Vision, Perception and Cognition

ID 413: Information Graphics and Data Visualization
Spring 2016

Venkatesh Rajamanickam (@venkatrajam)
venkatra@iitb.ac.in
http://info-design-lab.github.io/ID413-DataViz/

The Eye

- 70% of body's sense receptors reside in our eyes
- The eye and the visual cortex of the brain form a massively parallel processor that provides the highest-bandwidth channel into human cognitive centers."
  — *Colin Ware, Information Visualization, 2004*
- Important to understand how visual perception works in order to effectively design visualizations

The Eye

- The eye is not a camera!
- Better metaphor for vision: “dynamic and ongoing construction project"
  — *Healey, 1995*
- Attention is selective (Filtering)

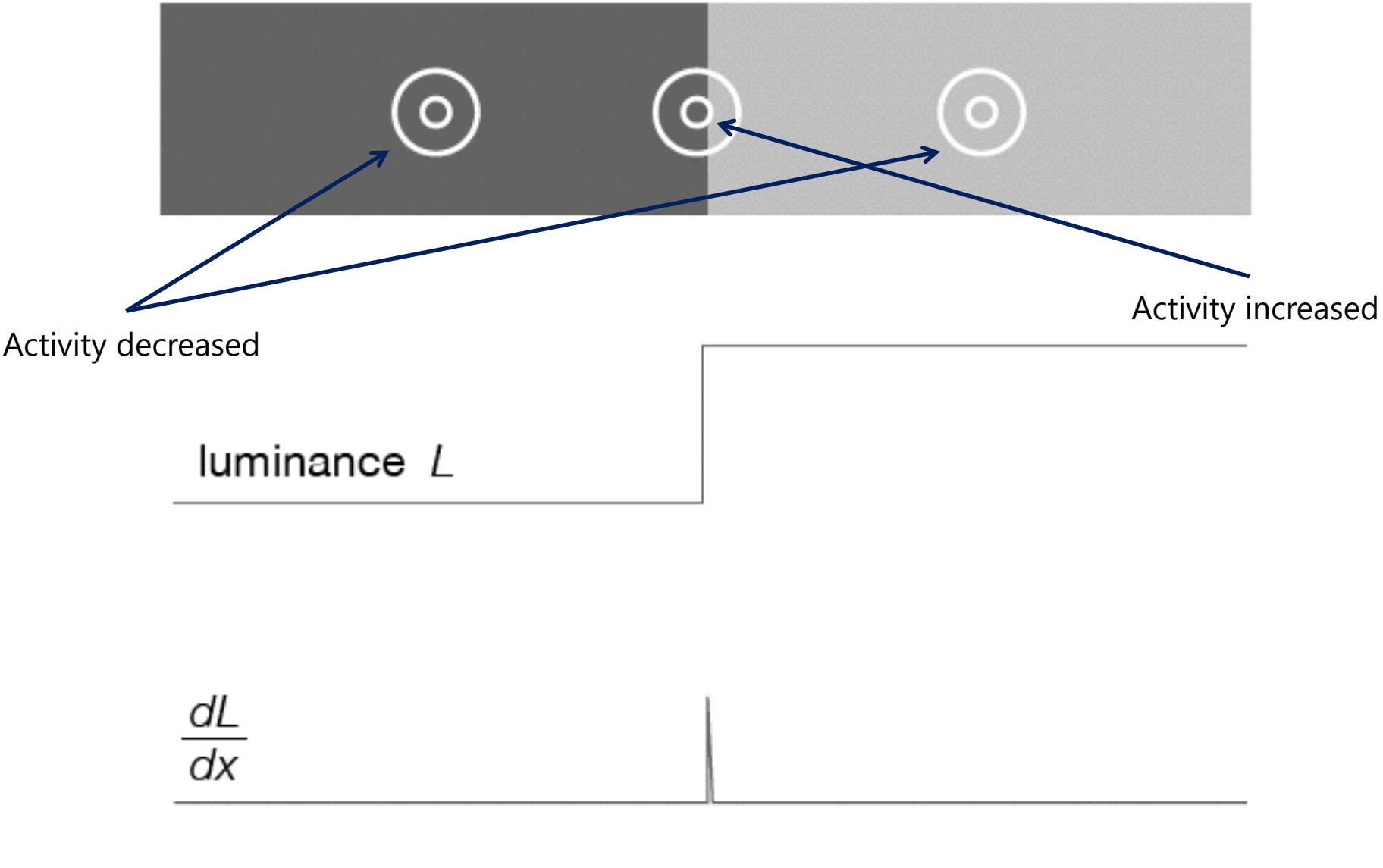
The Eye

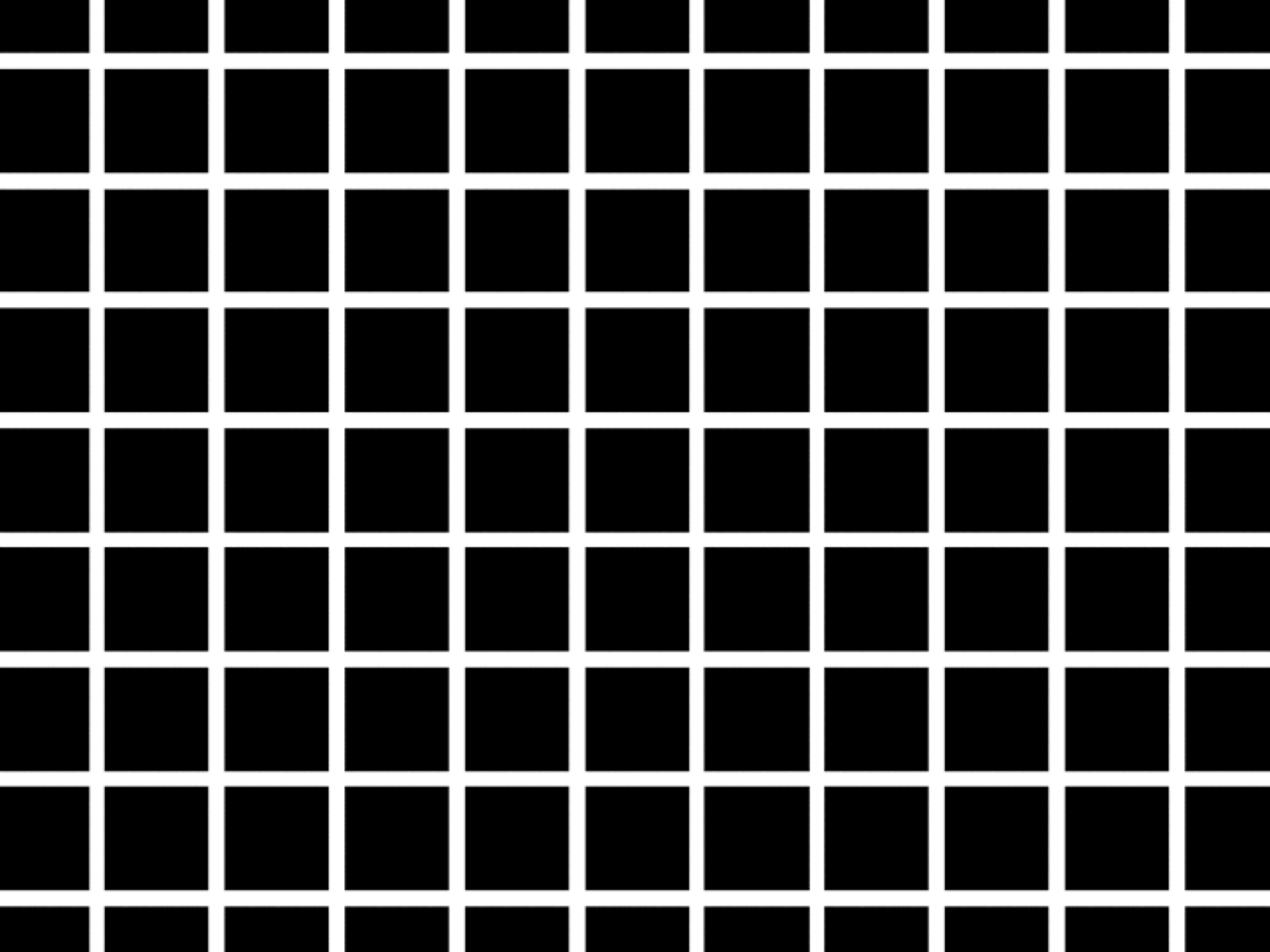
- **Cameras**
  — Good optics
  — Single focus, white balance, exposure
  — “Full image capture“

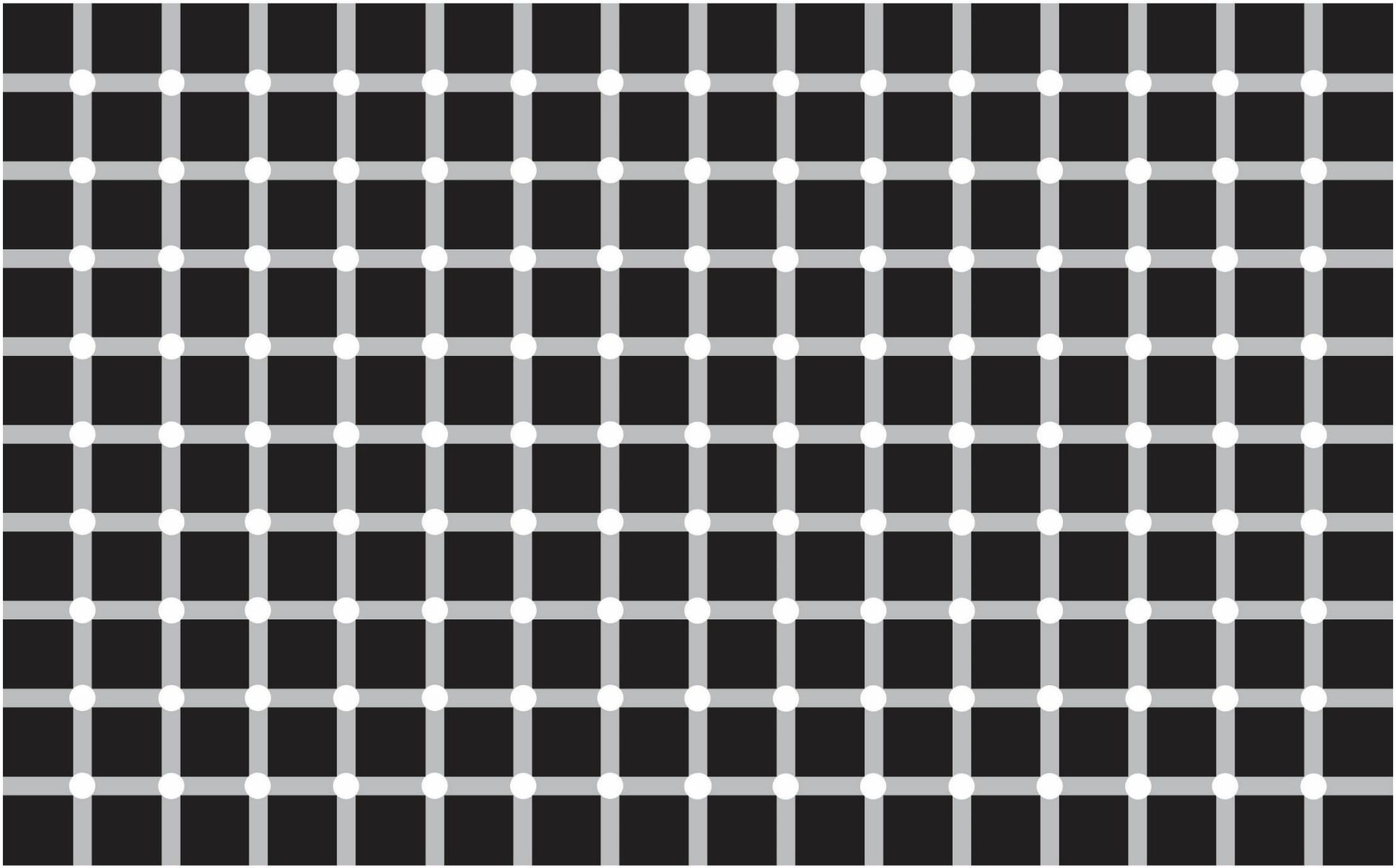
- **Eyes**
  — Relatively poor optics
  — Constantly scanning (saccades)
  — Constantly adjusting focus
  — Constantly adapting
  — Mental reconstruction of image

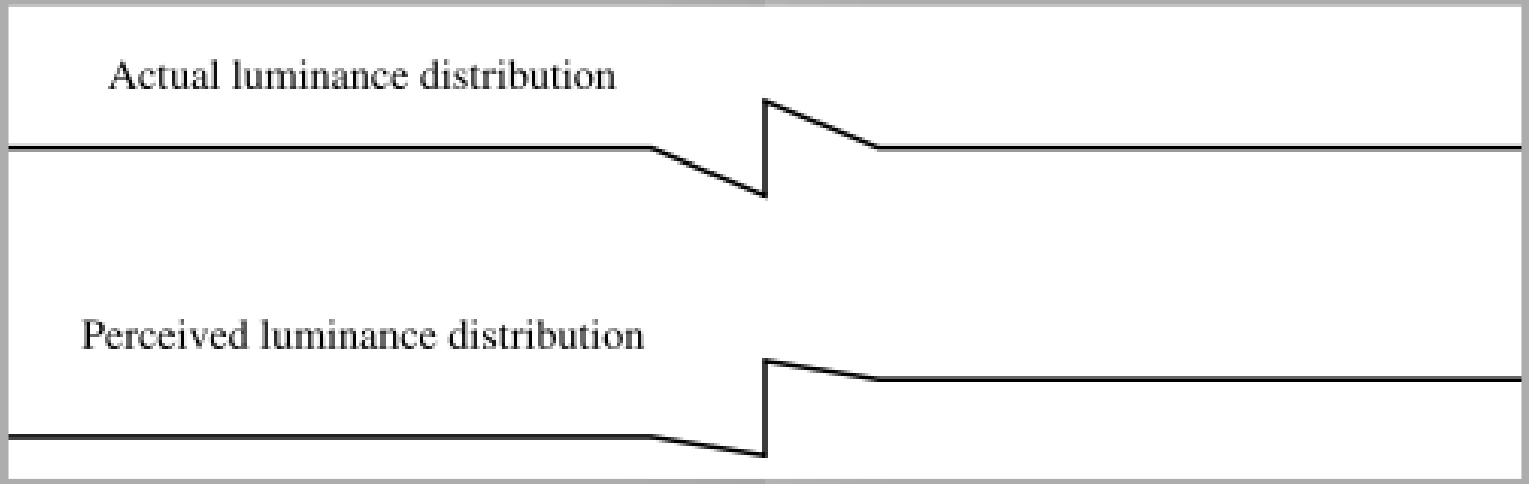
The Eye – Edge detection

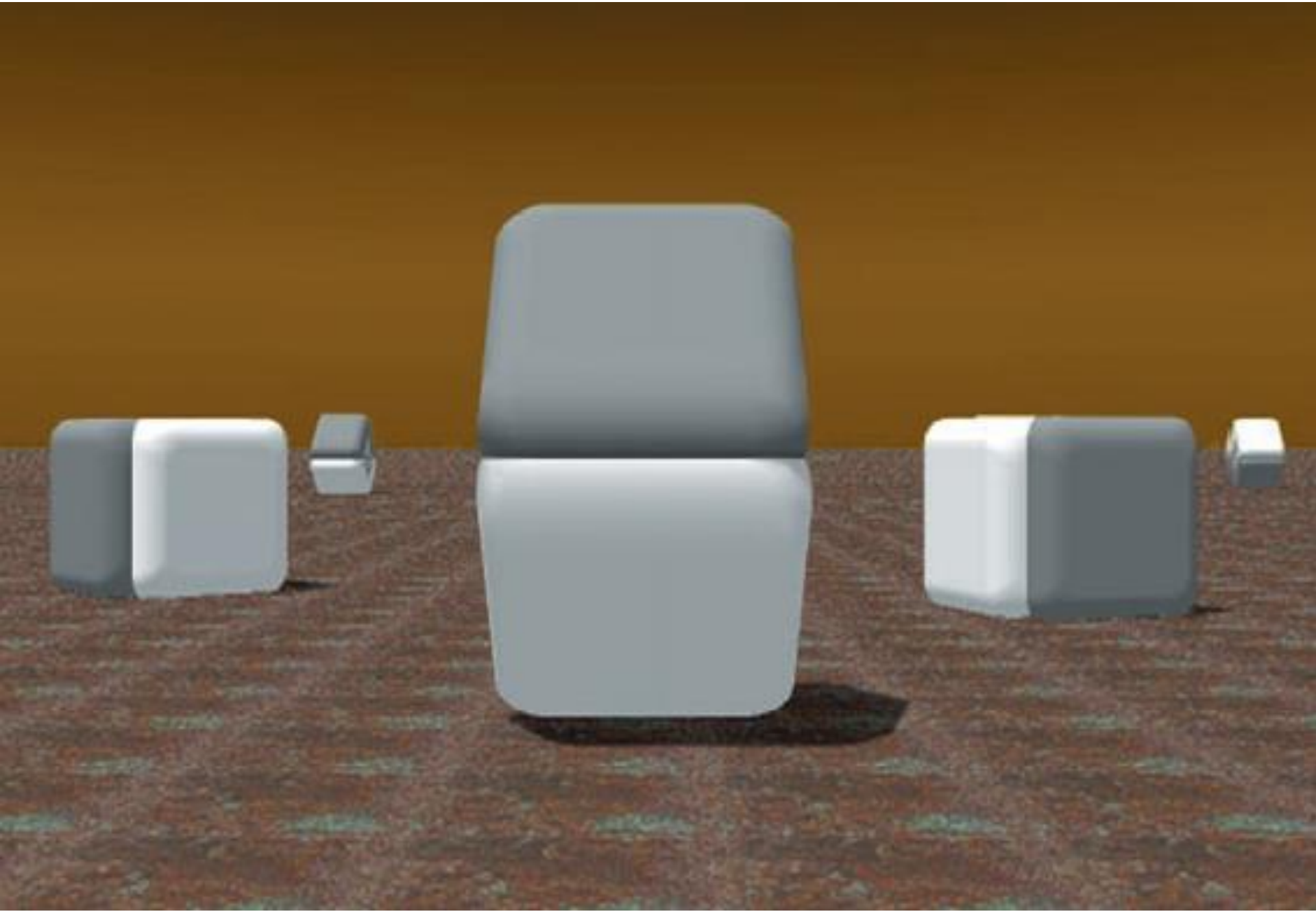
The Eye – Edge detection

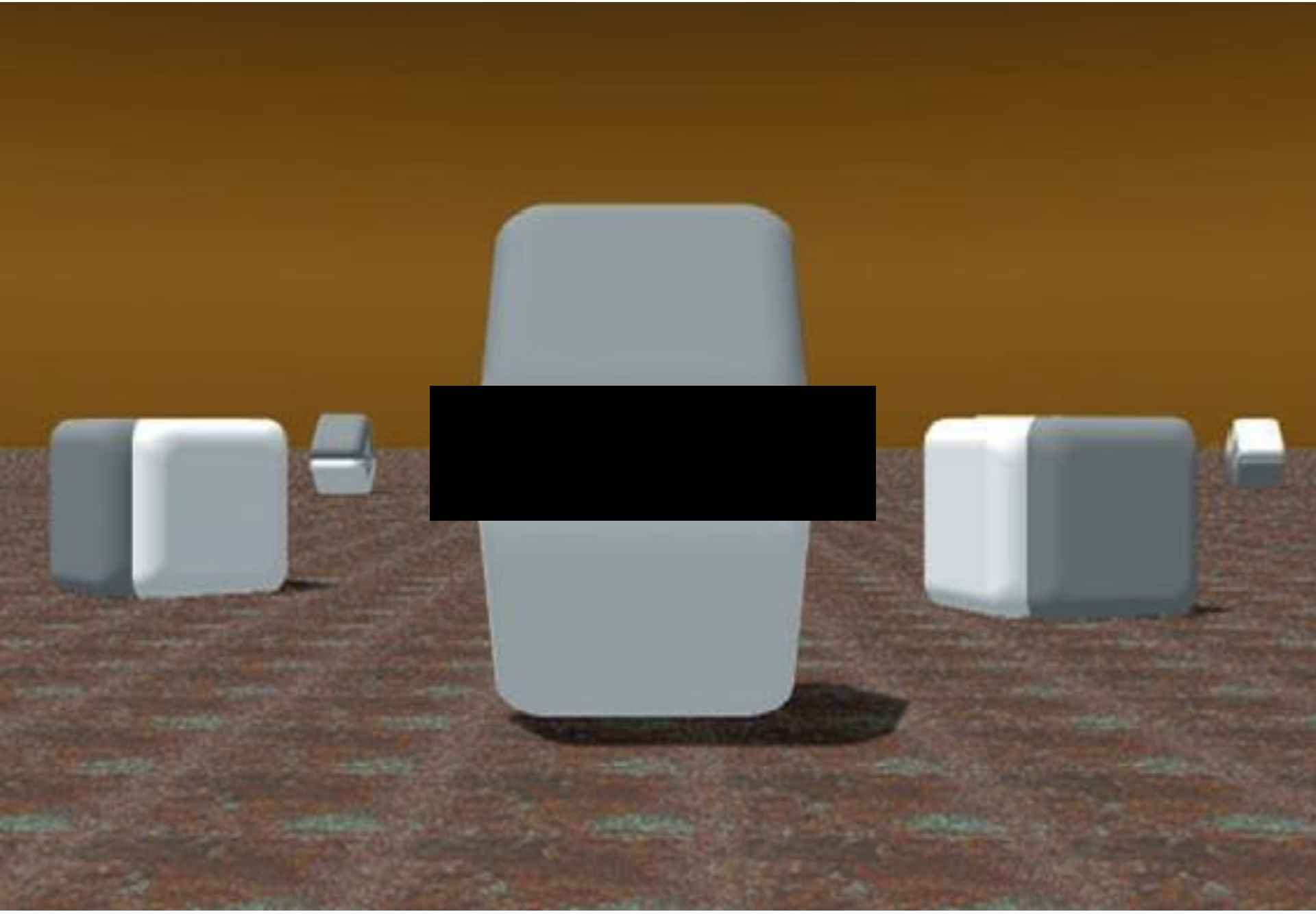


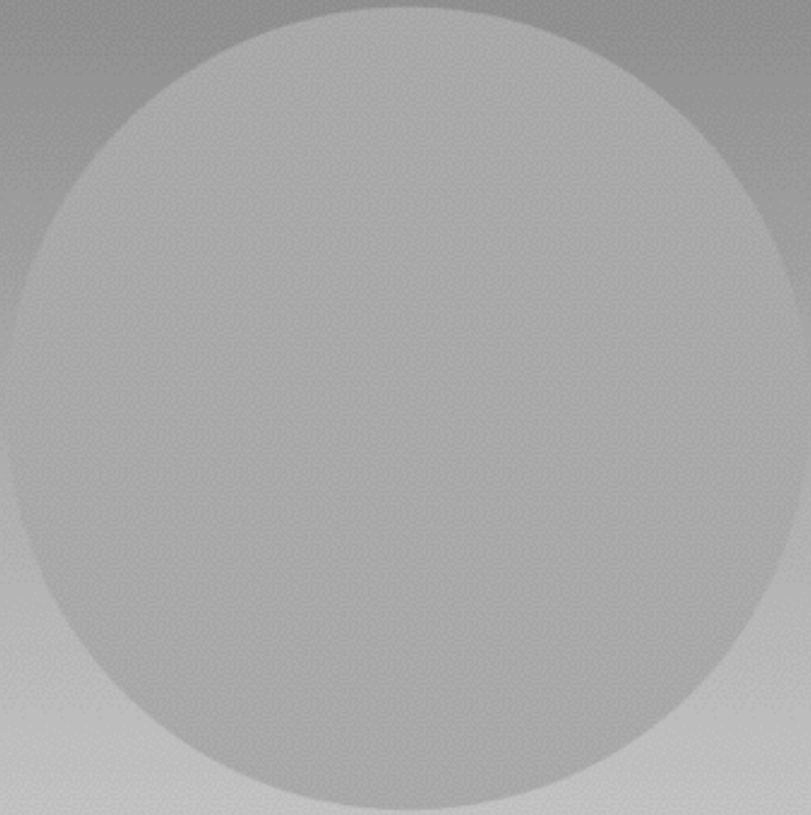


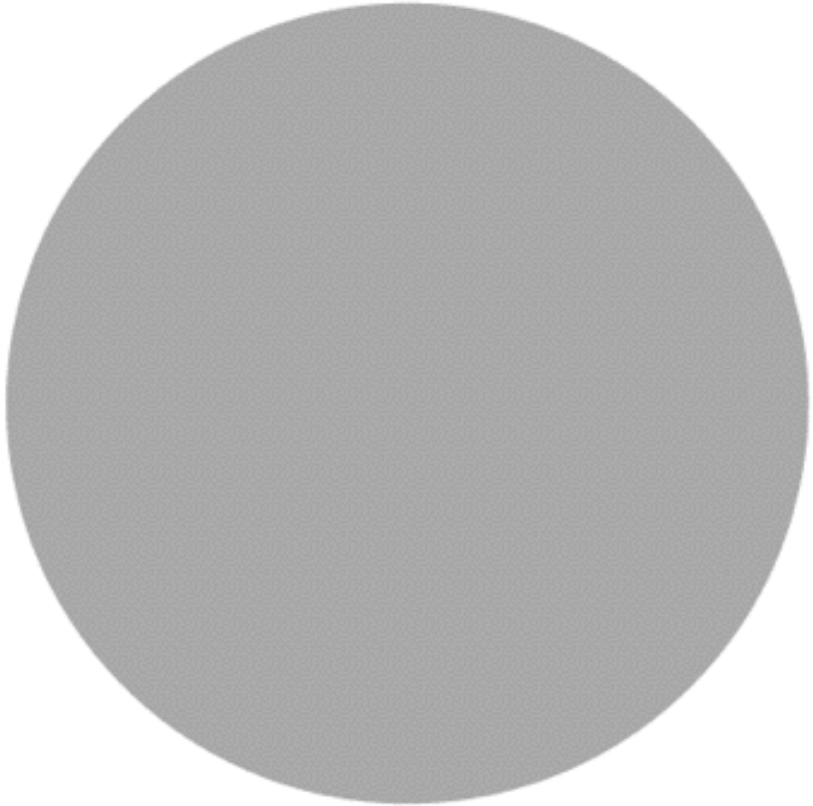


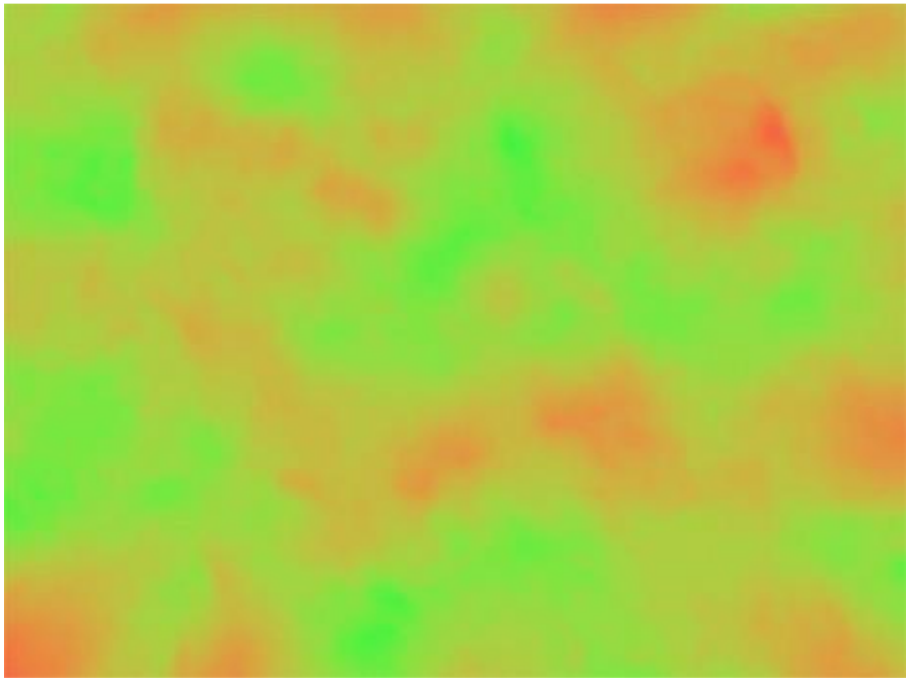

Actual luminance distribution
Perceived luminance distribution

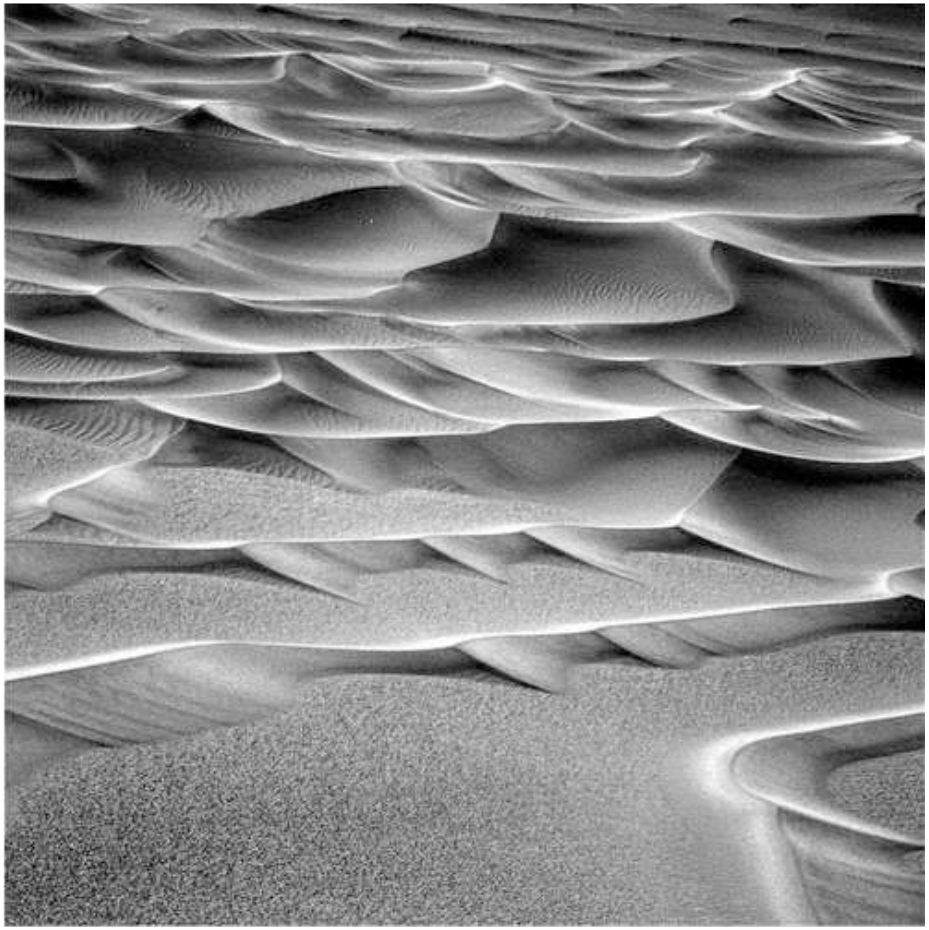


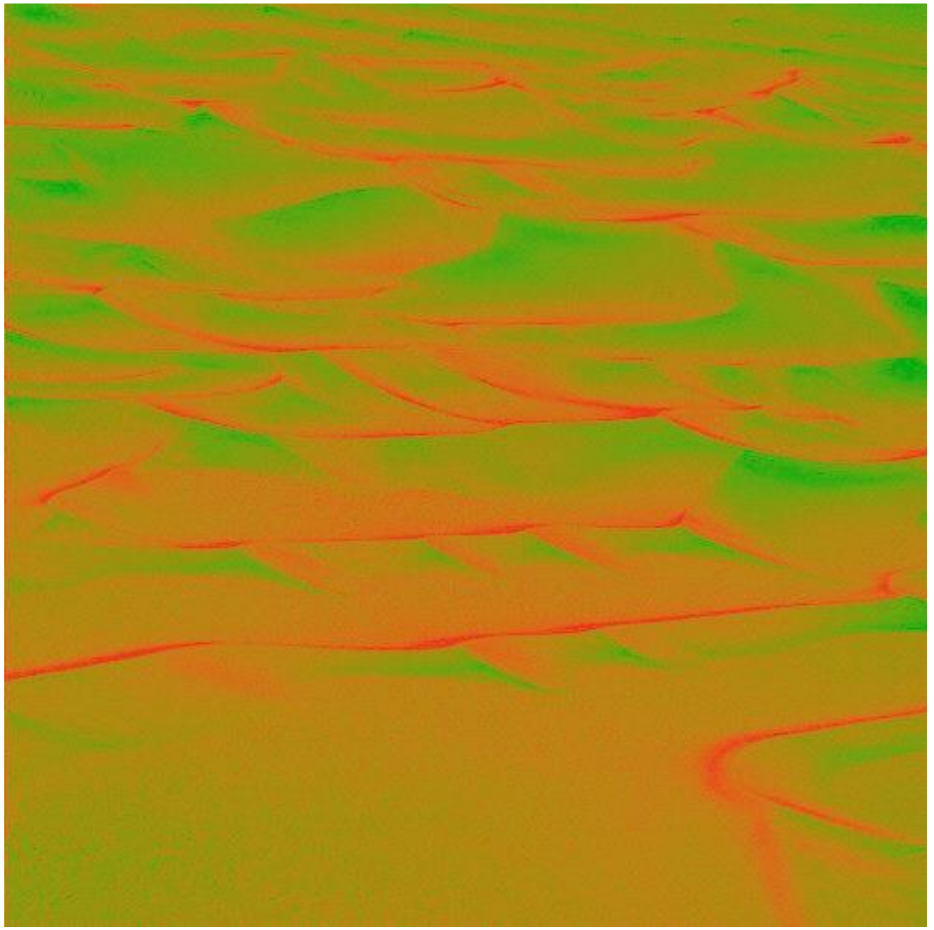












The Eye – Edge detection

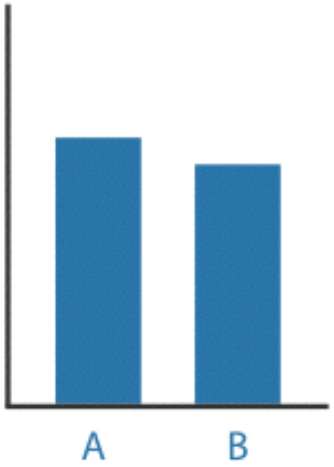
- Our visual system sees differences, not absolute values, and is attracted to edges.
- Maximize the contrast with the background if the outlines of shapes are important.
- Our visual system constructs surface colour based largely on edge contrast information.
- We have higher contrast sensitivity in the luminance than in the chrominance channel.

The Eye – Relativity of perception

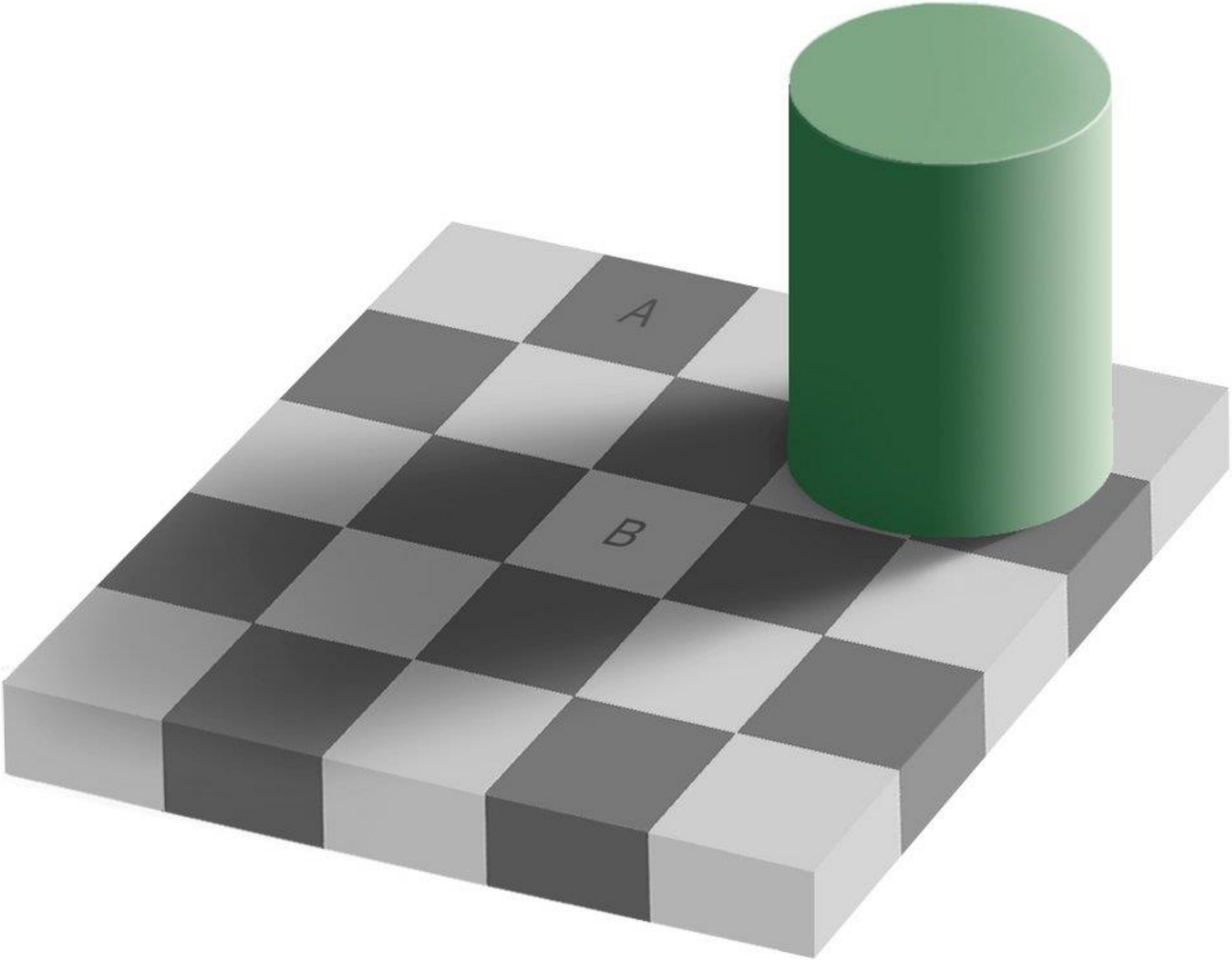
Weber's Law: We judge based on relative, not absolute, differences

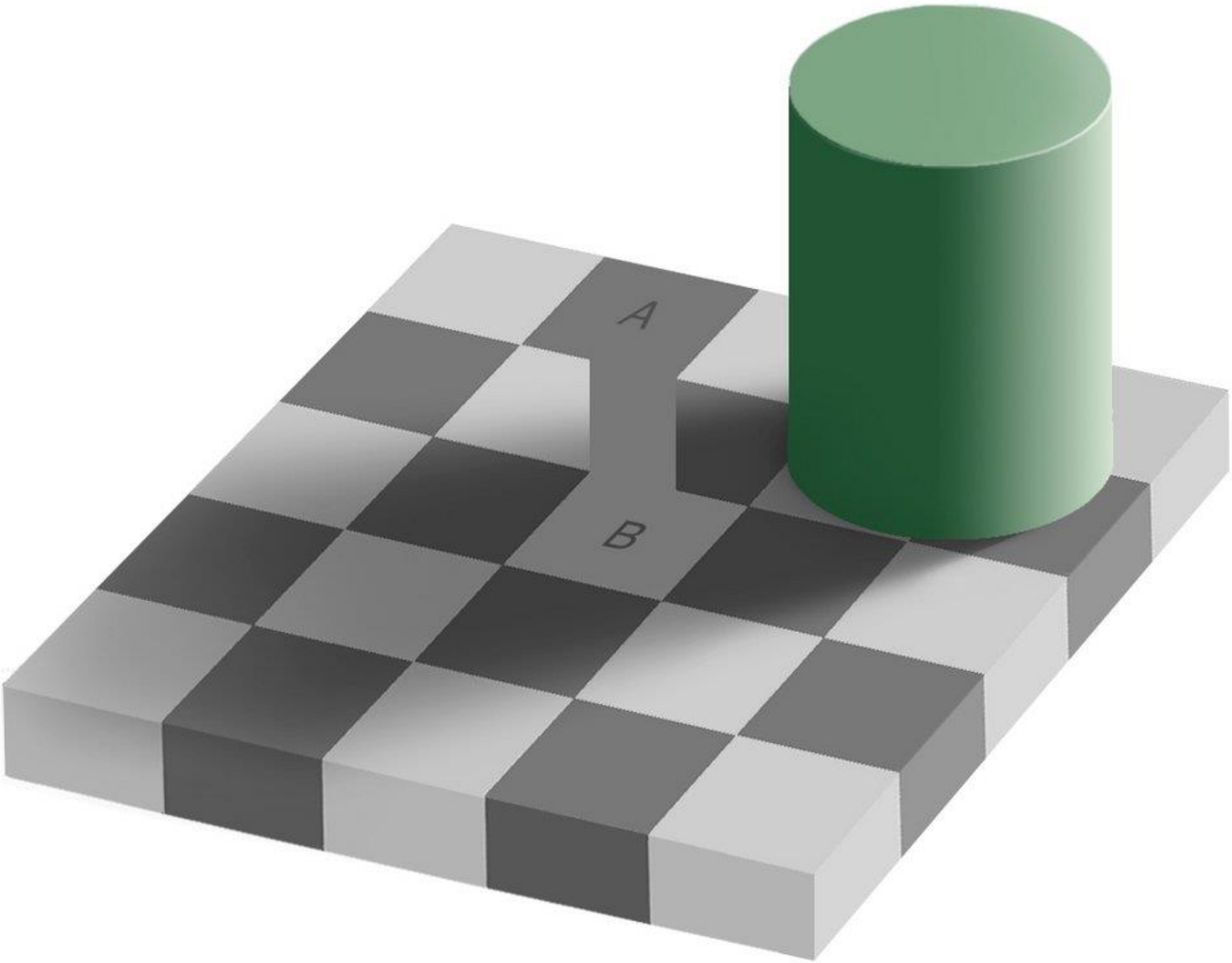
Unframed
Unaligned

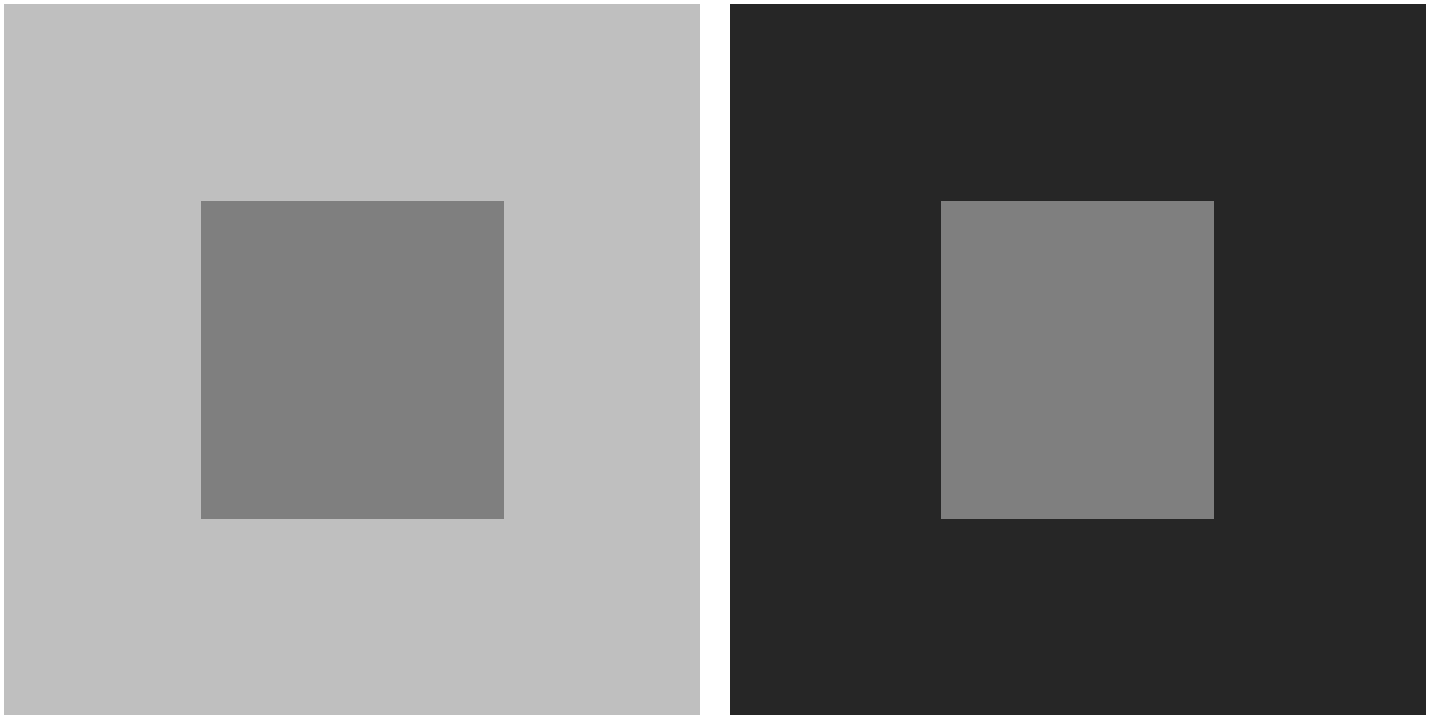
Framed
Unaligned

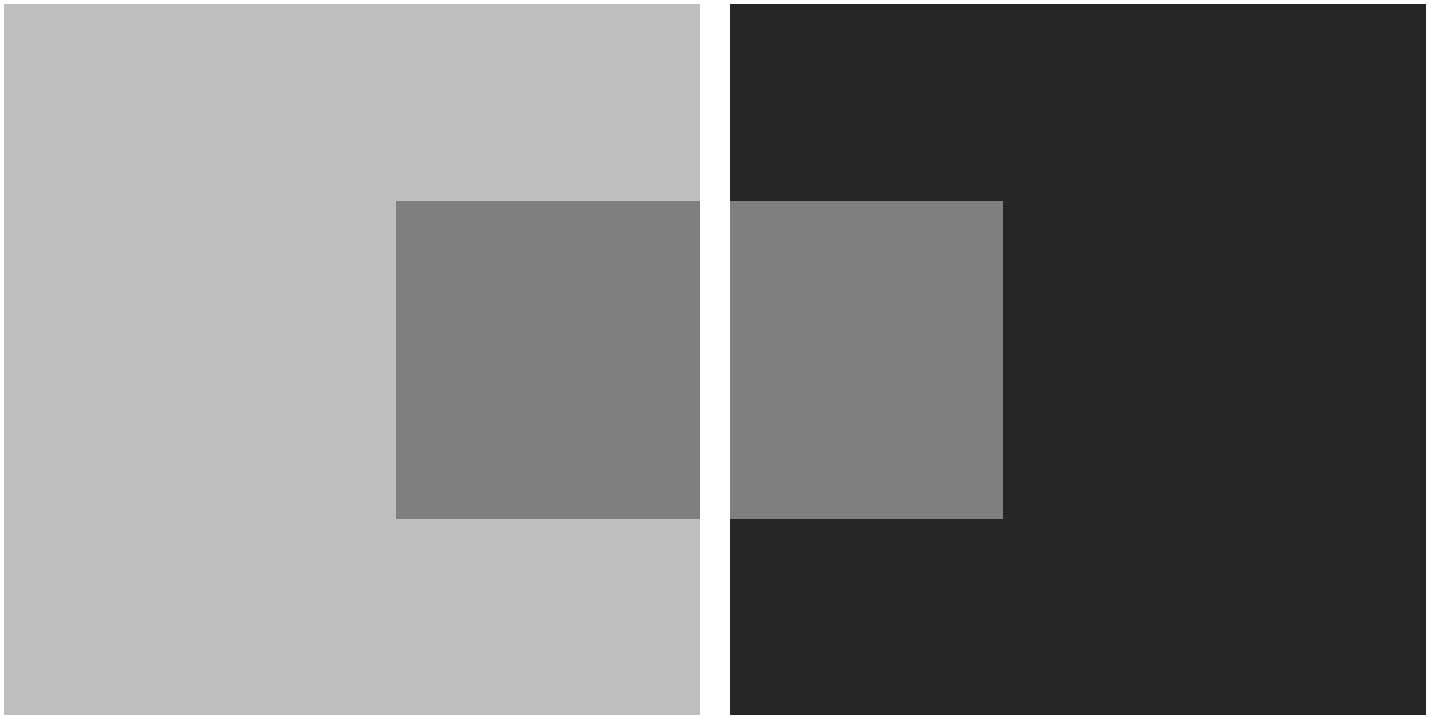


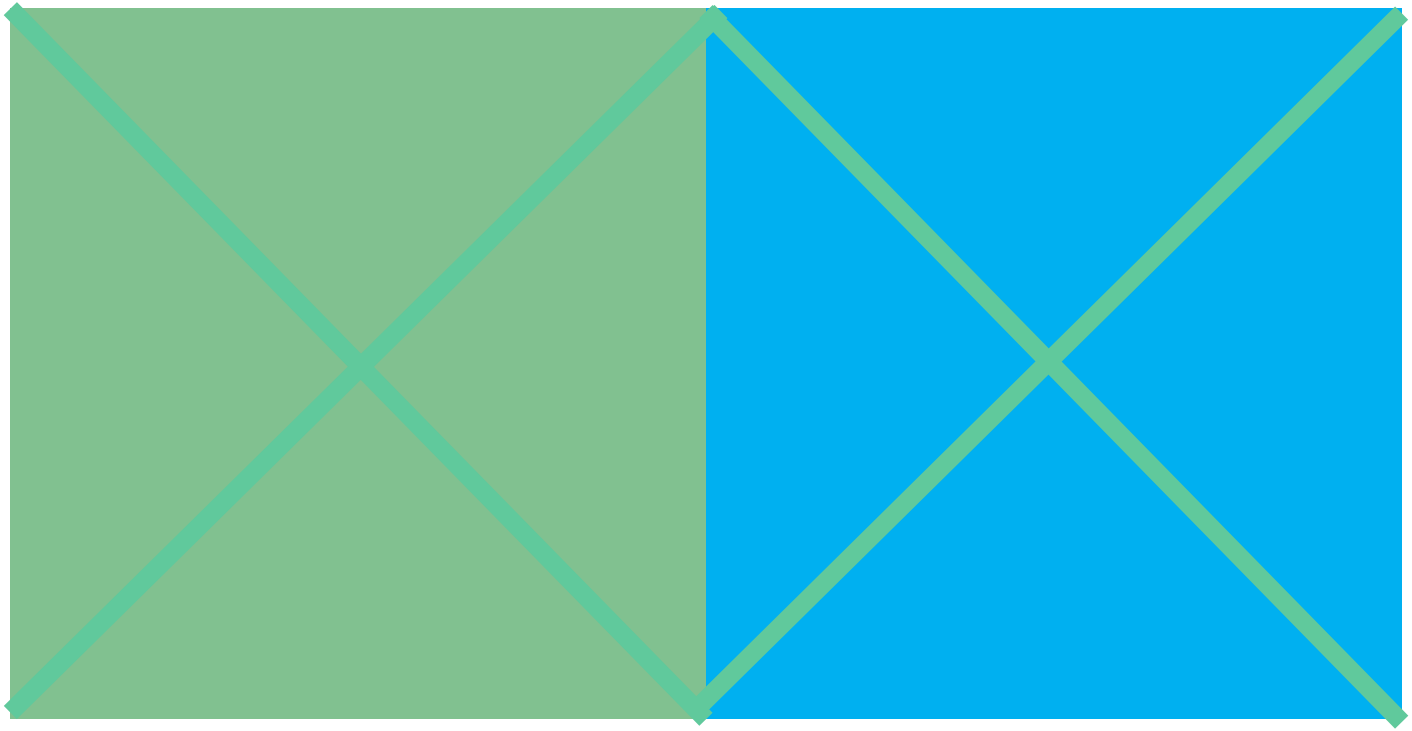
Unframed
Aligned

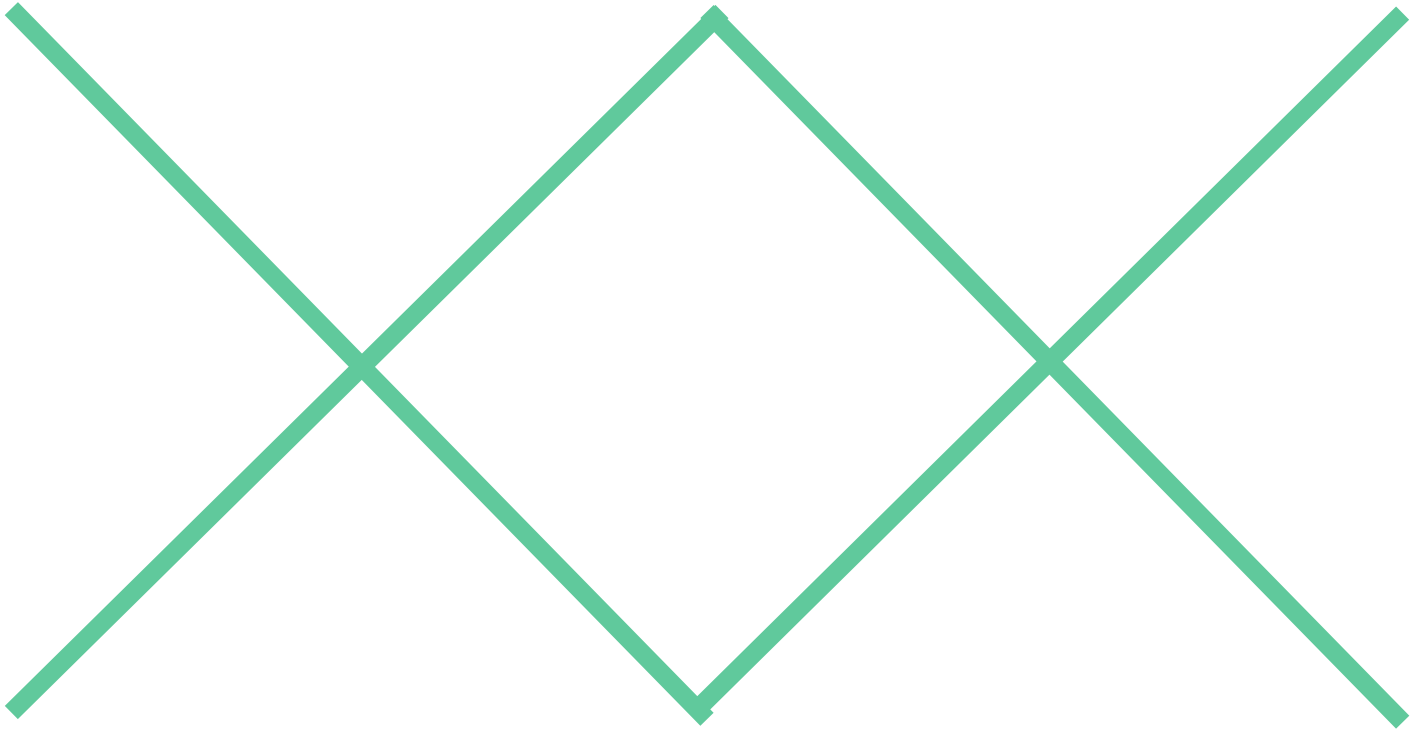

A
B


A
B

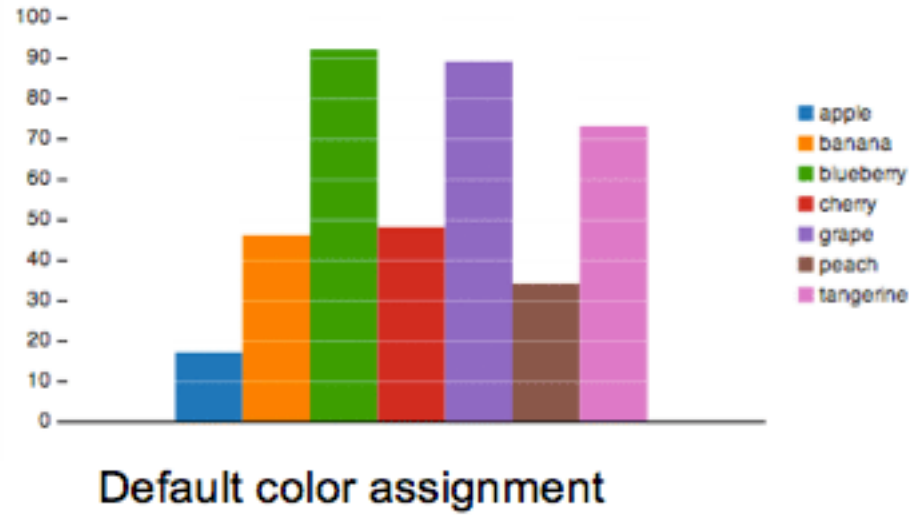




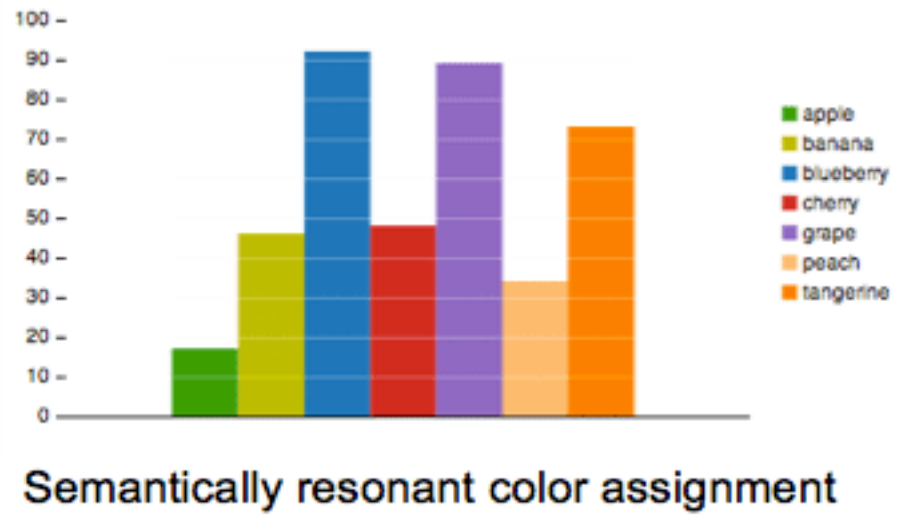




Semantically Resonant Colour Assignments



Default color assignment



Semantically resonant color assignment

Semantically-resonant colours improve speed on chart reading tasks compared to a standard palette

Stroop Effect

Stroop Effect: interference in the reaction time of a task

Green Red Blue Purple Blue Purple

Stroop Effect

Stroop Effect: interference in the reaction time of a task

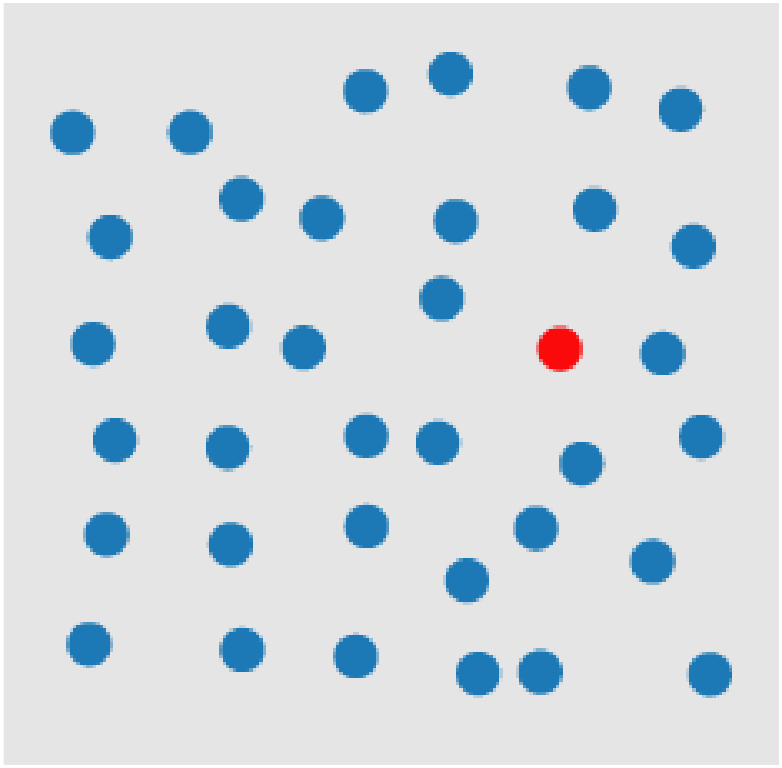
Green Red Blue Purple Blue Purple

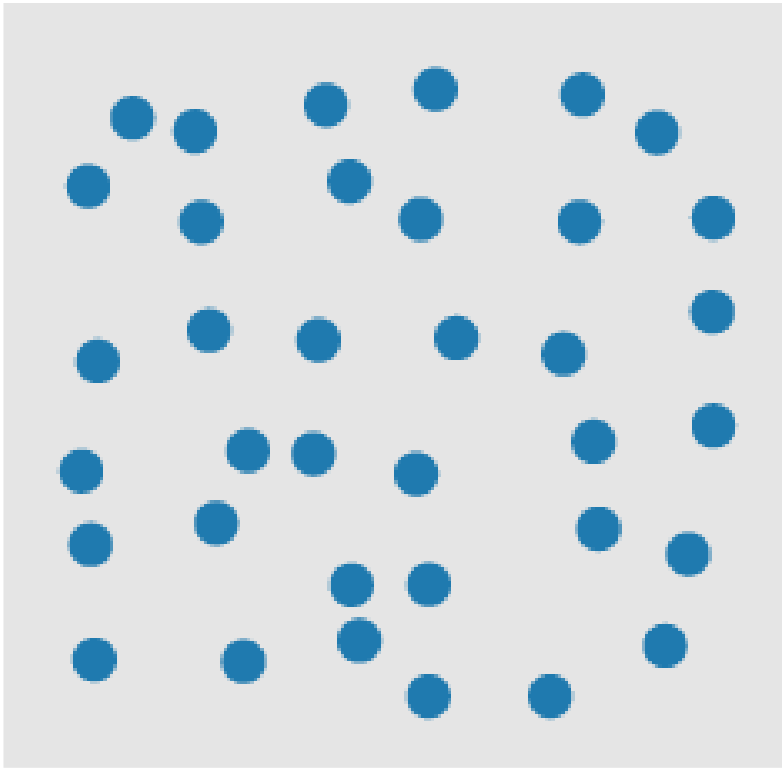
Blue Purple Red Green Purple Green

Stroop Effect

- brain's ability to recognize the colour of the word since the brain reads words faster than it recognizes colours
- colour recognition as opposed to reading a word, requires more attention
- recognizing colours is not an “automatic process" there is hesitancy to respond; whereas, the brain automatically understands the meaning of words as a result of habitual reading

Popout

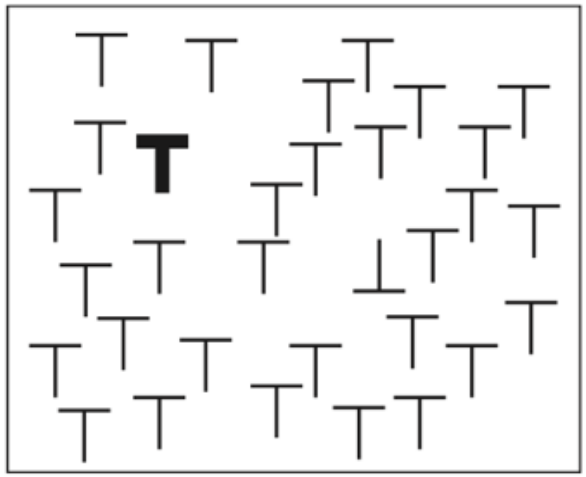




Popout

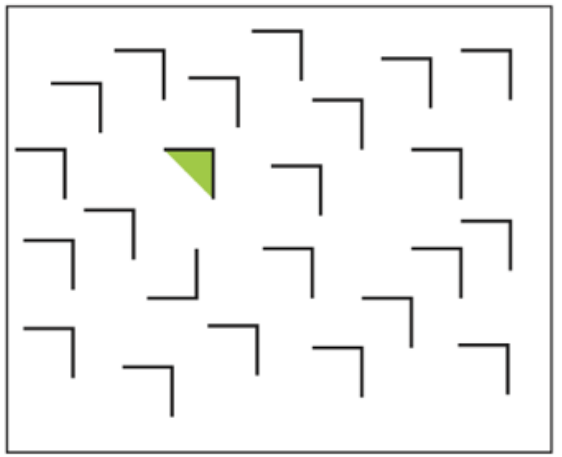
difficult

easy



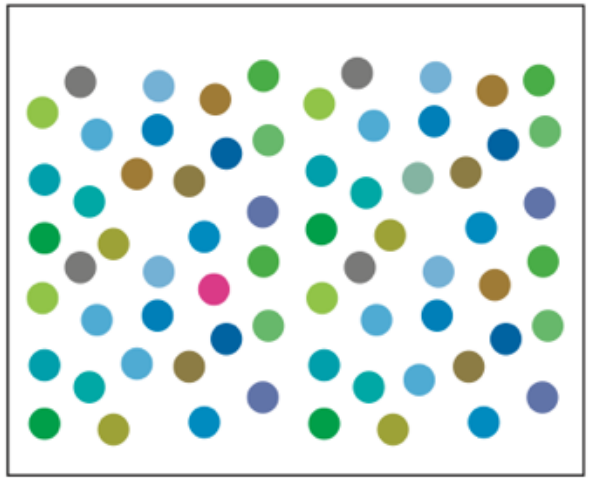
difficult

easy



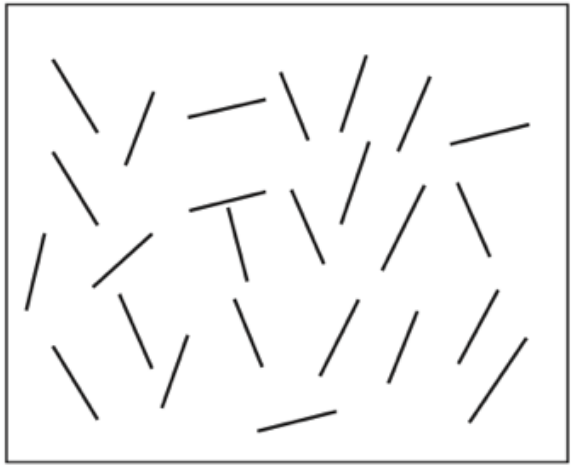
difficult

easy



difficult

easy



Popout

- We can easily see objects that are different in colour and shape, or that are in motion
- Use colour and shape sparingly to make the important information pop out

Properties of physical world

Human visual system assumes:

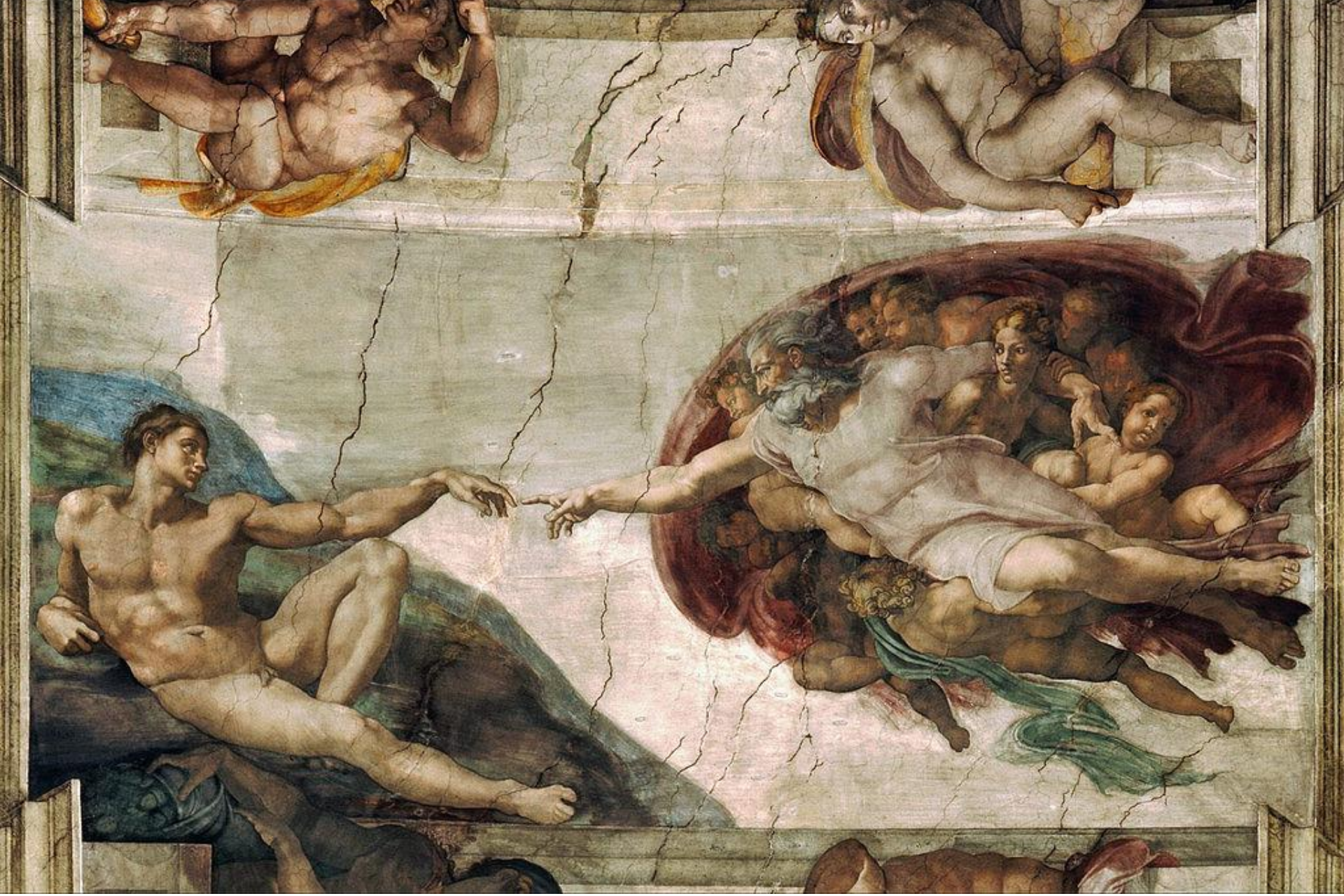
Definition: Objects have well-defined edges & surfaces

Appearance: Light travels in straight lines and reflects off surfaces in certain ways

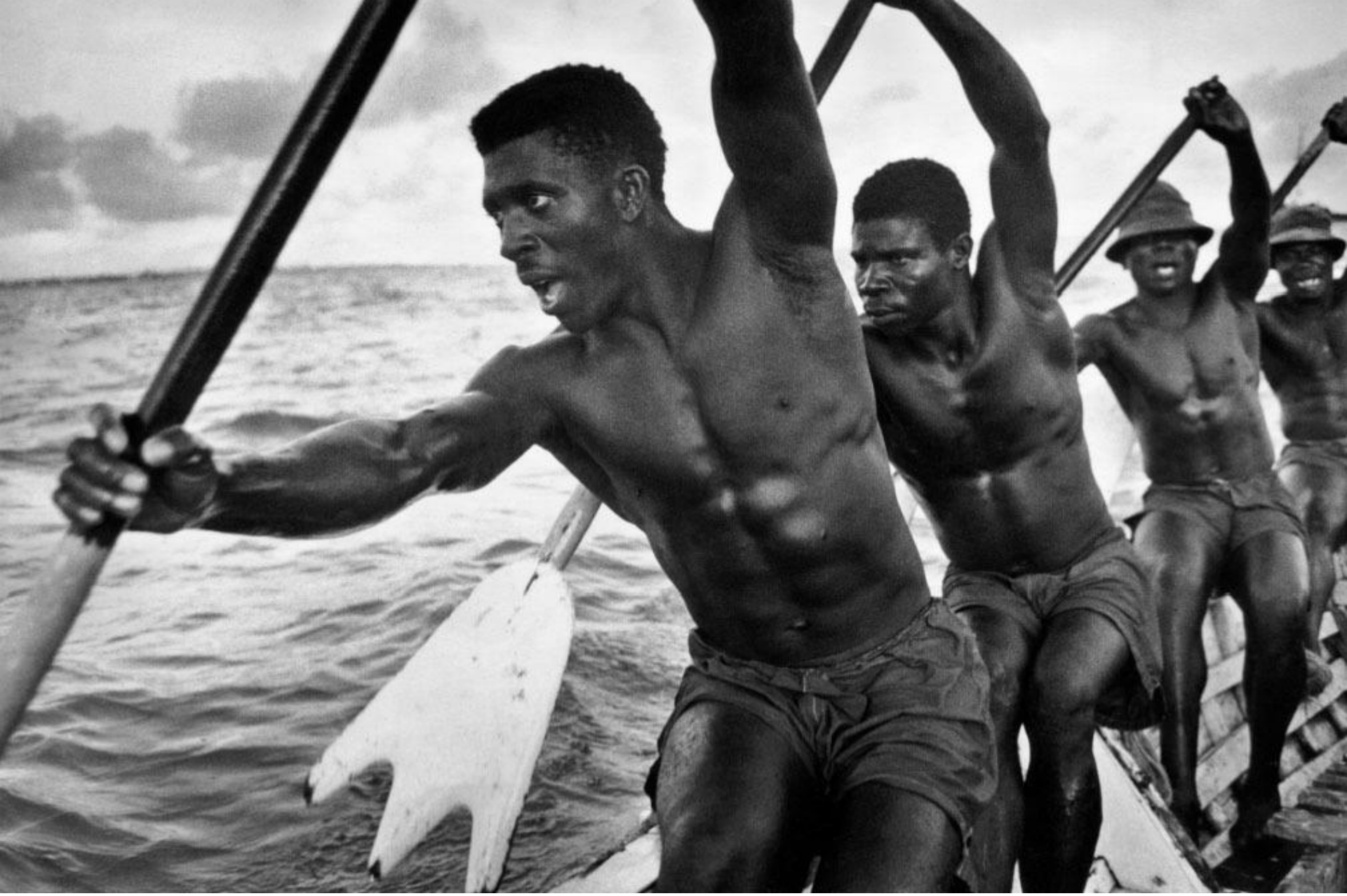
Temporal Persistence: Objects do not randomly appear/vanish

Gravity: Objects fall in predictable ways

Edward Weston, 1886-1958



The Creation of Adam by Michelangelo, fresco Sistine chapel, 1512



Marc Riboud, 1923-

Portrait of Adele Bloch-Bauer. 1907
by Guastav Klimt

Marc Riboud, 1923-

Marc Riboud, 1923-

Mughal style painting

Gestalt Psychology

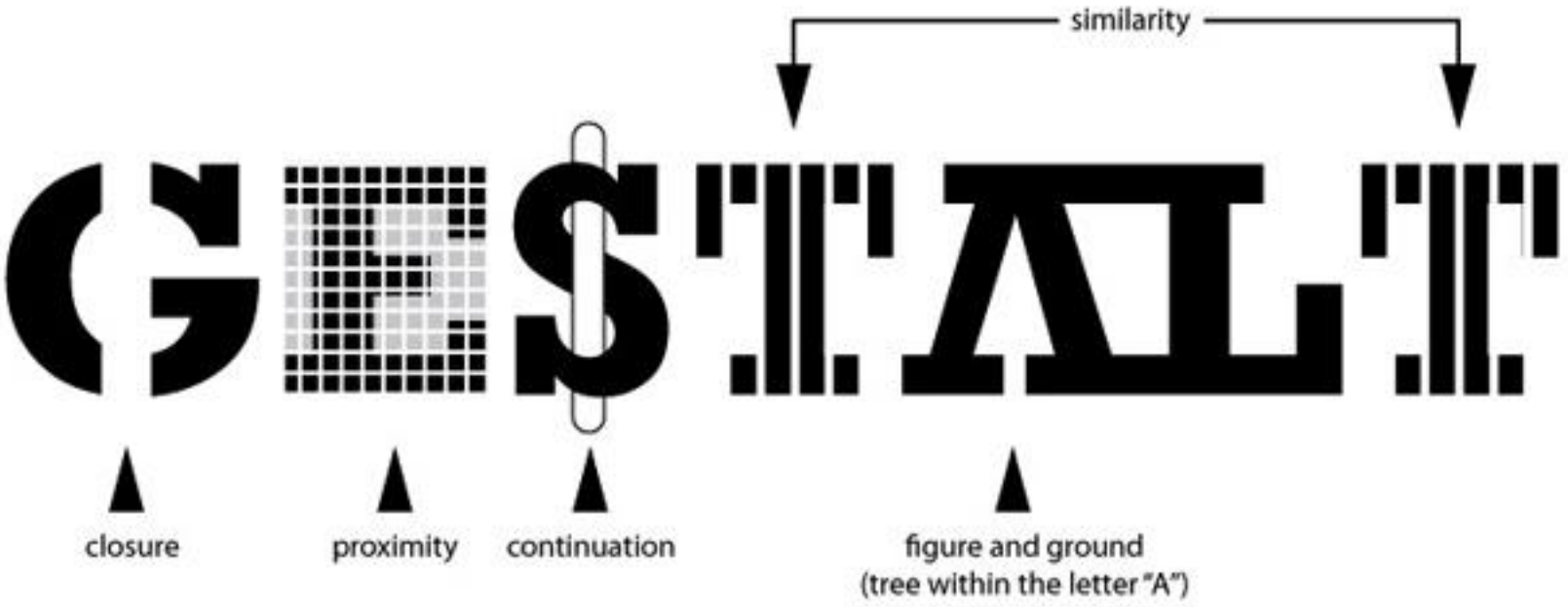
- Based on the work of Max Wertheimer
- Law of Prägnanz (pithiness, goodness)
- Things are organized spontaneously and assumed to be in the simplest configuration
- Perception as organised and structured wholes rather than the sum of their constituent parts
- Emergent properties, holism, and context

The gestalt laws of perceptual organization

- Emergence: The mind recognizes simple objects independent of rotation, translation, scale, deformations and lighting
- Invariance: The mind recognizes simple objects independent of rotation, translation, scale, deformations and lighting
- Proximity: Elements that are closer together are perceived to be more related than elements that are farther apart
- Similarity: Elements that are similar are perceived to be more related than elements that are dissimilar
- Enclosure: Elements that are enclosed by anything are perceived as belonging together
- Continuity: The mind continues visual, auditory, and kinetic patterns

The gestalt laws of perceptual organization

- Area: The mind perceives whole of a figure rather than the individual parts which make up the figure
- Closure: The mind perceives a set of individual elements as a single, recognizable pattern
- Symmetry: The mind perceives objects as symmetrical shapes that form around their center
- Figure-ground: Elements are perceived as either figures (objects of focus) or ground (the rest of the perceptual field)
- Connection: Elements that are connected (e.g. by a line) are perceived as belonging together
- Common-fate: Elements that share a common fate (e.g., moving in the same direction) as belonging together


similarity
closure
proximity
continuation
figure and ground
(tree within the letter "A")


Norway


IBM


III-51
M.C.E.
M.C. Escher No. 48/50
eigendruk


yoga australia

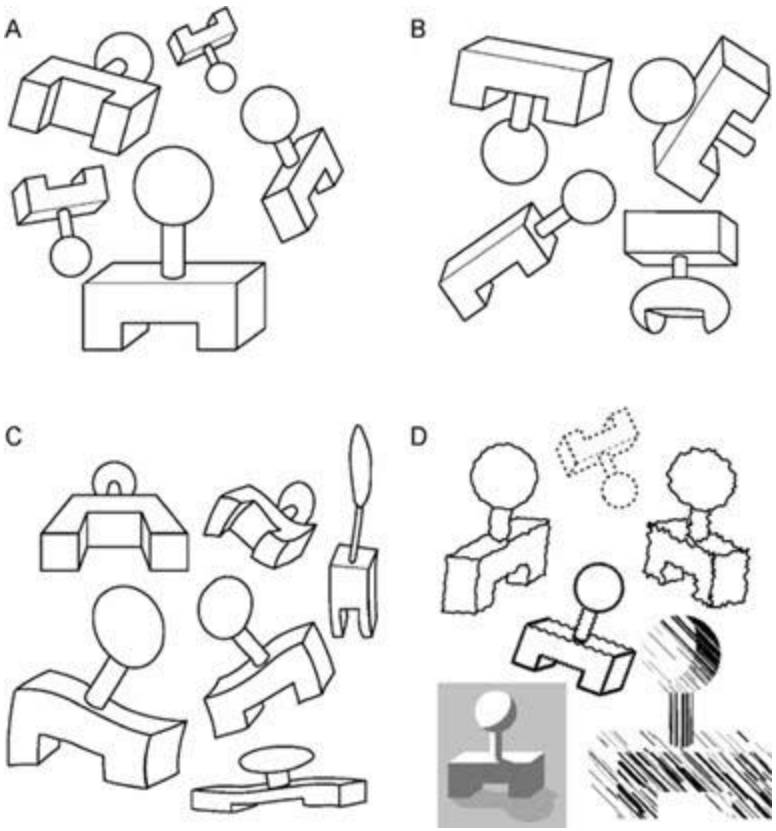

PIANO FOREST


ZIP

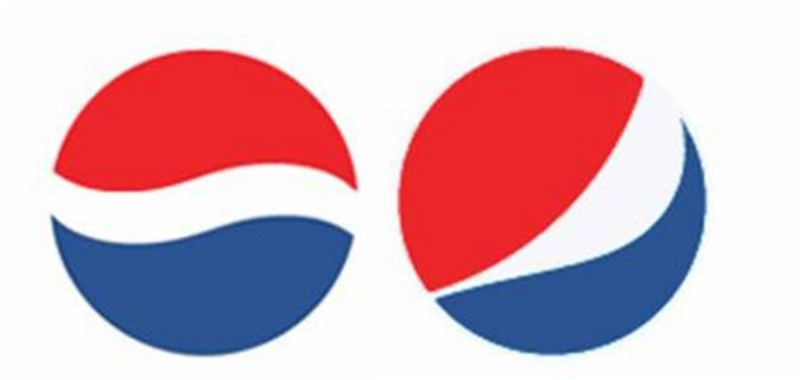

Eight

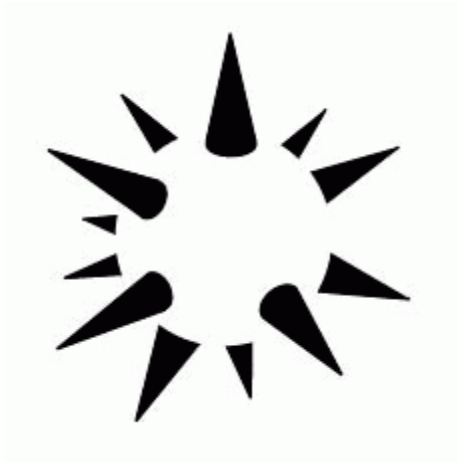

MOSLEEP


Unilever


A
B
C
D


Formula 1





Hope for African
Children Initiative

1. Tell us about yourself...

My Name: First Name | Owoh

Gender: - Select One -

Birthday: - Select Month - | Day | Year

I live in: United States

Postal Code:

2. Select an ID and password

Yahoo! ID and Email: @ yahoo.com | Check

Password | Password Strength

Re-type Password

3. In case you forget your ID or password...

Alternate Email

1.Security Question: - Select One -

Your Answer

2.Security Question: - Select One -

Your Answer