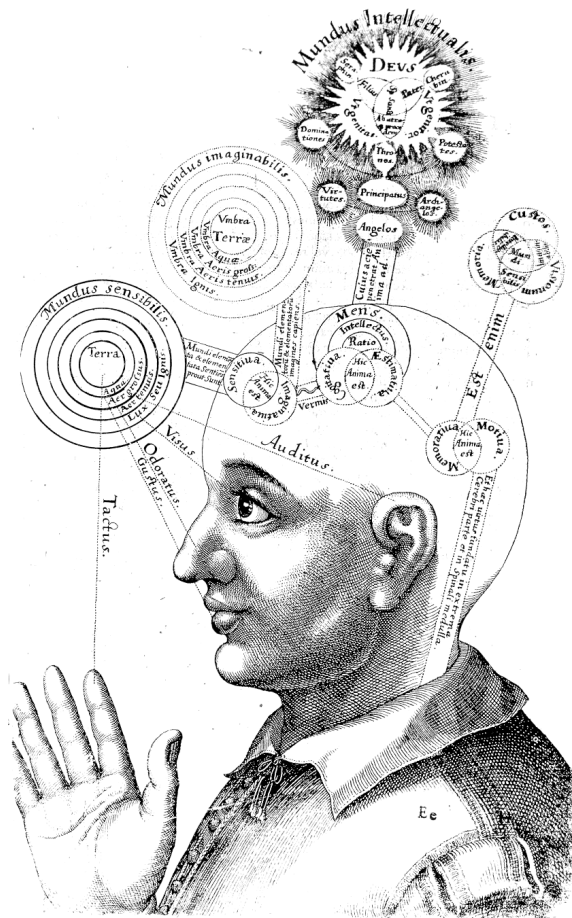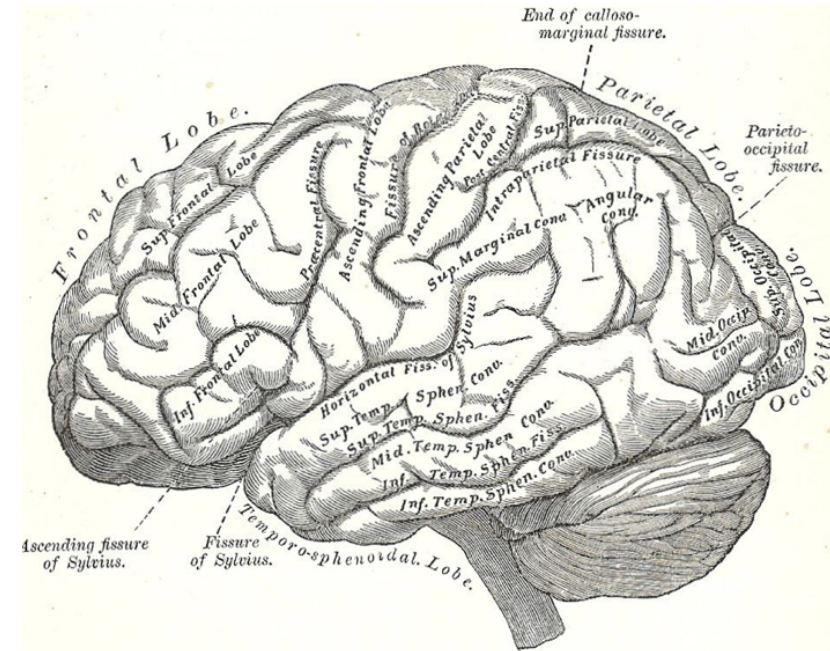# 2 VISION AND PERCEPTION

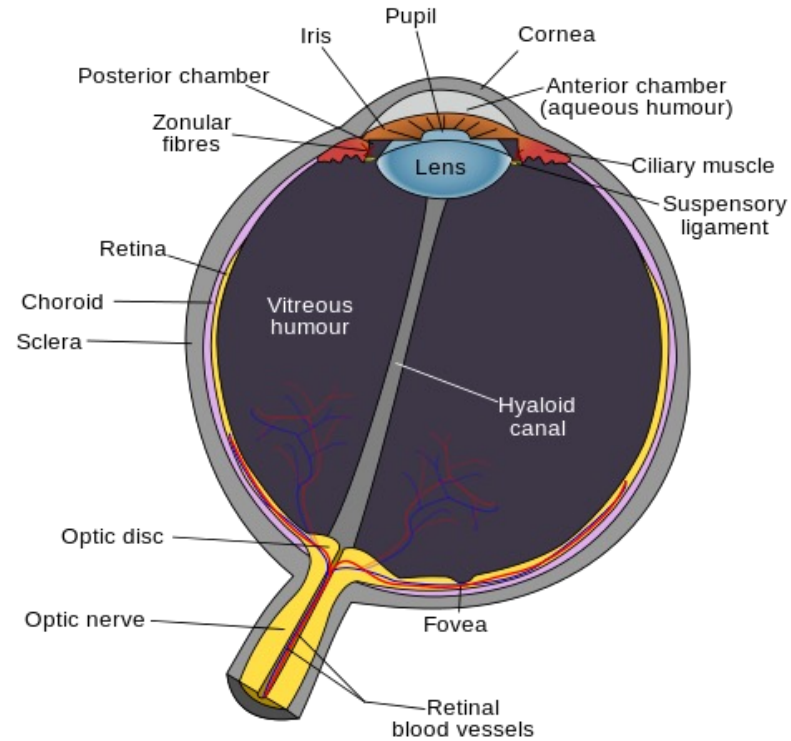S. Rinzivillo – rinzivillo@isti.cnr.it

70% of human sensors are located in the eyes
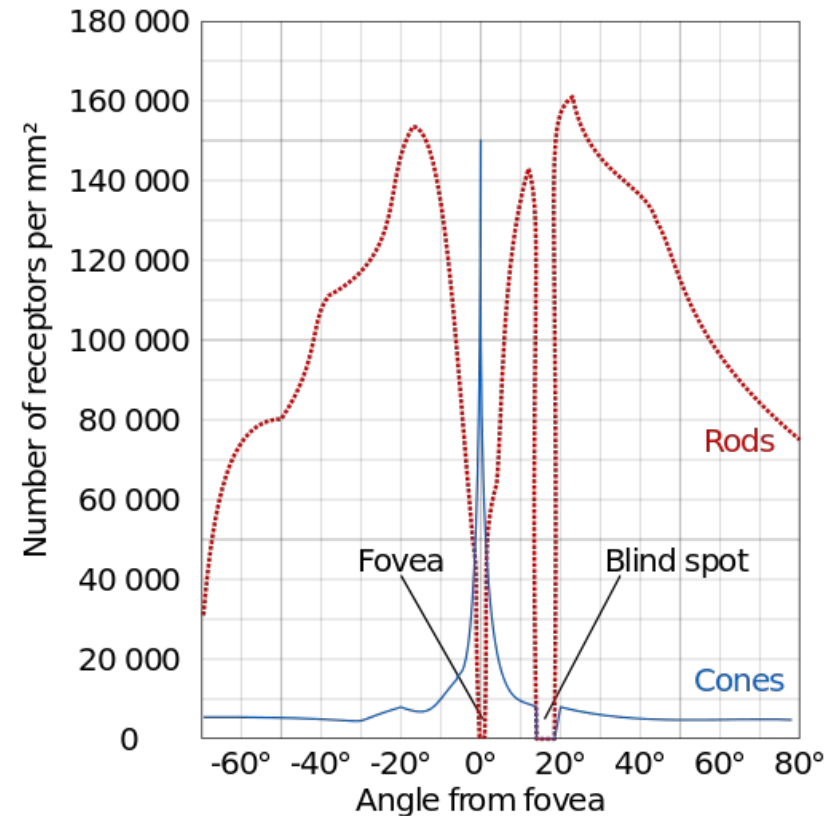

50% of brain processes are devoted to image processing

HUMAN EYE

"Schematic diagram of the human eye en" by Rhcastilhos - Schematic_diagram_of_the_human_eye_with_English_annotations.svg. Licensed under Public Domain via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Schematic_diagram_of_the_human_eye_en.svg#mediaviewer/File:Schematic_diagram_of_the_human_eye_en.svg
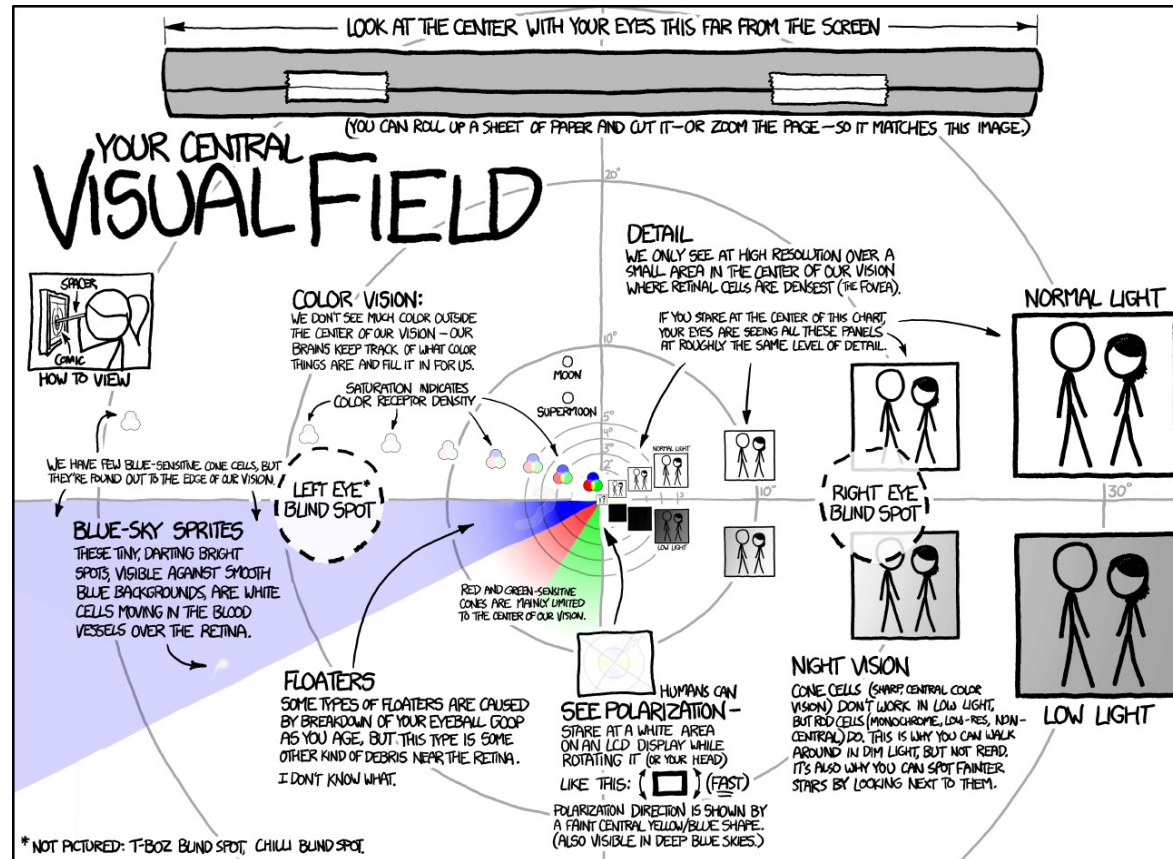
PHOTO RECEPTOR CELLS

- Two types of light sensitive cells
  - Rod Cells (~120M)
    - Provide low-light vision
    - Peripheral vision
    - Almost no role in color vision
  - Cone cells (~6M)
    - Provide normal vision
    - Three sub-types of cells
      - Sensitivity to different light wavelengths
      - Used for colored vision

"Human photoreceptor distribution" by Cmglee - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Human_photoreceptor_distribution.svg#mediaviewer/File:Human_photoreceptor_distribution.svg

VISION RESOLUTION
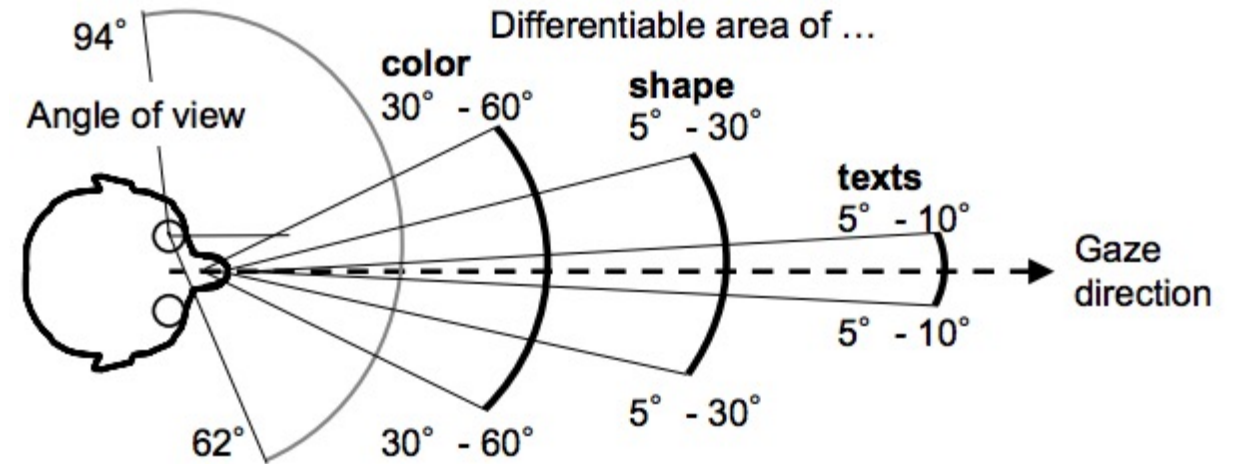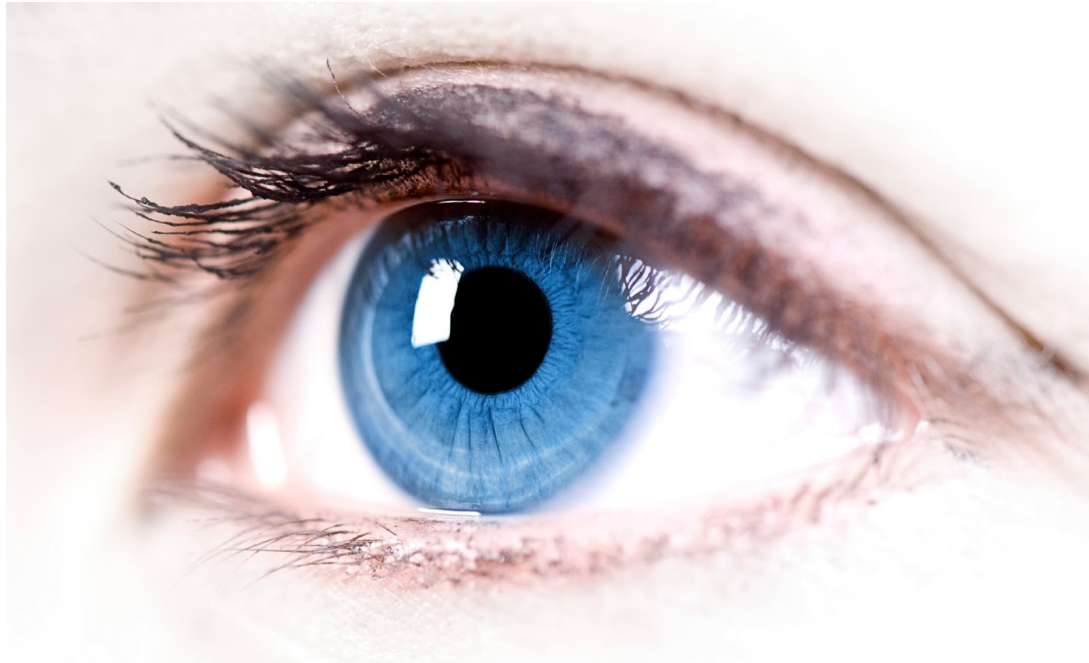

http://xkcd.com/1080/

VISION RESOLUTION

- Fovea yields the highest resolution (normal light)

- Fovea occupies around 15° of visual field

- Highest resolution is provided by *fovea centralis* (around 1°)

Komatsubara, A. Human error, Maruzen co. ltd. 2008. (In japanese)

PERCEPTION AND COGNITION

VS

THE GOBBLING GLUTTONS

ONCE UPON A TIME, WALDO
EMBARKED UPON A FANTASTIC
JOURNEY. FIRST, AMONG A
THRONG OF GOBBLING GLUTTONS,
HE MET WIZARD WHITEBEARD, WHO
COMMANDED HIM TO FIND A SCROLL AND
THEN TO FIND ANOTHER AT EVERY STAGE OF
HIS JOURNEY. FOR WHEN HE HAD FOUND
12 SCROLLS, HE WOULD UNDERSTAND THE
TRUTH ABOUT HIMSELF.

IN EVERY PICTURE FIND WALDO, WOOF (BUT
ALL YOU CAN SEE IS HIS TAIL), WENDA, WIZARD
WHITEBEARD, ODLAW, AND THE SCROLL. THEN
FIND WALDO'S KEY, WOOF'S BONE (IN THIS SCENE
IT'S THE BONE THAT'S NEAREST TO HIS TAIL),
WENDA'S CAMERA, AND ODLAW'S BINOCULARS.

THERE ARE ALSO 25 WALDO-WATCHERS, EACH OF
WHOM APPEARS ONLY ONCE SOMEWHERE IN
THE FOLLOWING 12 PICTURES. AND ONE MORE
THING! CAN YOU FIND ANOTHER CHARACTER,
NOT SHOWN BELOW, WHO APPEARS ONCE IN
EVERY PICTURE EXCEPT THE LAST?

HIGH RESOLUTION VISION

- HiRes vision is limited to a narrow angle of field vision

- Eyes move to scan an object in order to expose the image on the fovea
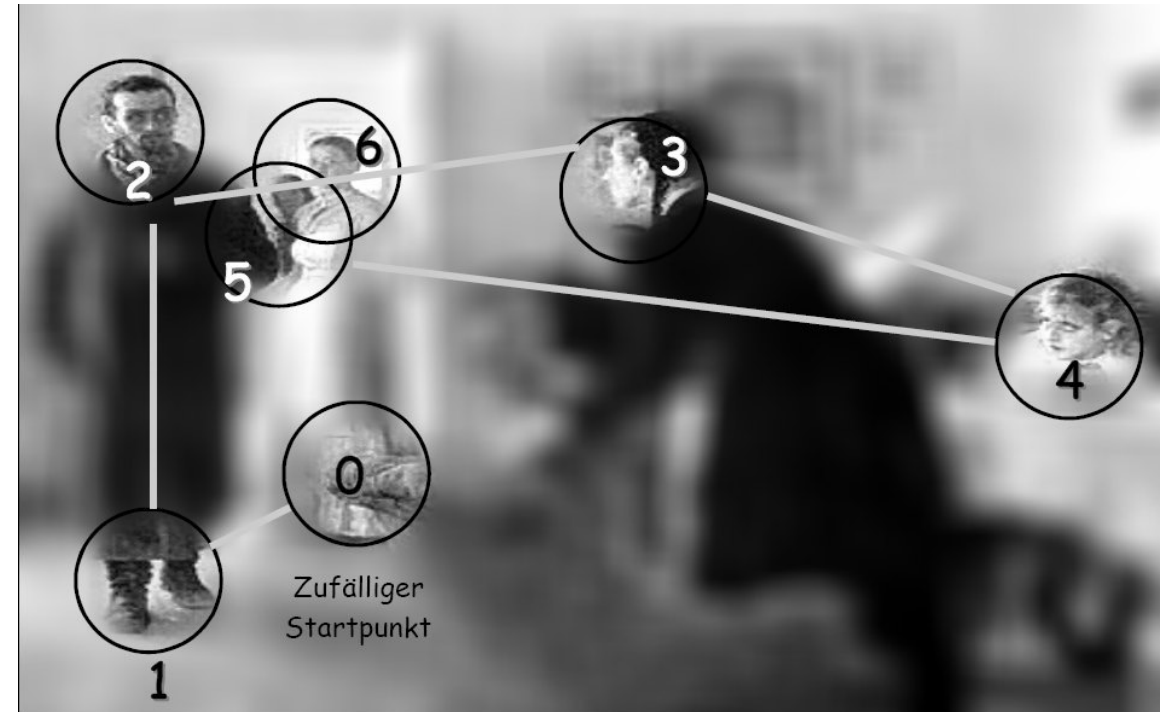
- The movement of eyes is not regular or linera

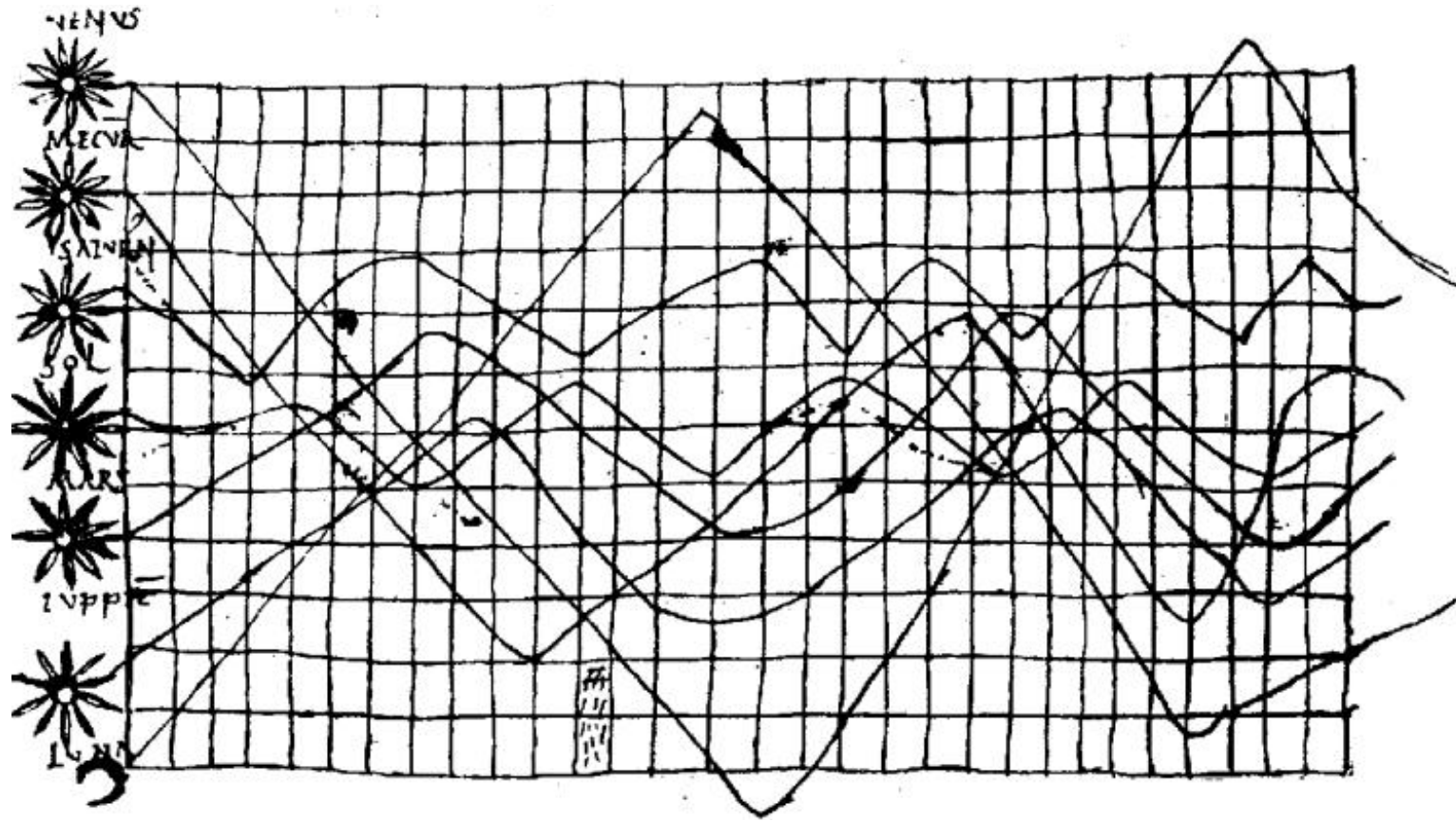Bild 11: Foveale Ergänzung durch die ersten 6 Fixationen (nach Daten von *Yarbus,1967*)

"Vision 2 secondes" by Hans-Werner Hunziker. Licensed under CC BY 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Vision_2_secondes.jpg#/media/File:Vision_2_secondes.jpg
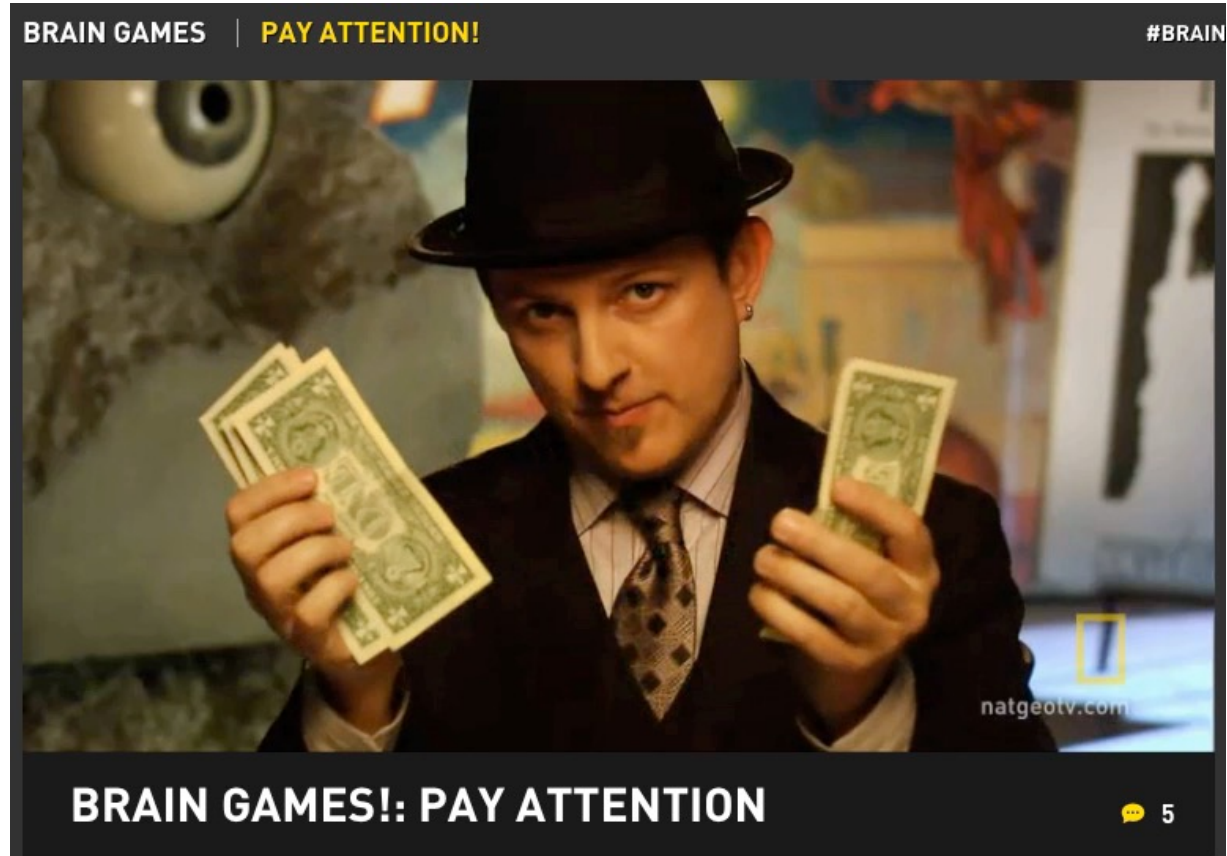
EYE TRACKING FOR DESIGN

PATTERNS, PATTERNS EVERYWHERE

TOP-DOWN ATTENTION

http://channel.nationalgeographic.com/brain-games/videos/brain-games-pay-attention/

TEST– HOW MANY 3S?

1258965168765132168943213
5463479654321320354968413
2068798417184529529287149
2174953178195293926546831
3546516509898554684982984

1258965168765132168943213
5463479654321320354968413
2068798417184529529287149
2174953178195293926546831
3546516509898554684982984

1258965168765132168943213
5463479654321320354968413
2068798417184529529287149
2174953178195293926546831
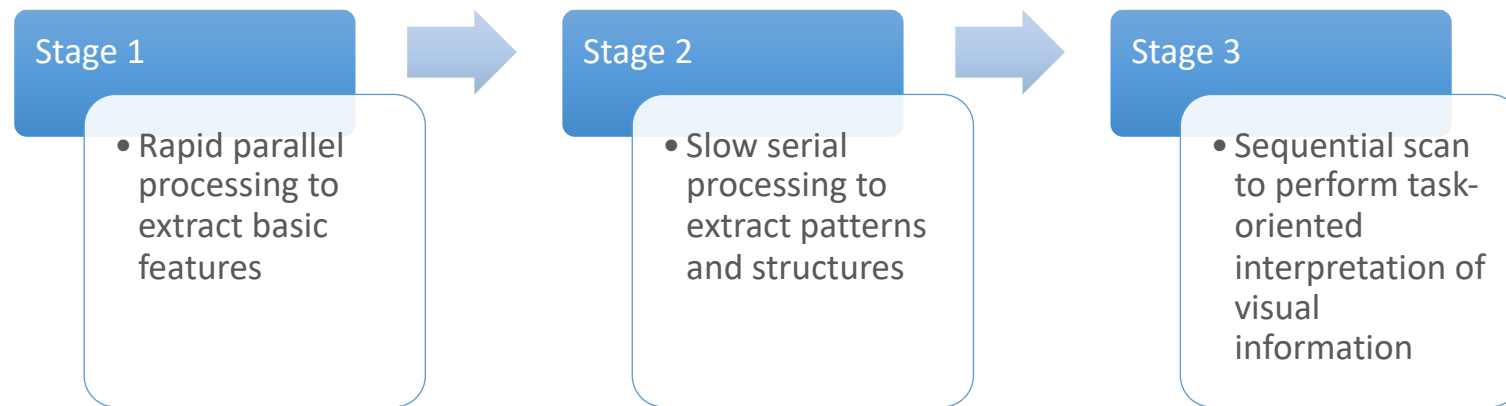3546516509898554684982984

Is there a "3"?
Are there more than 5
occurrences of "3"?
How many "3"?

VISUAL PERCEPTION

- Early visual processing takes places without our conscious intervention

- Graphs that convey information at this level allow the observer to be more efficient in decoding

Stage 1	Stage 2	Stage 3
• Rapid parallel processing to extract basic features	• Slow serial processing to extract patterns and structures	• Sequential scan to perform task-oriented interpretation of visual information

Ware Colin. Information Visualization, third edition. 2004

VISUAL COGNITION

- At second stage, the observer is required to consciously analyze the image/scene

- At this level, the observer can perform higher level reasoning
  - This object is larger than the other one
  - This street slope is lower than the previous

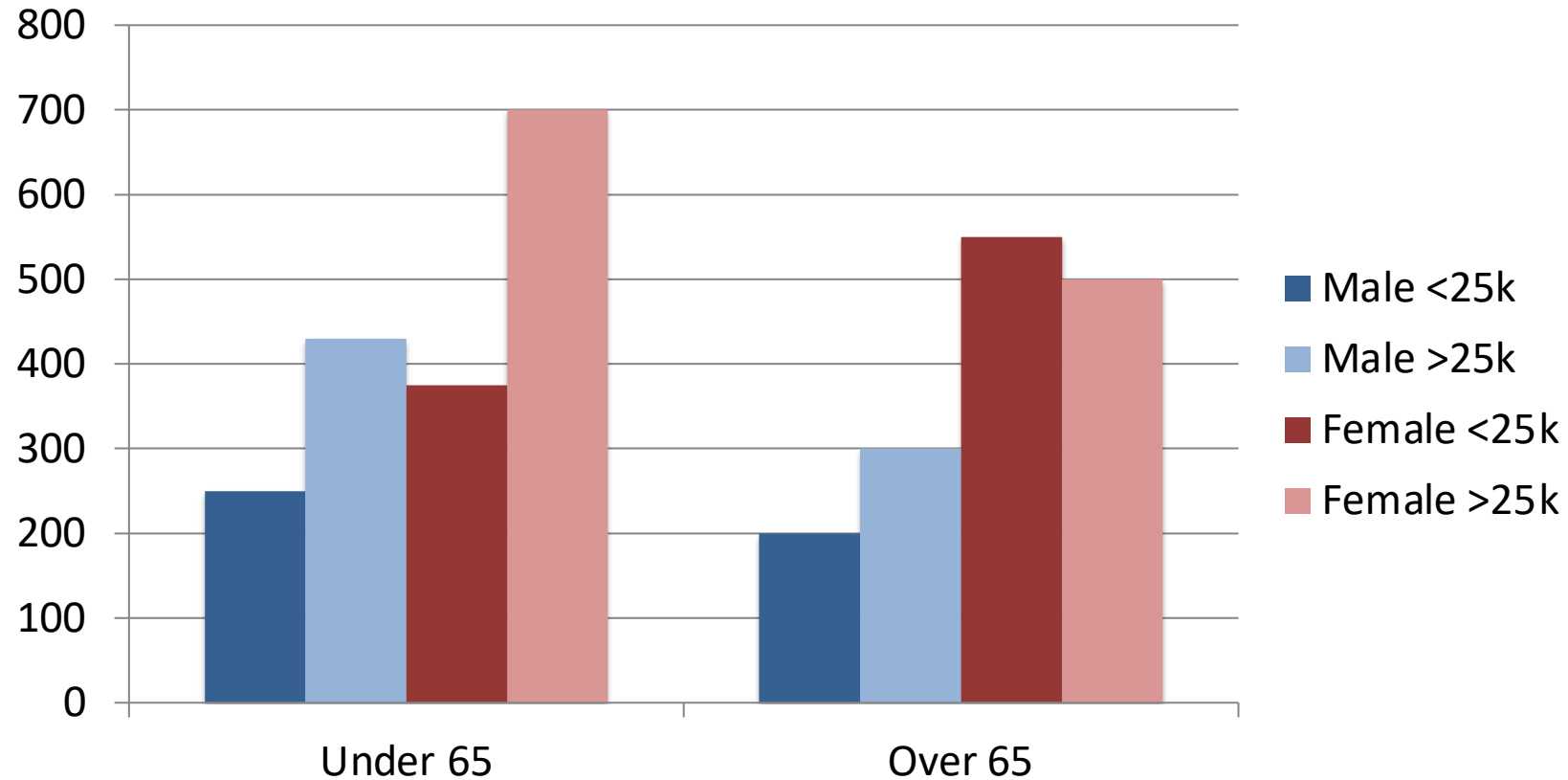# TEST – CHOLESTEROL, AGE, AND GENDER

TEST – CHOLESTEROL, AGE, AND GENDER

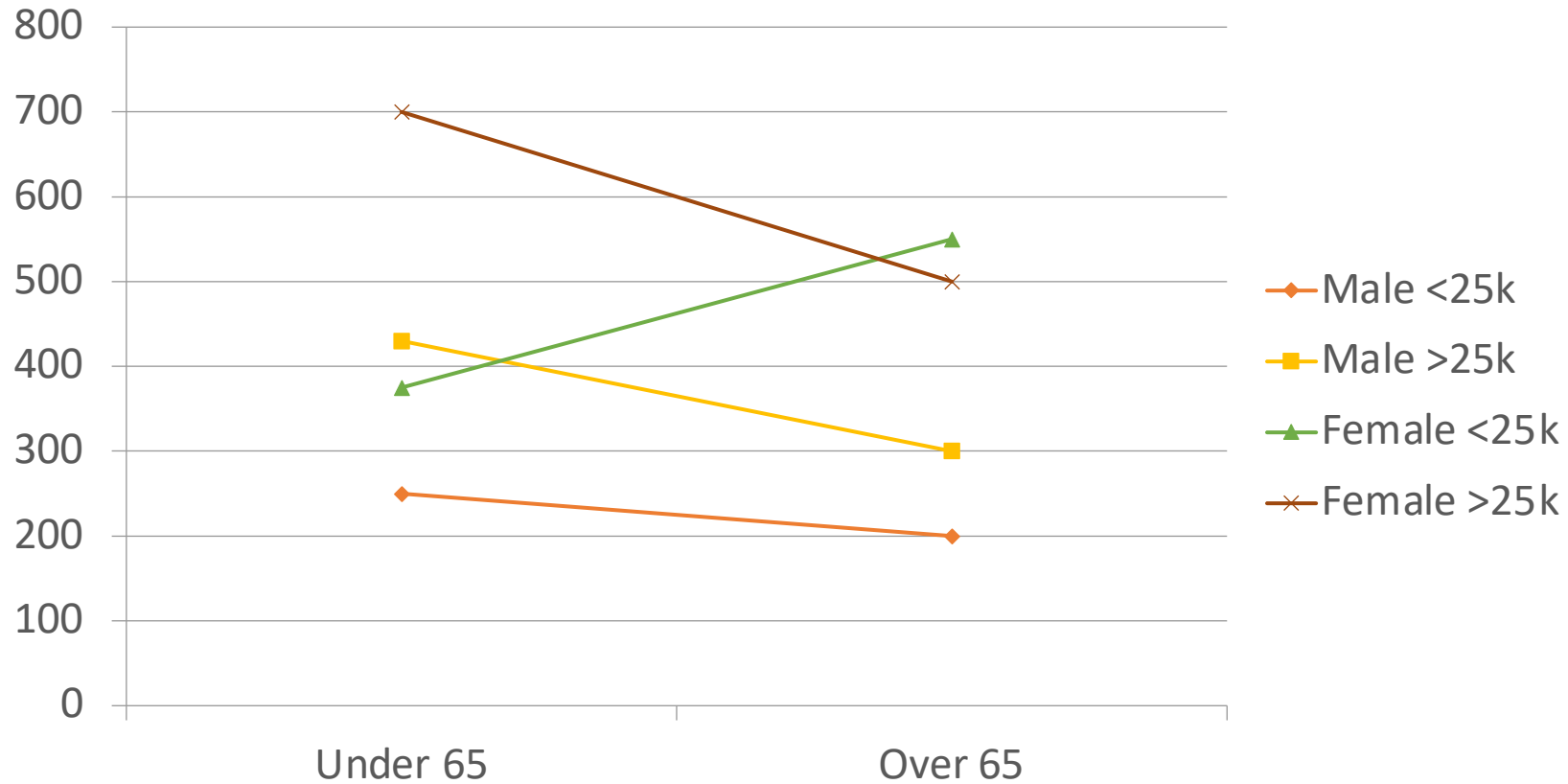Which relation between gender or income level groups?

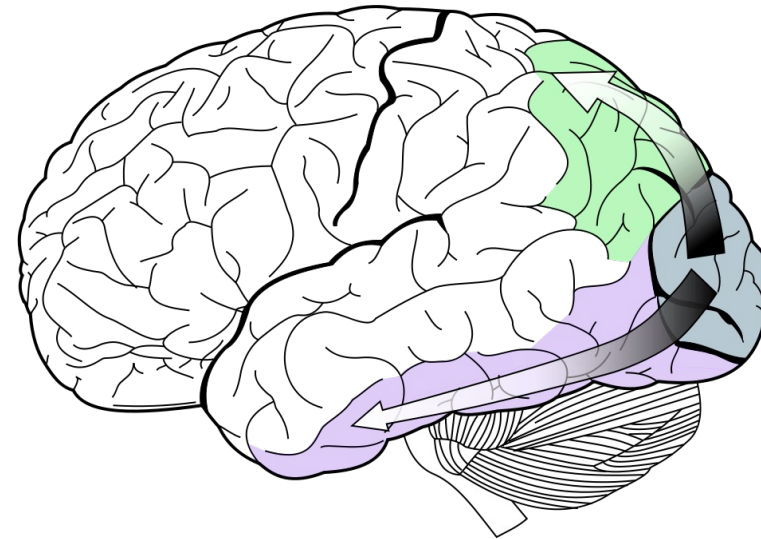| Income Group	Males		Females	
	Under 65	65 and Over	Under 65	65 and Over
0 – 24,999$	250	200	375	550
25,000$ +	430	300	700	500

GAME – VISUAL SOLUTION (1)

GAME – VISUAL SOLUTION (2)

PERCEPTION

- Perception: the way in which something is regarded, understood, or interpreted (Oxford Dictionary)

- Electrical signals from vision system are interpreted and organized by the brain

- Two-stream hypothesis:
  - Ventral Stream
  - Dorsal Stream

The dorsal stream (green) and ventral stream (purple) are shown. They originate from a common source in the visual cortex
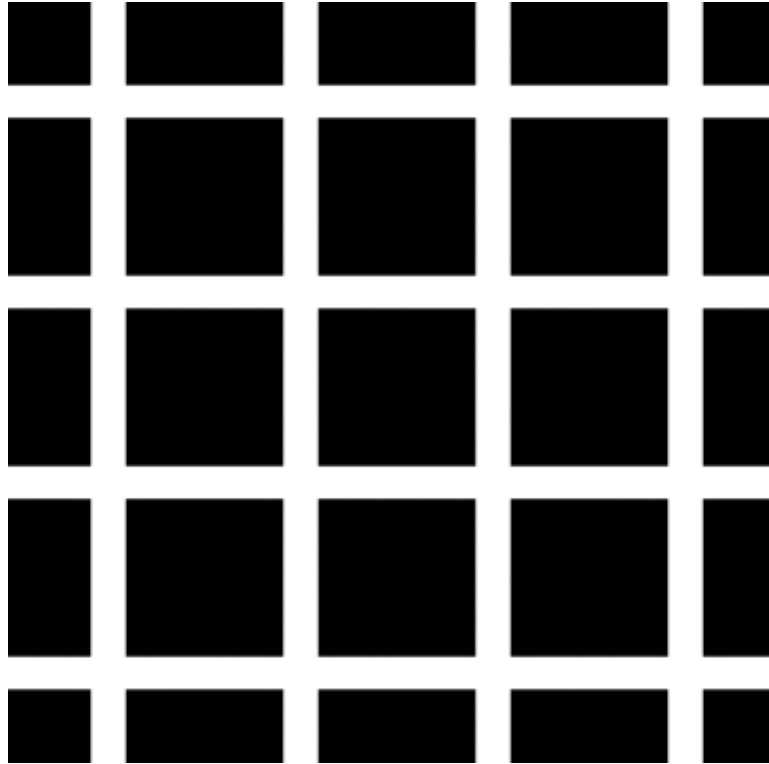

"Ventral-dorsal streams" by Selket - I (Selket) made this from Image:Gray728.svg. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Ventral-dorsal_streams.svg#/media/File:Ventral-dorsal_streams.svg
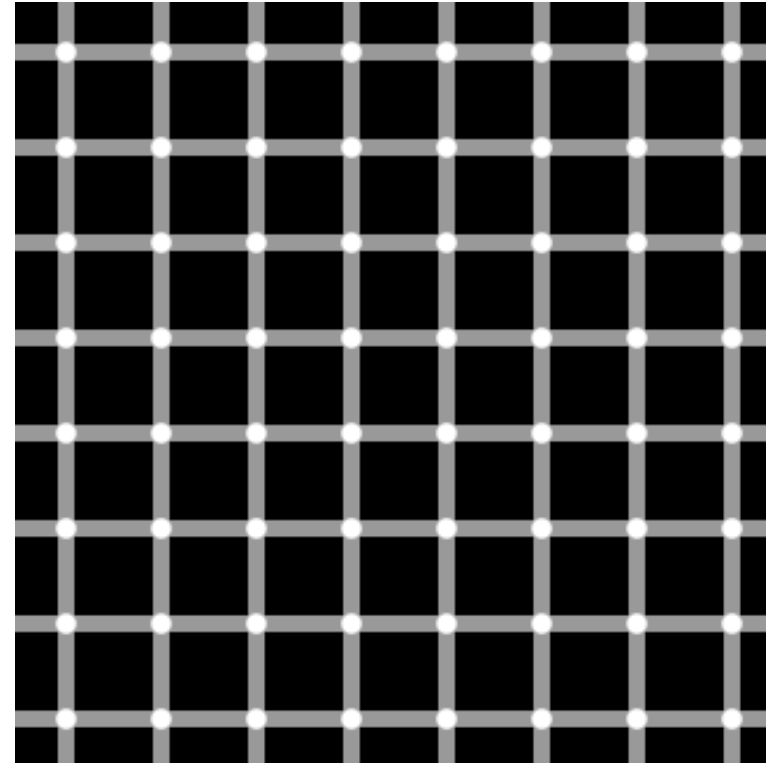
VISUAL ILLUSIONS

- Perceived images differ from measurable reality
  - Optical Illusions
  - Physiolagical illusions (Mach Bands)
  - Cognitive illusions
    - Arise by unconsciuos inferences based on assumptions about real world
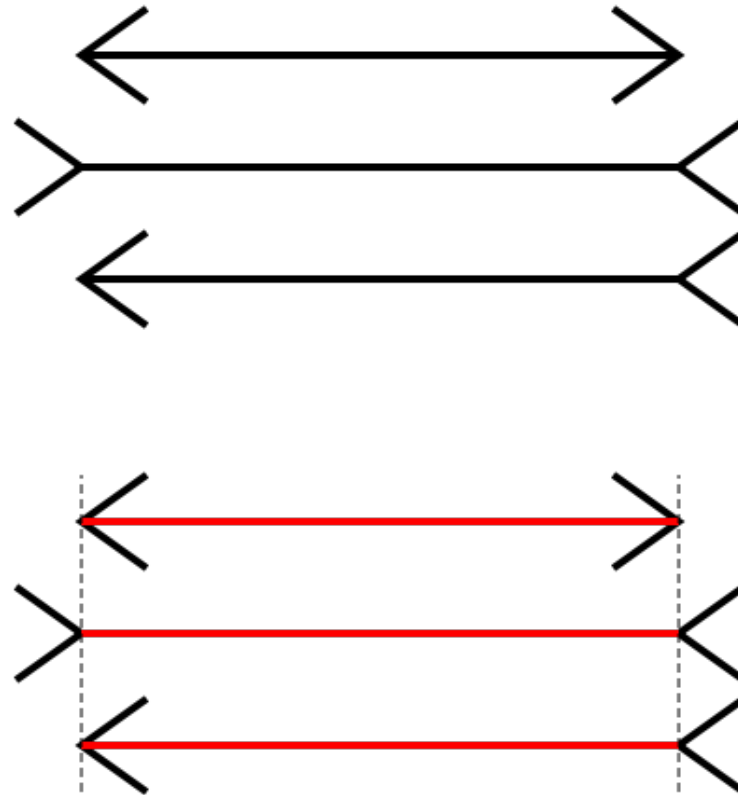
PHYSIOLOGICAL GRID ILLUSION

"HermannGrid" by en:User:Famousdog -
http://en.wikipedia.org/wiki/File:HermannGrid.gif. Licensed under
Public Domain via Wikimedia Commons -
http://commons.wikimedia.org/wiki/File:HermannGrid.gif#/media/
File:HermannGrid.gif

"Grid illusion" by User:Tó campos1 - Own work. Licensed under
Public Domain via Wikimedia Commons -
http://commons.wikimedia.org/wiki/File:Grid_illusion.svg#/media/
File:Grid_illusion.svg
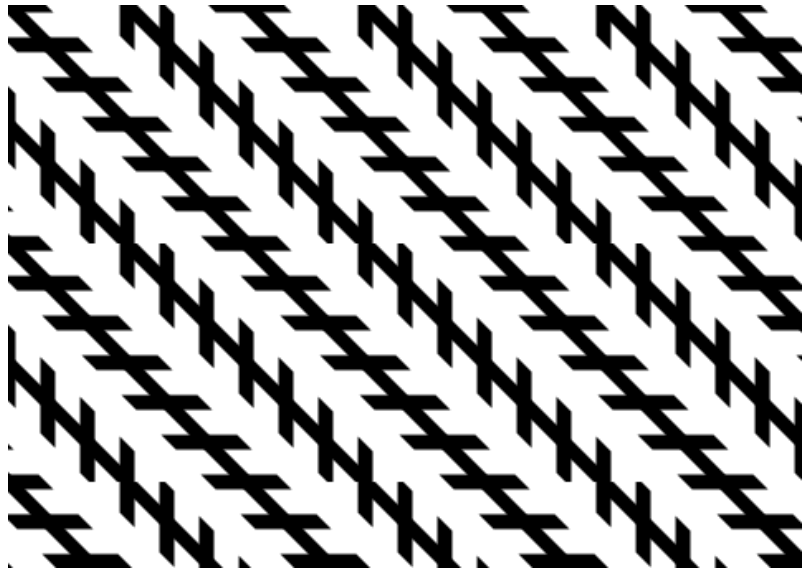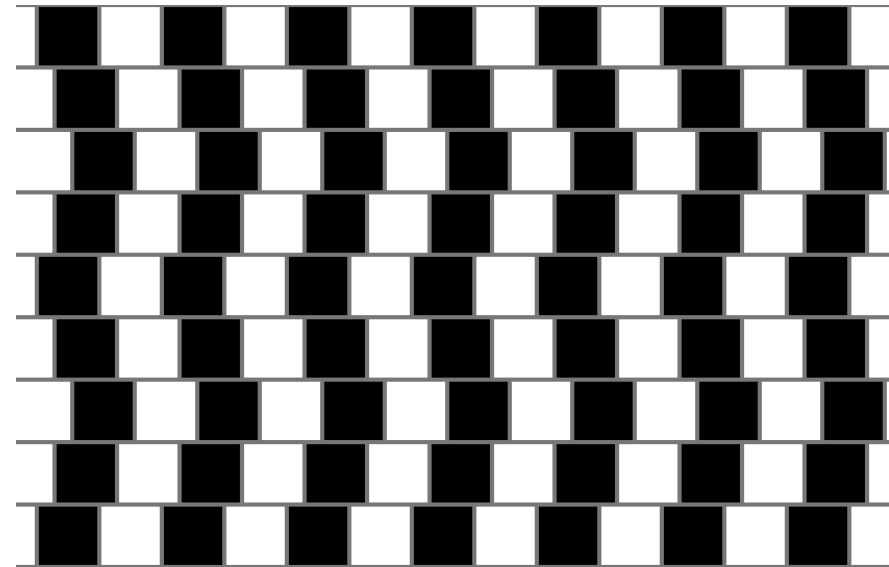
LENGTHS DISTORTION

Müller-Lyer illusion

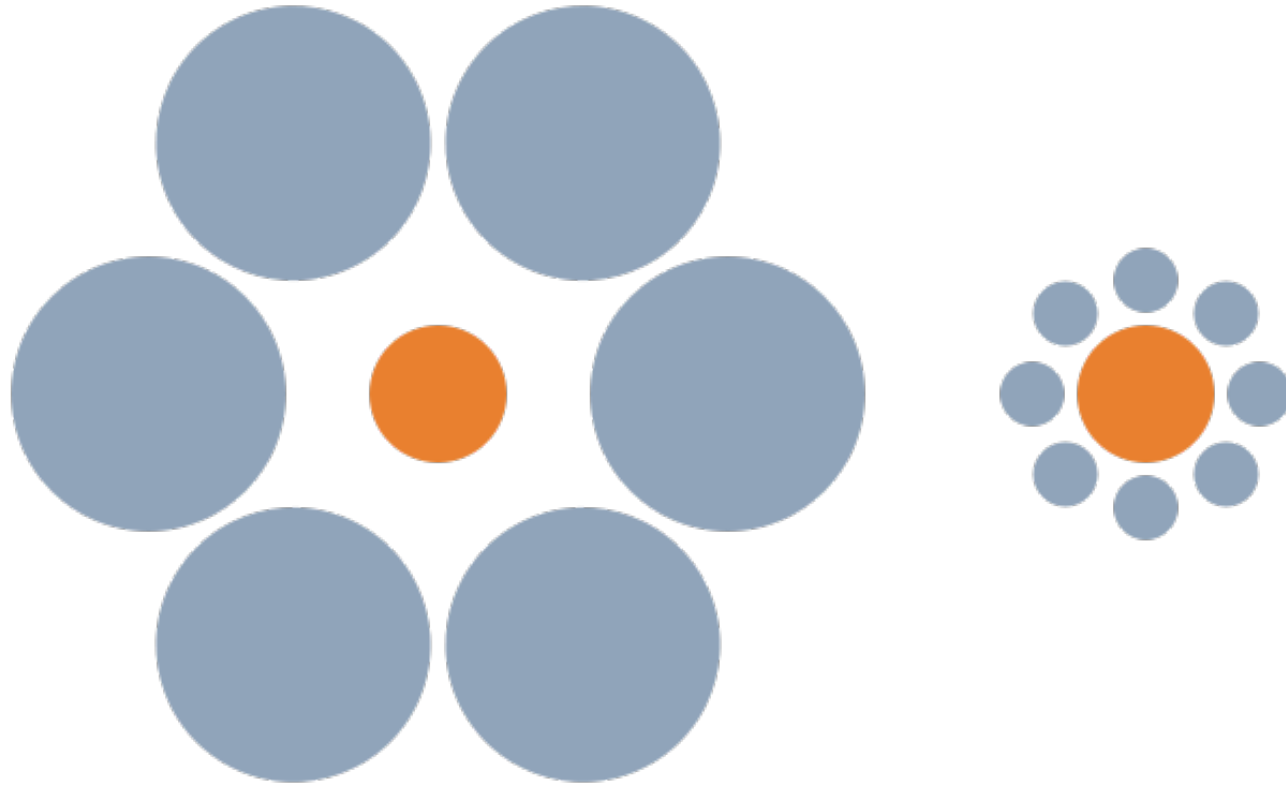# ORIENTATION ILLUSION

Zöllner illusion

"Zollner illusion" by Fibonacci - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Zollner_illusion.svg#/media/File:Zollner_illusion.svg
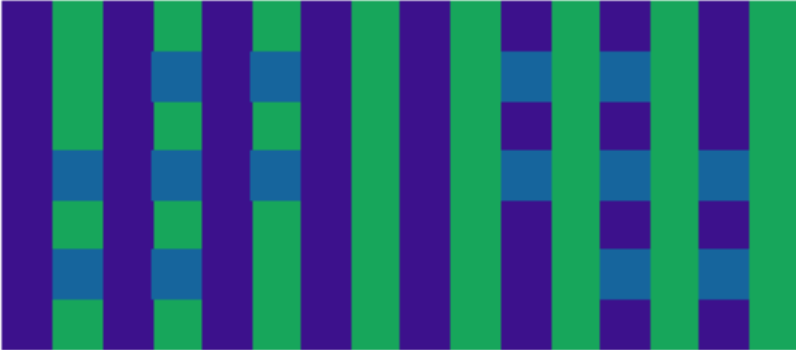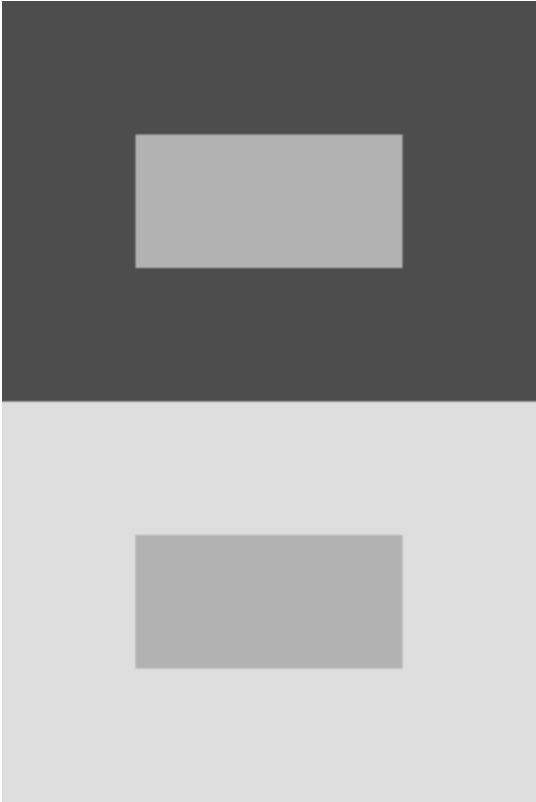

"Café wall" by Fibonacci - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Caf%C3%A9_wall.svg#/media/File:Caf%C3%A9_wall.svg
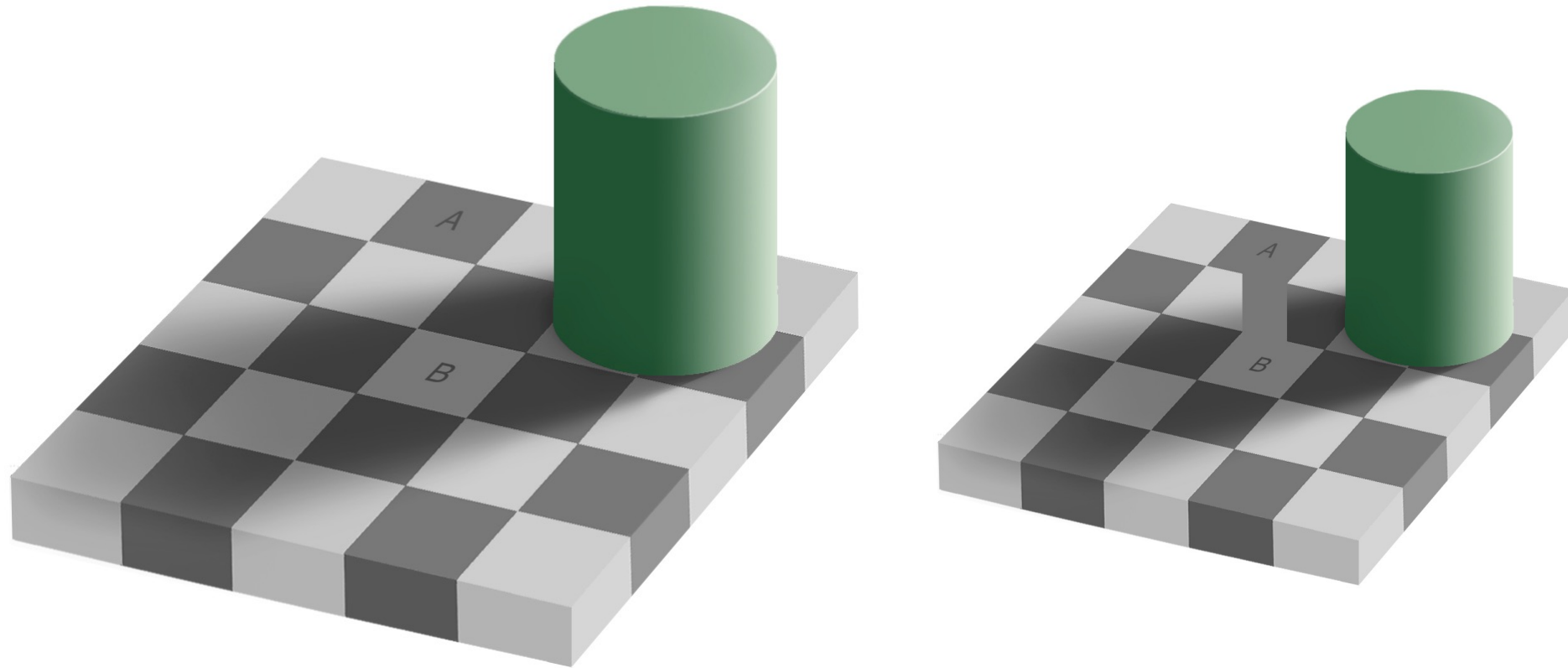
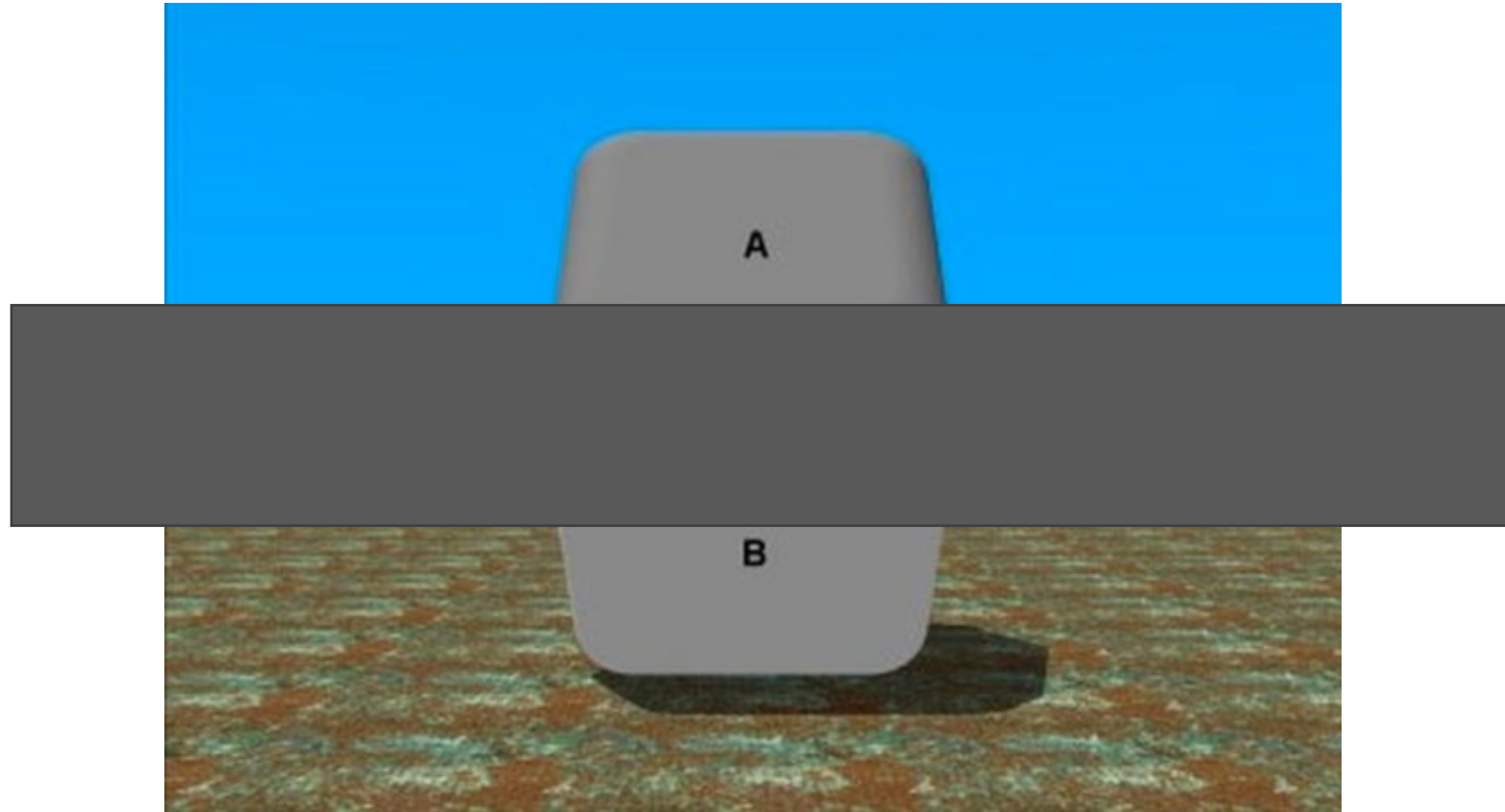# EBBINGHAUS ILLUSION

SIMULTANEOUS CONTRAST

ADELSON'S ILLUSION

"Grey square optical illusion" by Original by Edward H. Adelson, this file by Gustavb - File created by Adrian Pingstone, based on the original created by Edward H. Adelson. Licensed under Copyrighted free use via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Grey_square_optical_illusion.PNG#/media/File:Grey_square_optical_illusion.PNG

CONTEXT

TAKEAWAY MESSAGES

- Limiations of human vision system

- Exploits message brodcast at early stage of perception: preattemptive perception

- Avoid possible causes of biases