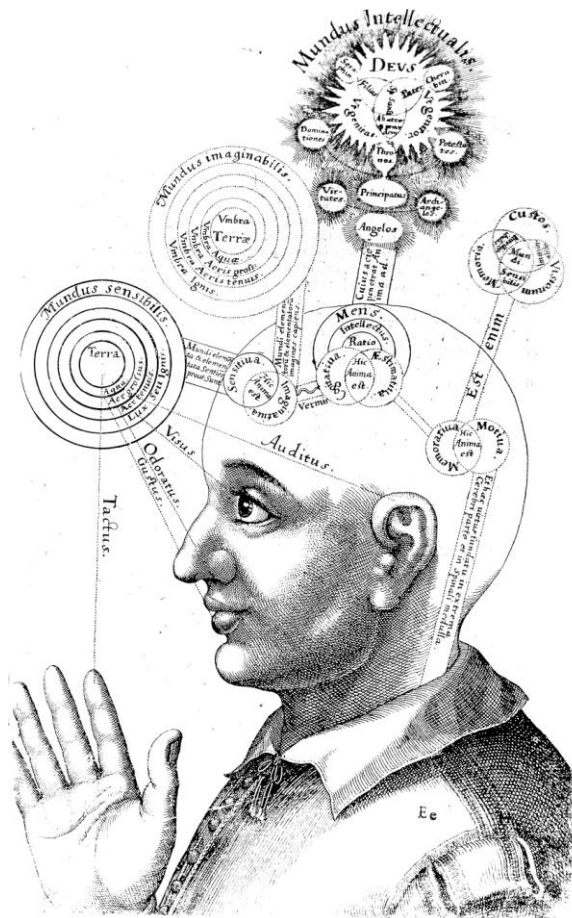
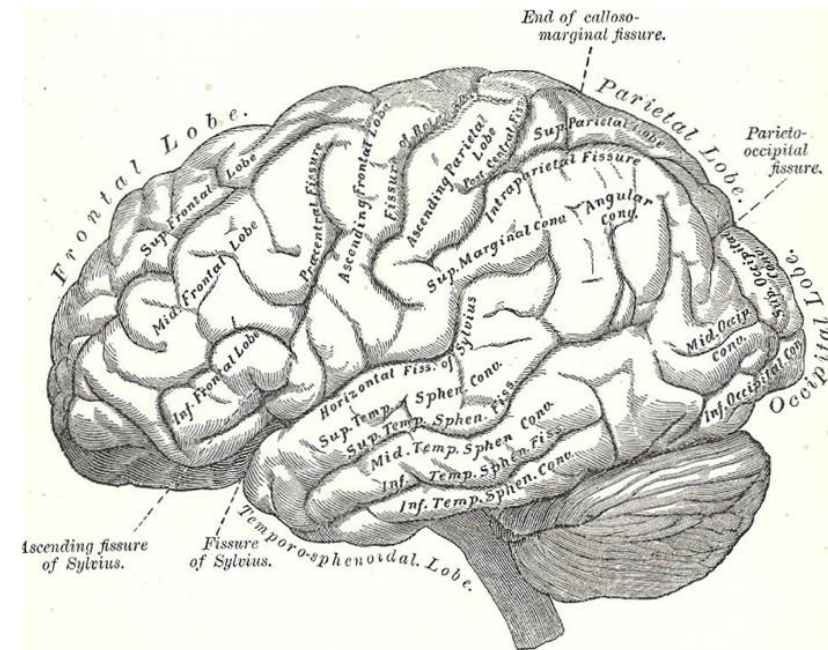


# 2 VISION AND PERCEPTION

S. Rinzivillo – [rinzivillo@isti.cnr.it](mailto:rinzivillo@isti.cnr.it)

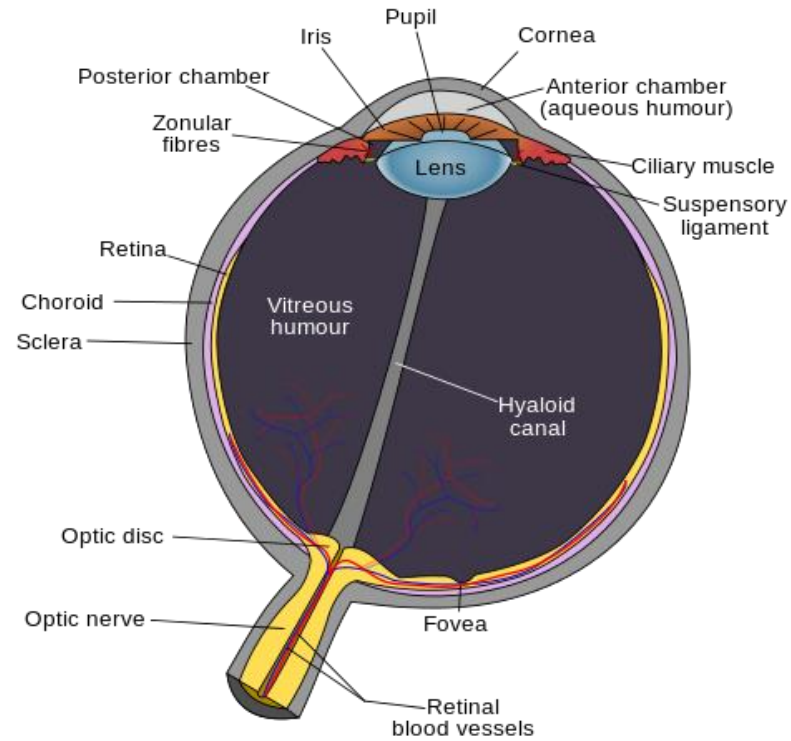


70% of human sensors are located in the eyes



50% of brain processes are devoted to image processing

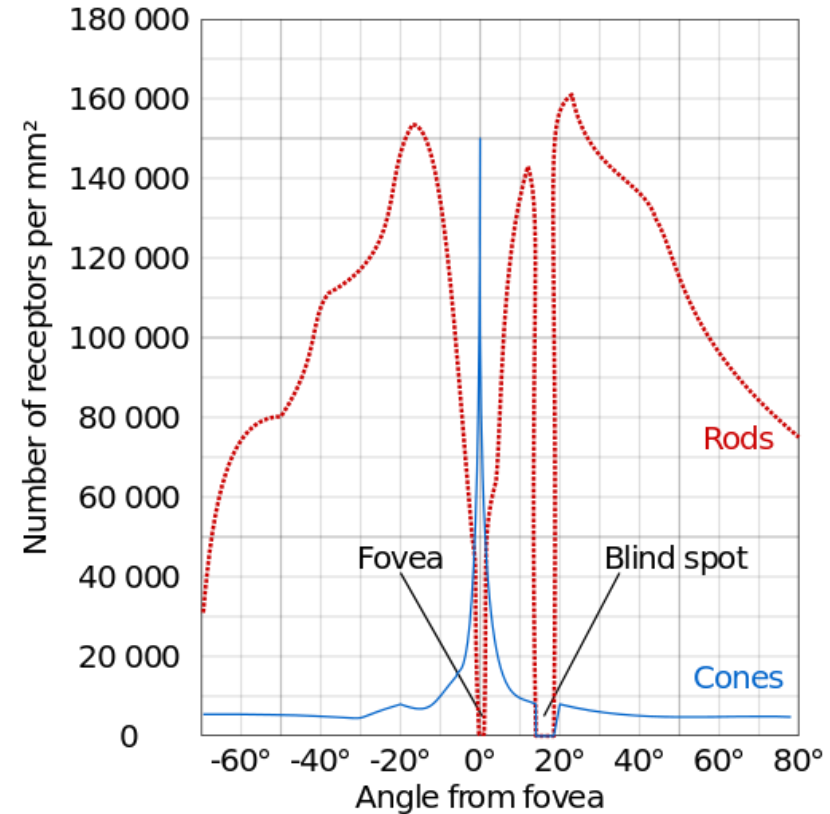
# HUMAN EYE



"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](http://commons.wikimedia.org/wiki/File:Schematic_diagram_of_the_human_eye_en.svg#mediaviewer/File:Schematic_diagram_of_the_human_eye_en.svg)

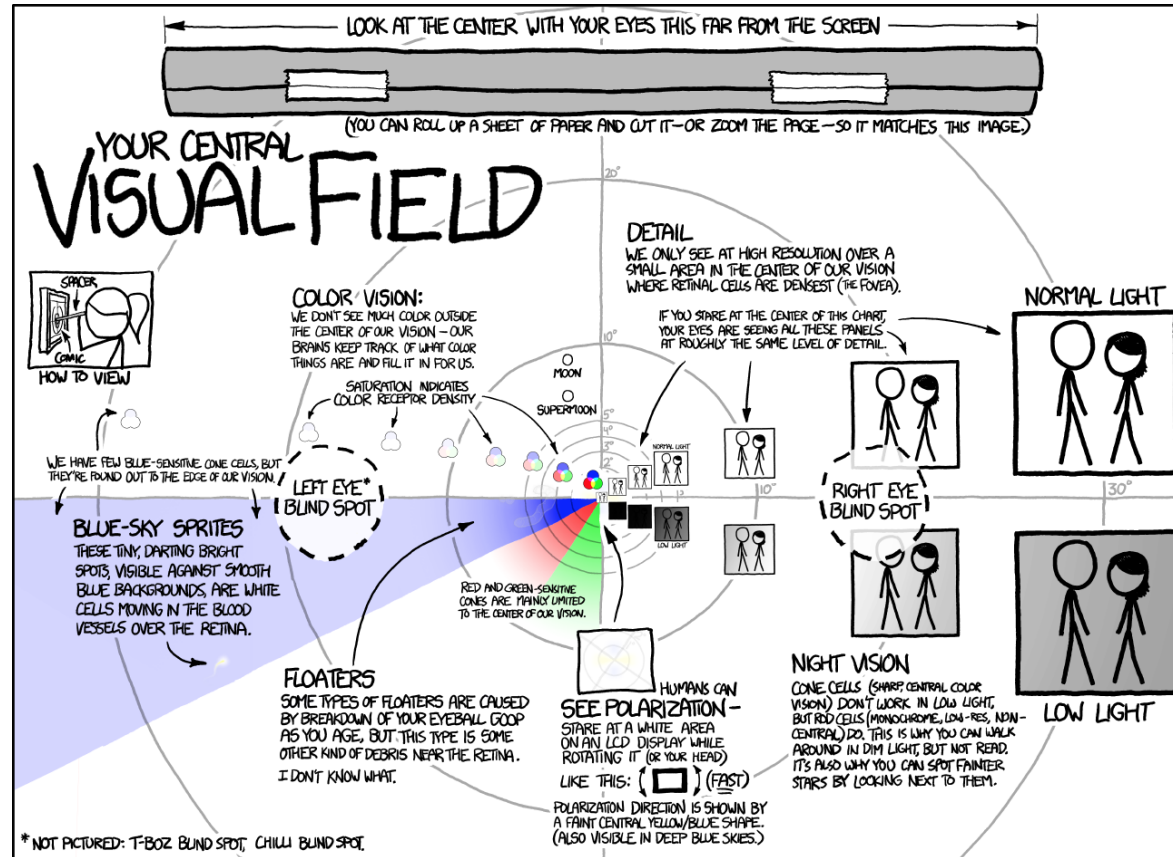
# PHOTO RECEPTOR CELLS

- 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](http://commons.wikimedia.org/wiki/File:Human_photoreceptor_distribution.svg#mediaviewer/File:Human_photoreceptor_distribution.svg)

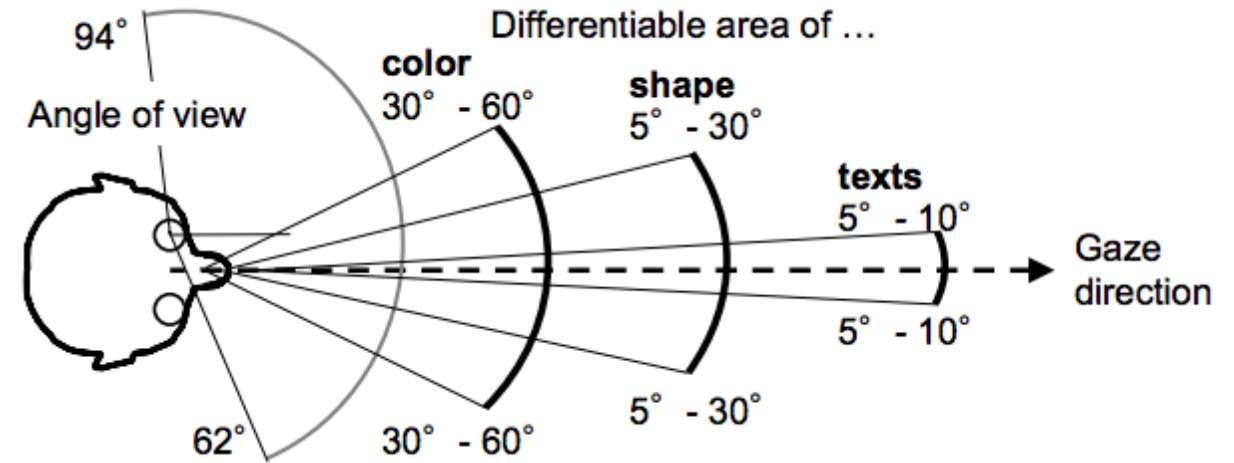
# VISION RESOLUTION



<http://xkcd.com/1080/>

# VISION RESOLUTION

- Fovea yields the highest resolution (normal light)
- Fovea occupies around  $15^\circ$  of visual field
- Highest resolution is provided by *fovea centralis* (around  $1^\circ$ )



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

# PERCEPTION AND COGNITION



VS



# WHERE IS WALDO?

## 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 linear

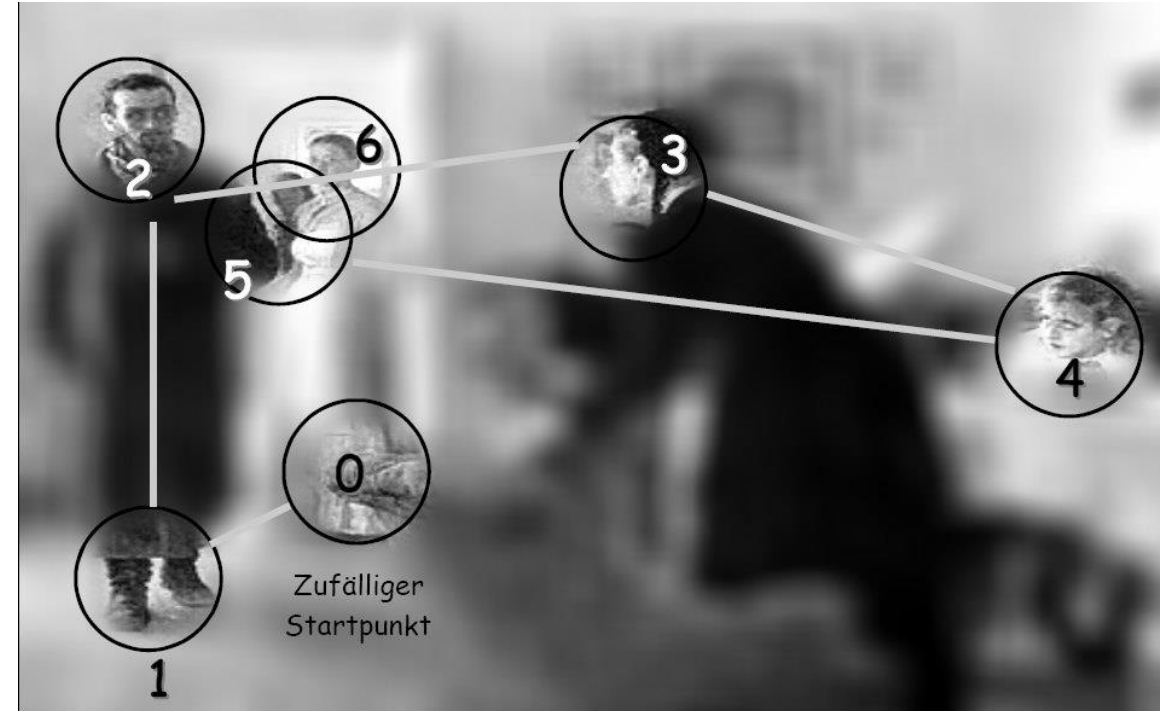


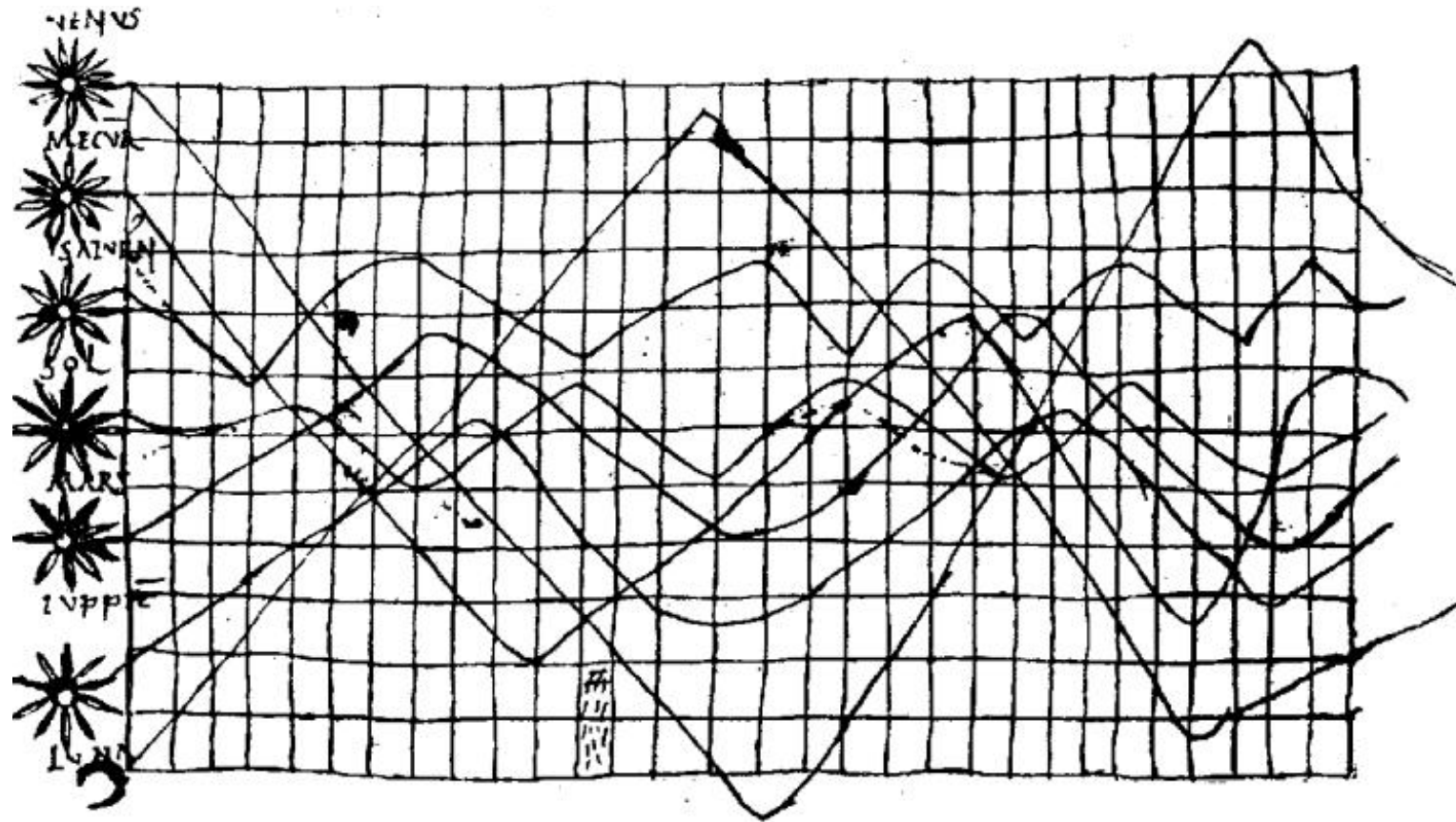
Bild 11: Foveale Ergänzung durch die ersten 6 Fixationen (nach Daten von *Yarbus, 1967*)

"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](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

12589651687651**3**216894**3**21**3**  
546**3**479654**3**21**3**20**3**5496841**3**  
2068798417184529529287149  
217495**3**178195 **3**939 65468**3**1  
**3**546516509898554684982984

1258965168765132168943213  
5463479654321320354968413  
2068798417184529529287149  
2174953178195 3939 6546831  
3546516509898554684982984

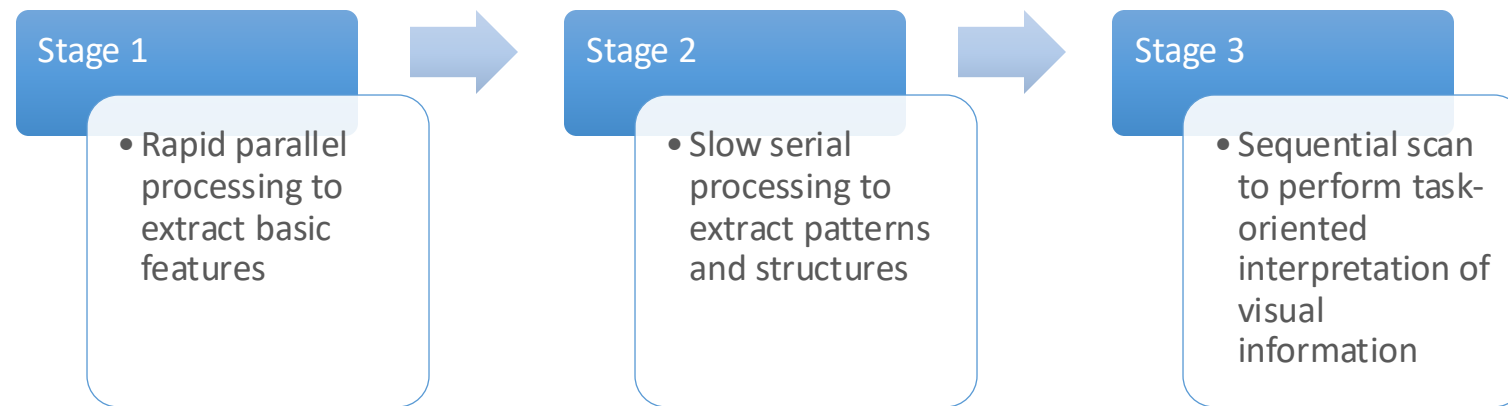
Is there a “3”?

Are there more than 5  
occurrences of “3”?

How many “3”?

# VISUAL PERCEPTION

- Early visual processing takes place without our conscious intervention
- Graphs that convey information at this level allow the observer to be more efficient in decoding



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

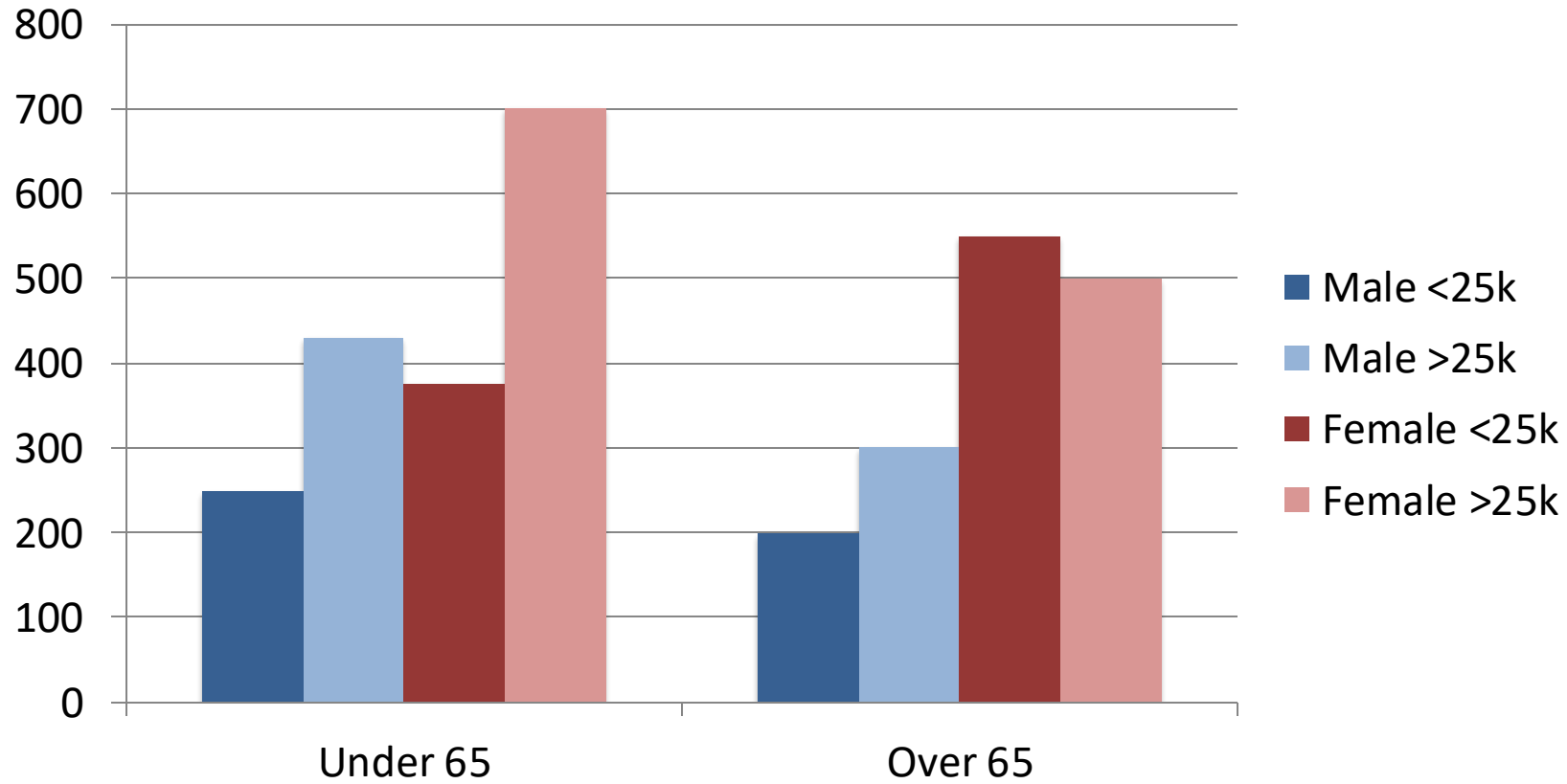


# TEST – CHOLESTEROL, AGE, AND GENDER

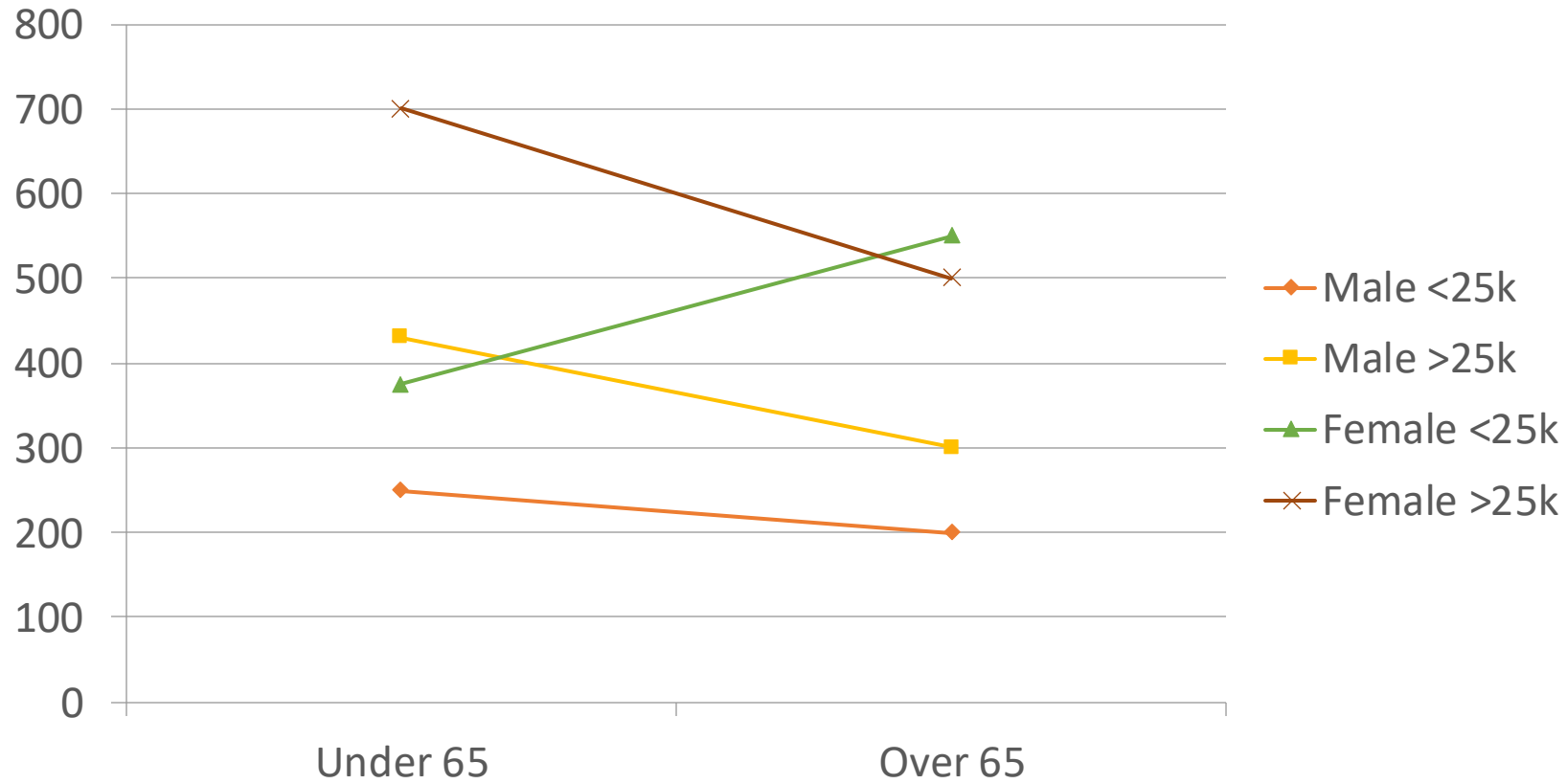
Which relation between gender or income level groups?

	Males		Females	
Income Group	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)



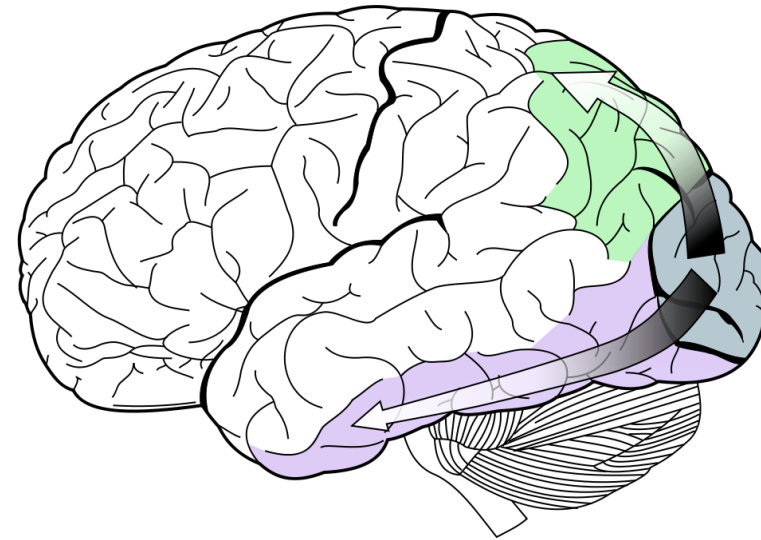
# GAME – VISUAL SOLUTION (2)



# 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

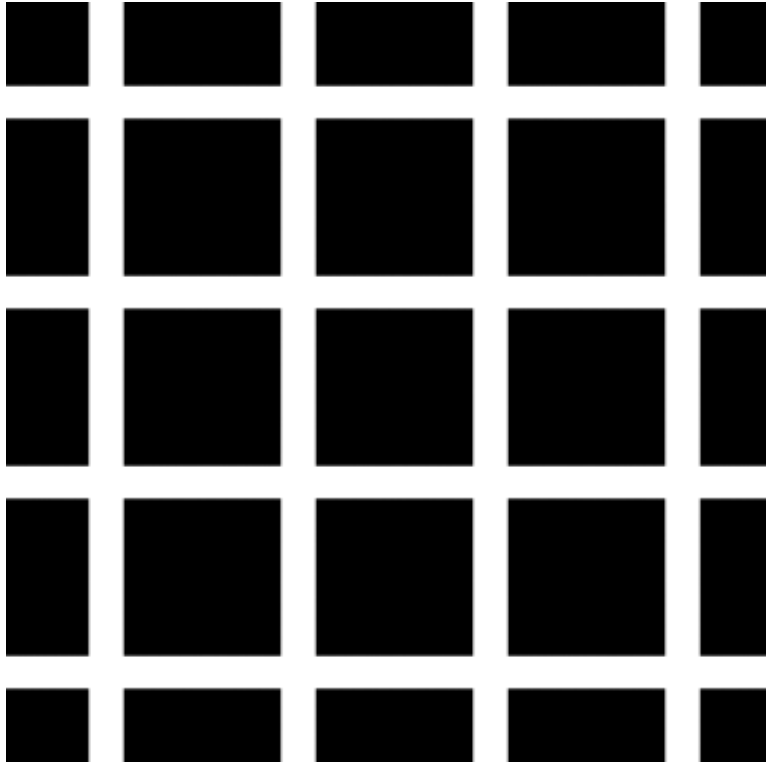


"Ventral-dorsal streams" by Selket - I (Selket) made this from Image:Gray728.svg. Licensed under CC BY-SA 3.0 via Wikimedia Commons - [http://commons.wikimedia.org/wiki/File:Ventral-dorsal\\_streams.svg#/media/File:Ventral-dorsal\\_streams.svg](http://commons.wikimedia.org/wiki/File:Ventral-dorsal_streams.svg#/media/File:Ventral-dorsal_streams.svg)

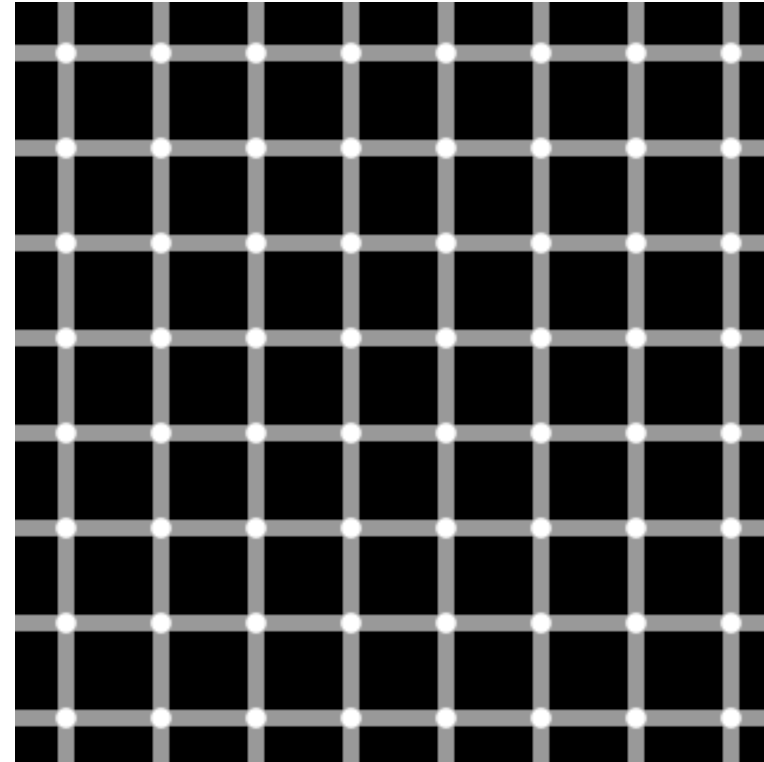
# VISUAL ILLUSIONS

- Perceived images differ from measurable reality
  - Optical Illusions
  - Physiological illusions (Mach Bands)
  - Cognitive illusions
    - Arise by unconscious inferences based on assumptions about real world

# PHYSIOLOGICAL GRID ILLUSION



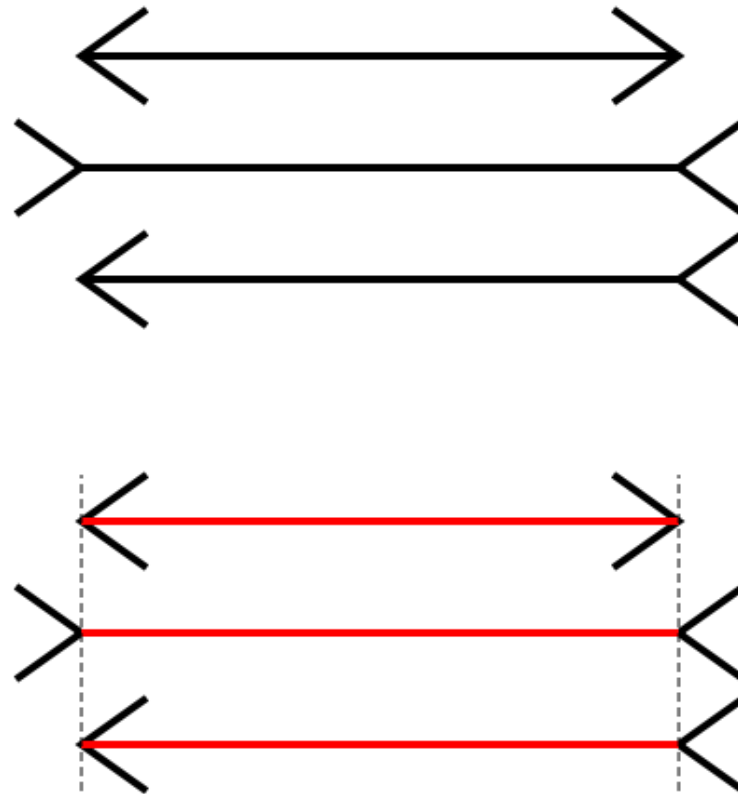
"HermannGrid" by en>User:Famousdog - <http://en.wikipedia.org/wiki/File:HermannGrid.gif>. Licensed under Public Domain via Wikimedia Commons - <http://commons.wikimedia.org/wiki/File:HermannGrid.gif#/media/File:HermannGrid.gif>



"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](http://commons.wikimedia.org/wiki/File:Grid_illusion.svg#/media/File:Grid_illusion.svg)

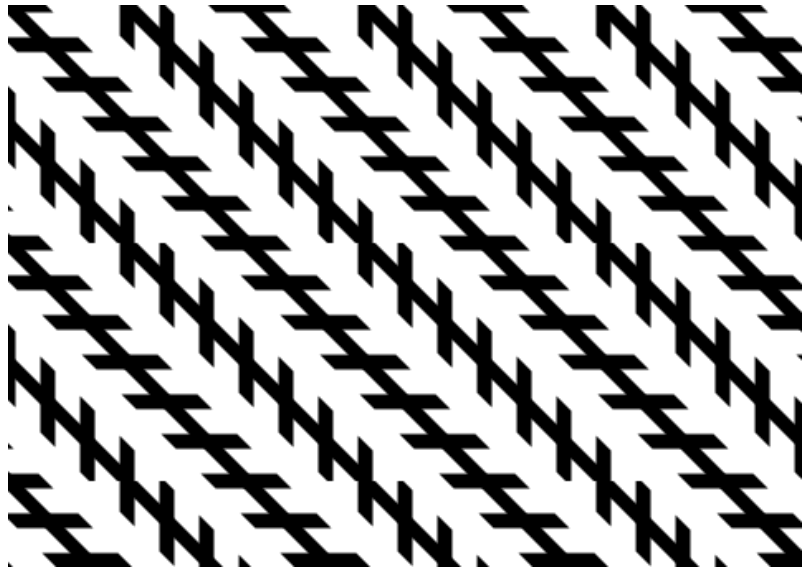
# LENGTHS DISTORTION

Müller-Lyer illusion

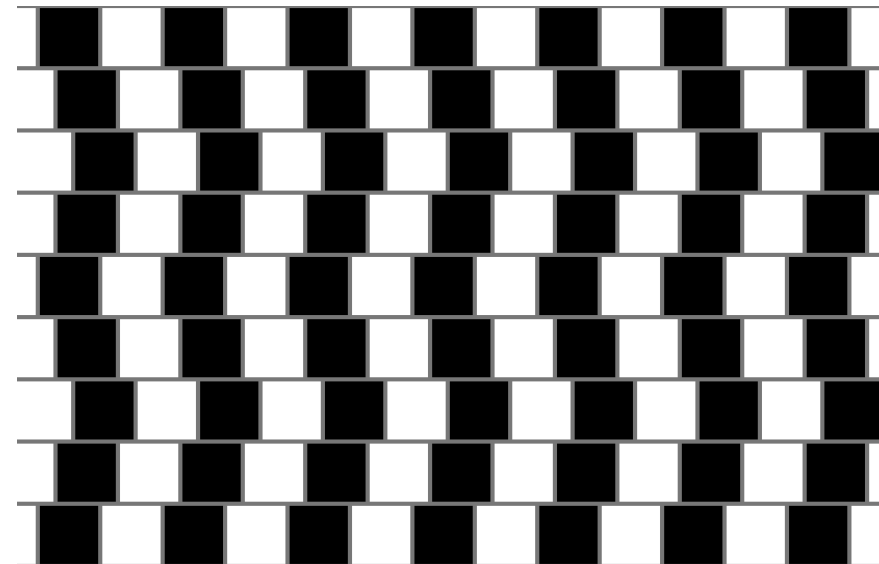


# ORIENTATION ILLUSION

## Zöllner illusion



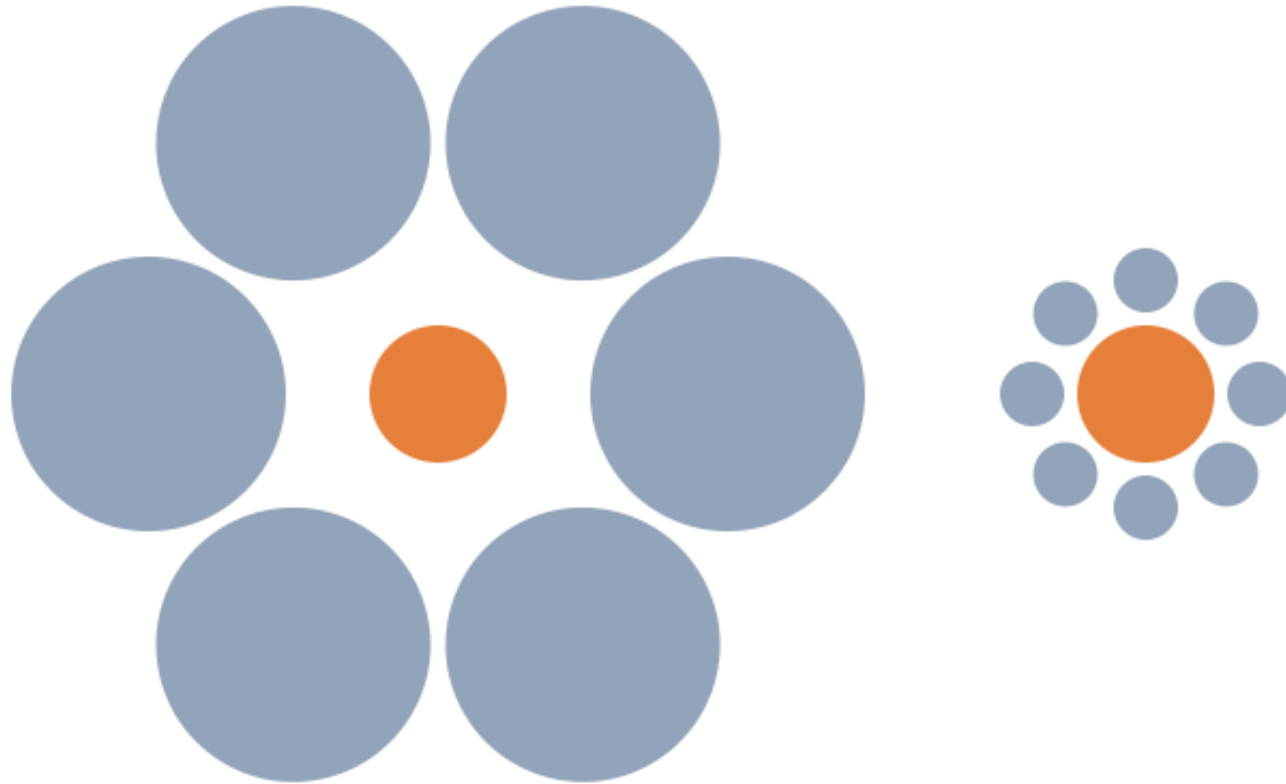
"Zollner illusion" by Fibonacci - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - [http://commons.wikimedia.org/wiki/File:Zollner\\_illusion.svg#/media/File:Zollner\\_illusion.svg](http://commons.wikimedia.org/wiki/File:Zollner_illusion.svg#/media/File:Zollner_illusion.svg)



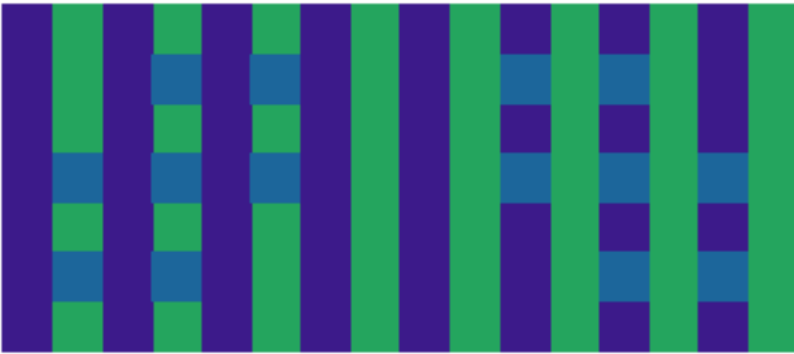
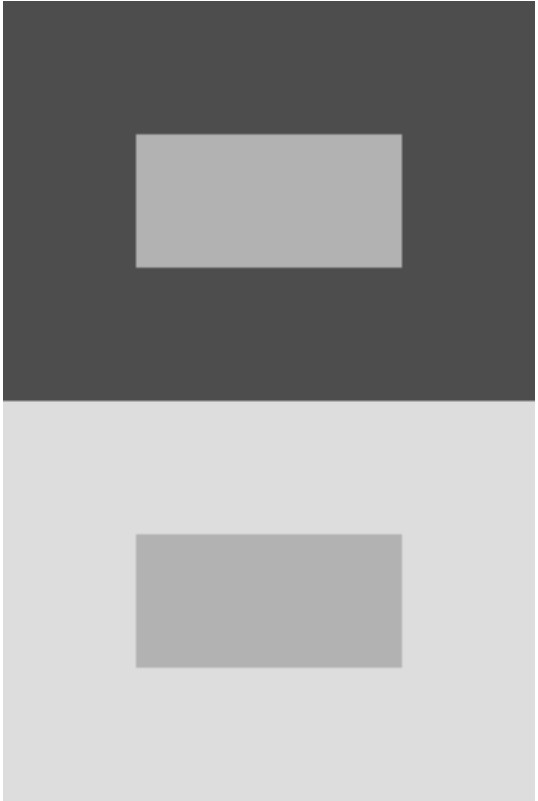
"Café wall" by Fibonacci - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - [http://commons.wikimedia.org/wiki/File:Caf%C3%A9\\_wall.svg#/media/File:Caf%C3%A9\\_wall.svg](http://commons.wikimedia.org/wiki/File:Caf%C3%A9_wall.svg#/media/File:Caf%C3%A9_wall.svg)



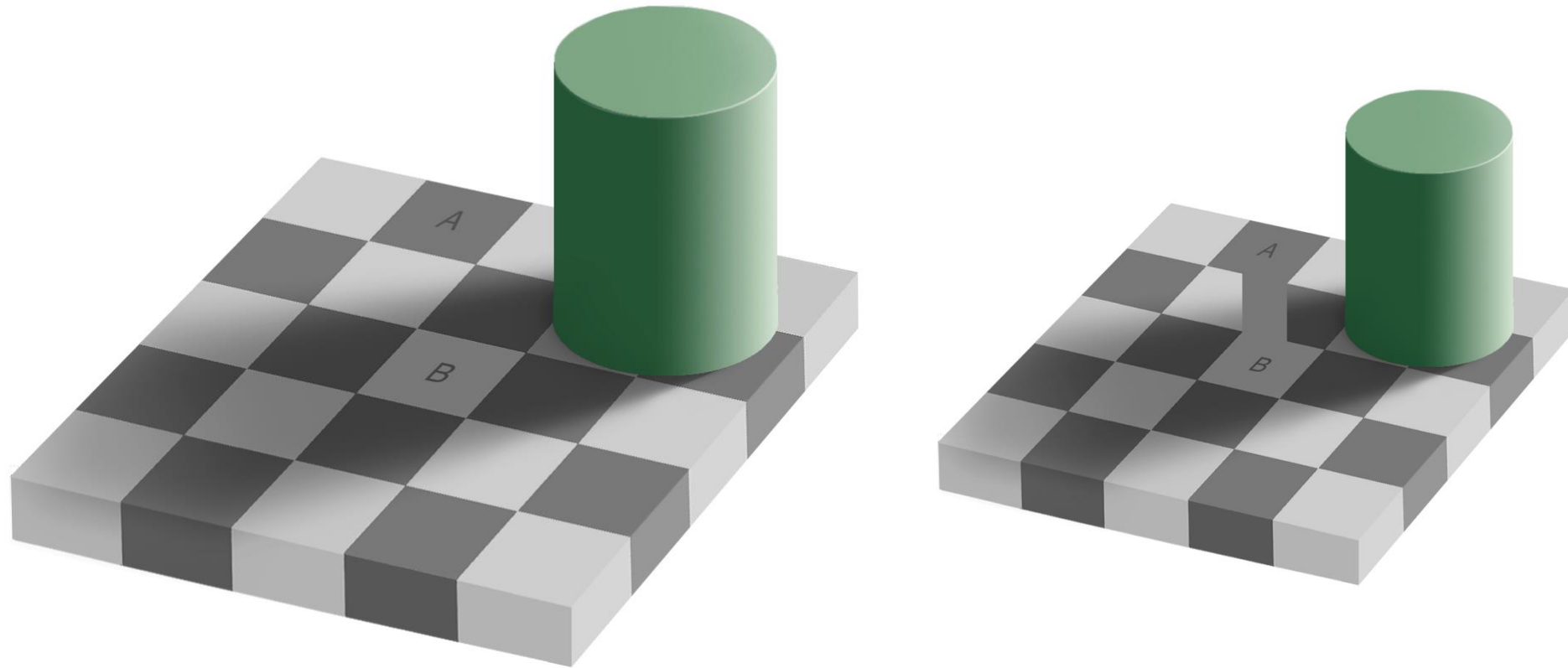
# EBBINGHAUS ILLUSION



# SIMULTANEOUS CONTRAST

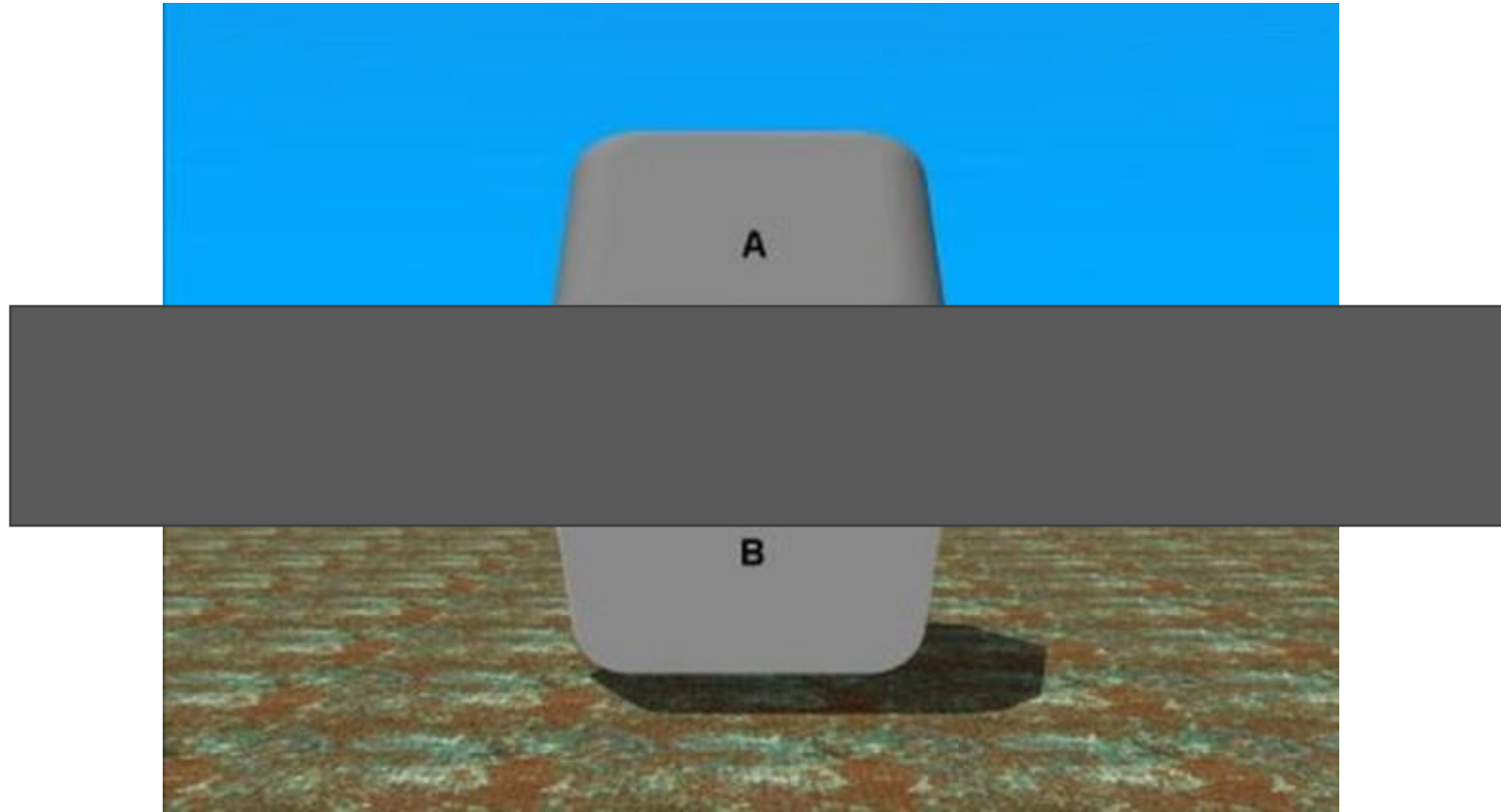


# ADELSON'S ILLUSION



"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](http://commons.wikimedia.org/wiki/File:Grey_square_optical_illusion.PNG#/media/File:Grey_square_optical_illusion.PNG)

# CONTEXT



# TAKEAWAY MESSAGES

- Limitations of human vision system
- Exploits message broadcast at early stage of perception: preatemptive perception
- Avoid possible causes of biases

