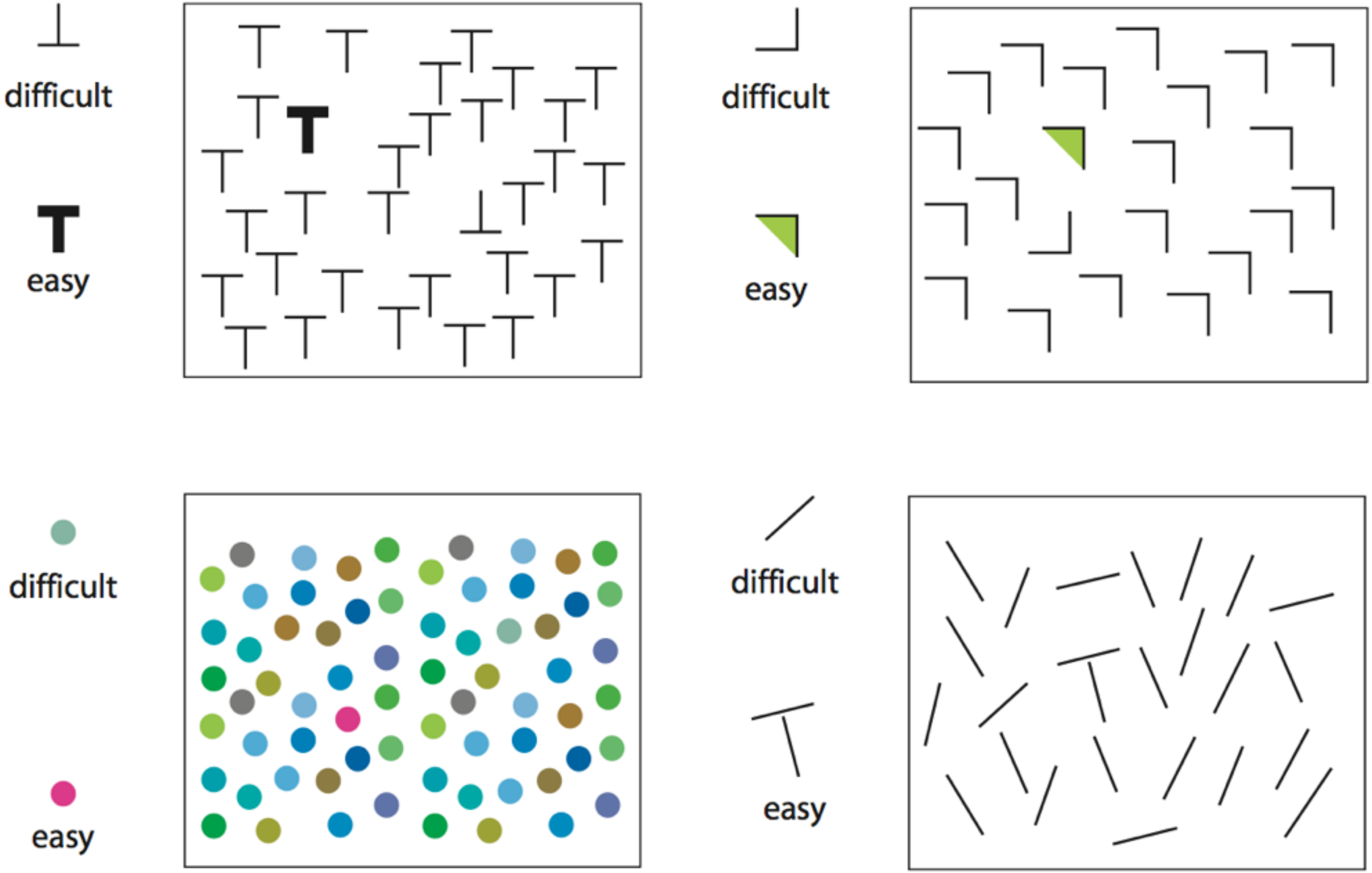
# CONJUNCTION
or, why to use a single channel at a time



Healey 2007

# CONJUNCTION




difficult
easy
difficult
easy
difficult
easy
difficult
easy

# Takeaway

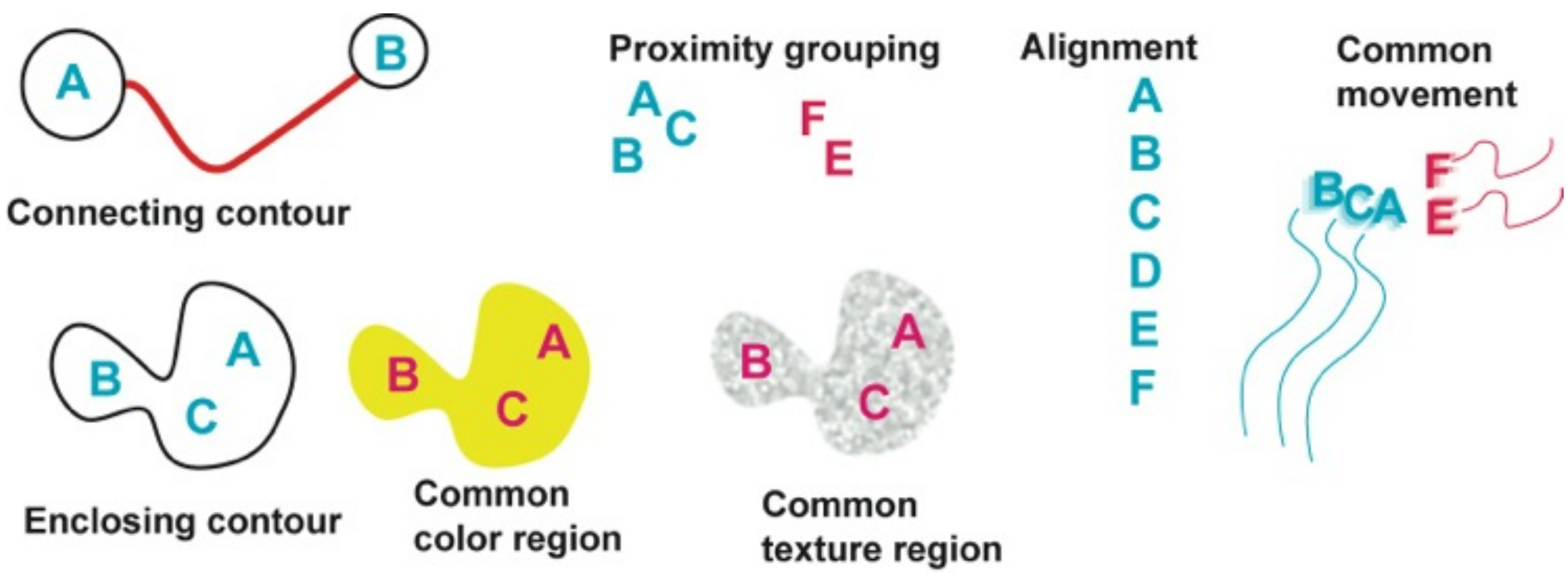
We can easily see objects that are different in color and shape, or that are in motion.

**Use color and shape sparingly to make the important information pop out.**

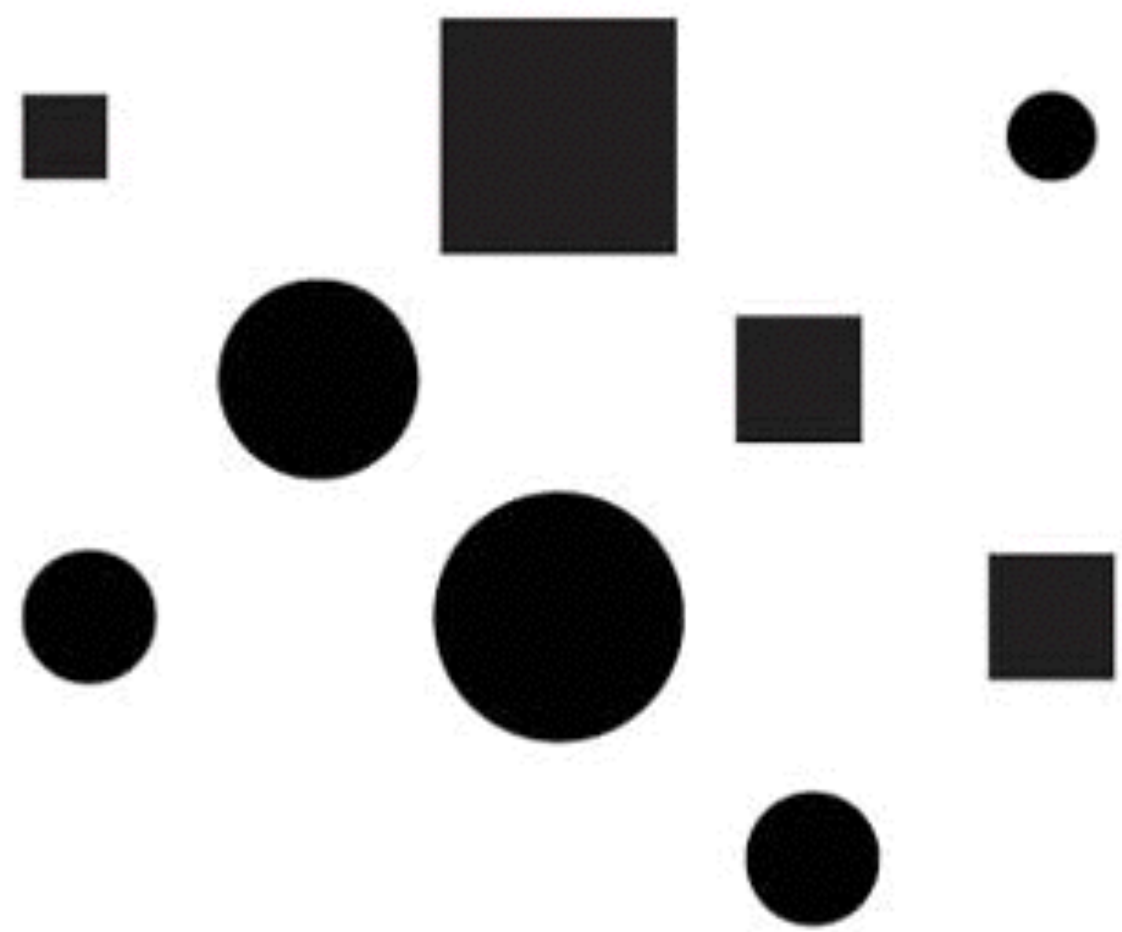
- the eye
- edge detection
- relativity of perception
- things that pop
- **gestalt principles**

# Gestalt principles

- **German:** *"Gestalt" = form*
- patterns transcend the visual stimuli that produced them

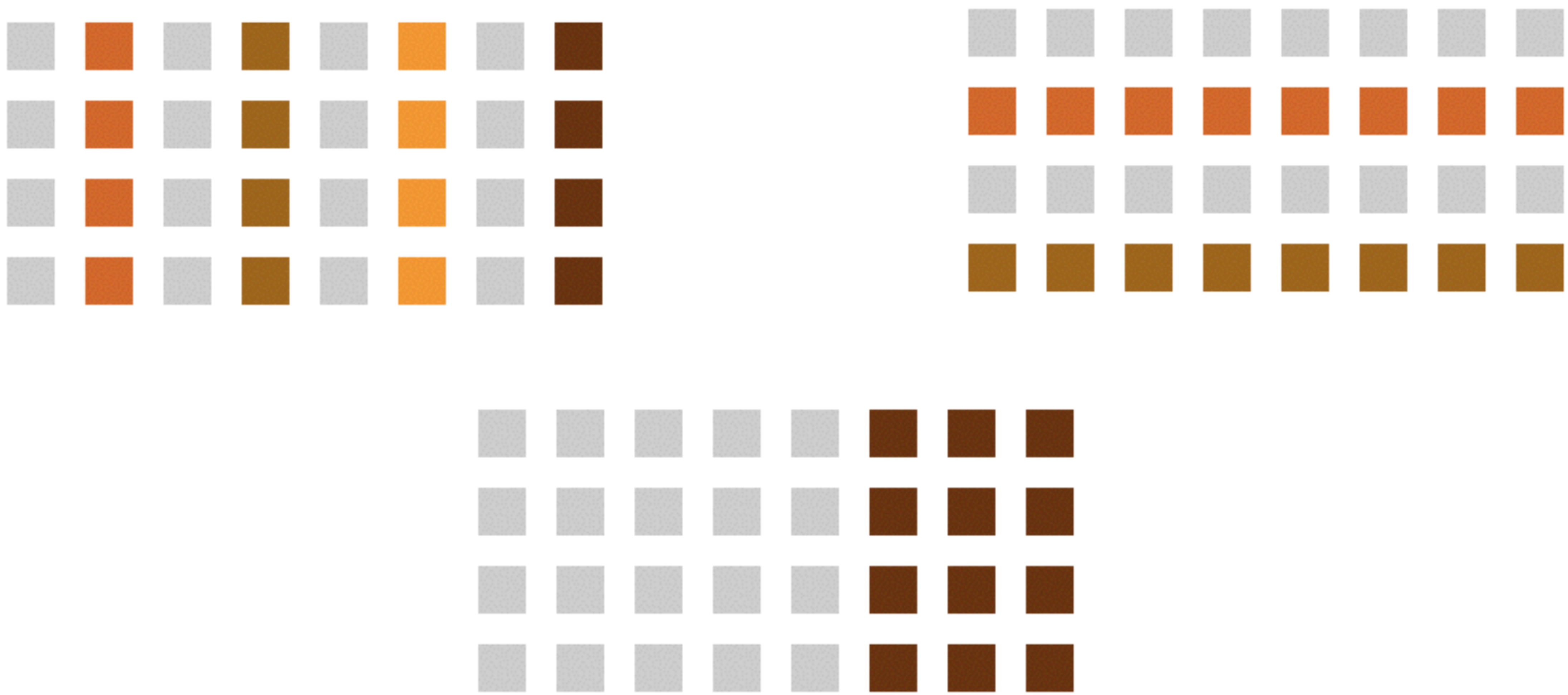


# similarity



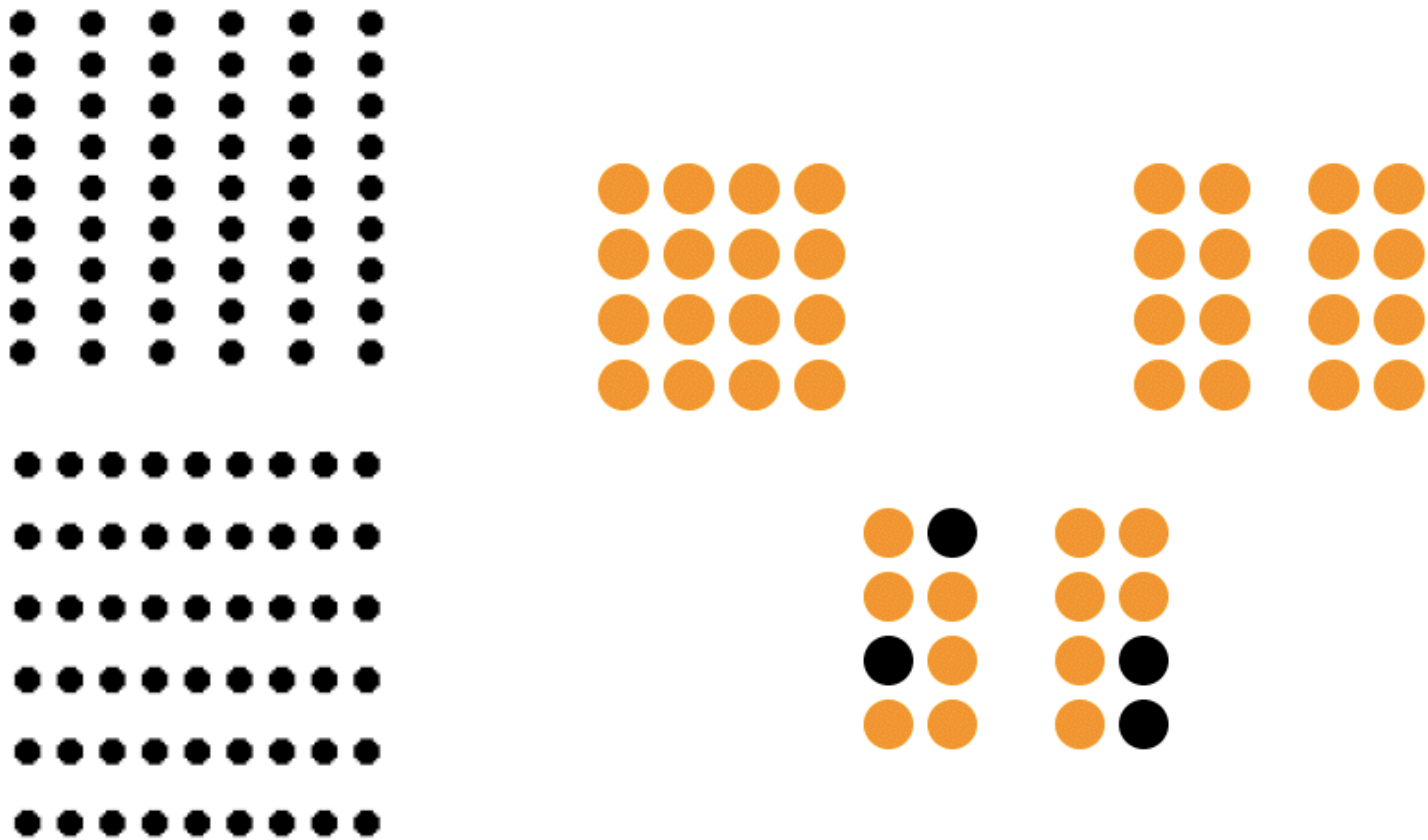
Bang Wong, "Gestalt Principles, 1", Nature Methods

# similarity



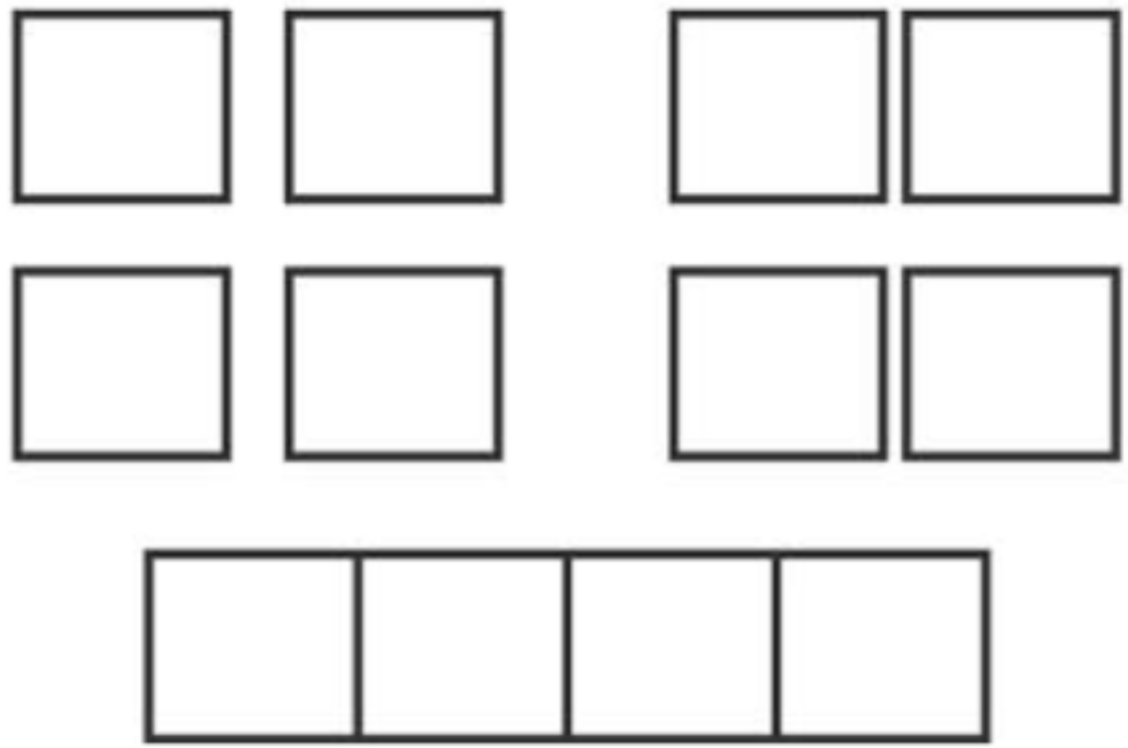
Andy Rutledge, "Gestalt Principles of Perception"

# proximity



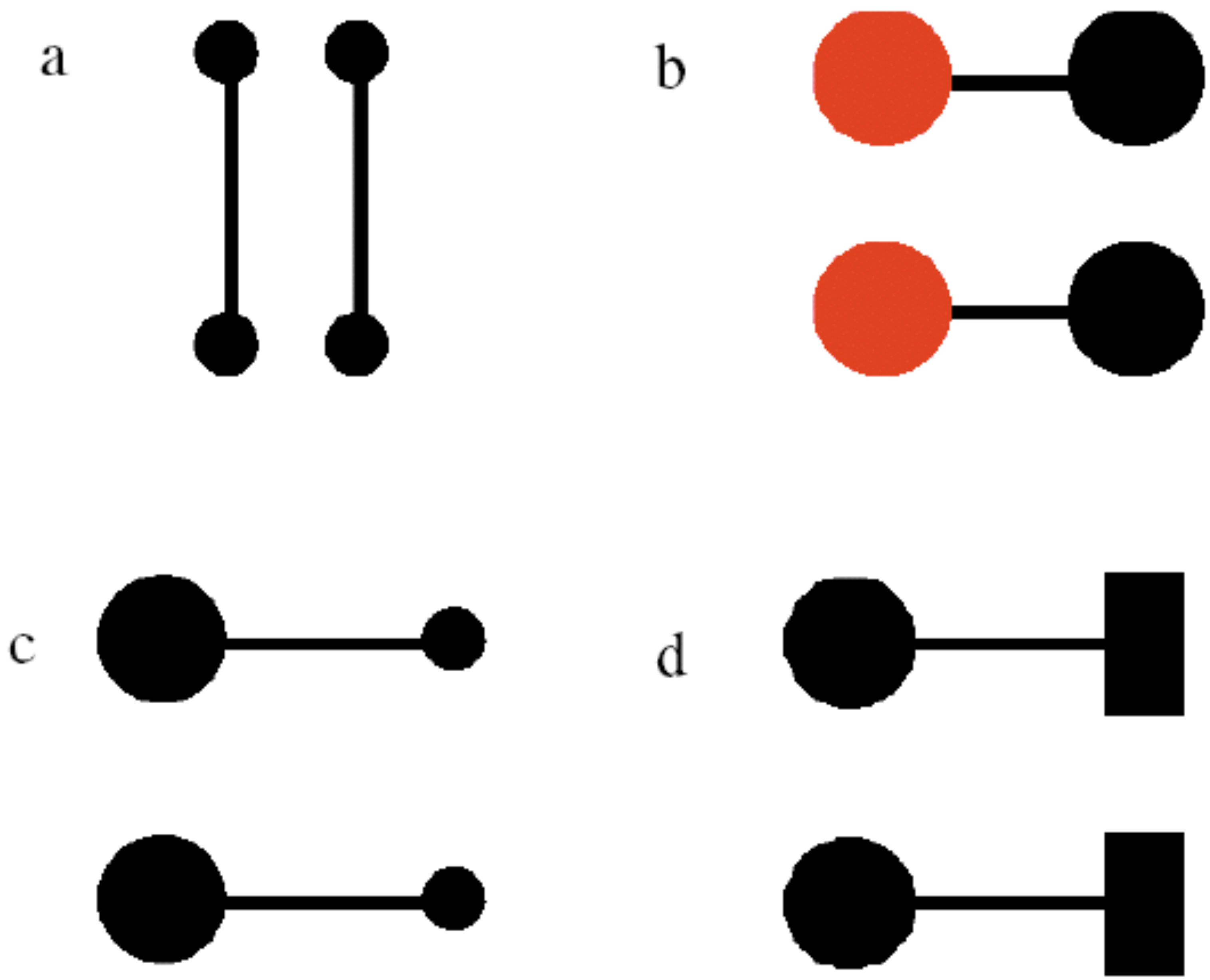
Andy Rutledge, "Gestalt Principles of Perception"

# proximity



Bang Wong, "Gestalt Principles, 1", Nature Methods

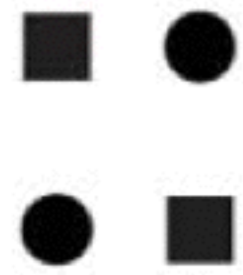
# connectedness



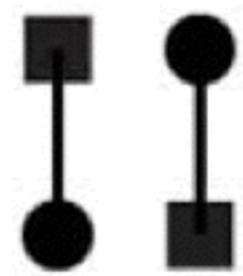

Ware, "Information Visualization"

# grouping

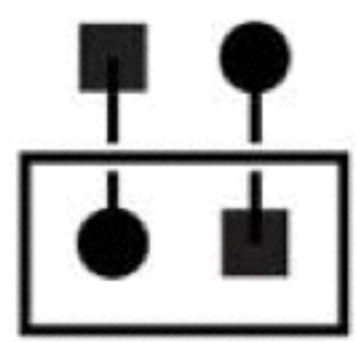
Similarity



Connection

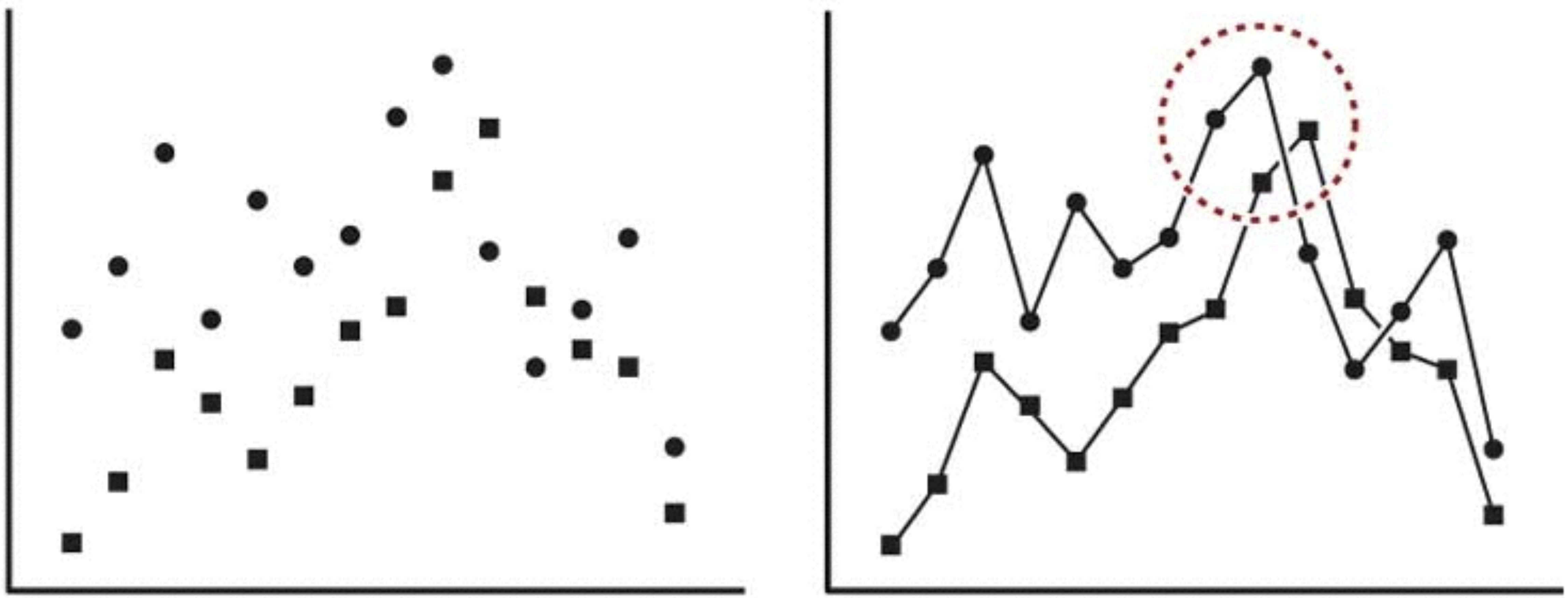


Enclosure



Bang Wong, "Gestalt Principles, 1", Nature Methods

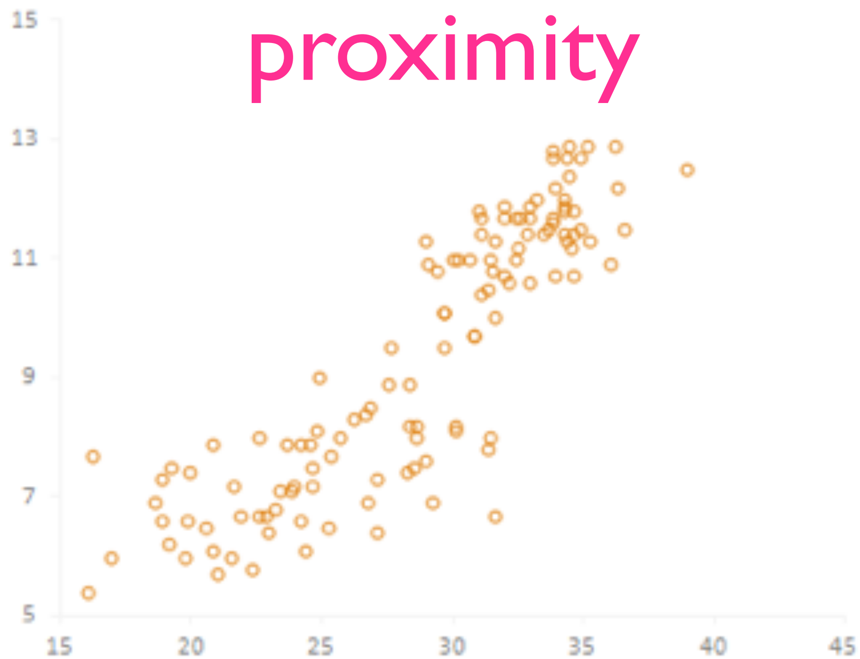
# grouping



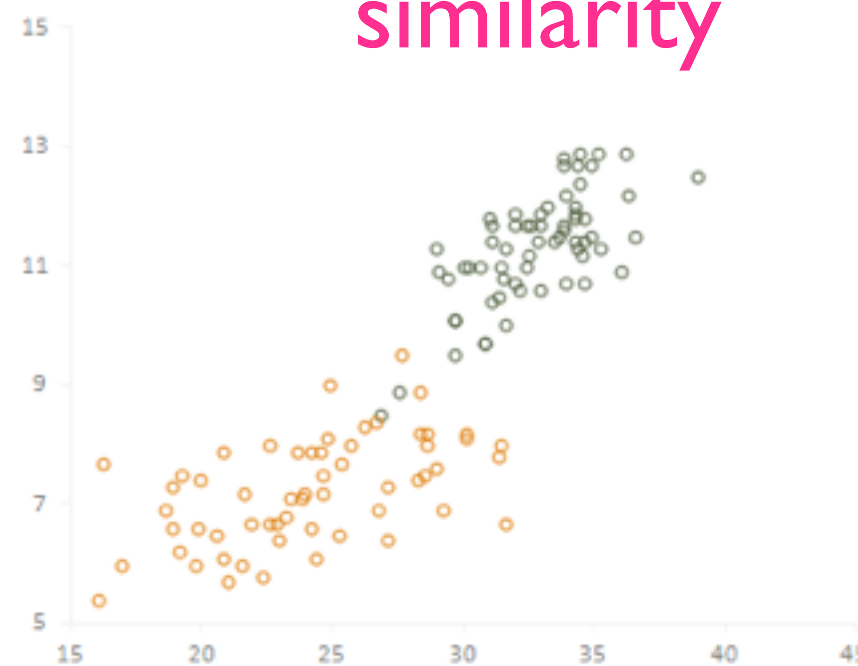
Bang Wong, "Gestalt Principles, 1", Nature Methods

# grouping

## proximity



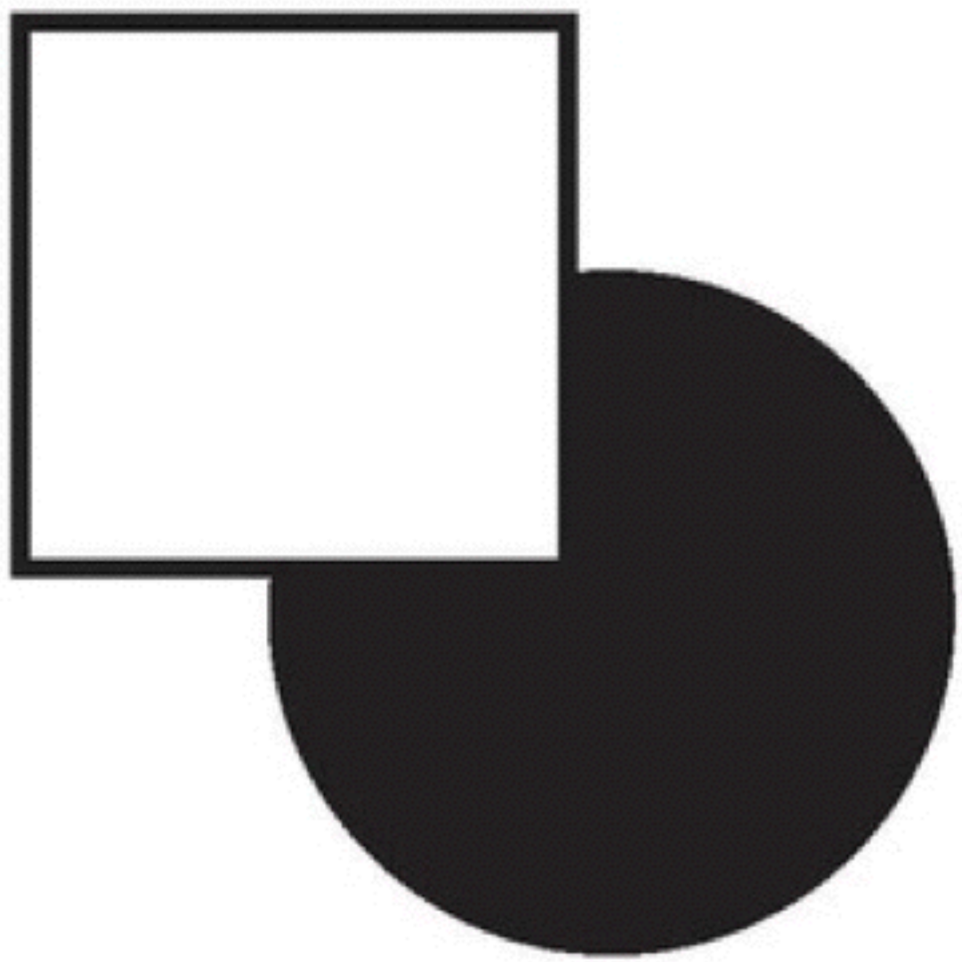

## similarity




## enclosure

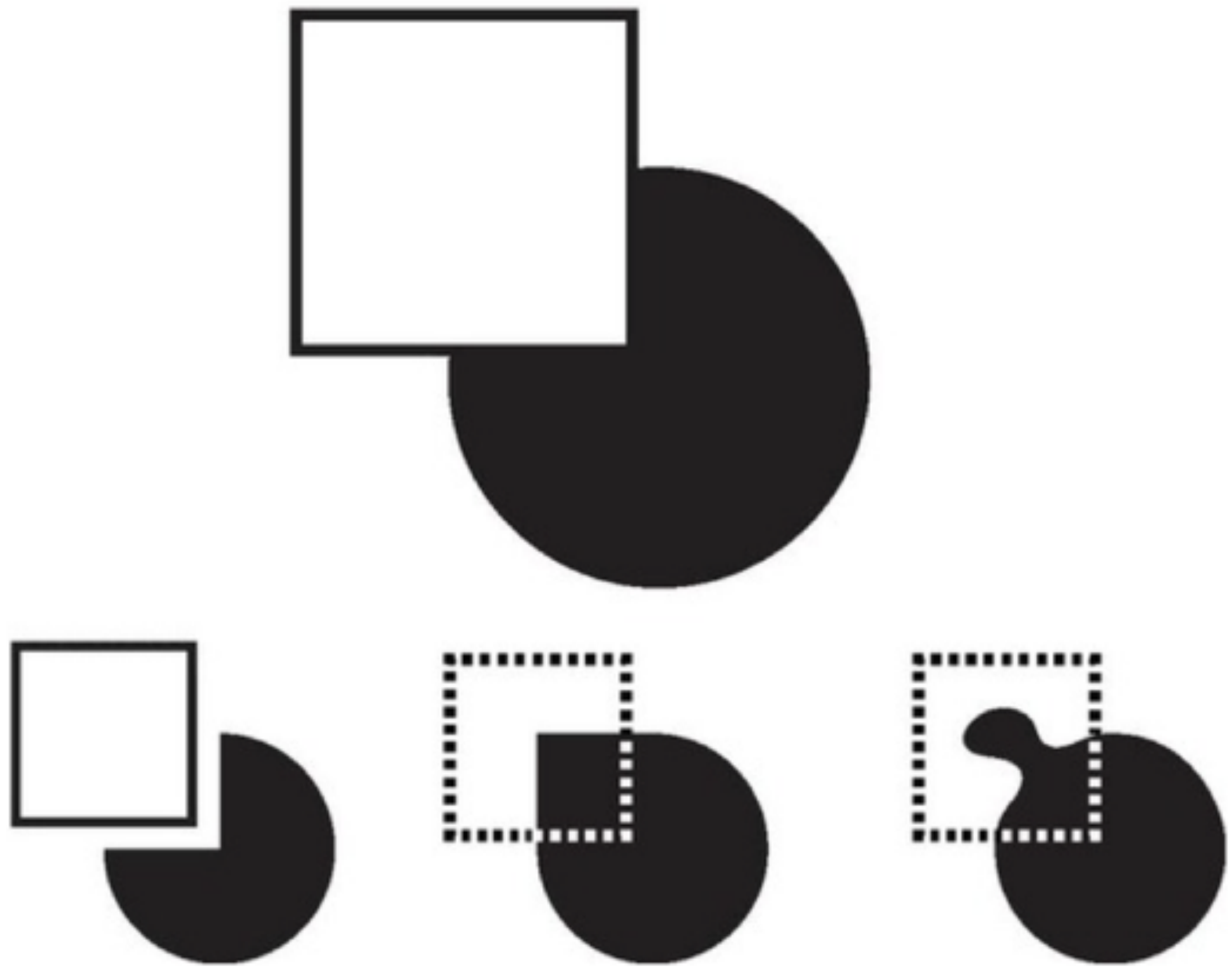

Jorge Camoes

# continuity



Bang Wong, "Gestalt Principles, II", Nature Methods

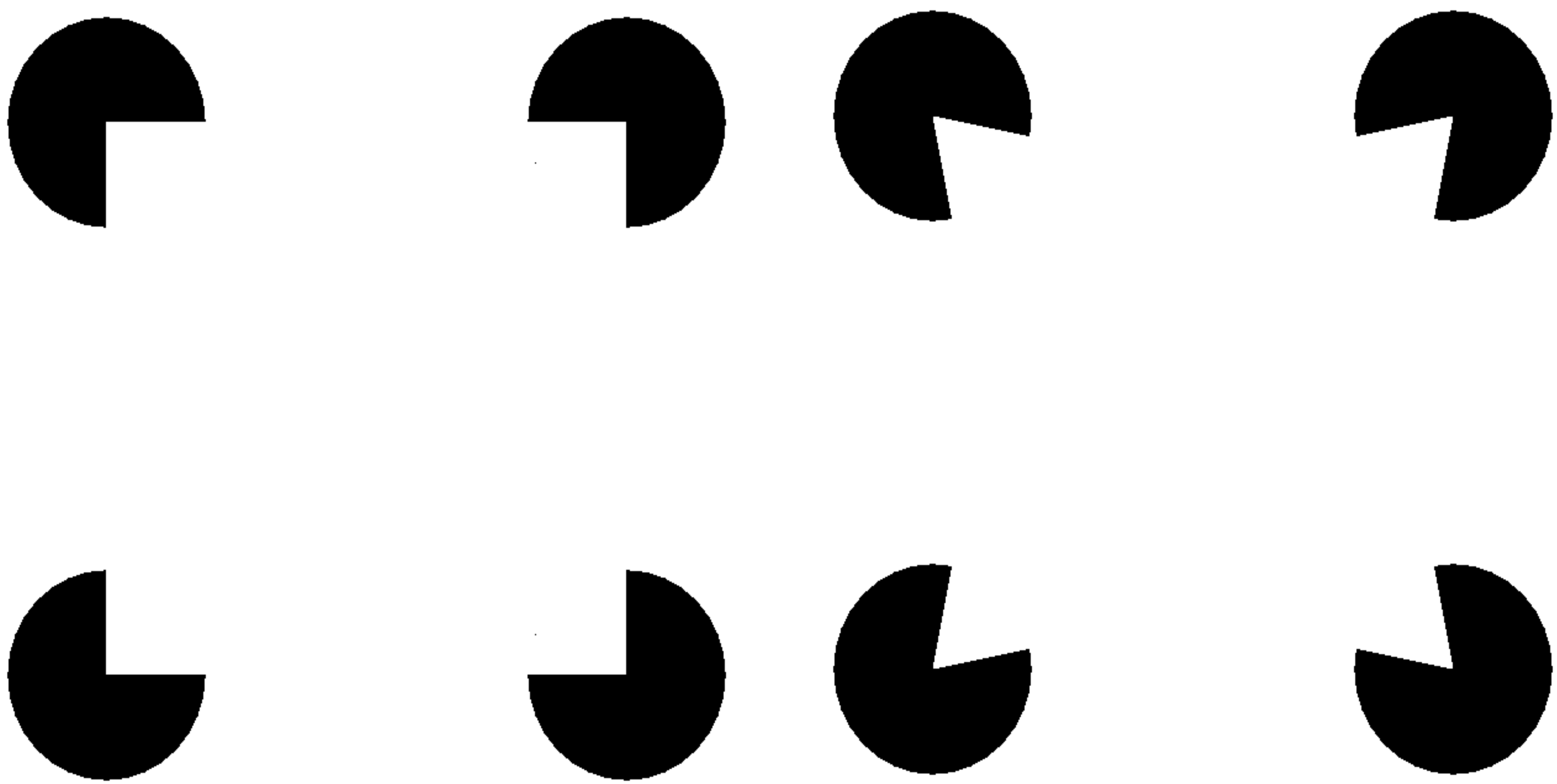
# continuity



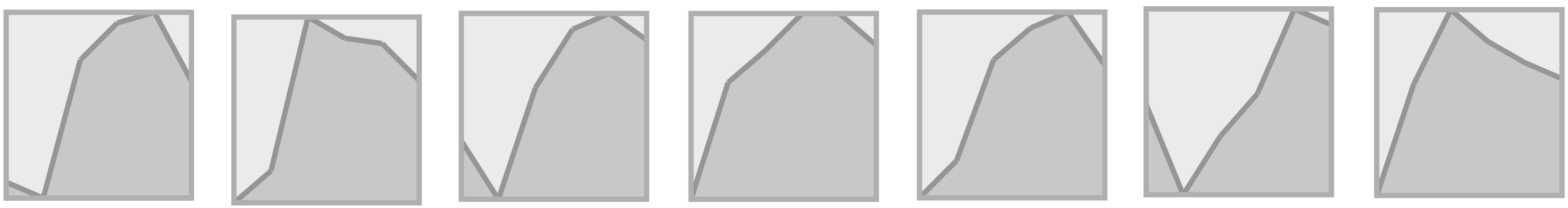
Bang Wong, "Gestalt Principles, II", Nature Methods

# closure

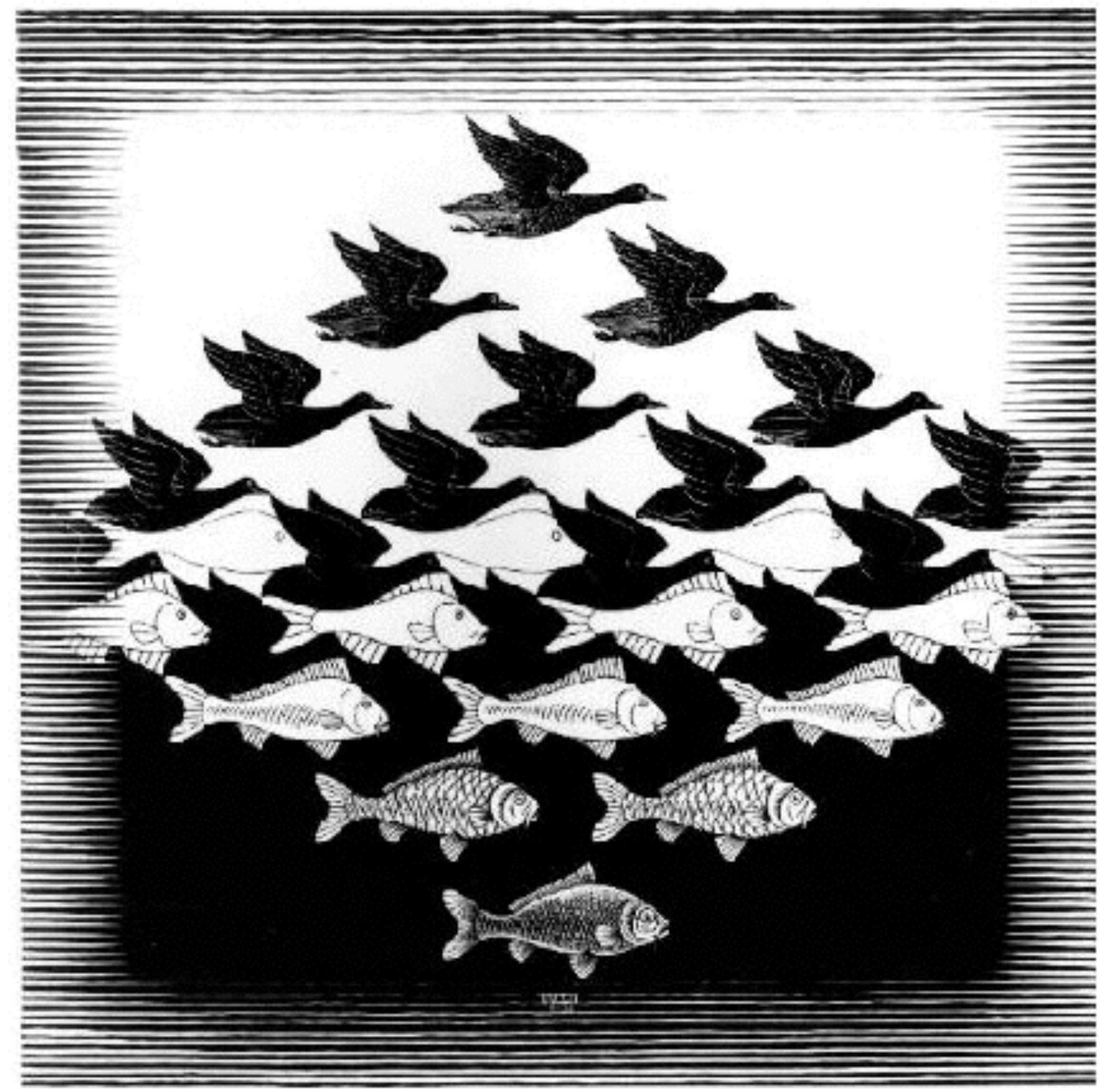
# closure



# closure

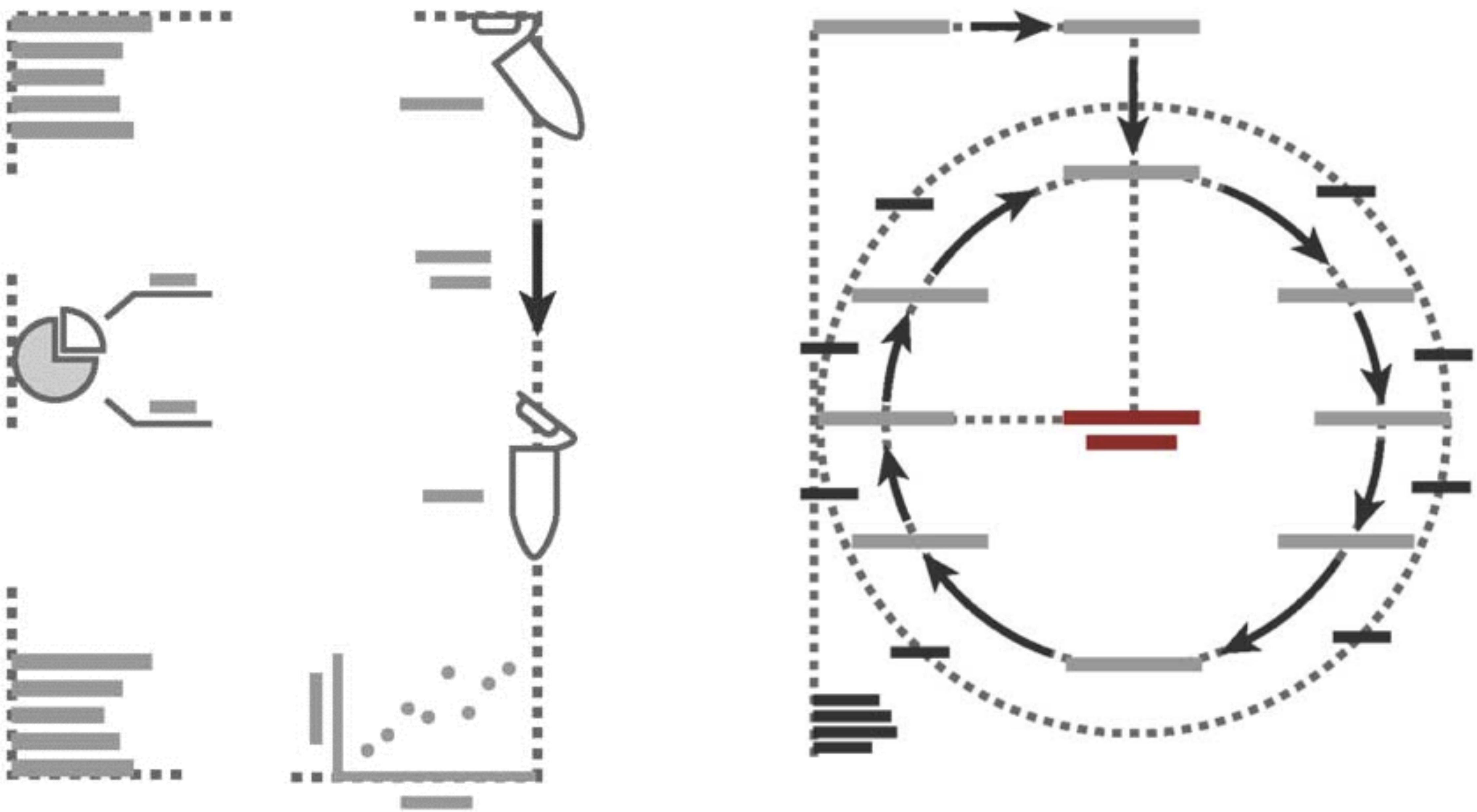


# figure / ground



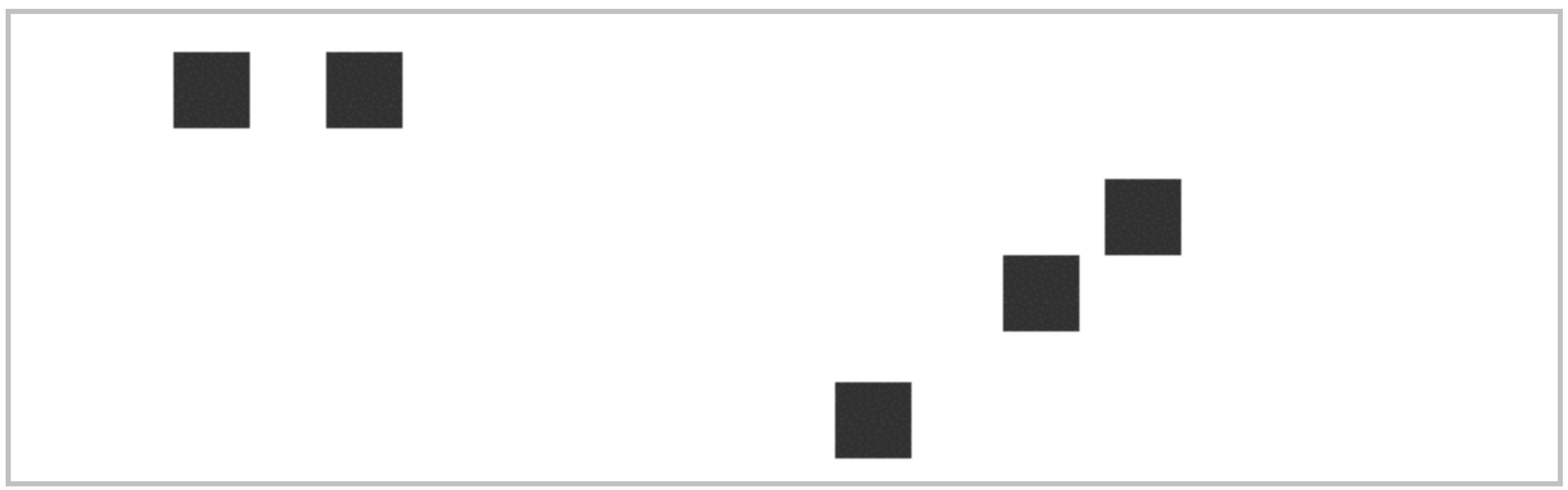
M.C. Escher: *Sky and Water I* 1938 woodcut

# alignment

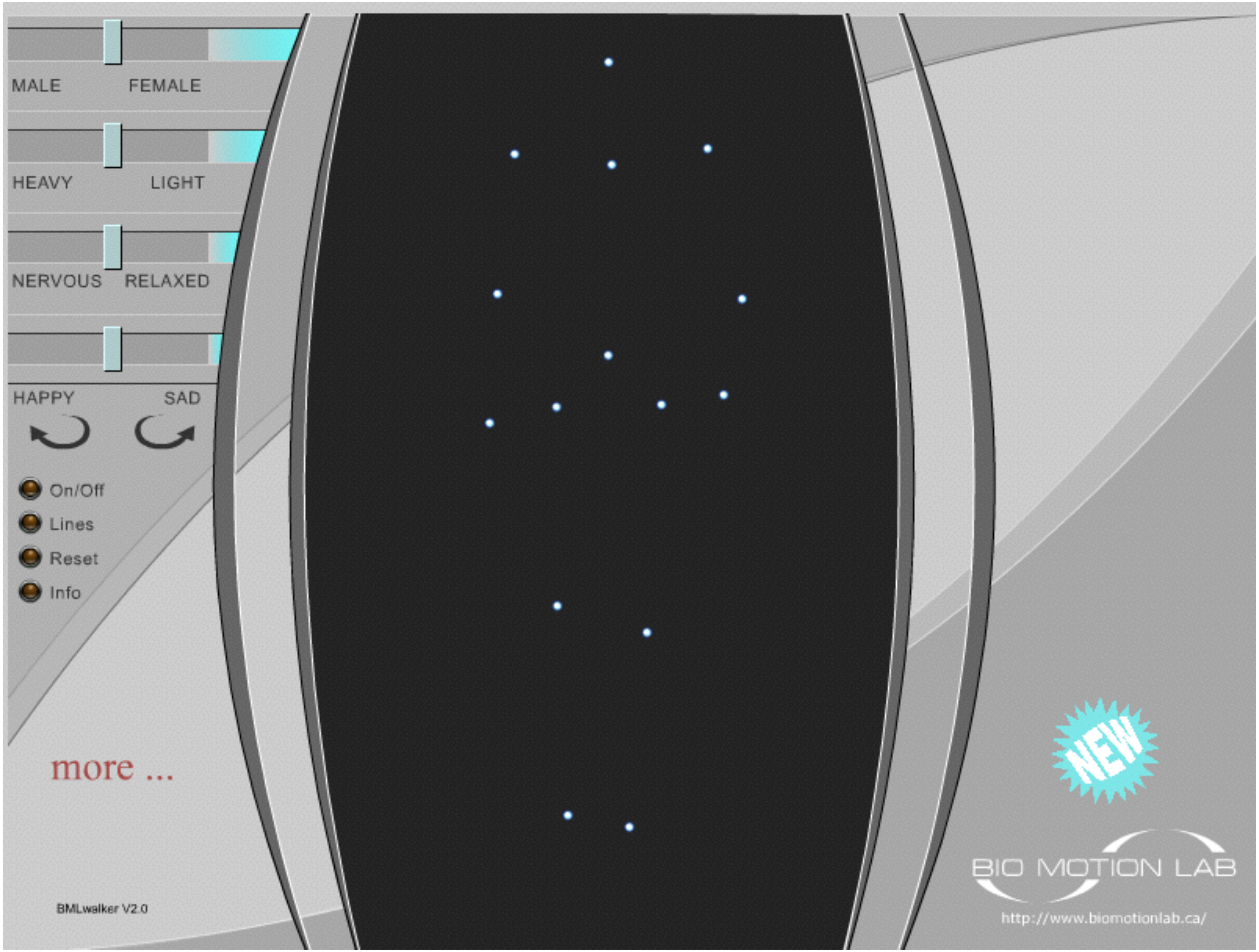


Bang Wong, "Gestalt Principles, II", Nature Methods

# common fate

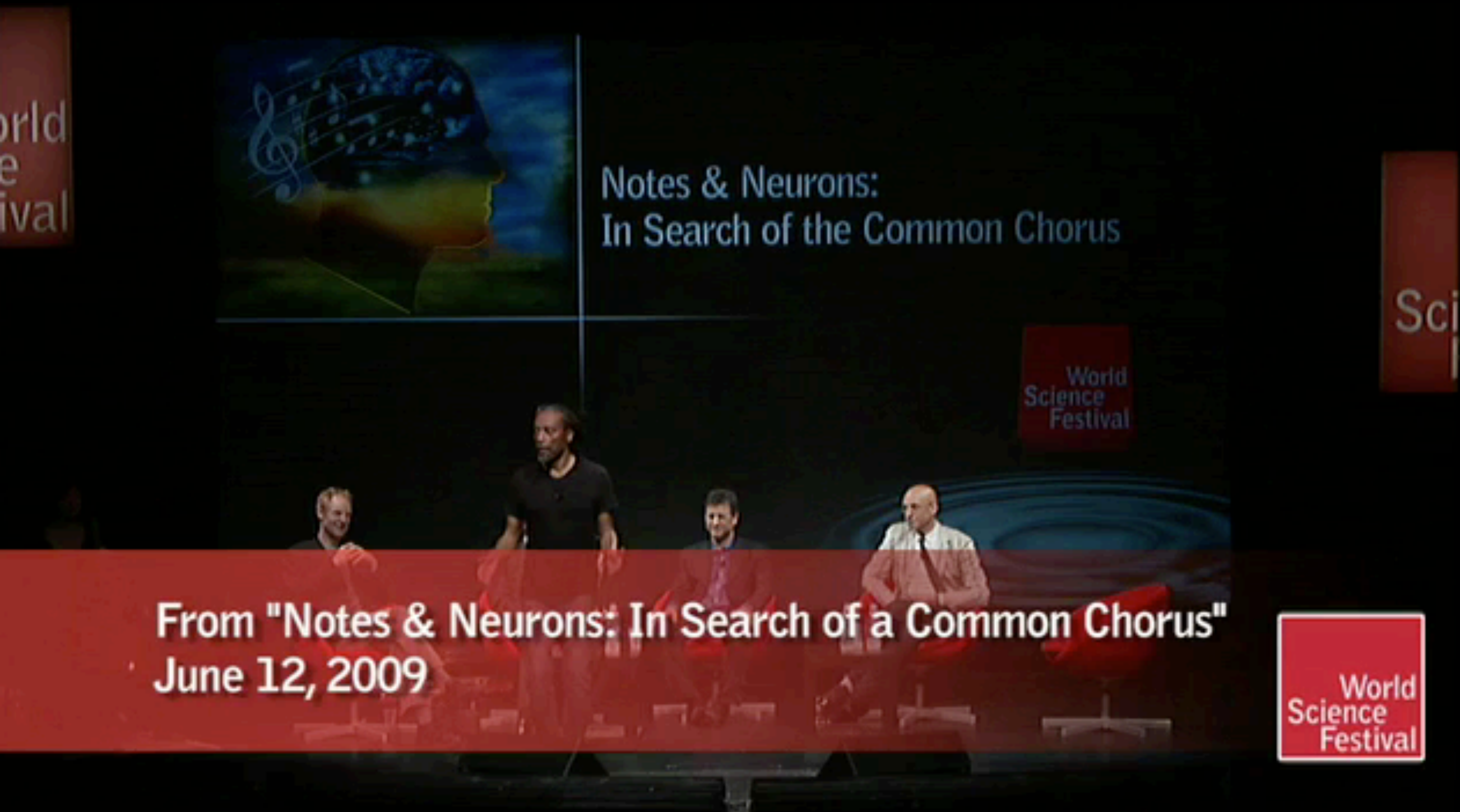


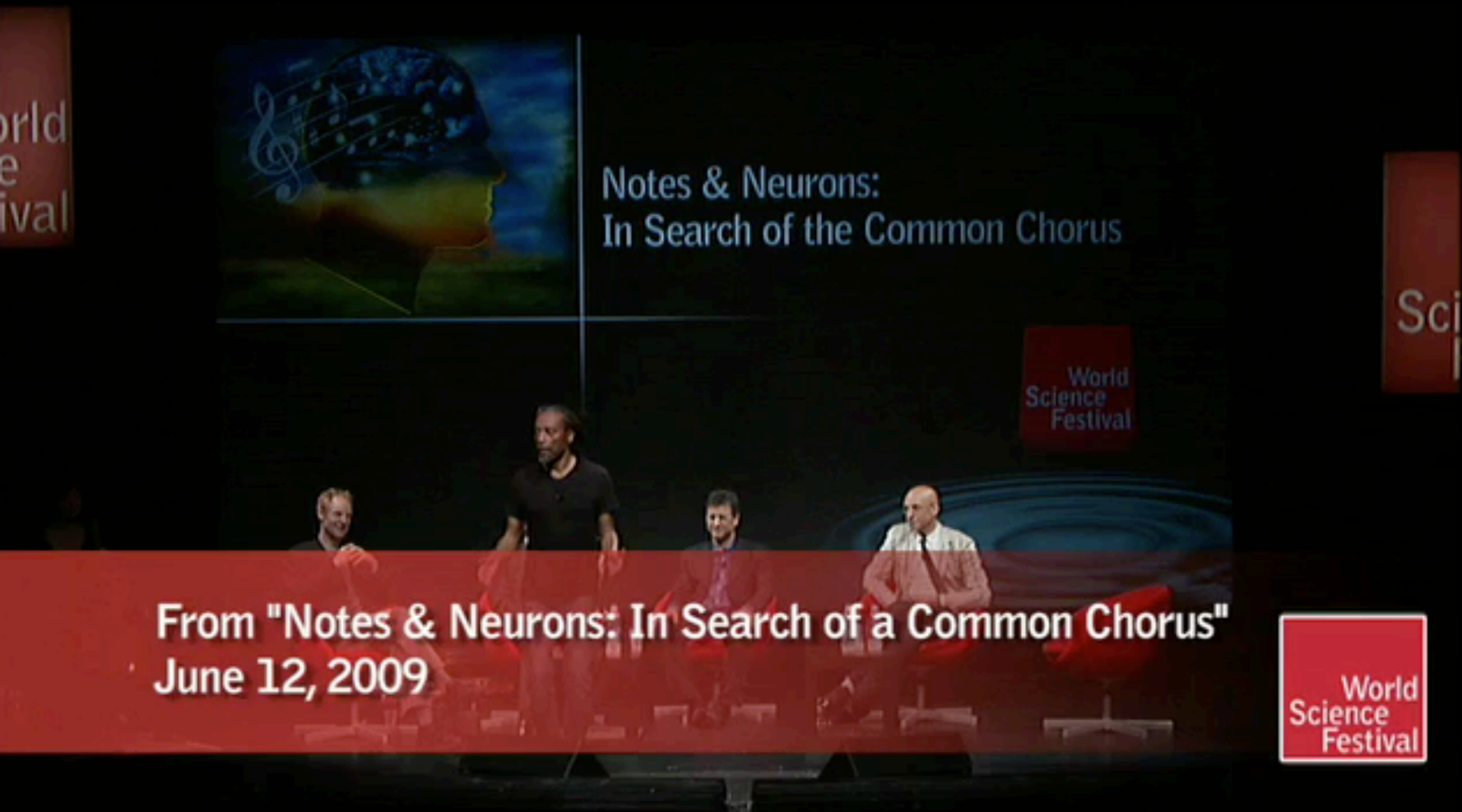
A. Rutledge


MALE
FEMALE
HEAVY
LIGHT
NERVOUS
RELAXED
HAPPY
SAD
On/Off
Lines
Reset
Info
more ...
BMLwalker V2.0
NEW
BIO MOTION LAB
http://www.biomotionlab.ca/

# Gestalt principles

- **similarity:** things that look like each other (size, color, shape) are related
- **proximity:** things that are visually close to each other are related
- **connection:** things that are visually connected are related
- **continuity:** we complete hidden objects into simple, familiar shapes
- **closure:** we see incomplete shapes as complete
- **figure / ground:** elements are perceived as either figures or background
- **common fate:** elements with the same moving direction are perceived as a unit


Notes & Neurons:
In Search of the Common Chorus
World Science Festival
From "Notes & Neurons: In Search of a Common Chorus"
June 12, 2009
World Science Festival


Notes & Neurons:
In Search of the Common Chorus
World Science Festival
From "Notes & Neurons: In Search of a Common Chorus"
June 12, 2009
World Science Festival

L4. Data abstraction

# REQUIRED READING

# Chapter 2

# What: Data Abstraction

## 2.1 The Big Picture

Figure 2.1 shows the abstract types of *what* can be visualized. The four basic dataset types are tables, networks, fields, and geometry; other possible collections of items include clusters, sets, and lists. These datasets are made up of different combinations of the five data types: attributes, items, links, grid cells, and positions. For any of these dataset types, the full dataset could be available immediately in the form of a static file, or it might be dynamic data processed gradually in the form of a stream. The type of an attribute can be categorical or ordered, with a further split into ordinal and quantitative. The ordering direction of attributes can be sequential, diverging, or cyclic.

## 2.2 Why Do Data Semantics and Types Matter?

Many aspects of vis design are driven by the kind of data that you have at your disposal. What kind of data are you given? What information can you figure out from the data, versus the meanings that you must be told explicitly? What high-level concepts will allow you to split datasets apart into general and useful pieces?

Suppose that you see the following data: