Lecture 2

CATCH UP:

SciViz and DataViZ

VS (contained in)

InfoViz

SCIVIS or DATAVIS:

visualize empirical/scientific data, or real data to be seen (observed, analized, unserstood, perceived)

- o presents results, tells a data story
- o allows exploring data,
- o Understand the data (making hypothesis, verifying hypothesis, dempnstrating them, thus demonstrating a thesis)
- o uses well known techniques: tabs, graphs, maps, plots, …
- o Must choose
  - Best = most representative/well represented data
  - Proper (already existing) visualization method

INFOVIS/ INFOGRAPHIC (INFORMATION + DATA)

- Allows to
  - show results and tell stories, by reporting key findings
  - make comparisons
  - present a timeline story
  - advertisement
  - give instructions, explain processes
  - call to action
  - simplify complex data, resume a complex story

- It builds/discovers/finds out the best visualization methods making up novel ones
- Jointly exploits art and scivis methods

INTERACTIVE and DYNAMIC

or

STATIC?

VISUALIZATION (both InfoViz and SciViz): INTERACTIVE OR STATIC?

A static visualization depicts a data story, a result that you want to explain to others.

The result does not change in time.

An interactive graphic tells a different story each time new data is automatically or manually inserted.

It is dynamic (automatic dynamic update o manual update)

Most often used by visual analytics and business intelligence tools

INTERACTIVE https://www.nasdaq.com/

STATIC https://www.nasdaq.com/articles/when-performance-matters%3A-nasdaq-100-vs.-sp-500-2019-07-22

The S&P 500, or just the S&P, is a stock market index that measures the stock performance of 500 large companies listed on stock exchanges in the United States. It is one of the most commonly followed equity indices, and many consider it to be one of the best representations of the U.S. stock market

Interaction techniques

are particularly useful for allowing dynamic exploration of large scale datasets, eventually showing interaction between points in the dataset.

- overview+detail [1] techniques provide users with a coarse overview of the dataset structure and allow detailed views of portions of the dataset on demand. Do not distort data but allowing zooming back and forth.
- Focus+context [2] techniques aim at integrating both, detailed views (focus) and overview (context). Examples: fish-eyes views, distorted views (logarithmic views)

[1] B. Shneiderman, "The eyes have it: a task by data type taxonomy for information visualizations," Proceedings 1996 IEEE Symposium on Visual Languages, Boulder, CO, USA, 1996, pp. 336-343. doi: 10.1109/VL.1996.545307. URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=545307&isnumber=11360.

[2] Y. K. Leung and M. D. Apperley. 1994. A review and taxonomy of distortion-oriented presentation techniques. ACM Trans. Comput.-Hum. Interact. 1, 2 (June 1994), 126–160. DOI:https://doi.org/10.1145/180171.180173

Design and evaluation

Some works concentrate on the design and evaluation of interactive visualization tools. Both design and evaluation must comprise:

Task abstraction studies: the task must be viewed at a higher, abstract level.

Human Computer interaction (HCI) studies: focus on the user needs, to design proper computerized systems by particularly focusing in
the **interaction** between **humans** (the users) and **computers.**

User-centered design (UCD) studies: interactive **design** process in which designers focus on the **users** and their needs in each phase of the **design** process.

When the dynamic process regards environmental data, maps are used.

One of the mostly viewed interactive dashboards in February/March 2020:

https://experience.arcgis.com/experience/685d0ace521648f8a5beeee1b9125cd

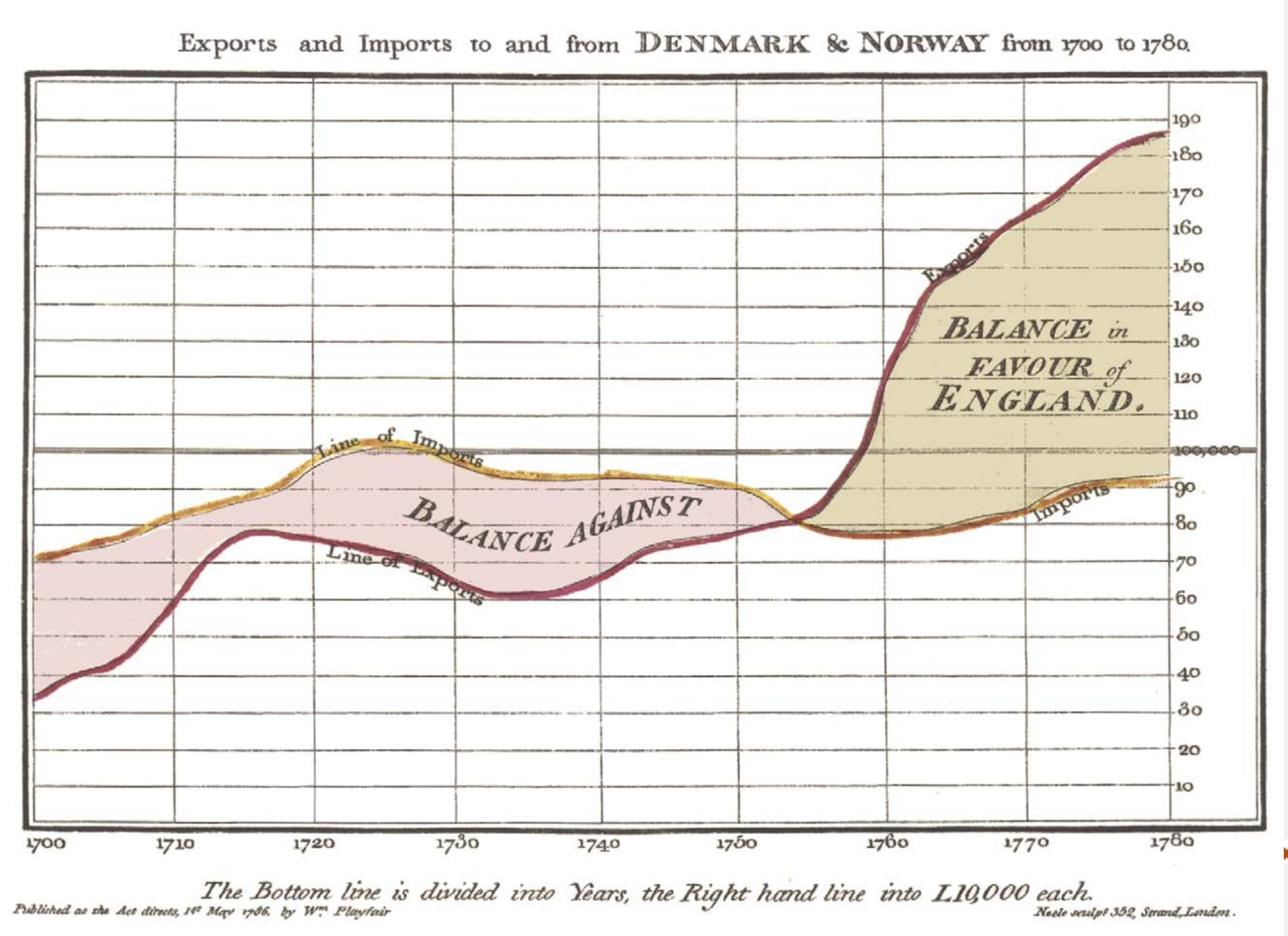
WHERE DID GRAPHS / TABLES / PLOTS COME FROM?

A Brief History of Data Visualization

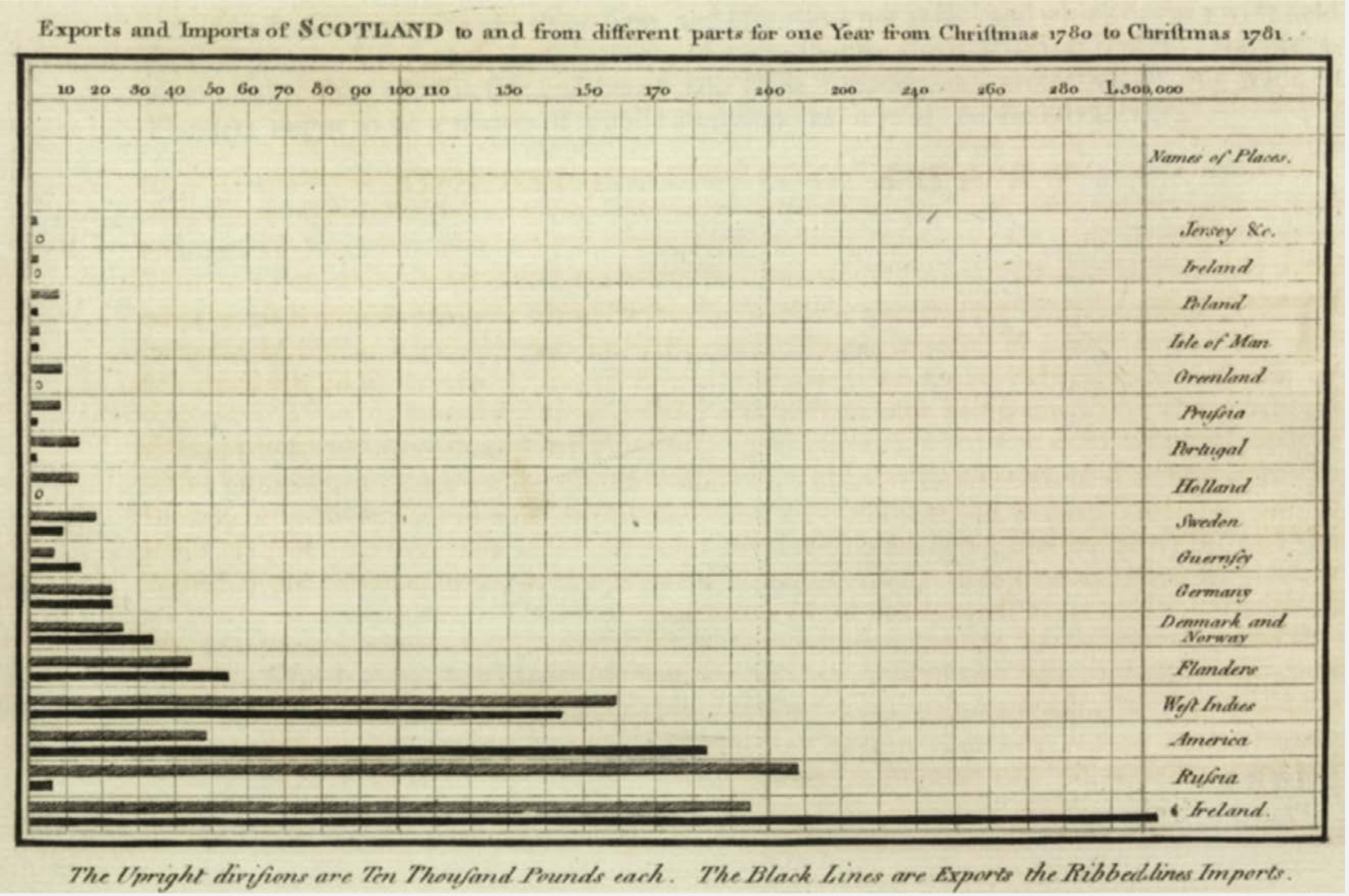
Michael Friendly

UNIVERSITÀ DEGLI STUDI DI MILANO

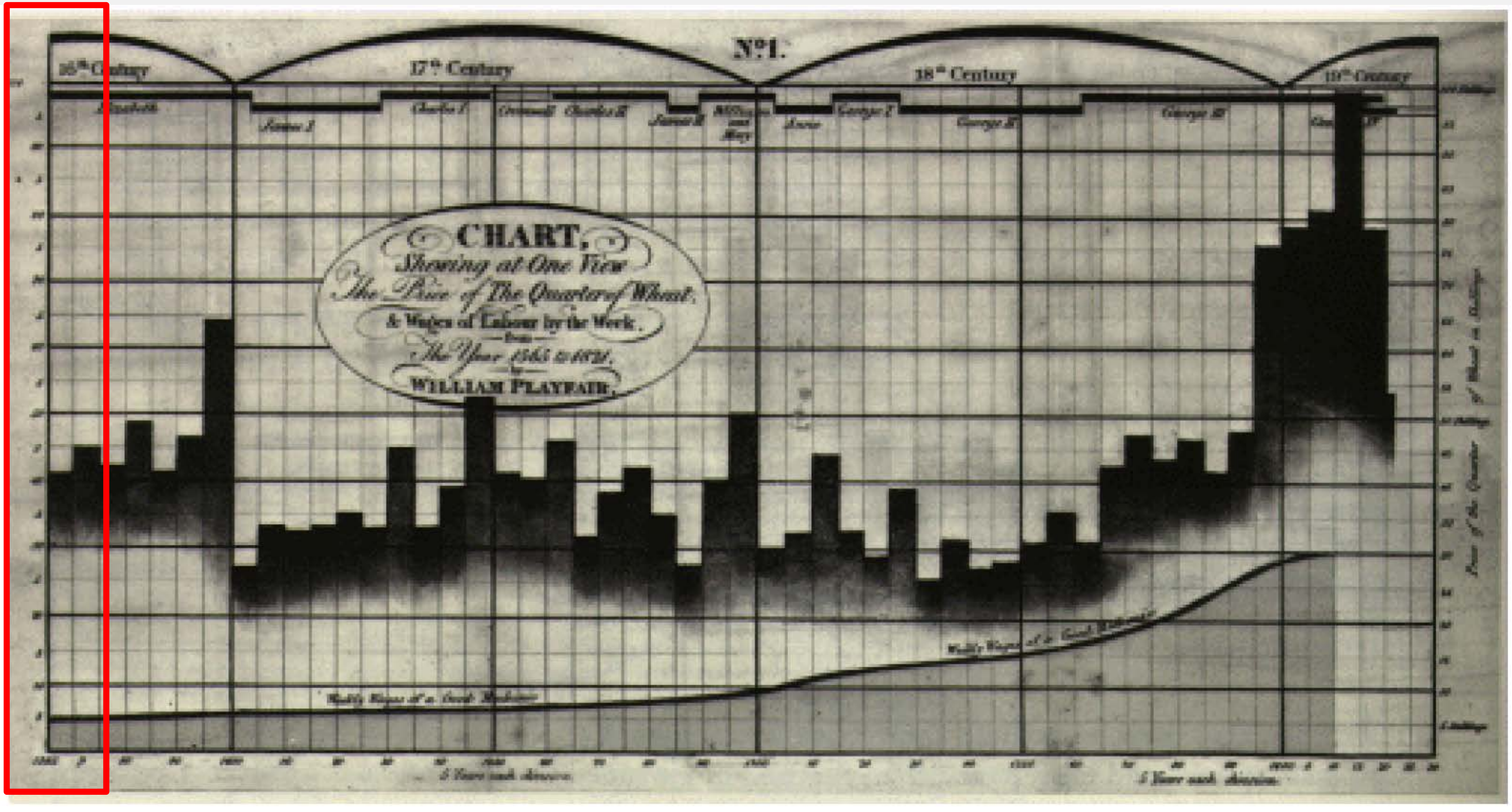
1786. William Playfair “Commercial and political Atlas”



THE FIRST BAR CHART (it's horizontal: Playfair already knew and considered psychological principles)



PLAYFAIR ALSO INTRODUCED THE USAGE OF SUPERIMPOSED GRAPHS (TWO AXIS)



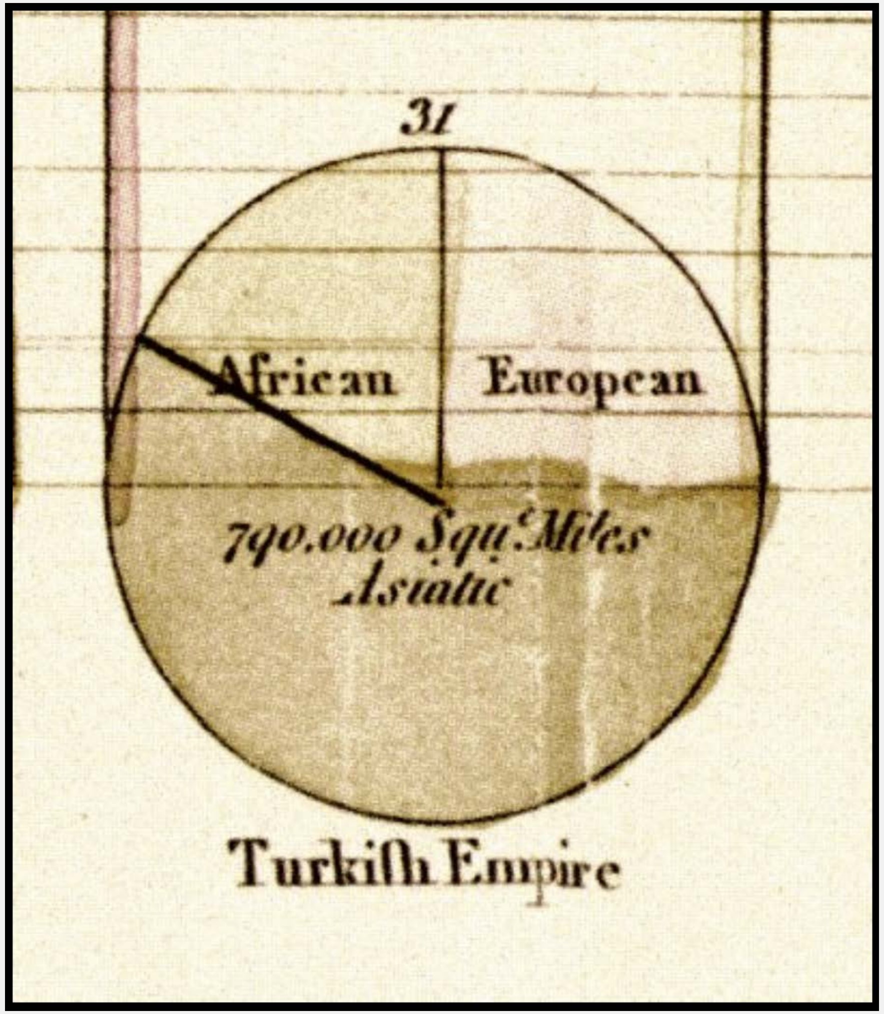
Playfair used three parallel time series to show the price of wheat,

weekly wages,

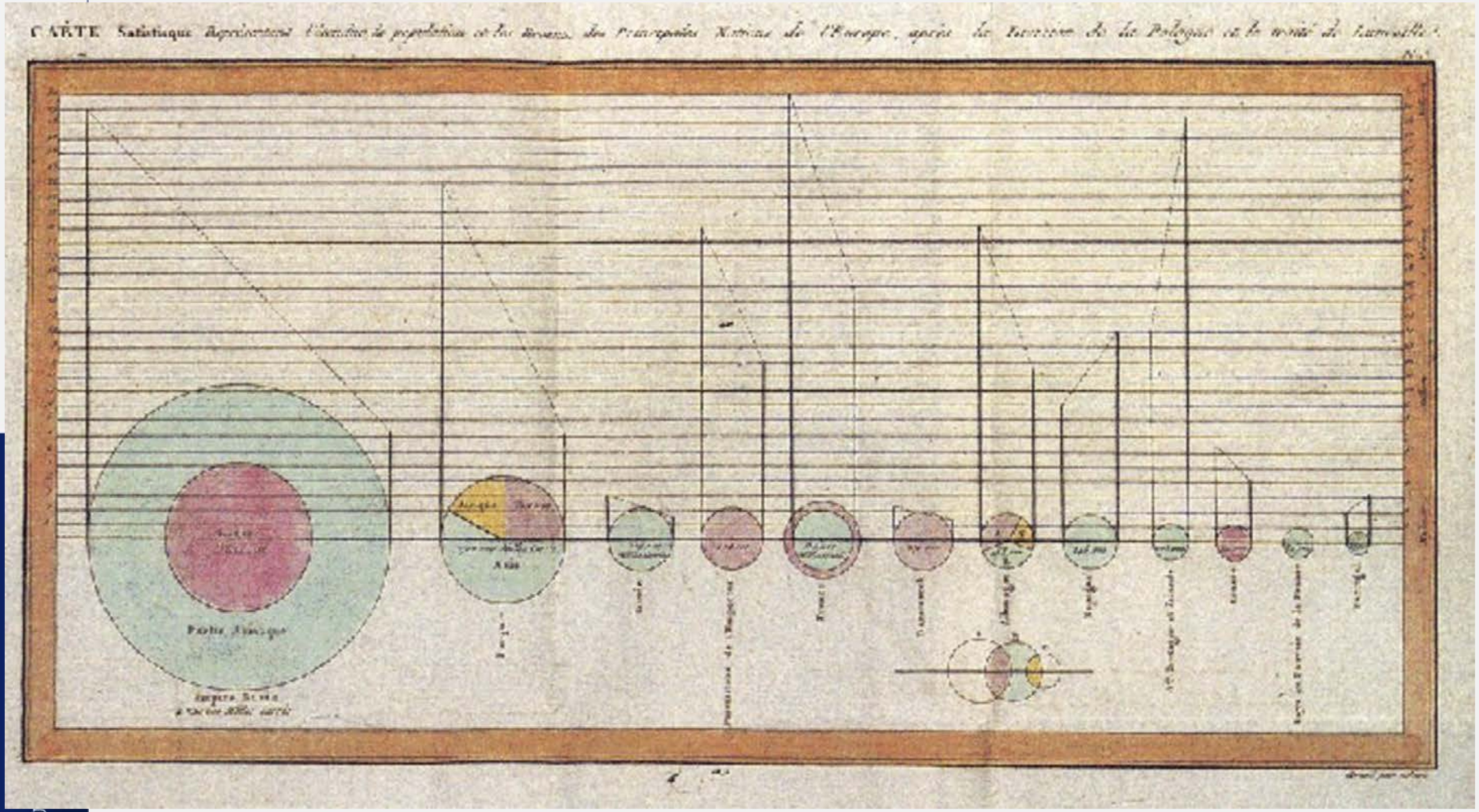
and reigning monarch (top line)

over a 250 year span from 1565 to 1820, and used this graph to argue that workers had

become better off in the most recent years.



Pie chart from Playfair's *Statistical Breviary* (1801), showing the proportions of the Turkish Empire located in Asia, Europe and Africa before 1789

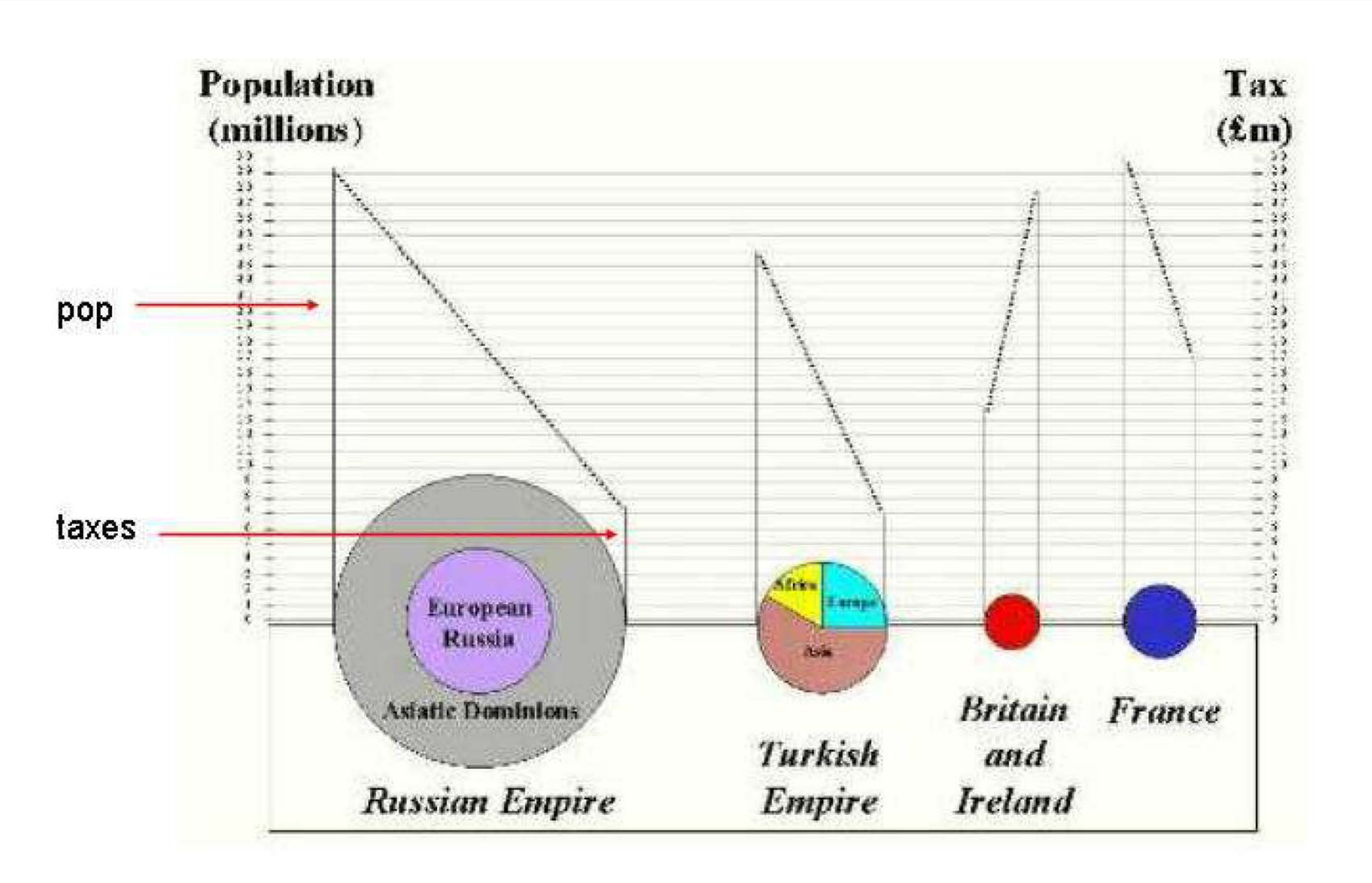


Pie charts from William Playfair's "Statistical Breviary", 1801.

He loved circles.

In this graphs compares population (left vertical line) and taxes (right vertical line) in several nations.

Re-drawn version of a portion of Playfair's 1801 pie-circle-line chart



Use of two separate vertical scales for different quantities (population and taxes).

Tries to directly compare population and taxes and argue that the British were overtaxed, compared with others.

In this figure the left axis and line on each circle/pie graph shows population, while the right axis and line shows taxes.

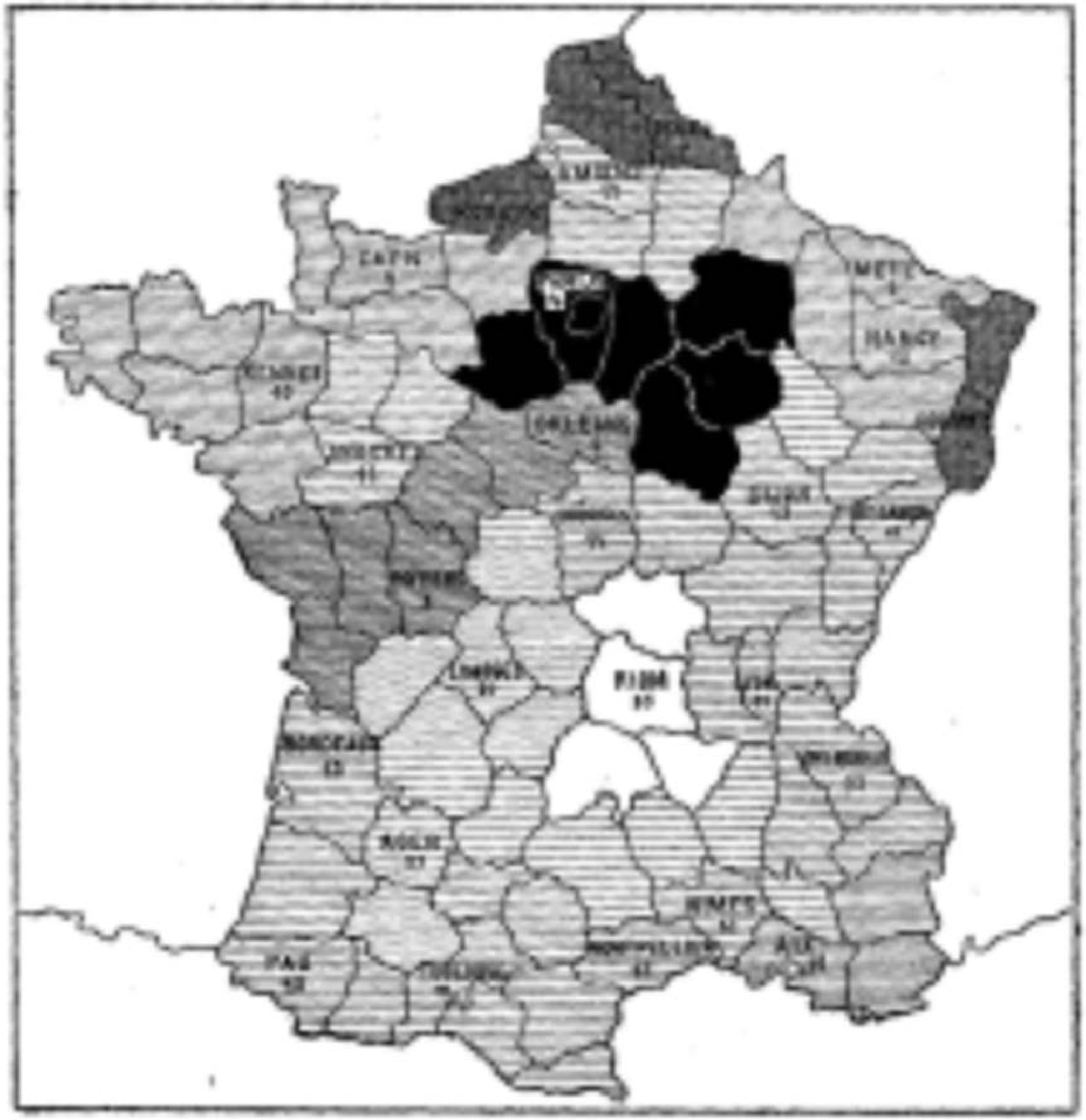
Playfair intended that the *slope* of the line connecting the two would depict the rate of taxation directly to the eye;

WRONG! The slope also depends on the diameters of the circles (geographical area which has been considered).

However the direction of the slope is right in telling which country is more taxed.
Britain is in opposite direction with respect to other countries

1826. **Baron Pierre Charles Dupin**

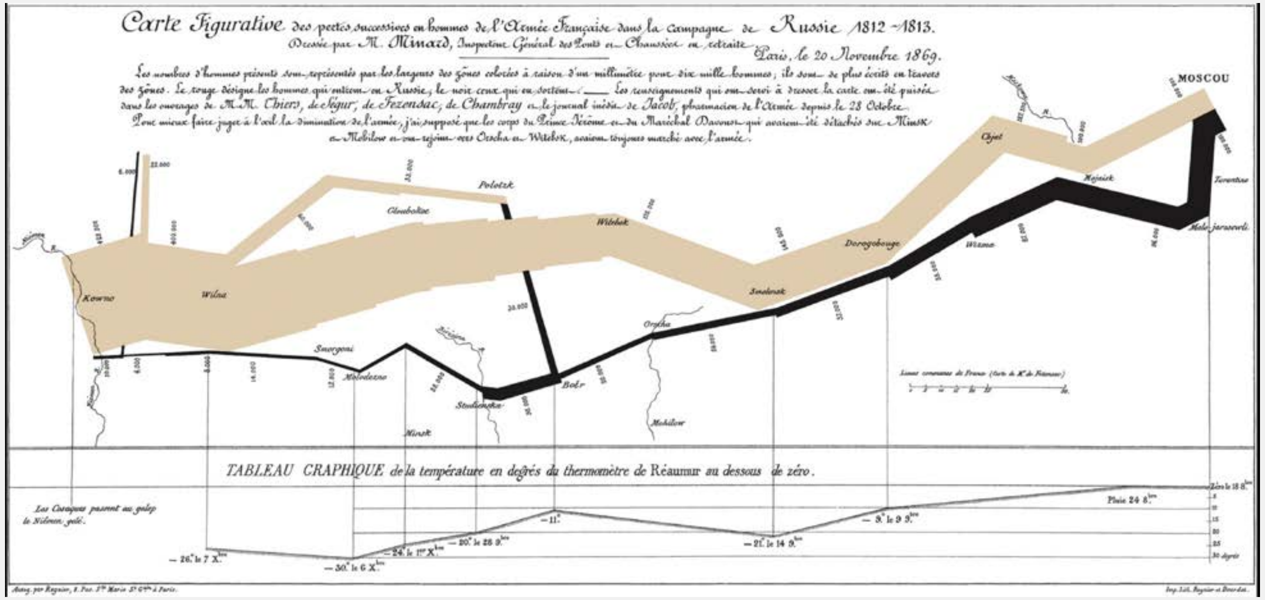
Choropleth map with shadings from black to white (distribution and intensity of illiteracy in France), the first (unclassed) choropleth map, and perhaps the first modern statistical map.

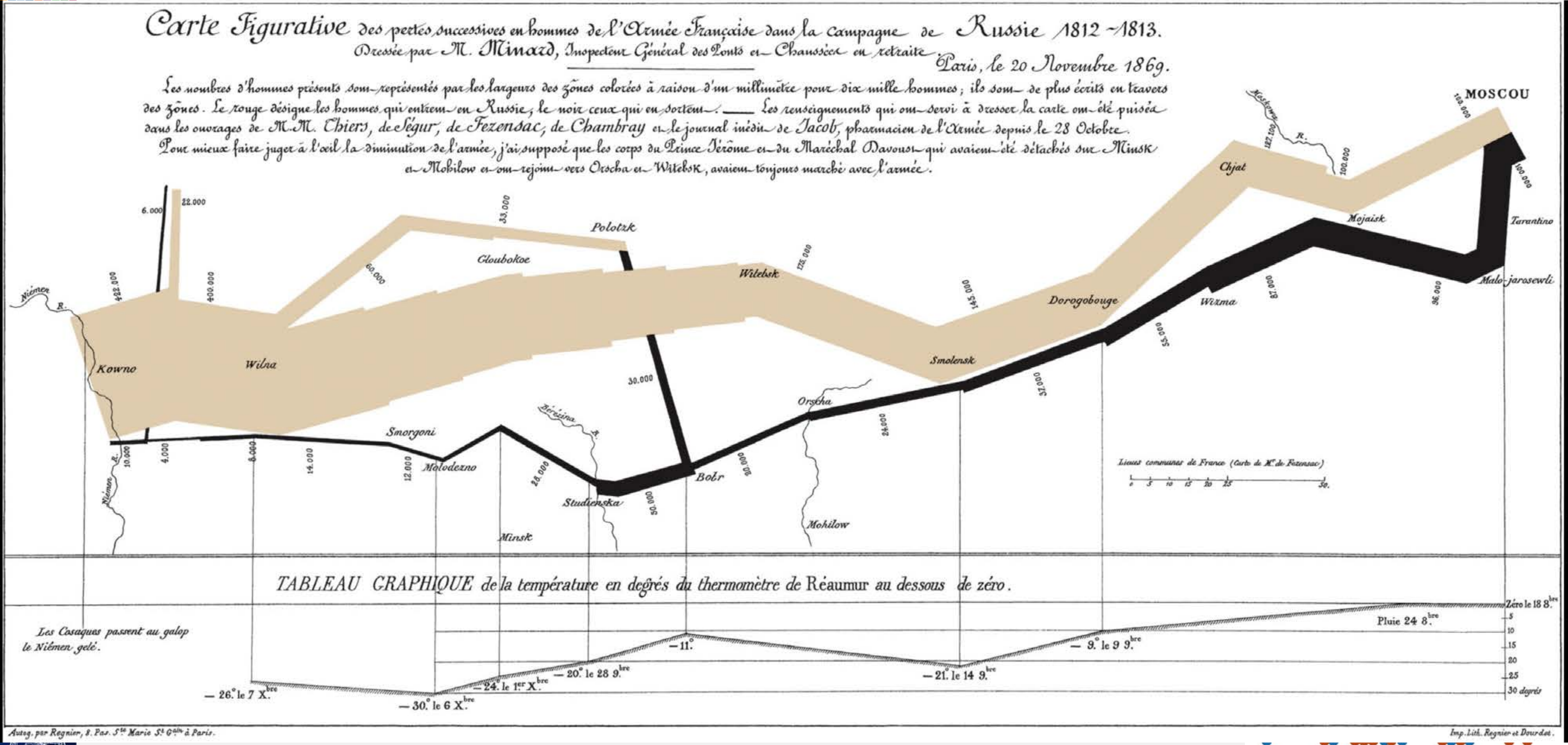


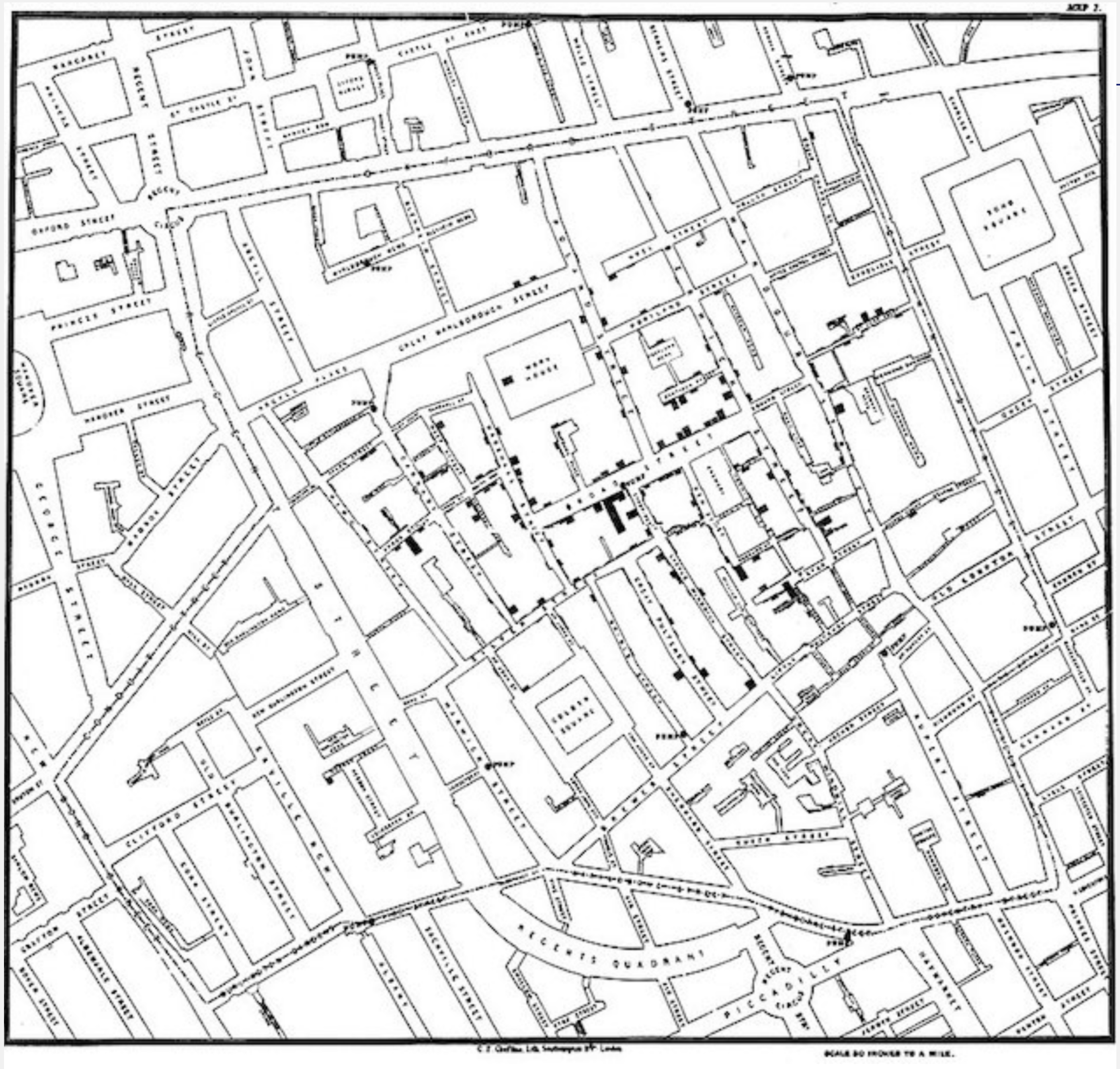
1812. Charles Minard's map of Napoleon's disastrous Russian campaign of 1812.

Represents in 2D six types of data:

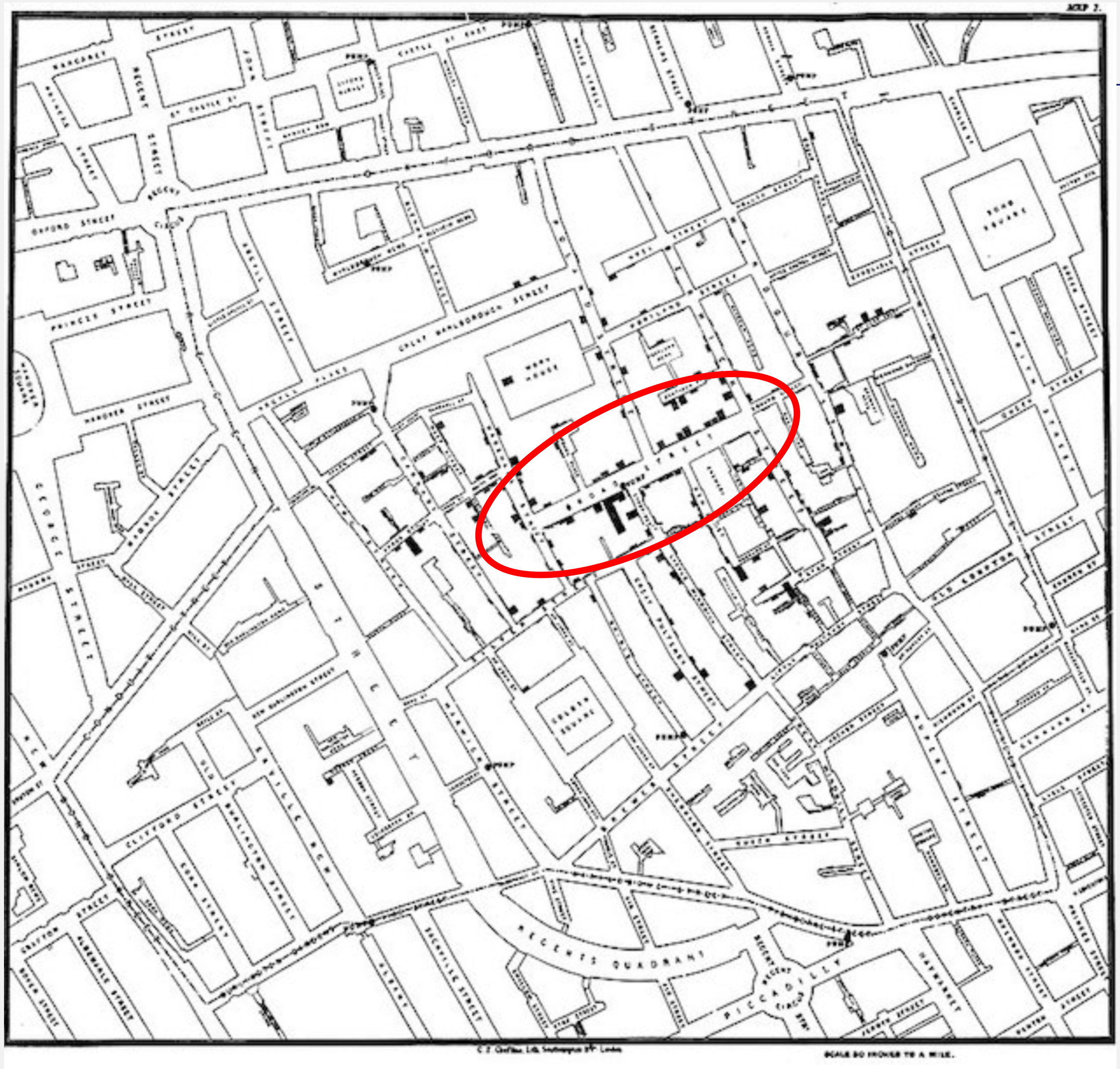
- the number of Napoleon's troops;
- distance;
- temperature;
- the latitude and longitude;
- direction of travel;
- and location relative to specific dates.




Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.
Dressée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite.
Paris, le 20 Novembre 1869.
Les nombres d'hommes présents sont représentés par les largeurs des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en travers des zones. Le rouge désigne les hommes qui entrent en Russie, le noir ceux qui en sortent. ___ Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M.M. Thiers, de Ségur, de Fezensac, de Chambray et le journal inédit de Jacob, pharmacien de l'Armée depuis le 28 Octobre.
Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Jérôme et du Maréchal Davoust qui avaient été détachés sur Minsk et Mobilow et ont rejoint vers Orscha et Witebsk, avaient toujours marché avec l'armée.
MOSCOU
Moskowa R.
Chjat
Mojaisk
Tarantino
Malo-jarosewli
Wizma
Dorogobouge
Smolensk
Orscha
Mohilow
Bobr
Studienska
Bérézina R.
Minsk
Molodezno
Smorgoni
Wilna
Kowno
Niémen R.
Polotzk
Gloubokoe
Witebsk
422.000
400.000
22.000
6.000
60.000
33.000
30.000
175.000
145.000
127.100
100.000
100.000
100.000
96.000
87.000
55.000
37.000
24.000
20.000
50.000
28.000
12.000
14.000
8.000
4.000
10.000
Lieues communes de France (Carte de M. de Fezensac)
TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Réaumur au dessous de zéro.
Les Cosaques passent au galop le Niémen gelé.
Zéro le 18 8.bre
Pluie 24 8.bre
— 9.° le 9 9.bre
— 21.° le 14 9.bre
— 11.°
— 20.° le 28 9.bre
— 24. le 1.er X.bre
— 30.° le 6 X.bre
— 26.° le 7 X.bre
30 degrés
Autog. par Regnier, 8. Pas. Ste Marie St G.ain à Paris.
Imp. Lith. Regnier et Dourdet.



John Snow and the cholera in London (1854)

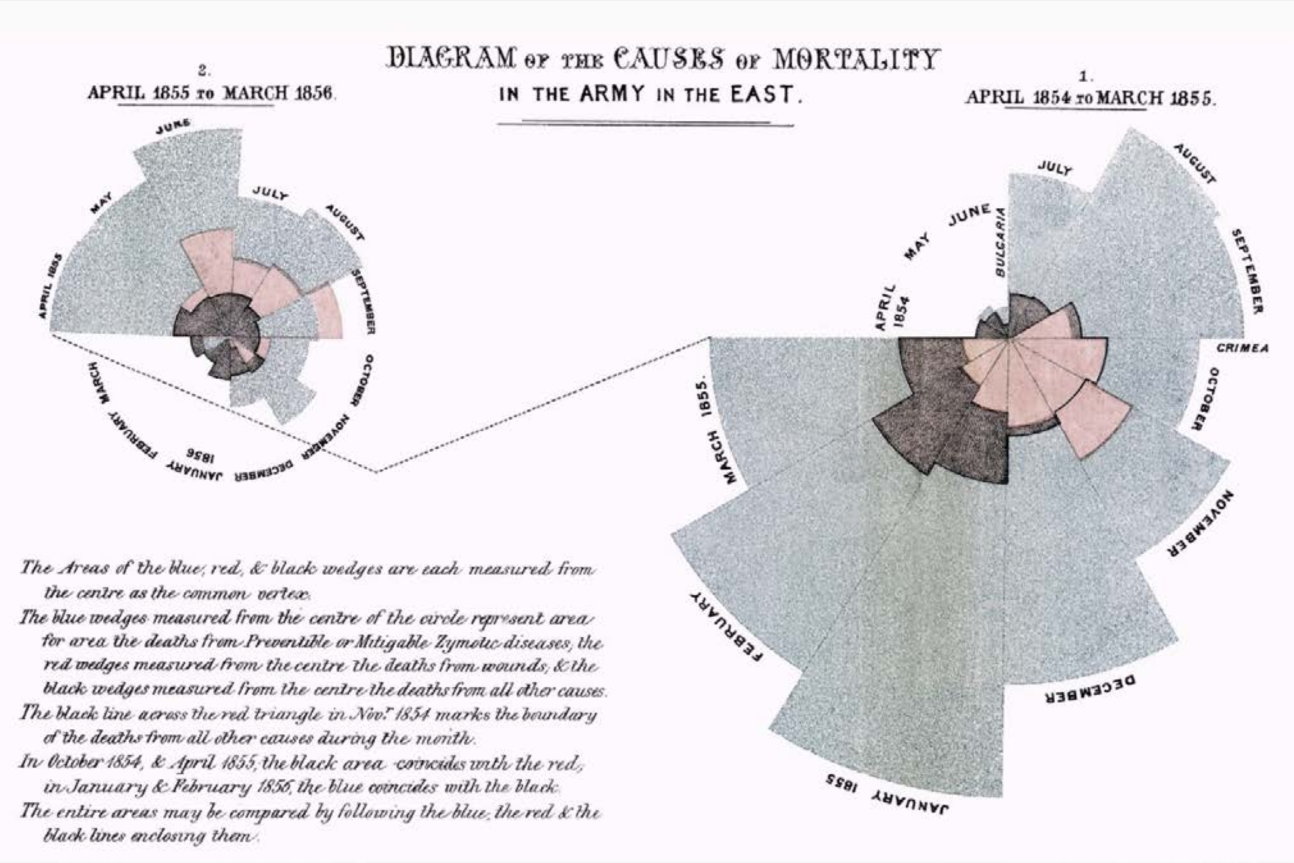


John Snow and the cholera in London (1854)

The enemy was a public water pump in Broad Street.

1856. Rose diagram of Florence Nightingale

famous for her contributions to medicine, her rose diagram describes causes of deaths in soldiers during the Napoleonic wars and enabled improving sanitation for soldiers on the battlefield



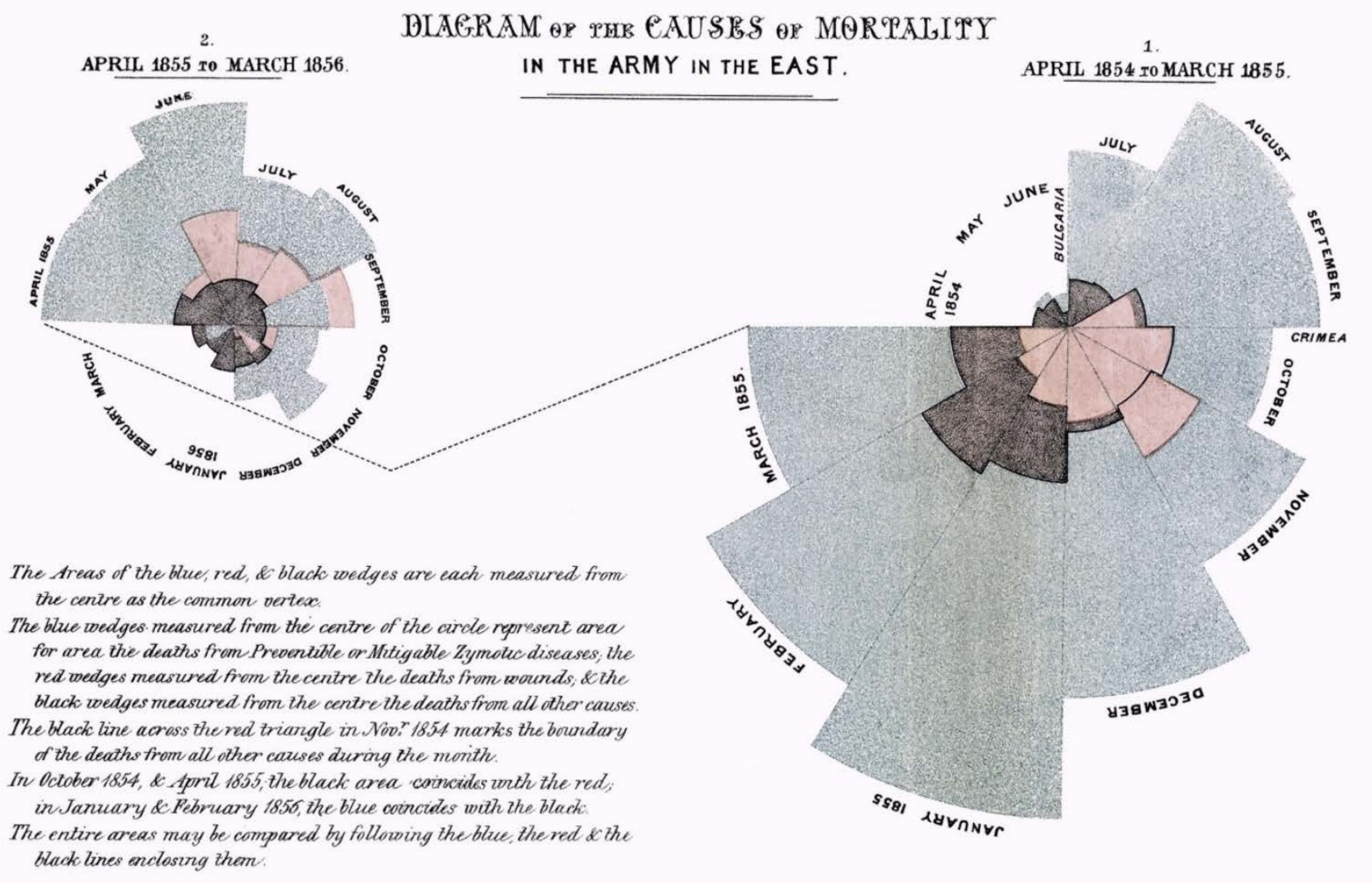
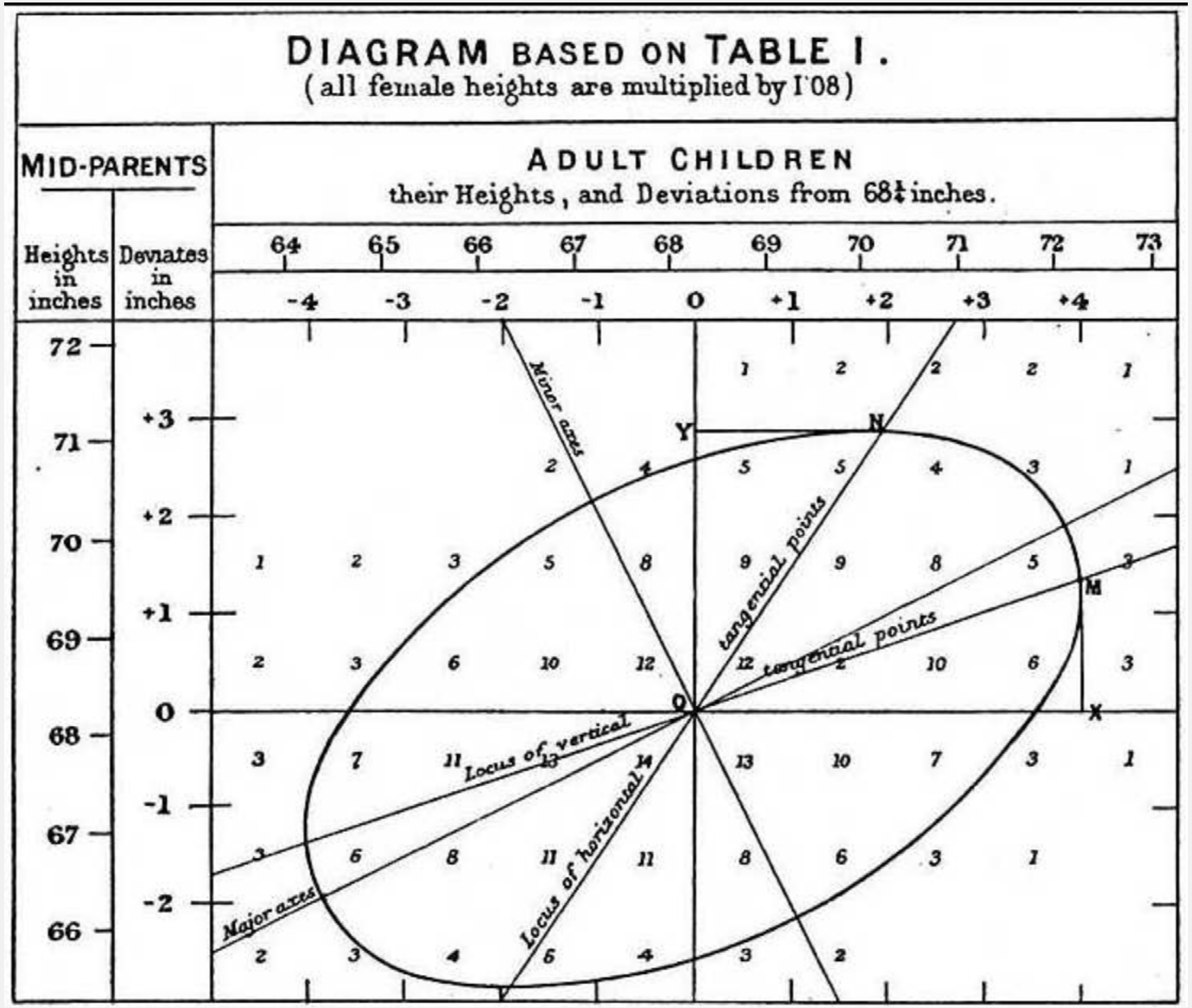


DIAGRAM OF THE CAUSES OF MORTALITY
IN THE ARMY IN THE EAST.
2.
APRIL 1855 TO MARCH 1856.
1.
APRIL 1854 TO MARCH 1855.
APRIL 1855
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
1856
FEBRUARY
MARCH
APRIL 1854
MAY
JUNE
BULGARIA
JULY
AUGUST
SEPTEMBER
CRIMEA
OCTOBER
NOVEMBER
DECEMBER
JANUARY 1855
FEBRUARY
MARCH 1855.
The Areas of the blue, red, & black wedges are each measured from the centre as the common vertex.
The blue wedges measured from the centre of the circle represent area for area the deaths from Preventible or Mitigable Zymotic diseases; the red wedges measured from the centre the deaths from wounds; & the black wedges measured from the centre the deaths from all other causes.
The black line across the red triangle in Novr. 1854 marks the boundary of the deaths from all other causes during the month.
In October 1854, & April 1855, the black area coincides with the red; in January & February 1856, the blue coincides with the black.
The entire areas may be compared by following the blue, the red & the black lines enclosing them.

1886. Galton's correlation diagram (parents' height and Adult children's height)



And from the beginning of the past century (1900) many graphs/plots/charts have been created

1933. Henry C. Beck

And we arrive to modern times:

A visual history of human knowledge (Manuel Lima)

TED'S TALKS

About graphs

Graphs visualization generally represents interactions between entities, as a network:

A Survey on Graph Visualization

Visual Analysis of Large Graphs: State-of-the-Art and Future Research Challenges

A Survey on Information Visualization for Network and Service Management

UNIPred-Web: a web tool for theintegration and visualization of biomolecularnetworks for protein function prediction

CerebroVis: Designing an Abstract yet Spatially Contextualized Cerebral Artery Network Visualization

Treemaps by BenShneiderman for visualizing graphs and multiresolution data:

Graphs visualization captures connections between elements, shows relationships

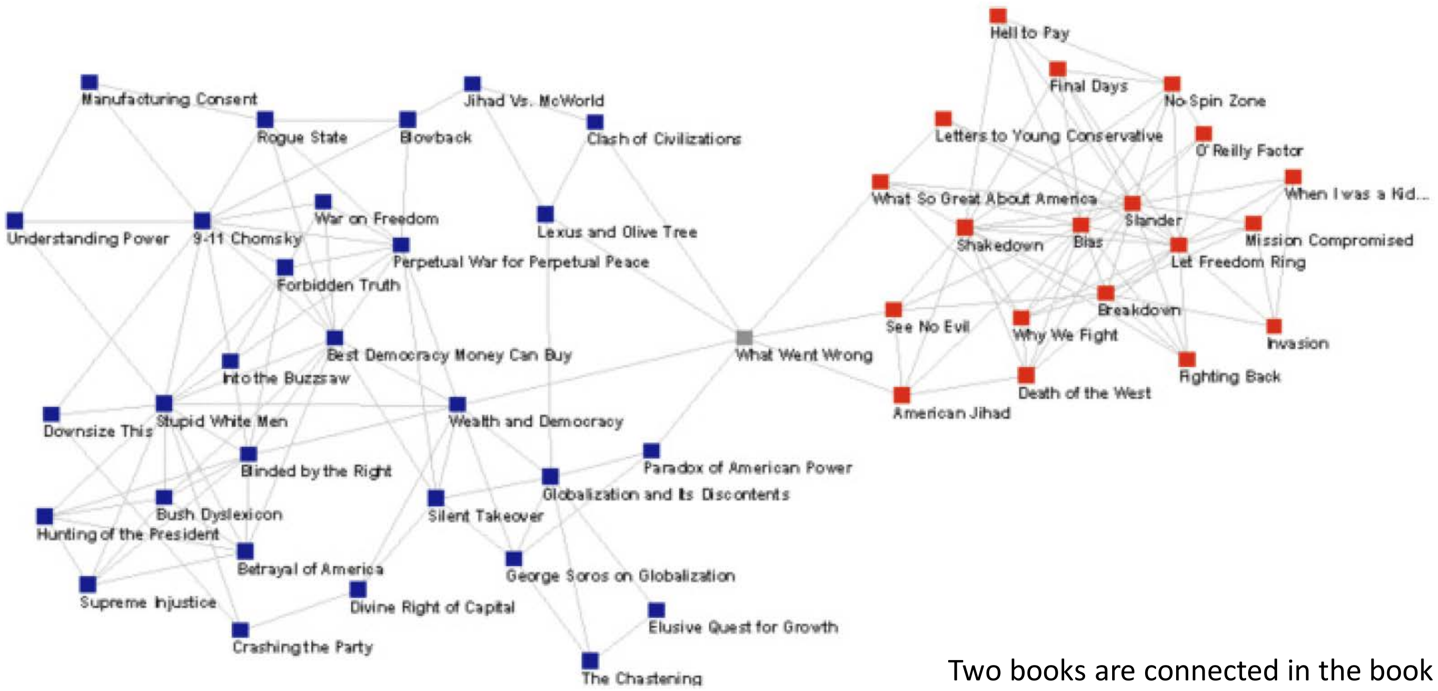


Figure 7-10. *Divide of political books in 2003*

Two books are connected in the book network if Amazon reports that they were frequently bought together by the same consumer

I have been doing a social network analysis of the purchase patterns of political books since 2003. Unsurprisingly, from my very first mapping I saw two distinct political clusters: a red one designating those who read right-leaning books and a blue one designating those who read left-leaning books. In my 2003 network analysis, I saw just one book holding the red and blue clusters together. Ironically, that book was named *What Went Wrong*. This map is shown in Figure 7-10.

“Beautiful Visualizations”

Network visualizations allow understanding social phenomena

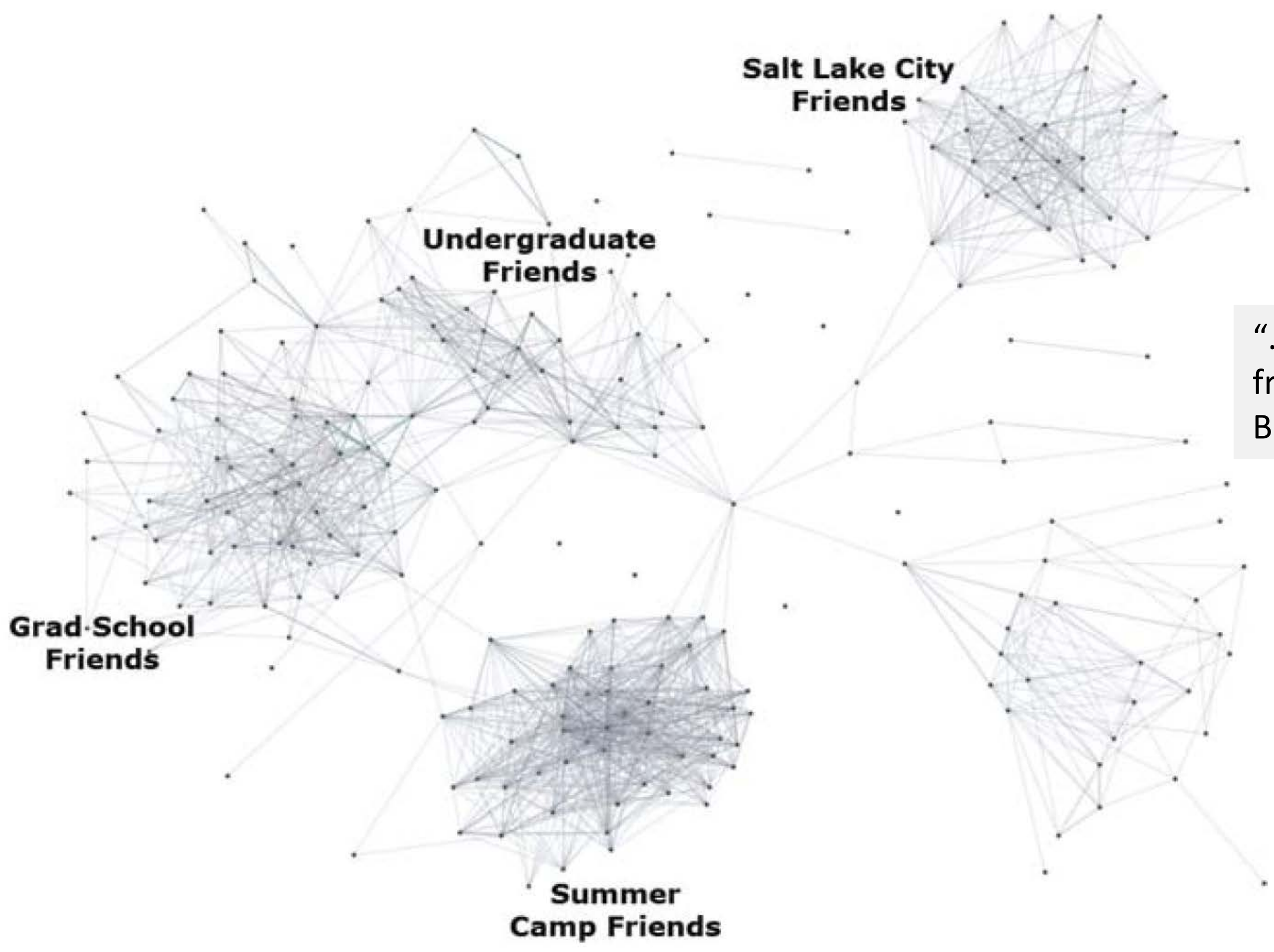


Figure 2-7. *Nexus rendering of a network visualization of my Facebook friends*

"…Figure 2-7 shows a network visualization of my Facebook friends and how many of them have "friended" one another."
Beautiful Visualizations

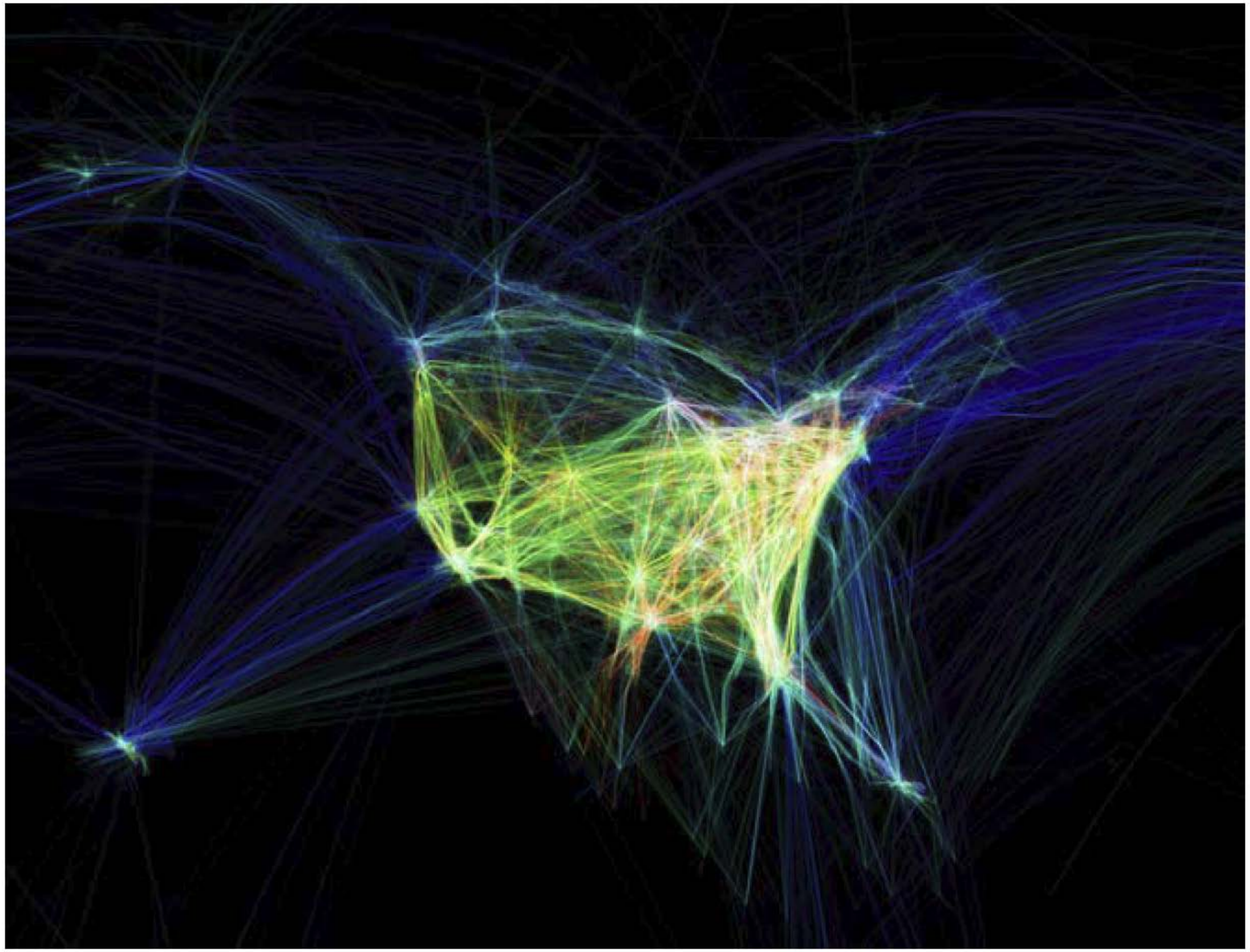


Figure 6-1. *Flight Patterns, a visualization of aircraft location data for airplanes arriving at and departing from U.S. and Canadian airports*

“[…] *Flight Patterns* is a project I started in 2005 that visualizes civilian air traffic in the United States and Canada. It […] traces aircraft arriving and departing from U.S. and Canadian airports over a 24-hour period. […]”

Beautiful visualizations

http://www.aaronkoblin.com/work/flightpatterns/

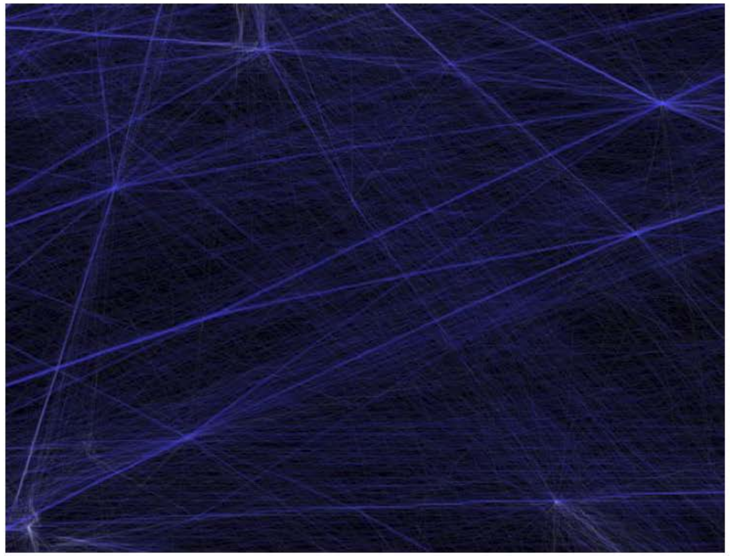


Figure 6-2. *Closeup of a section of Figure 6-1 that reflects what I expected to find throughout the data: flight paths going in every direction*

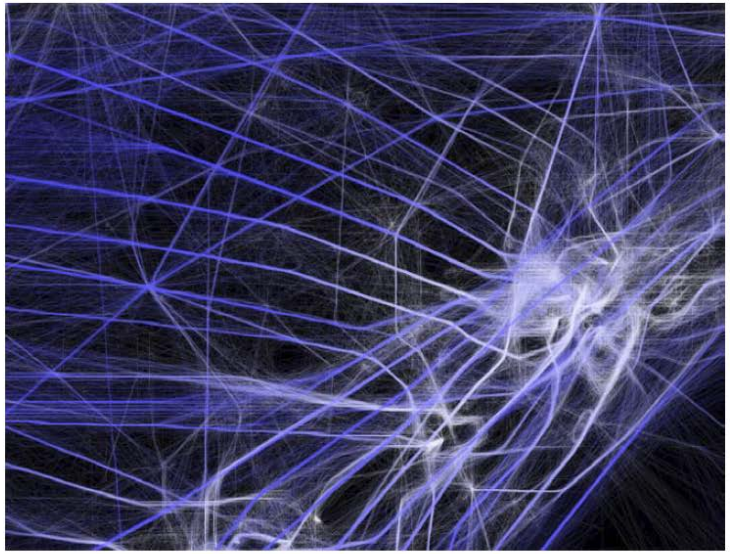


Figure 6-3. *Another closeup that reflects what I found to be common instead: clear, bright lines that indicate flight paths followed closely by high volumes of planes*

- Vision of flight patterns (concentration of aerial paths).

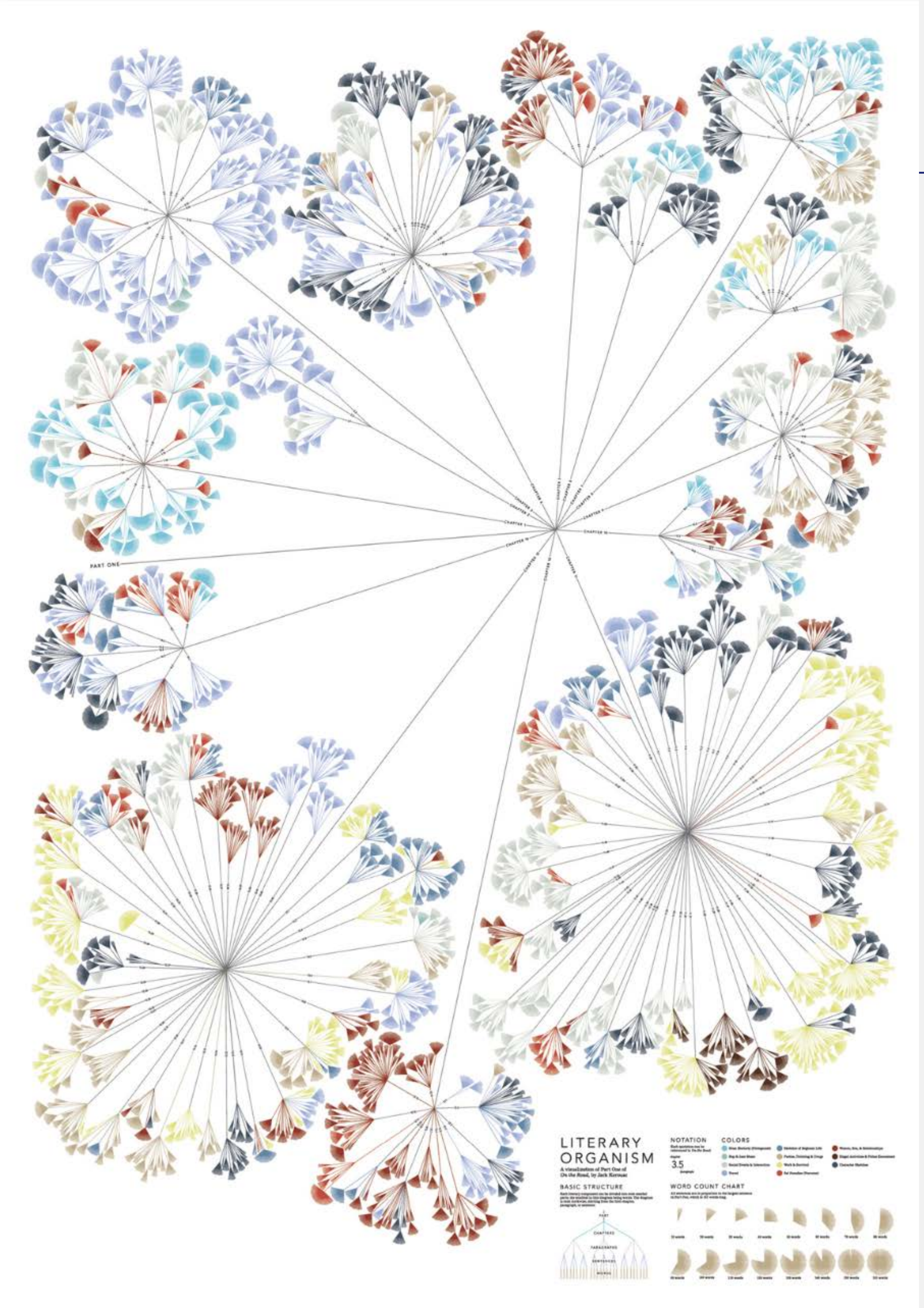
- Perception of the wide number of flights passing over our heads.

Uses colors for showing quantities.

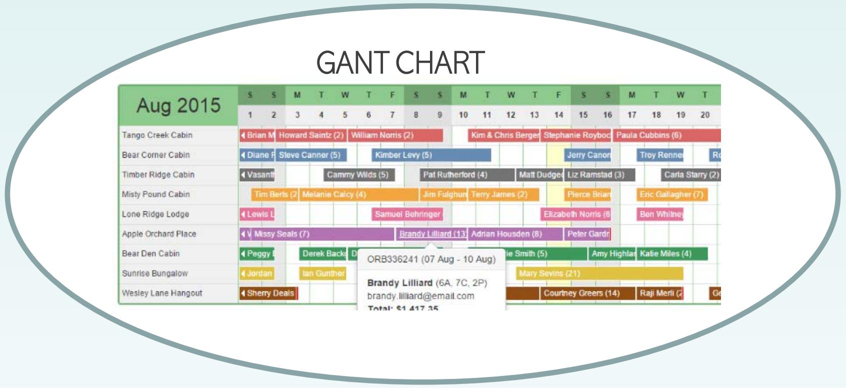
Using colors for describing quantities is fine if user do not need an exact perception of quantities

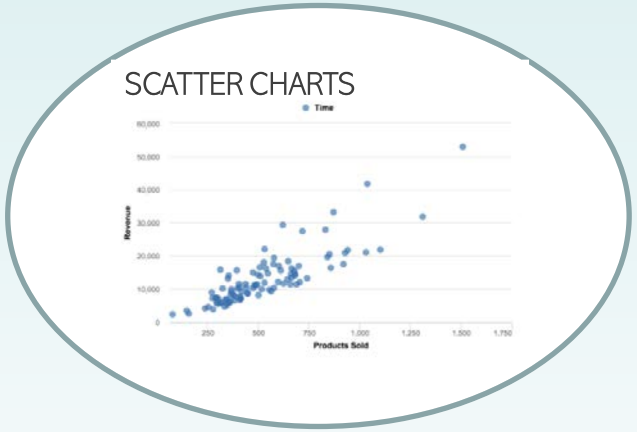
(color perception is not international, areas are international)

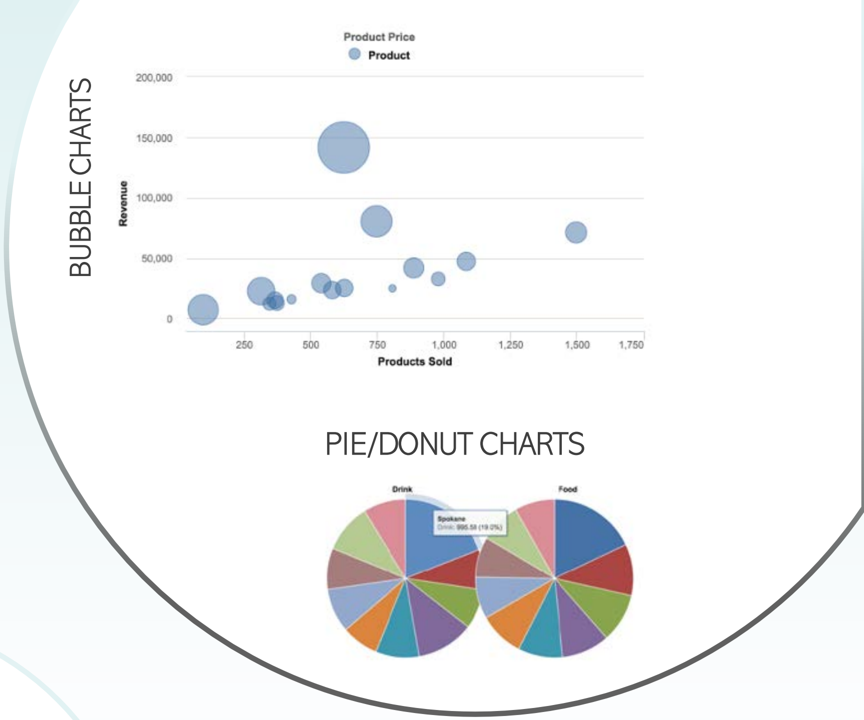
Visualizations have been realized by implementing with *Processing*



http://www.stefanieposavec.com/writing-without-words

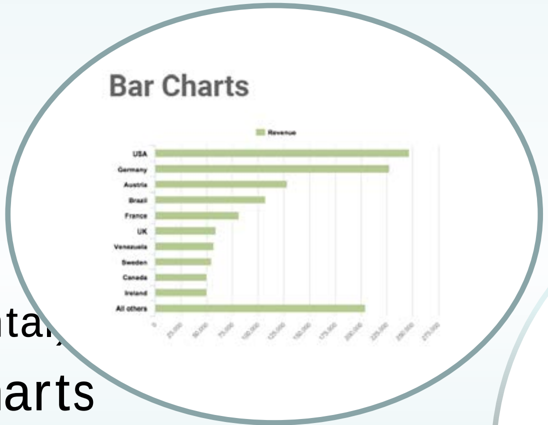


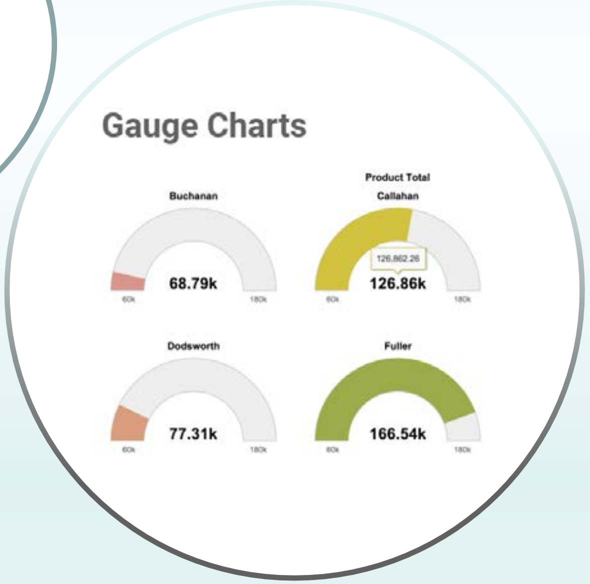




Graphs Explosion…

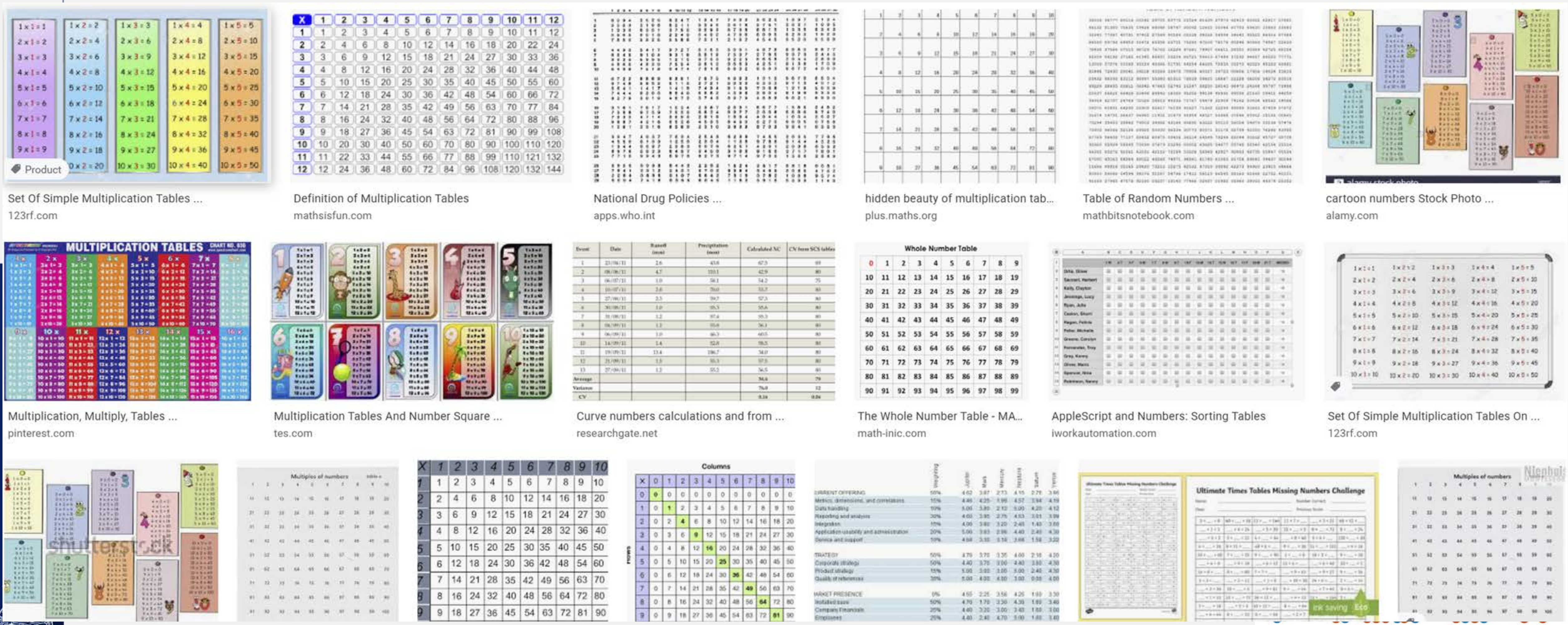
- Gant charts
- plots
- Bar charts (vertical/horizintal)
- Pie Charts and Donut Charts
- Scatter charts
- Bubble charts
- Gauge charts





Each one with
a peculiarity

And Tables explosion….



What do we use to plot them and see them?

Suppose that for each of the 50 states of the U.S.A. we need to study cancer rates.

Here are the data (csv, xlsx) for years 2005, 2014-2018

WHAT ABOUT A LOOK-UP TABLE??

SILLY TABLE DESIGN BRINGS NO UNDERTSANDING

OR SILLY UNDERSTANDING

Tables are generally used for looking up specific numbers,

BUT:

They should be well organized

They should be placed in the right place

They should be well designed

The should contain the right data

Product	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Product 01	93,993	84,773	88,833	95,838	93,874	83,994	84,759	92,738	93,728	93,972	93,772	99,837
Product 02	87,413	78,839	82,615	89,129	87,303	78,114	78,826	86,246	87,167	87,394	87,208	92,848
Product 03	90,036	81,204	85,093	91,803	89,922	80,458	81,191	88,834	89,782	90,016	89,824	95,634
Product 04	92,737	83,640	87,646	94,557	92,620	82,872	83,626	91,499	92,476	92,716	92,519	98,503
Product 05	86,245	77,785	81,511	87,938	86,136	77,071	77,773	85,094	86,002	86,226	86,043	91,608
Product 06	88,833	80,119	83,956	90,576	88,720	79,383	80,106	87,647	88,582	88,813	88,624	94,356
Product 07	82,614	74,511	78,079	84,236	82,510	73,826	74,498	81,511	82,382	82,596	82,420	87,751
Product 08	85,093	76,746	80,421	86,763	84,985	76,041	76,733	83,957	84,853	85,074	84,893	90,384
Product 09	87,646	79,048	82,834	89,366	87,535	78,322	79,035	86,475	87,399	87,626	87,440	93,095
Product 10	90,275	81,420	85,319	92,047	90,161	80,672	81,406	89,070	90,021	90,255	90,063	95,888

Product	Jan	Feb	Mar	Apr	May	Jun
Product 01	93,993	84,773	88,833	95,838	93,874	83,994
Product 02	87,413	78,839	82,615	89,129	87,303	78,114
Product 03	90,036	81,204	85,093	91,803	89,922	80,458
Product 04	92,737	83,640	87,646	94,557	92,620	82,872
Product 05	83,733	75,520	79,137	85,377	83,627	74,826
Total	447,913	403,976	423,323	456,705	447,346	400,264

Why not using colorbars??

Esempio

Let’s using colorbars in the csv

Anyhow,

How could we create good tables?

When could we use them?

The Gestalt principles and data/ink ratio will help us!

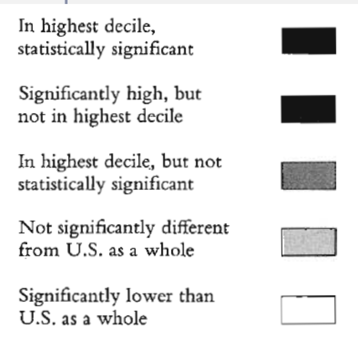
Otherwise, we could use maps, e.g. interactive maps:

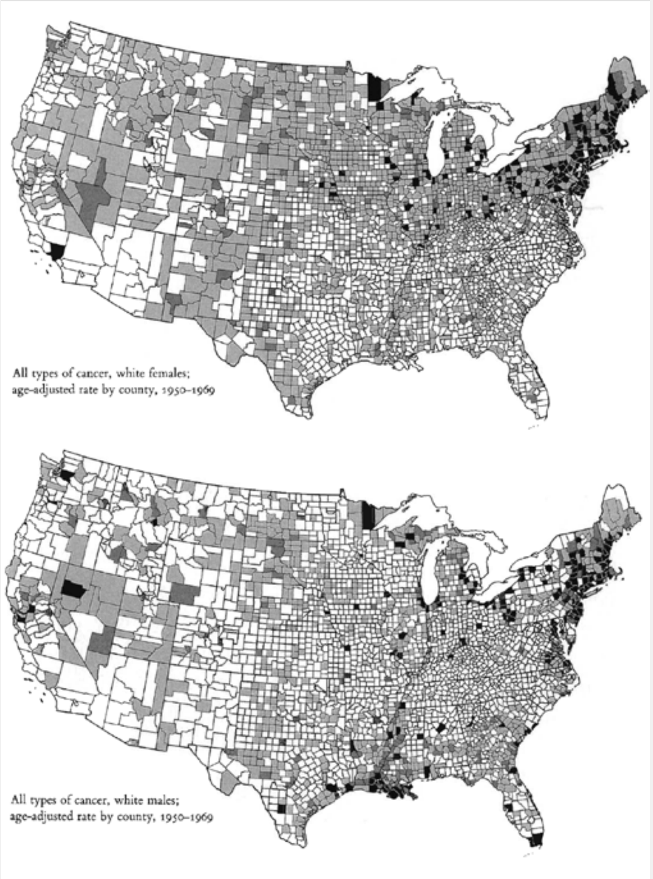
https://www.cdc.gov/nchs/pressroom/sosmap/cancer_mortality/cancer.htm

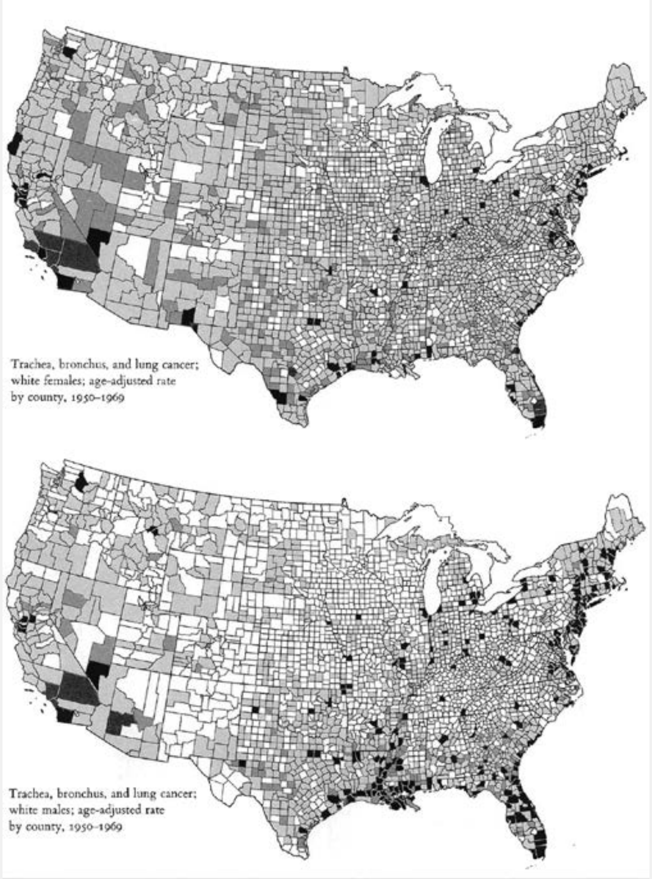
Here is a (per country) solution: same periods but different types of cancers

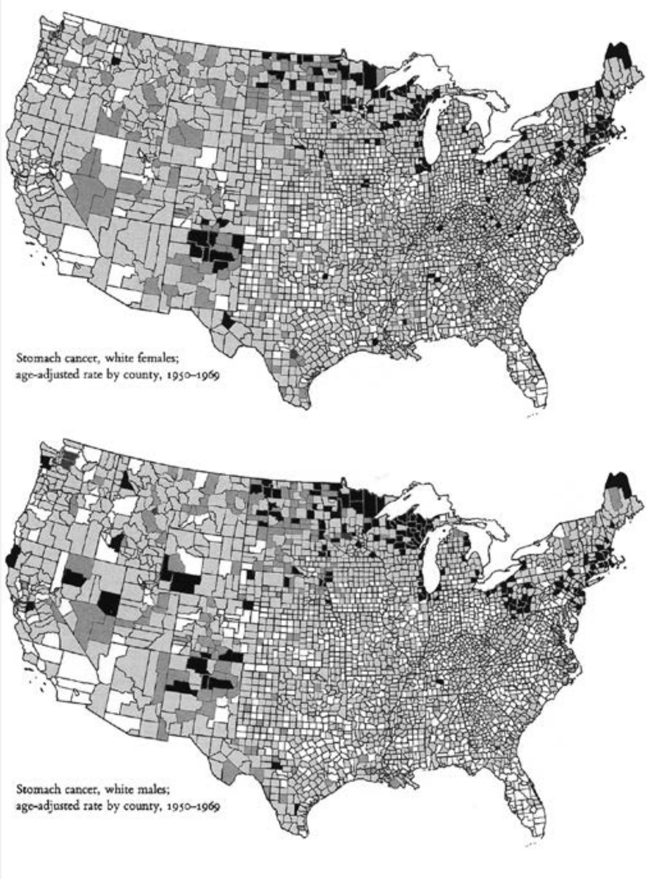
Maps of age adjusted cancer rates for the 3056 countries in the USA. The size and shape of each country might be described by at least four values…

THIS MAP VISUALIZES: 3056*(1 + 4) values









What we «see» when looking at the picture:

- High low rates
- Hot spots
- Women / men difference in rates
- Type of tumour

Looking at data we may capture risk zones and men/wemen risks

E.g. we could start planning ad hoc screens in different areas or try to understand in there are particular reasons for cancers being concentrated in certain areas.

We could use maps

RECALL THAT SILLY DATA BRING TO SILLY VISUALIZATIONS!

Data must be well done

- Data should not be biased (Plotted data are diagnosis data. What if there are errors in diagnosis?)
- Moreover, cancer rate must be age-adjusted, sex-adjusted,….

Maps of **age adjusted** cancer rates for the 3056 countries in the USA.

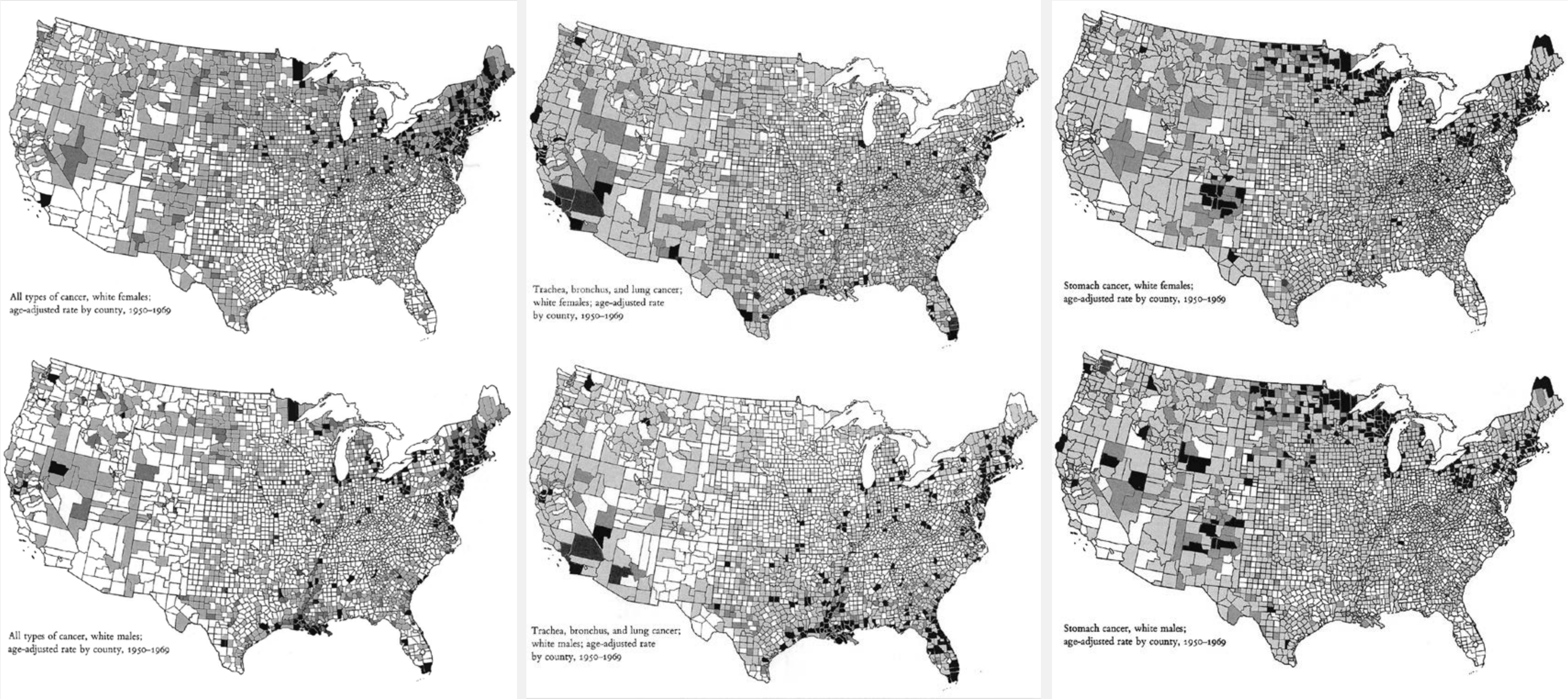
In highest decile, statistically significant

Significantly high, but not in highest decile

In highest decile, but not statistically significant

Not significantly different from U.S. as a whole

Significantly lower than U.S. as a whole



x-ADJUSTED … what does it mean?

Example with AGE-ADJUSTED

Study the rate of an event in the population of geographic area G

INPUT:

H : age ranges

H = {h1,h2,h3, …h20} = {1-4, 5-9, 10-14, …, 75-79, 80-84, …, 95-99}

Age Standardization of Death Rates: Implementation of the Year 2000 Standard

If N is the number of age ranges

Estimate the number of event for each age range

E = [e(h1), …, e(hN)]

e(hi) = # of events in persons living in geographic area G with age hi

Estimate the number of persons in G for each age.

N = [n(h1), …, n(hN)]

n(hi) = # of persons in G with age hi

--------------------------PROCEDURE------------------------

1) FOR EACH AGE RANGE compute the **age-specific rate (ASR) per h**

ASR(h) answers to the question: if all the persons with age in range h in G were 100,000 which rate would I have measured?

The rate in the area of study (e.g., county, state) for age group h is computed by:

dividing the number of events in people with age h by the number of people with age in h (in geographical area G)

and then multiplying by a constant of 100,000.

This results in an age-specific event rate (ASR) per 100,000 population for the age group h:

$$ASR(h) = \frac{\text{events in age group}}{\text{estimated population of that age group}} \times 100{,}000 = \frac{e(h)}{n(h)} \times 100{,}000$$

Each ASR is normalized by multiplying it by the proportion of the standard population of that same age group (see Tables)

$ASR_{Norm}(h) = ASR(h) \times \text{standard proportion}(h)$

The age-specific results are summed to get the age-adjusted death rate for the area of study.

$$AAR = \sum_{\text{for each age group } h} ASR\ (h)\ x \text{ standard proportion}(h)$$

$$= \sum_{h \in H} ASR_{Norm}(h)$$

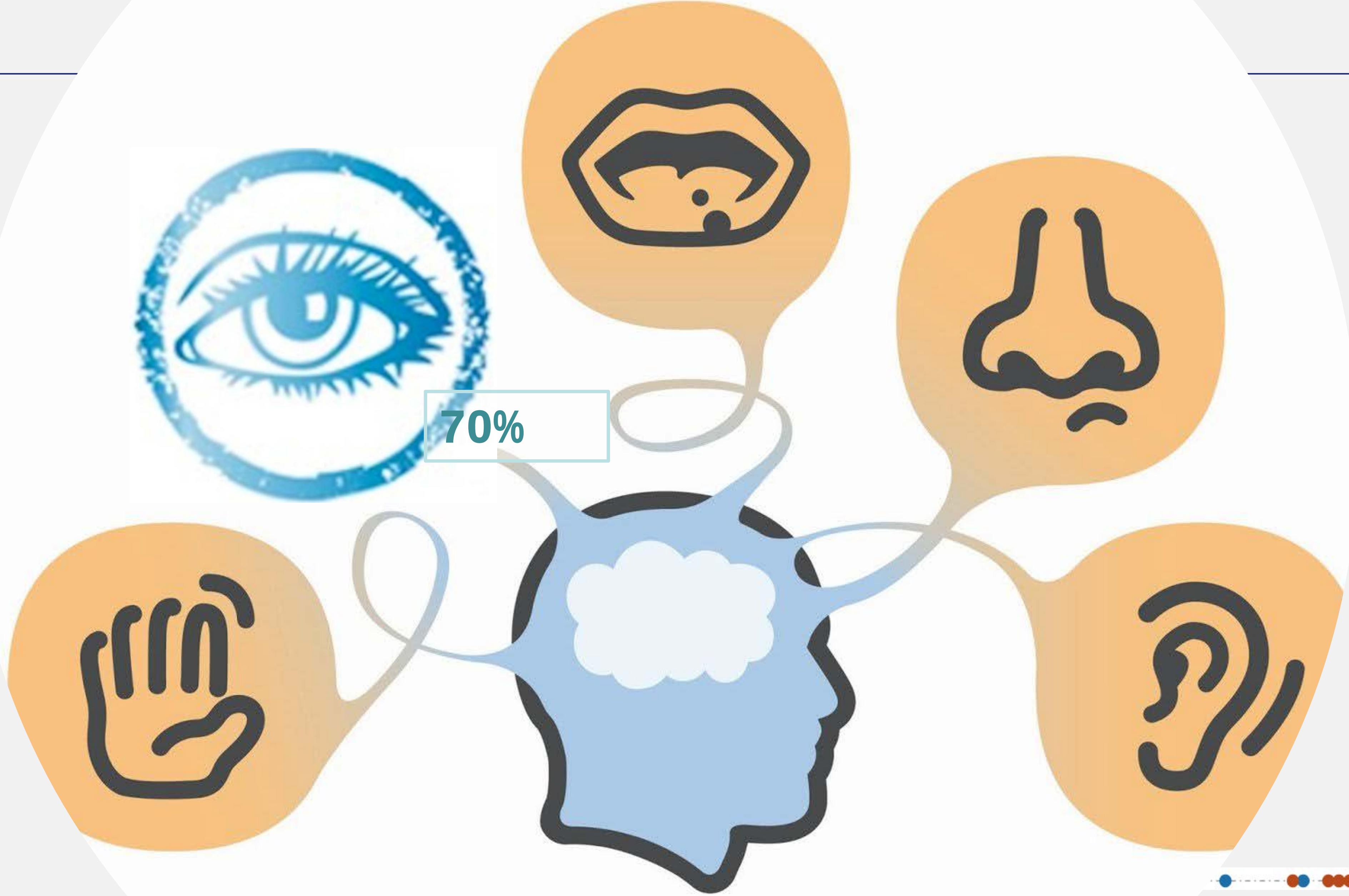
This is called the direct method of standardization.

Revision of the European Standard Population, 2013

Age Group (years)	Standard Population
0,0	1 000
1-4	4 000
5-9	5 500
10-14	5 500
15-19	5 500
20-24	6 000
25-29	6 000
30-34	6 500
35-39	7 000
40-44	7 000
45-49	7 000
50-54	7 000
55-59	6 500
60-64	6 000
65-69	5 500
70-74	5 000
75-79	4 000
80-84	2 500
85-89	1 500
90-94	800
95+	200
Total	**100 000**

Age	1940 Proportion	1970 Proportion	2000 Proportion
Under 1 year	0.015343	0.017151	0.013818
1 - 4 years	0.064718	0.067265	0.055317
5 - 14 years	0.170355	0.200506	0.145565
15 - 24 years	0.181677	0.174406	0.138646
25 - 34 years	0.162066	0.122569	0.135573
35 - 44 years	0.139237	0.113614	0.162613
45 - 54 years	0.117811	0.114265	0.134834
55 - 64 years	0.080294	0.091480	0.087247
65 - 74 years	0.048426	0.061195	0.066037
75 - 84 years	0.017303	0.030112	0.044842
85 and over	0.002770	0.007435	0.015508
All ages	1.000000	1.000000	1.000000

> Vision trumps all other senses. We learn and remember best through pictures, not through written or spoken words.
>
> —John Medina, *Brain Rules*


70%

70% of **sensory receptor** are for viewing

Therefore vision captures the **70%** of the stimuli humans receive from the external world

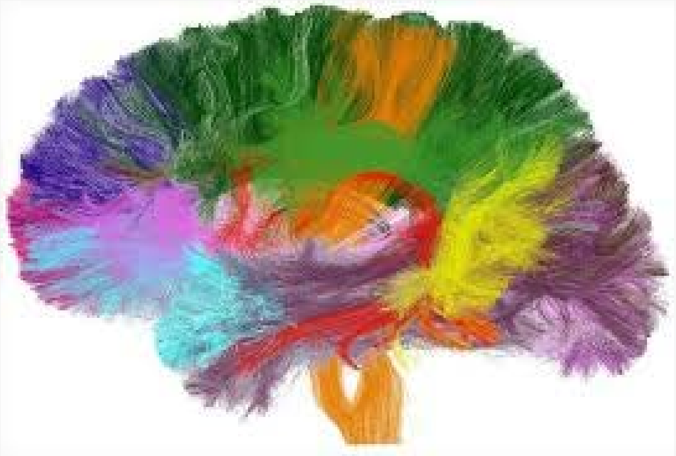
Stephen Few, «Show me the Numbers», pag 61
http://www.percezionevisiva.com/anatomia-occhio/

Most of our cognition then happens thanks to vision!

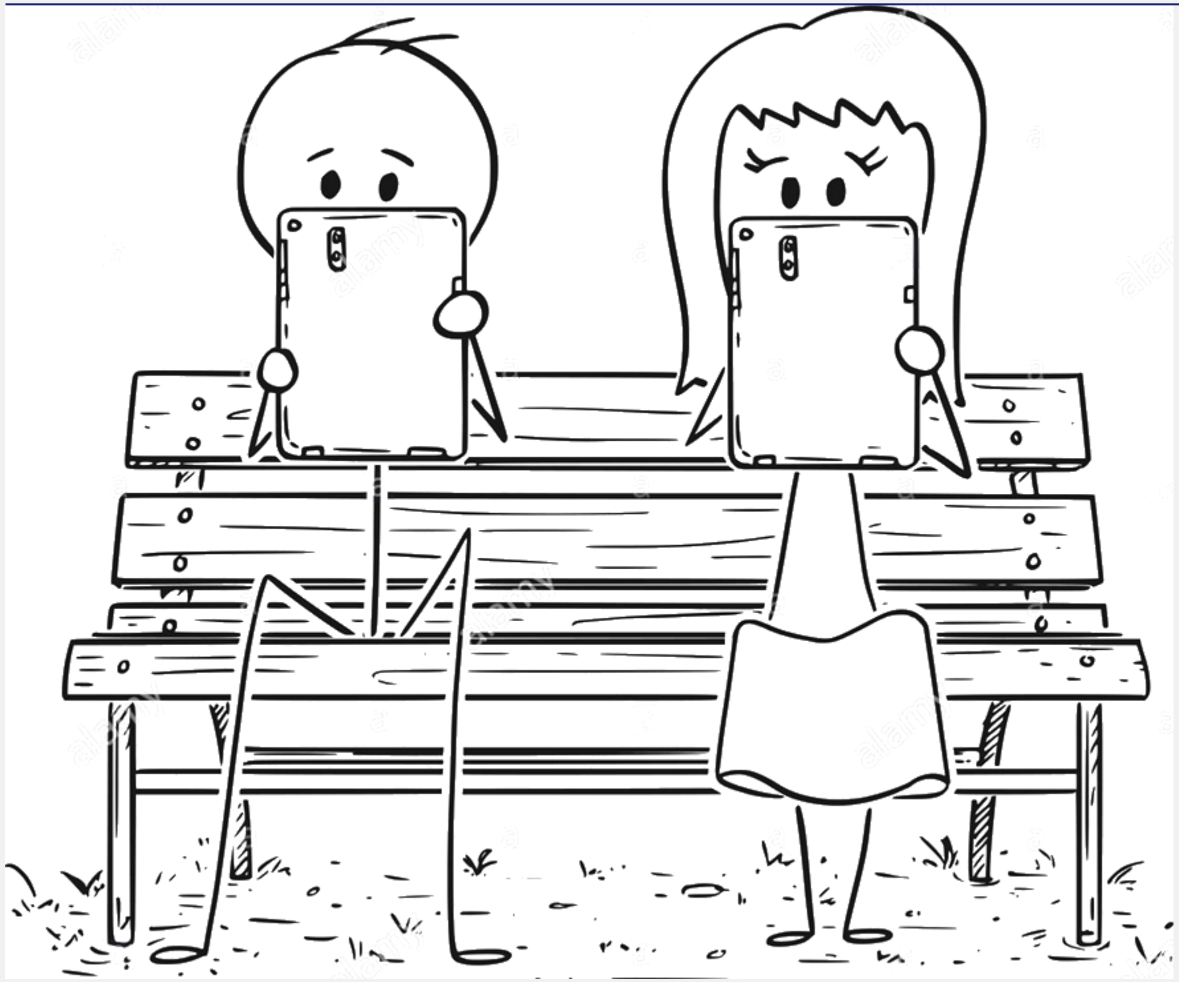
Sensation-Perception-Cognition

«La caratteristica distintiva dei cervelli come il nostro è la prodigiosa capacità di creare mappe»

Antonio Damaso, Self Comes to Mind: Constructing the conscious brain



https://www.quag.com/it/thread/26682/andy-clark-la-natura-incorporata-della-cognizione-umana-e-la-mente-estesa/



Suppose you are sitting in the park…

Reading a book…

Relaxed and concentrated in your reading

WHO/WHAT SAW THE BALL? WHAT ALLOWED US TO SEE THE BALL?

Something inside us saw the ball withouth us being conscious.

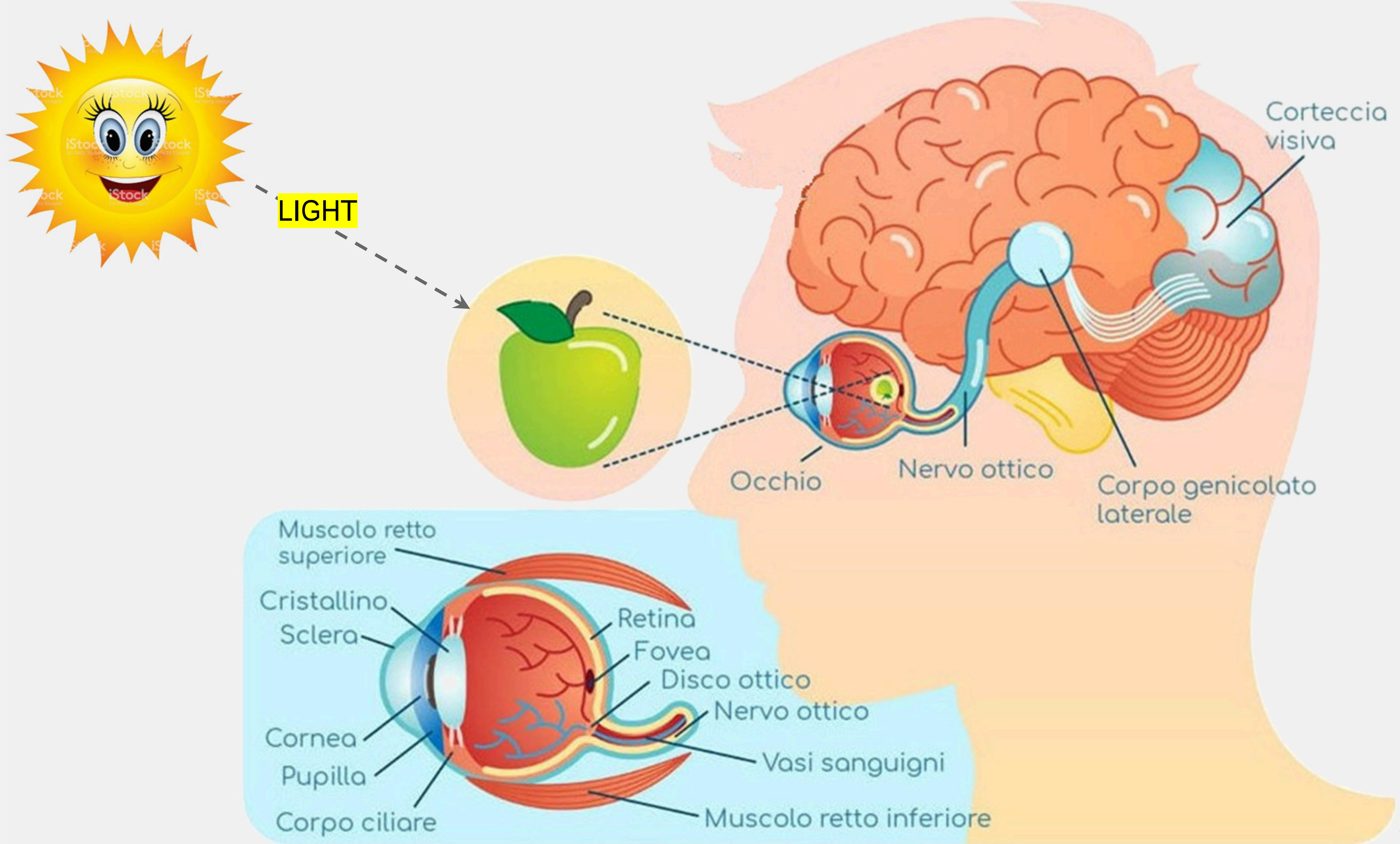
Our mind (our thinking ego) was slow; we recognize that a ball hit us, only when the ball has already hit us and is on the floor

Therefore:

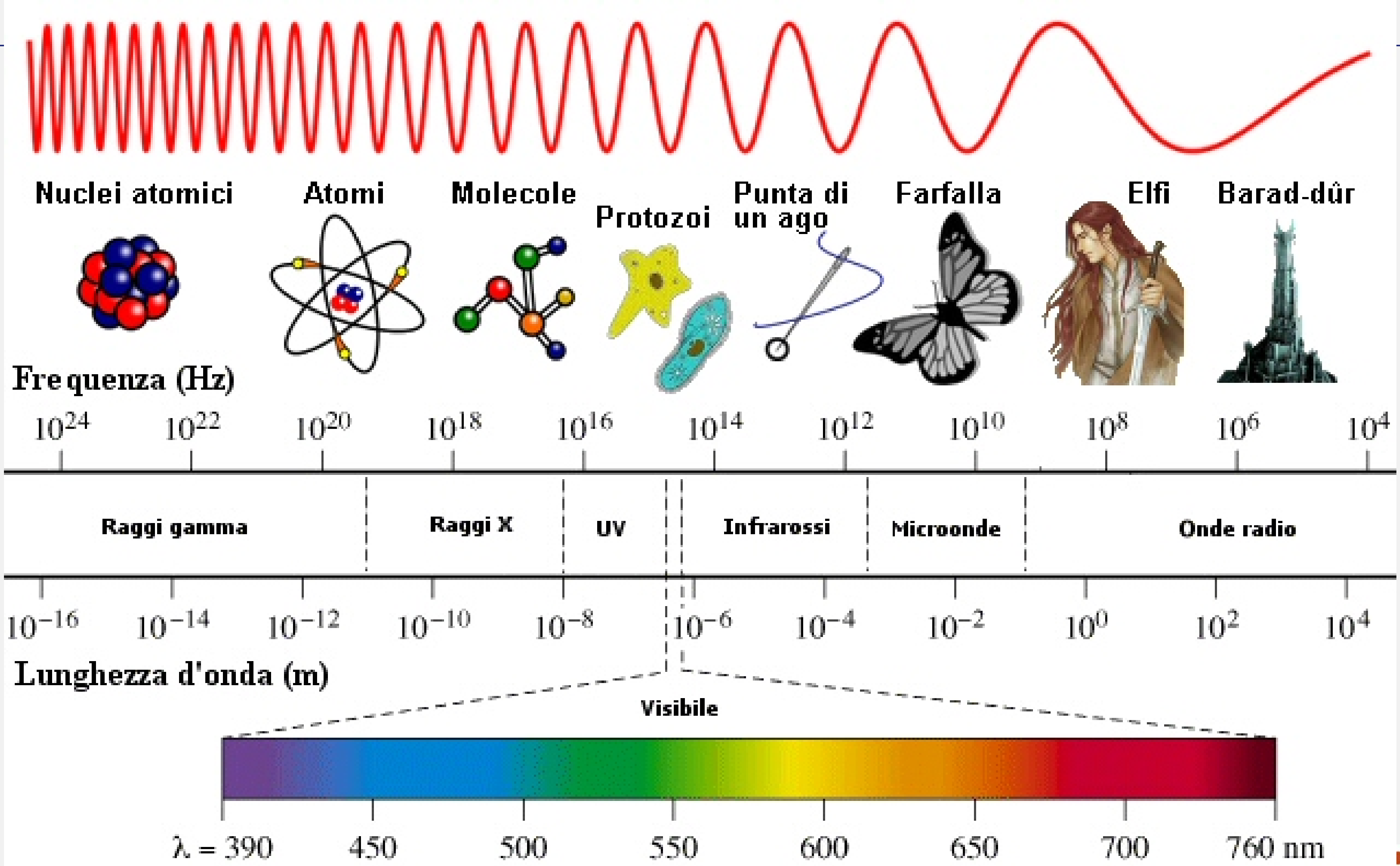
- Vision and Perception are fast, the mind is slow
- The brain is cartographer (IF it sees the ball, it knows where it is and how long it will approximately take before hitting us).
- Though connected, VISION, PERCEPTION, AND COGNITION are different phenomena
    - we see and perceive before having any cognition

HOW ARE VISION / PERCEPTION / MIND INTERACTING AND

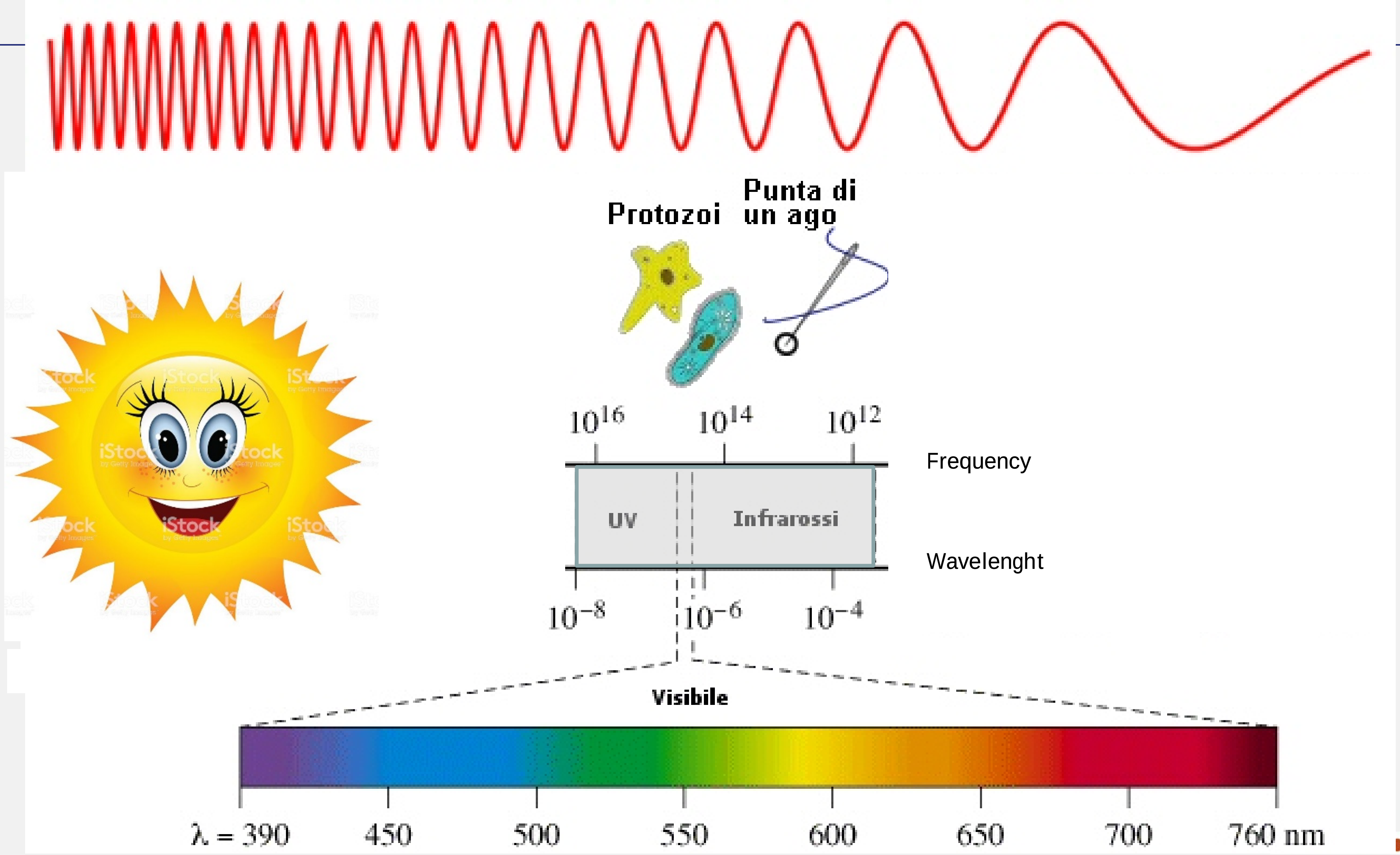
COMMUNICATING TO LET US FORM OUR COGNITION?


LIGHT
Corteccia visiva
Occhio
Nervo ottico
Corpo genicolato laterale
Muscolo retto superiore
Cristallino
Sclera
Cornea
Pupilla
Corpo ciliare
Retina
Fovea
Disco ottico
Nervo ottico
Vasi sanguigni
Muscolo retto inferiore

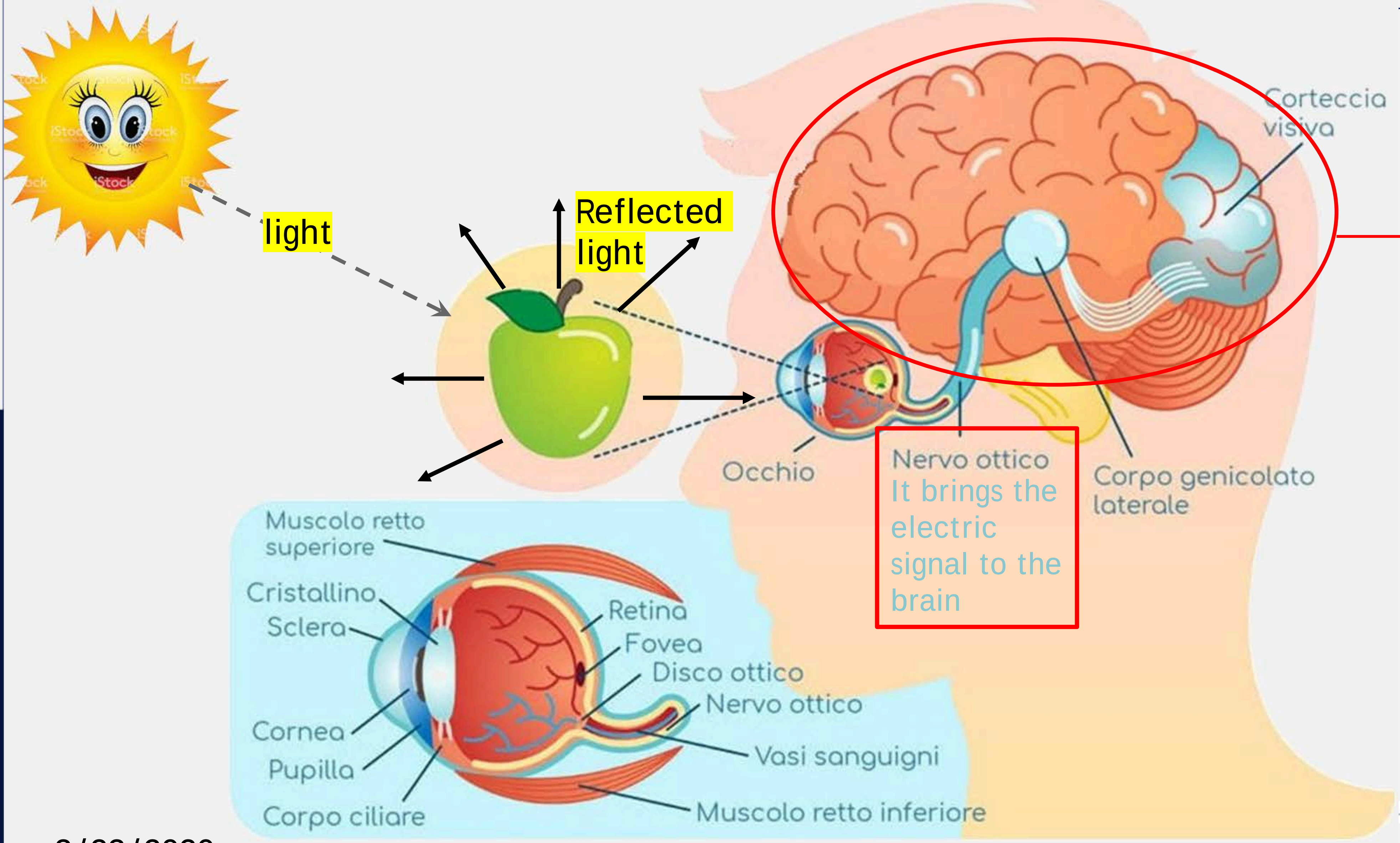
La luca è una Onda/radiazione elettromagnetica



Tra tutte le onde elettromagnetiche la luce solare
è



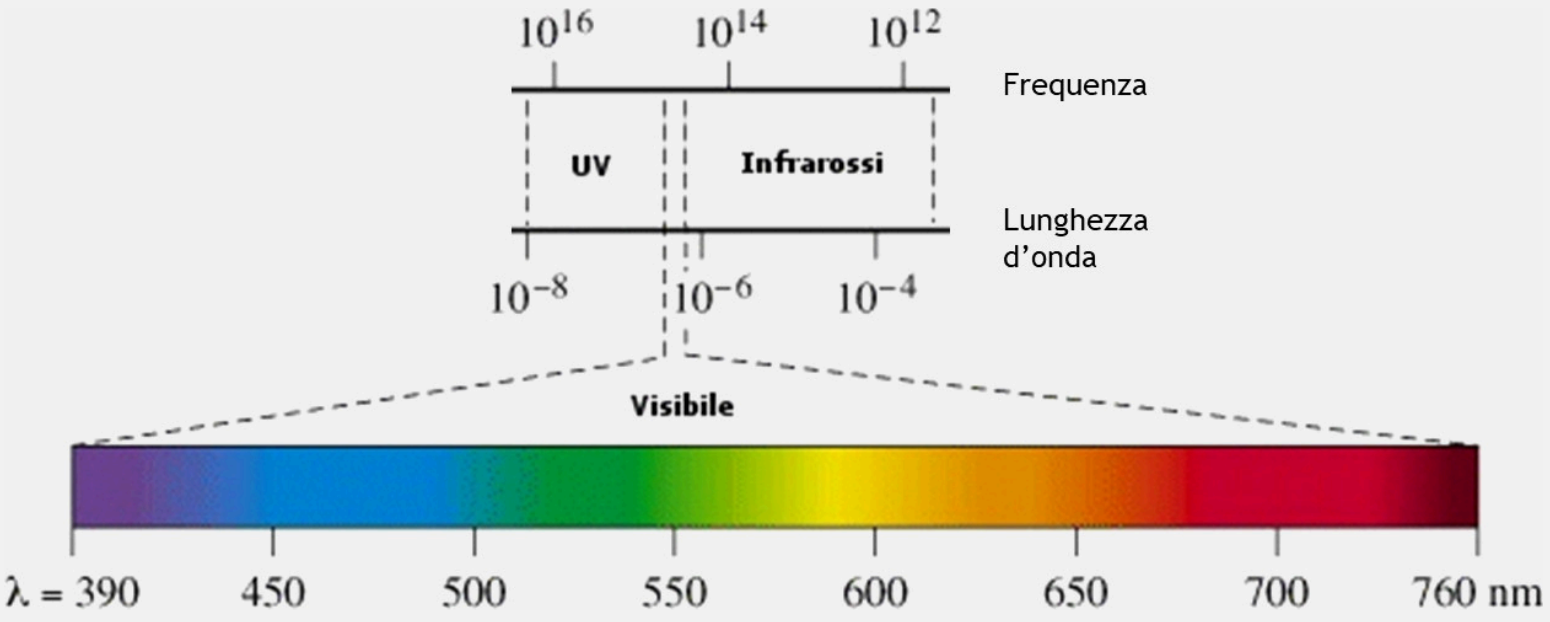
Radiations from light (fotoni) hit the object that absorbs some of them and reflects the others



The brain processes the received signal

We see only a small portion of the light radiation (visible light)

- blu-violet radiations (400-490 nm);
- greed radiations (490-560 nm);
- yellow radiations (560-590 nm);
- red-orange radiations (590-700 nm).

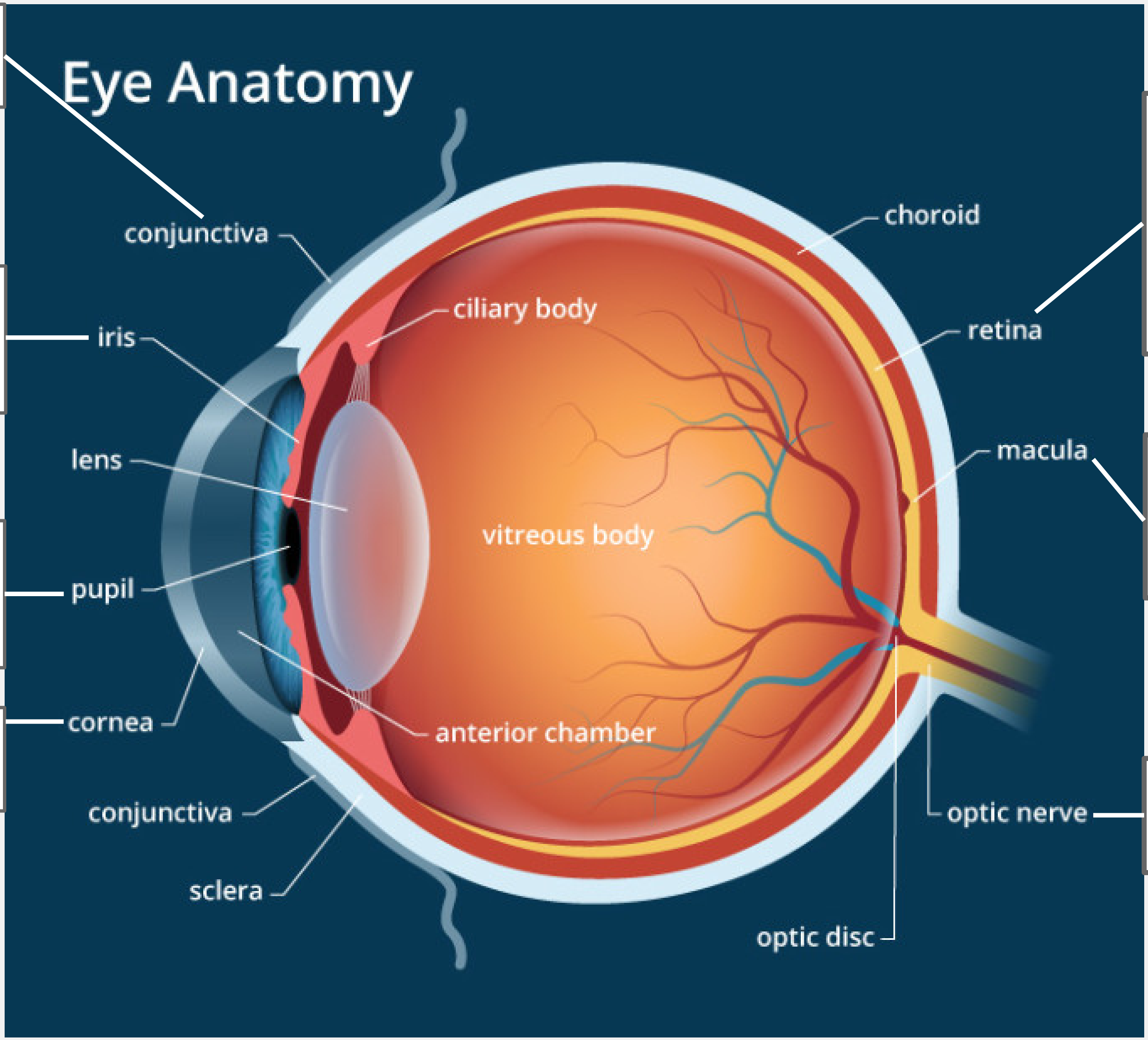


white eye protection

iris: is a muscle that lets more or light to enter the eye

Together with iris functions like the camera objective

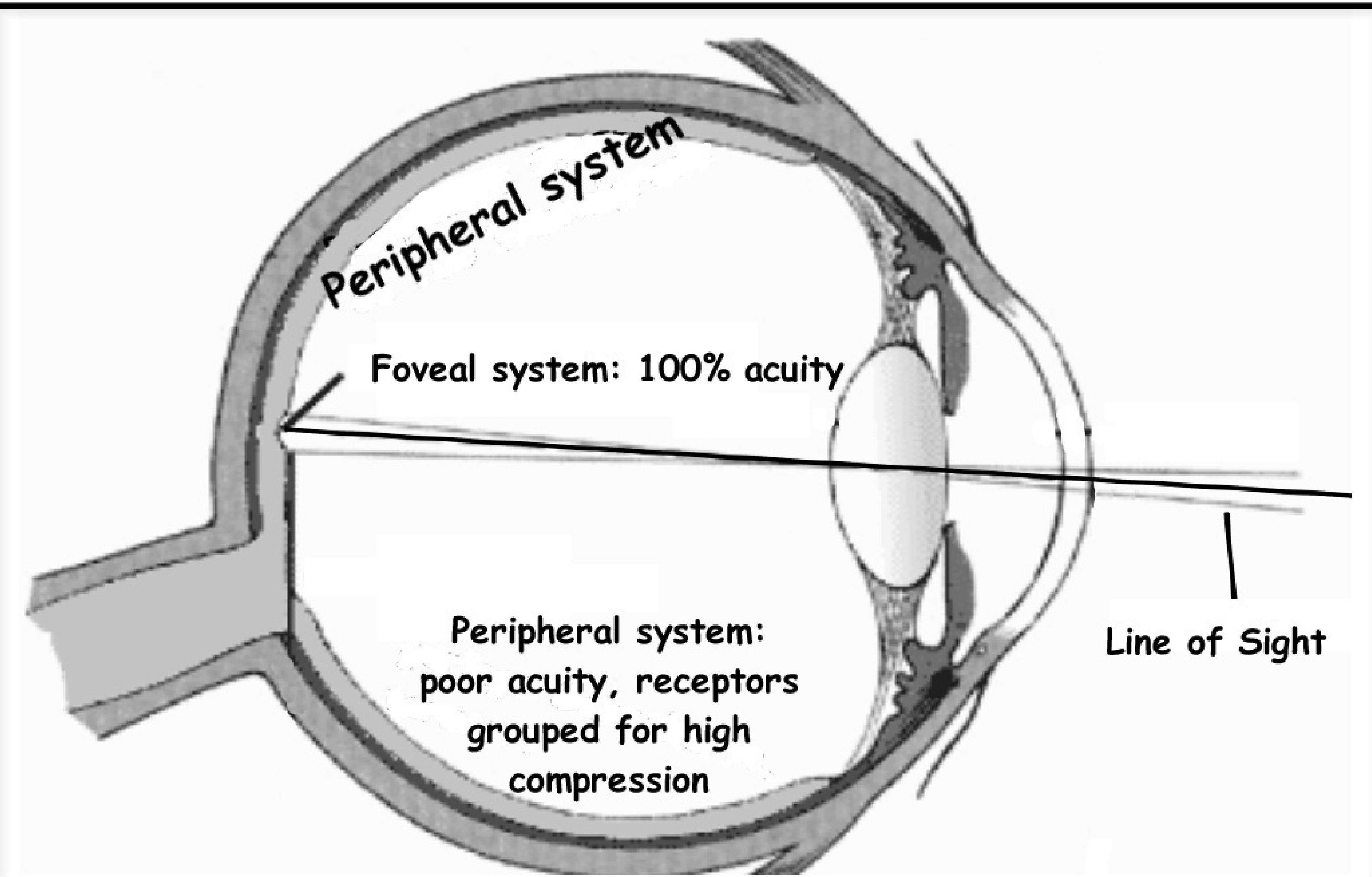
Cornea: protective lens



it is a part of the brain. It contains fotoreceptors for colors (cones) and light/dark (bast

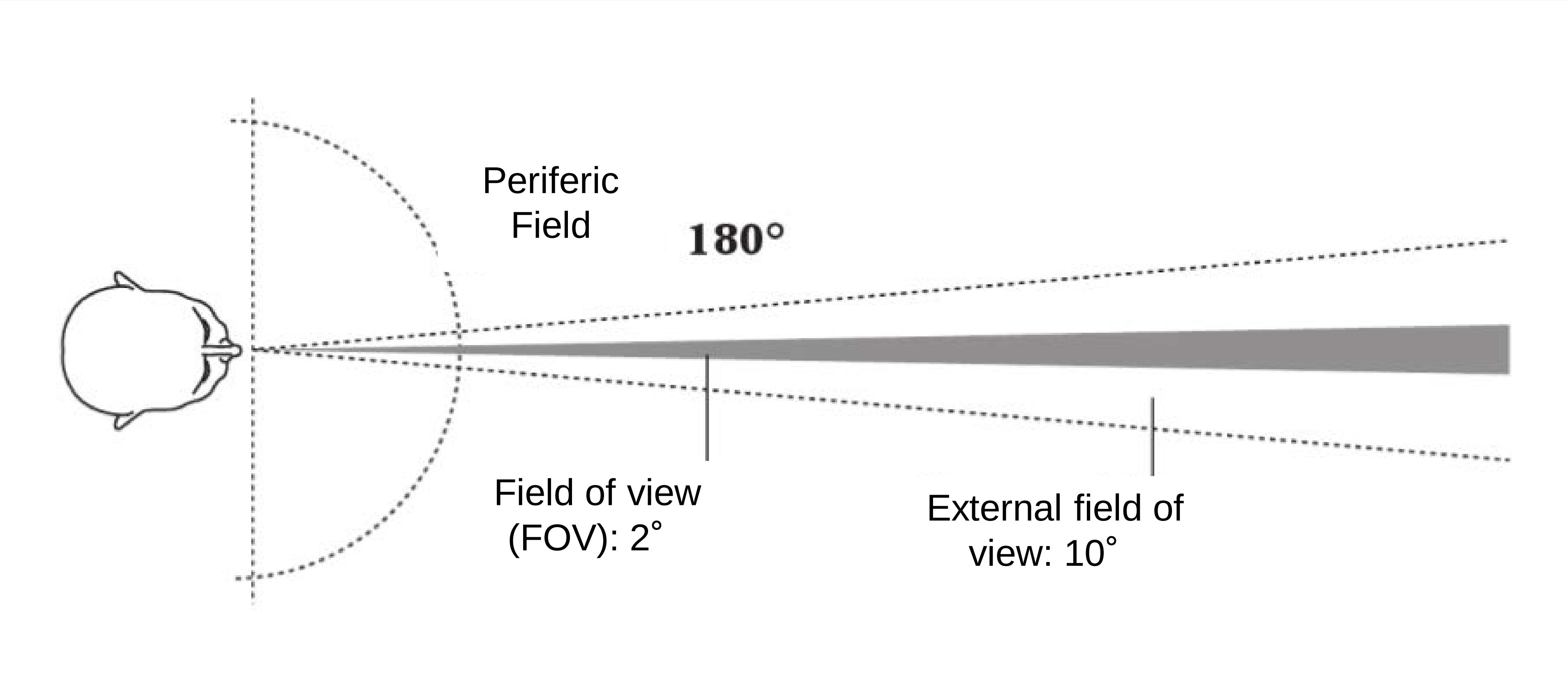
(Fovea) A small part where most of all the photoreceptors are.

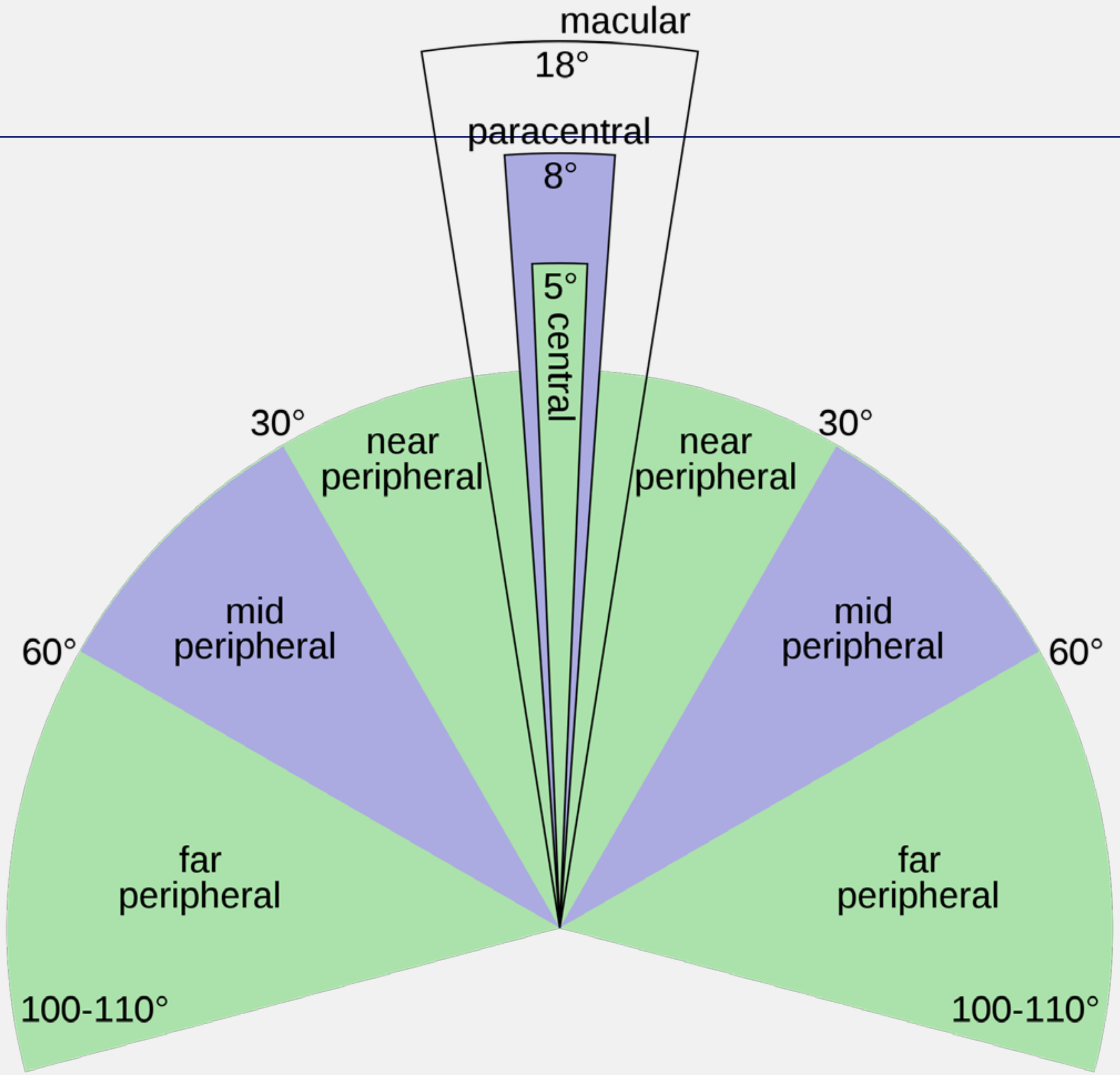
Brings stimuli to the brain



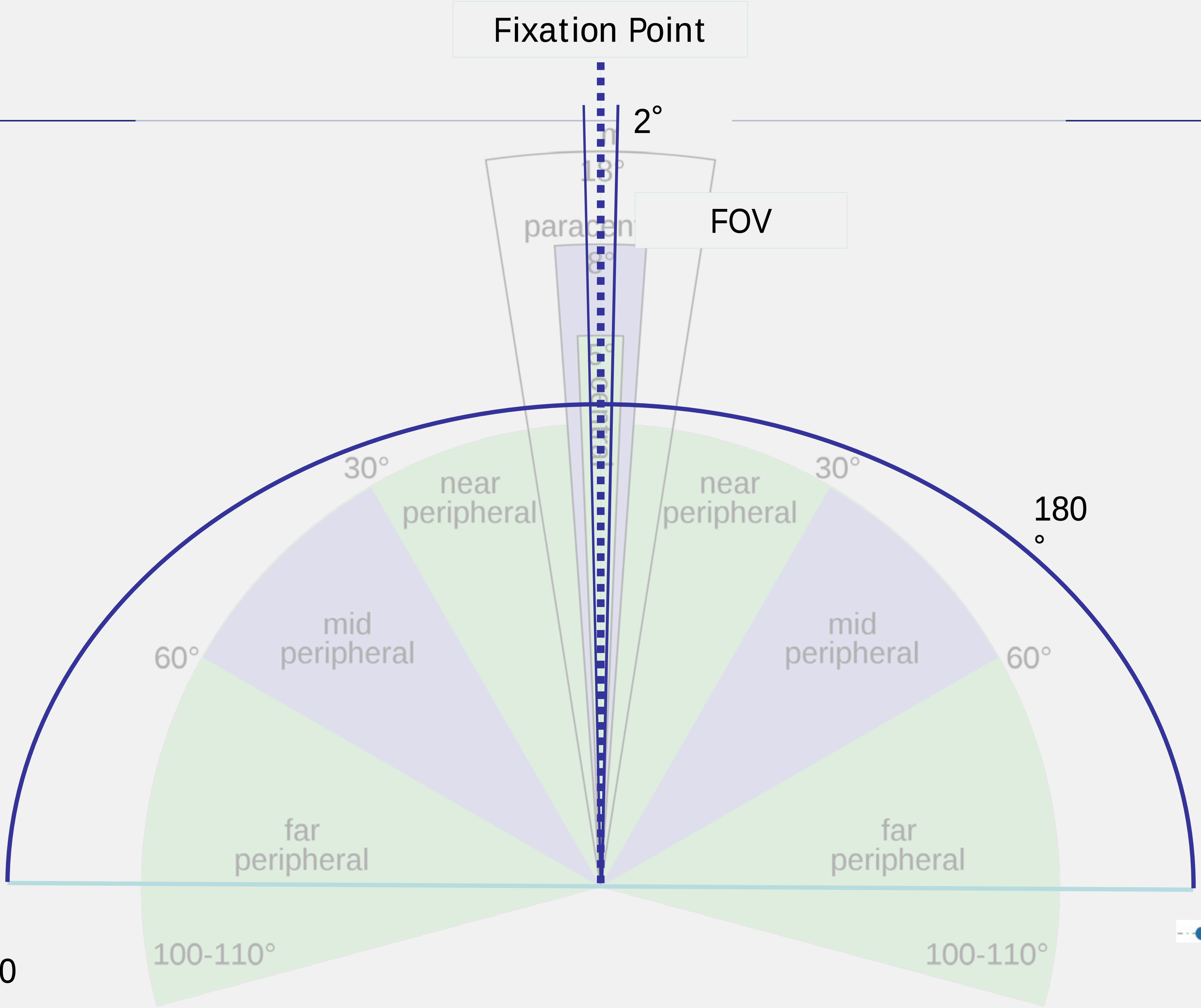
Peripheral system for general holistic impression of the situation.
Foveal system for high quality details.

Foveal vision





macular
18°
paracentral
8°
5° central
30°
near peripheral
30°
near peripheral
60°
mid peripheral
mid peripheral
60°
far peripheral
far peripheral
100-110°
100-110°


Fixation Point
2°
18°
paracent
8°
5°
central
FOV
30°
near
peripheral
30°
near
peripheral
180
°
mid
peripheral
60°
mid
peripheral
60°
far
peripheral
far
peripheral
100-110°
100-110°

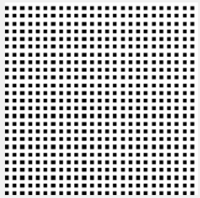
To view details we close the lens to let less light enter into the eye.

Light concentrates into the fovea.

In this way we are able to see 625 points in 1 square inch (2.54 square cm).

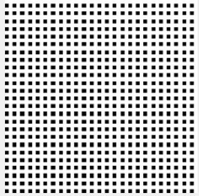
[Edward Tufte (2001). The visual display of quantitative Information]

25 points in 1’’



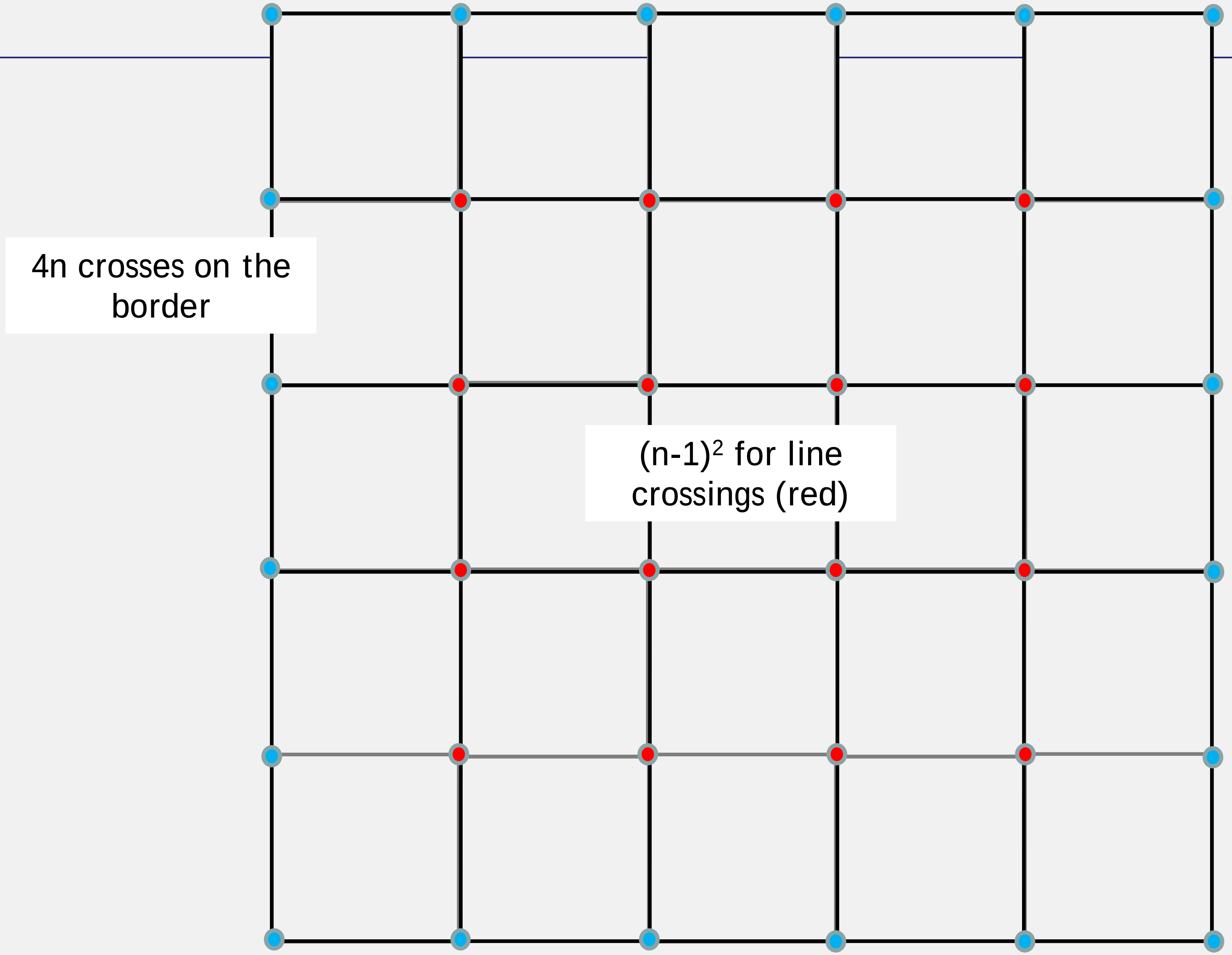
25 points in 1’’

Griglia n x n = 25x25 in 1’’



25 black squares and 26 = white squares for each line

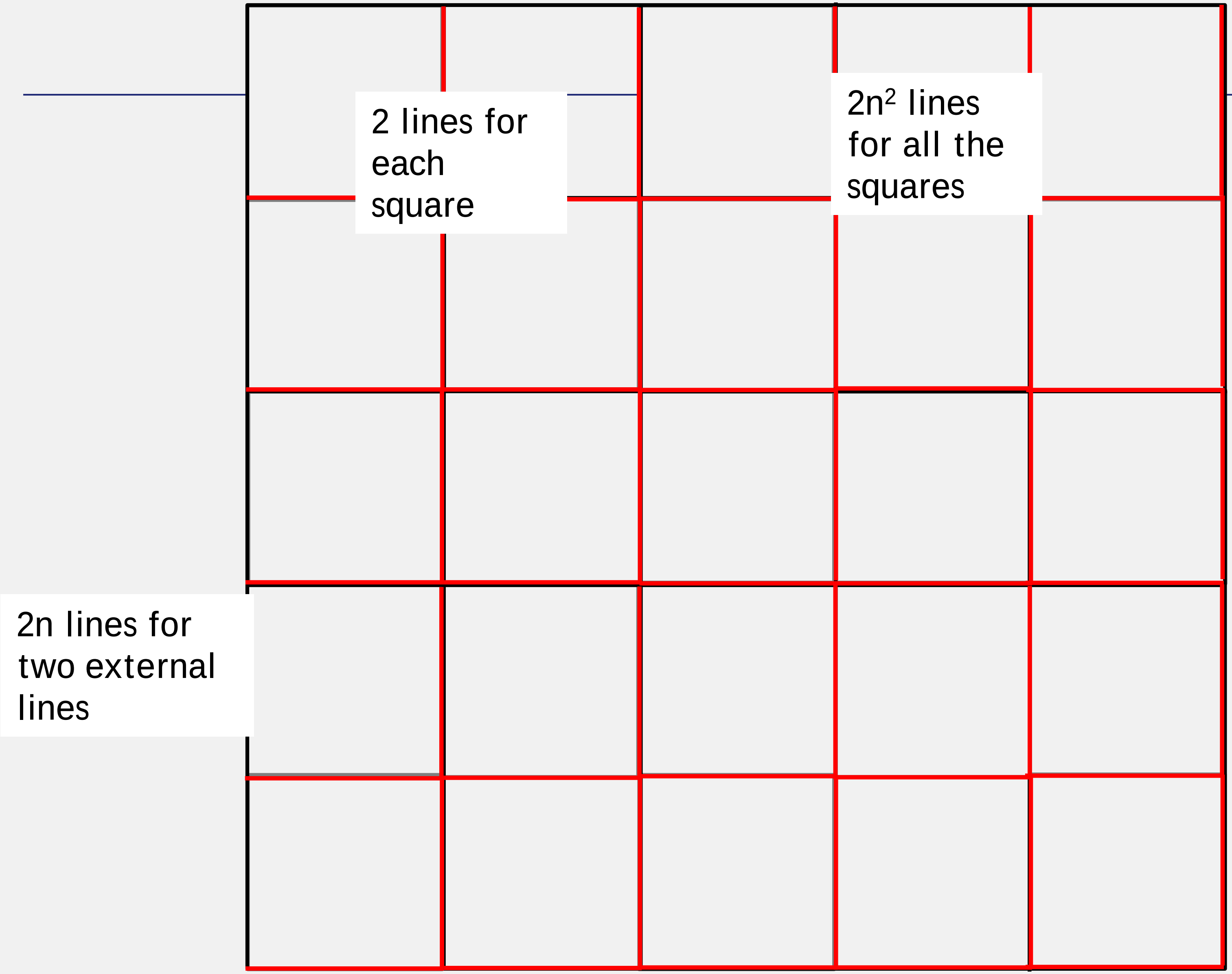
How many details can I see?



I see

$$(n-1)^2 + 4n = (n+1)^2$$

line crosses



$2n^2 + 2*n = 2n(n+1)$ lines

Therefore

$(n+1)^2$ crosses

$2n(n+1)$ lines

Ovvero vedo:

$3n^2 + 6n + 1$ details

which is

$3 * 25^2 + 6 * 25 + 1 =$ dettagli

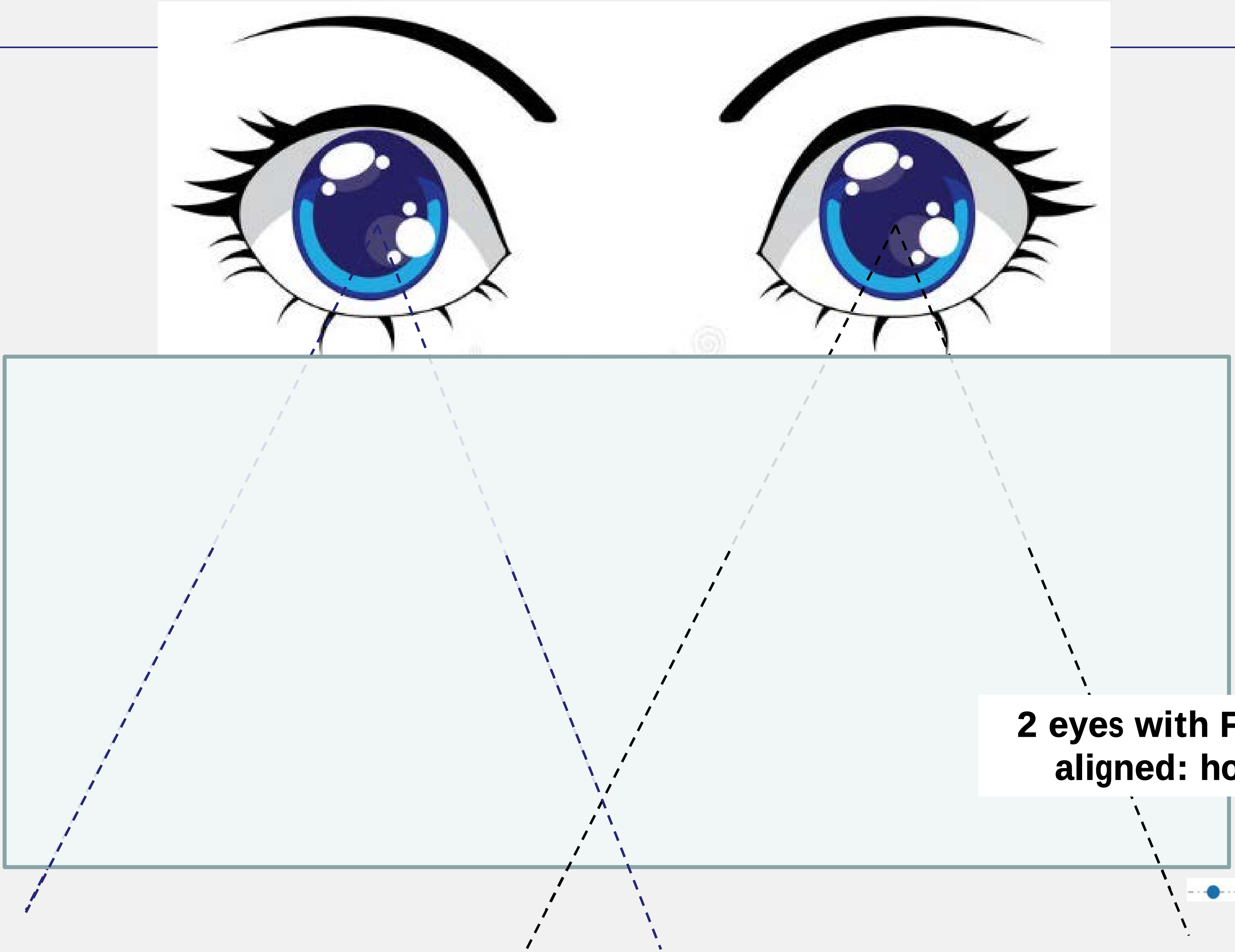
2050 details

This is all seen through stimuli going through macula in the left and right eye

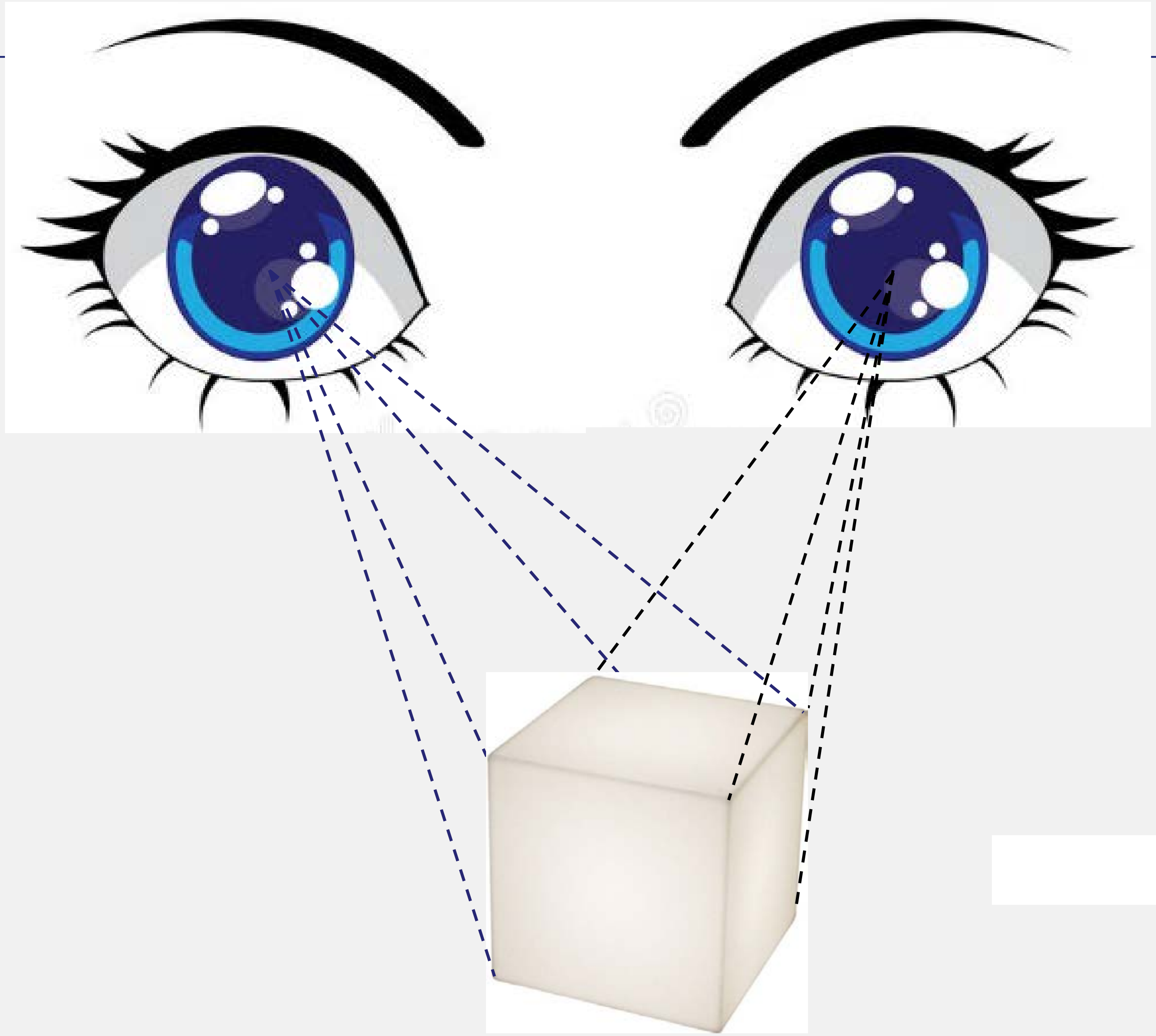
Mind that we have two eyes: fovea (right eye) + fovea (left eye)

The combination of such stimuli produces:

- Horizontal, peripheral view
- 3D view



2 eyes with FOV horizontally aligned: horizontal FOV

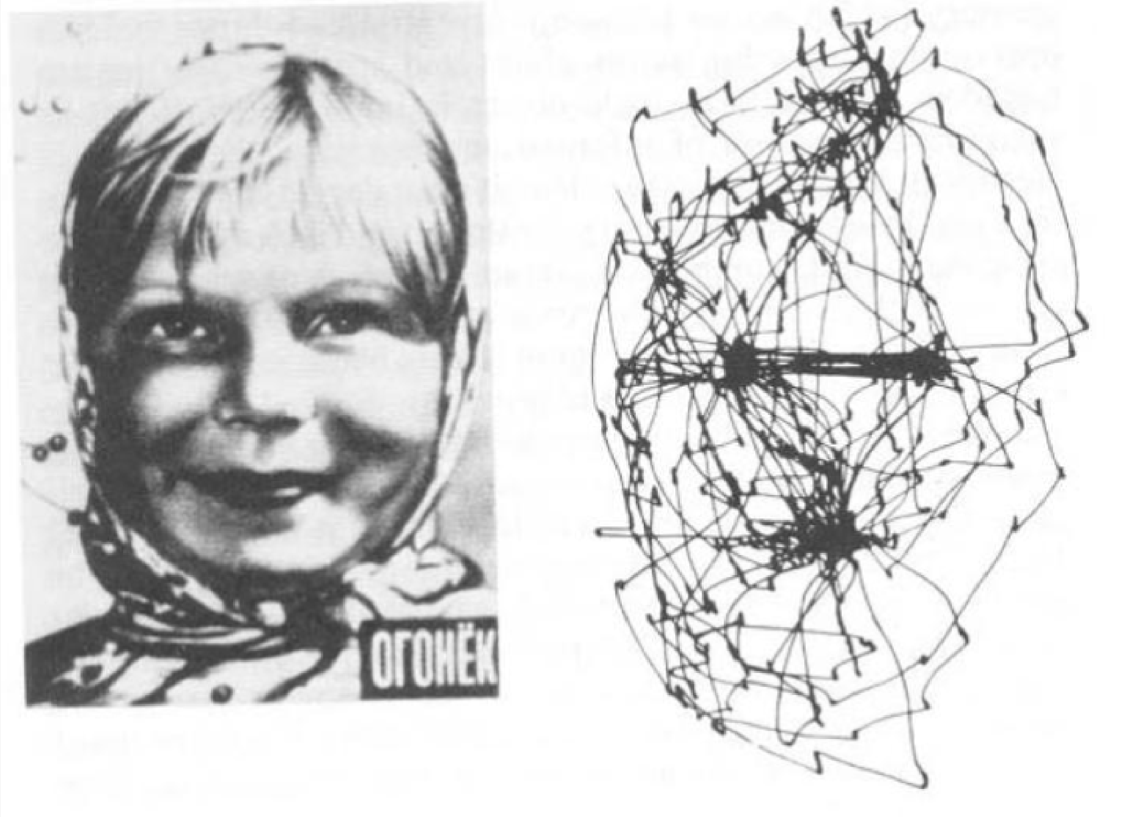


2 eyes: 3D view

The blind spot

SACCADIC movements: eye move with a frequency of 2-3 movements per second

Fixations: when eyes stop on the scene



An experiment:

Movement of the eyes

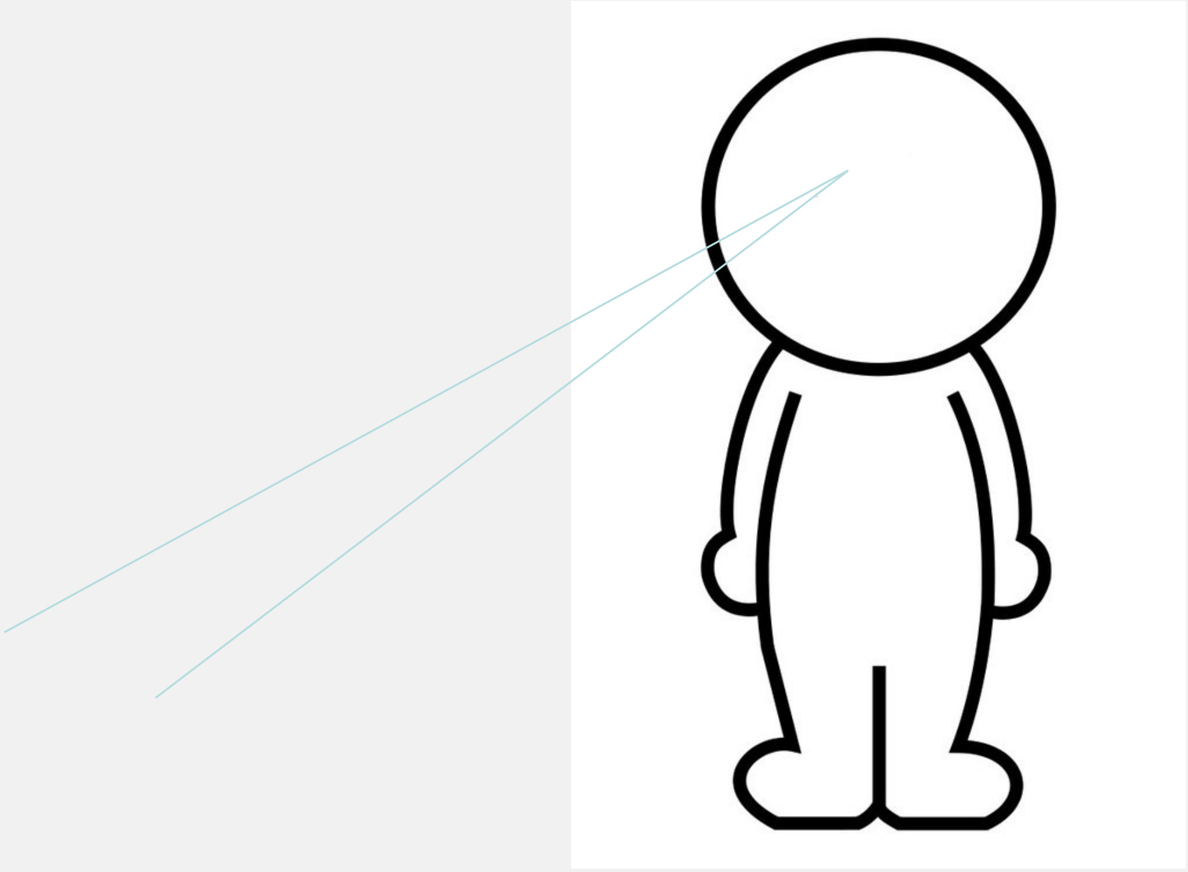
Fixations are on Spots containing points of interest (PoIs)

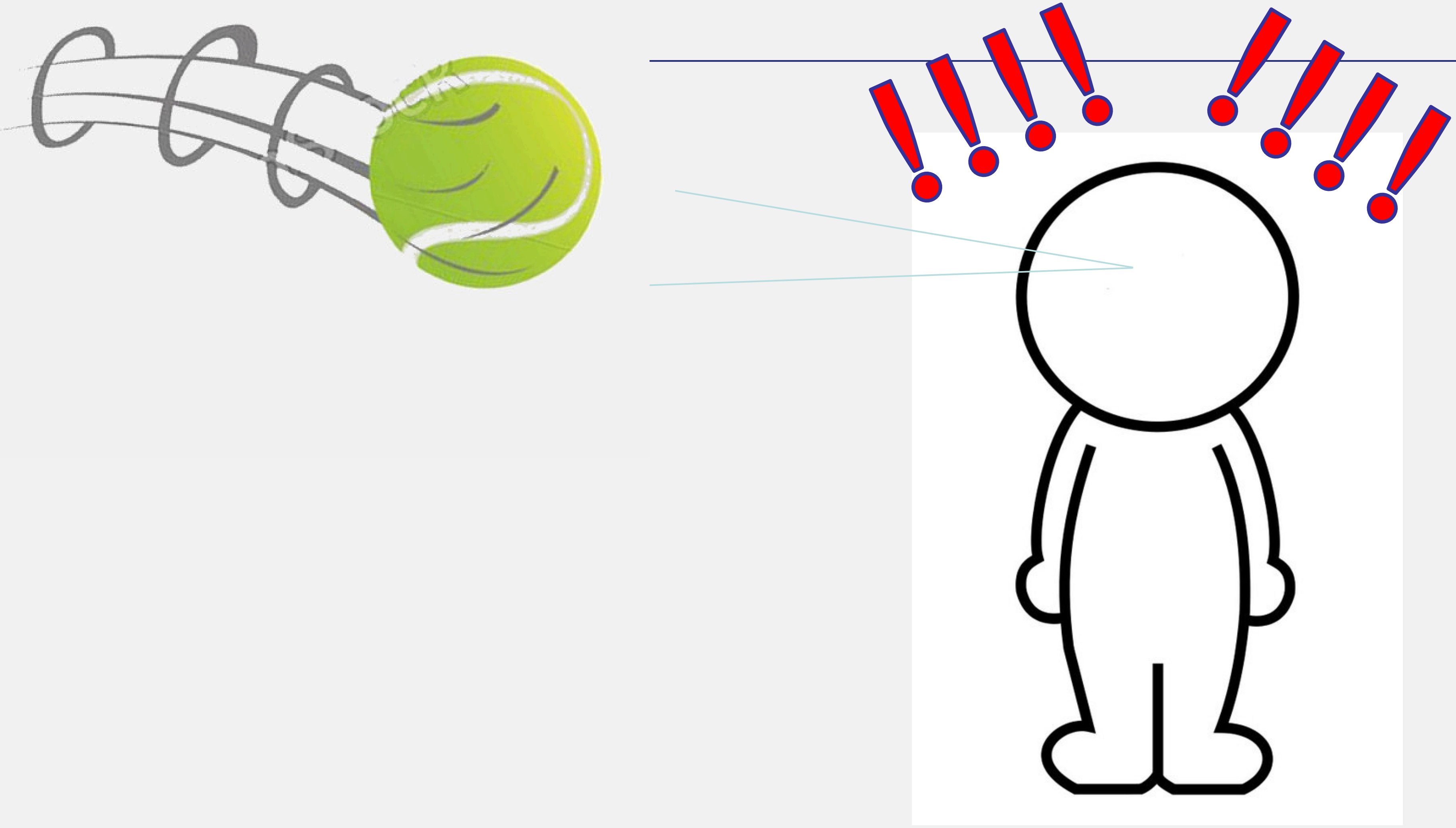
Spots with PoIs:

- contain lots of details (high frequency points)
    - lot of text in the document creates low frequencies. Eyes don’t stop
    - In the desert, a unique advertisement would make your eyes stop on it
- where details are clearer
    - differing fonts for text have different effects
- contain uncommon shapes, or moving (living) shapes
- contain bright/saturated colors

UNIVERSITÀ DEGLI STUDI DI MILANO

Ma se i punti di interesse sono



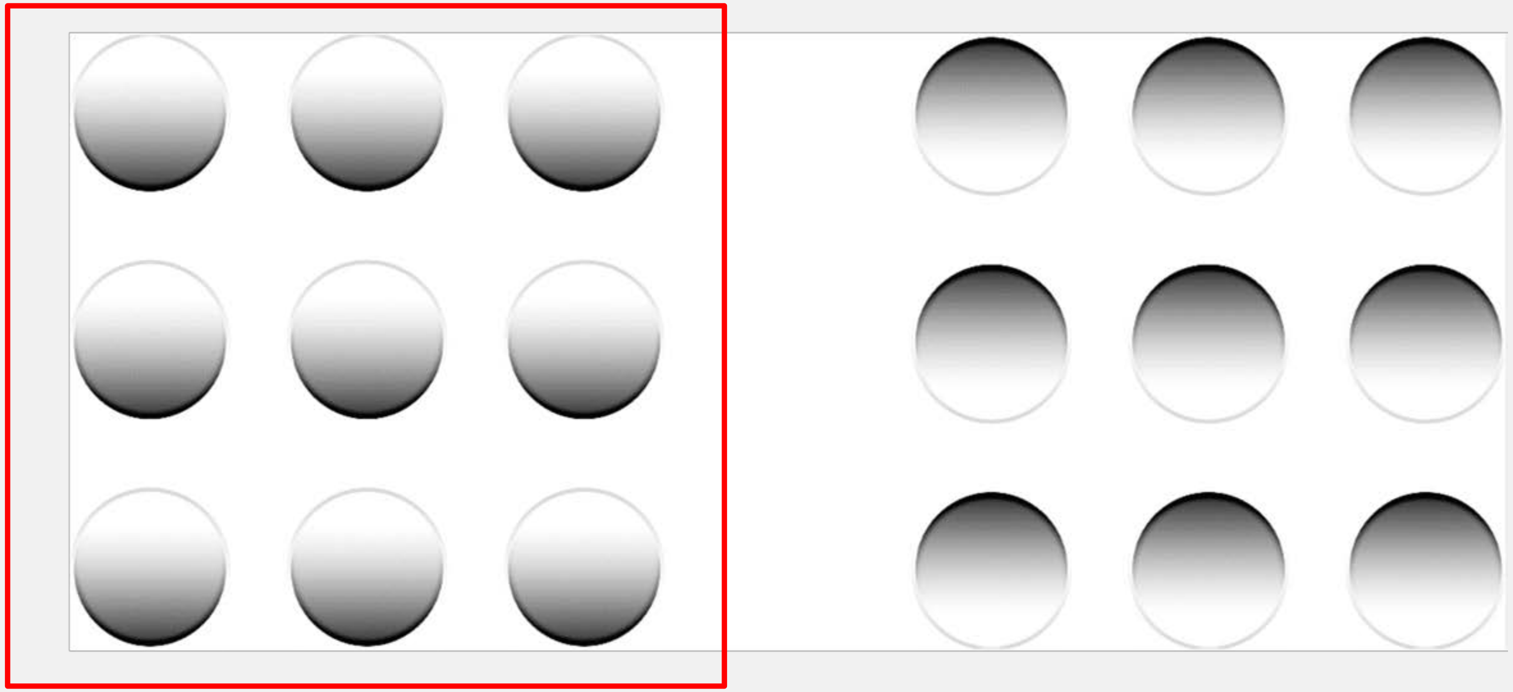


VISION IS NOT PERCEPTION

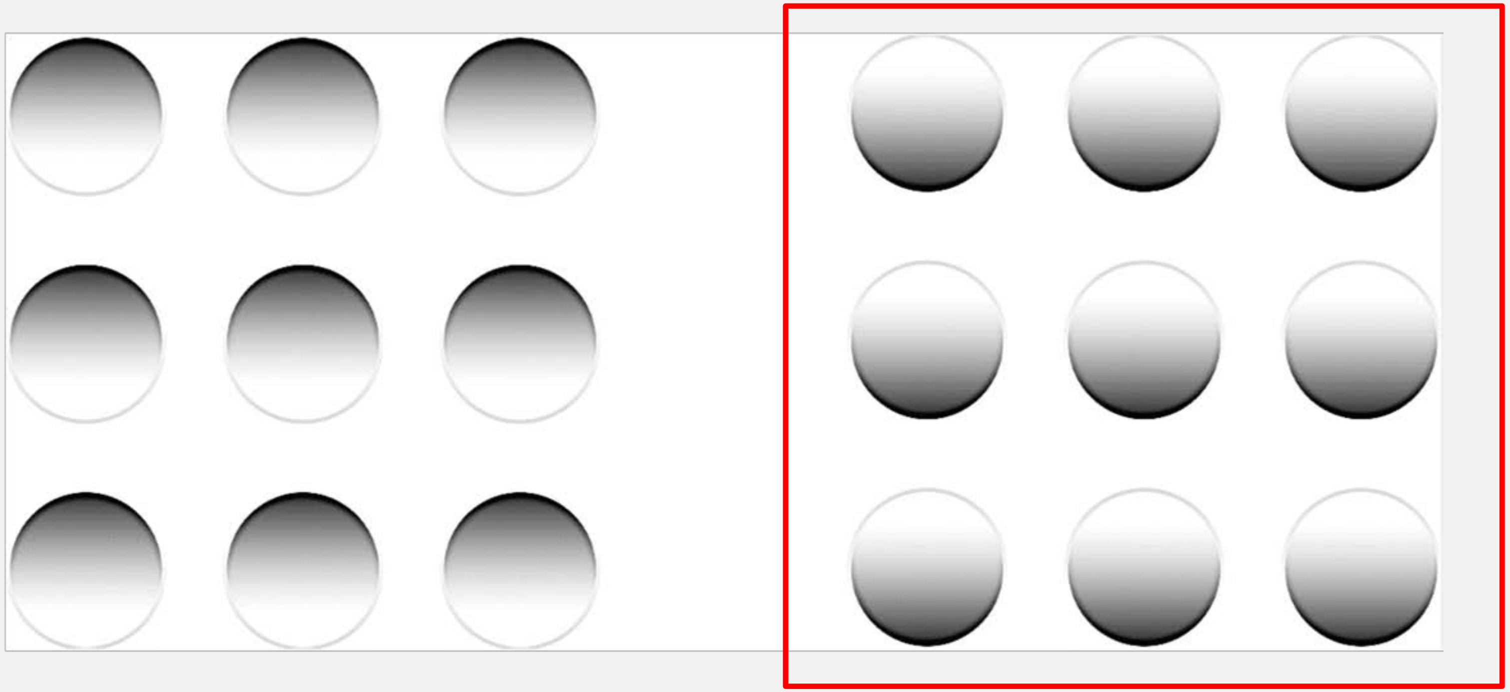
BUT

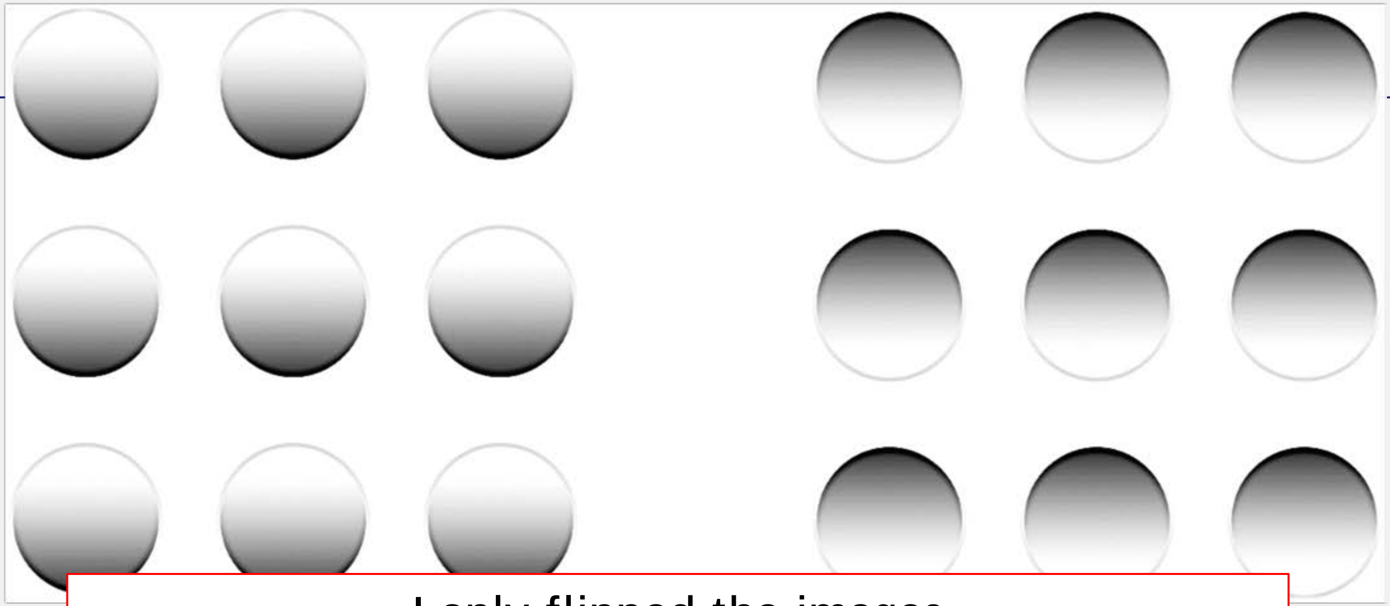
PERCEIVING ALLOWS SEEING

But often vision and brain work together to cheat us

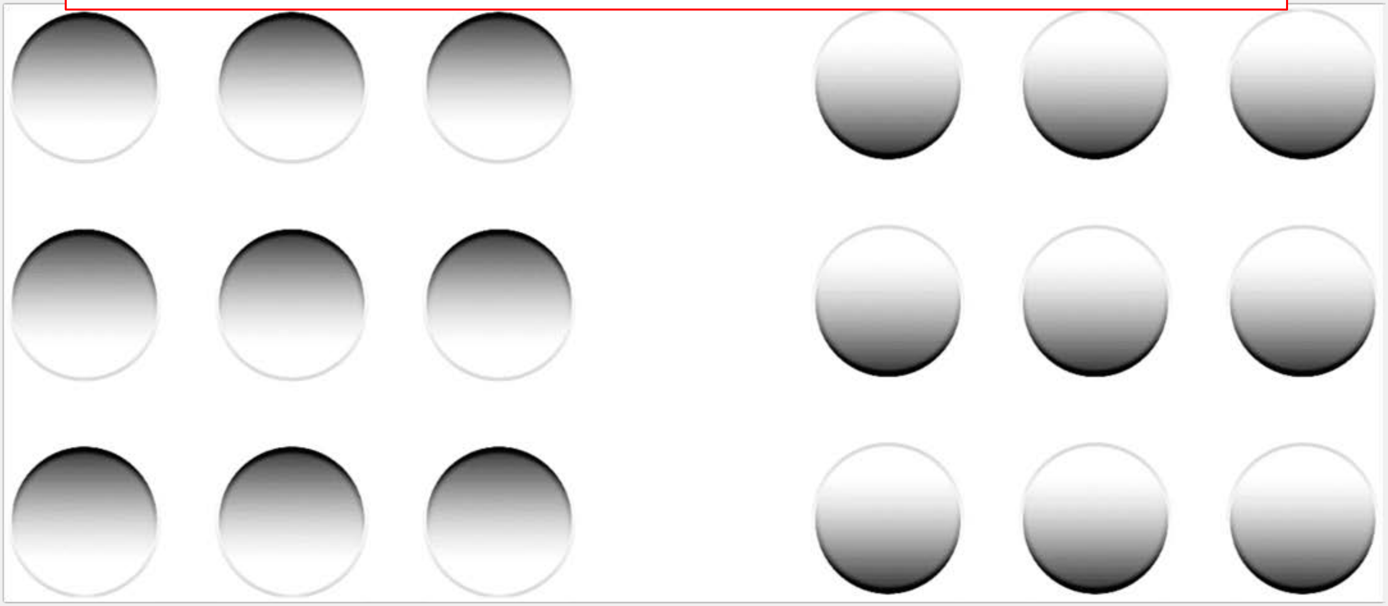


E ora?





I only flipped the images

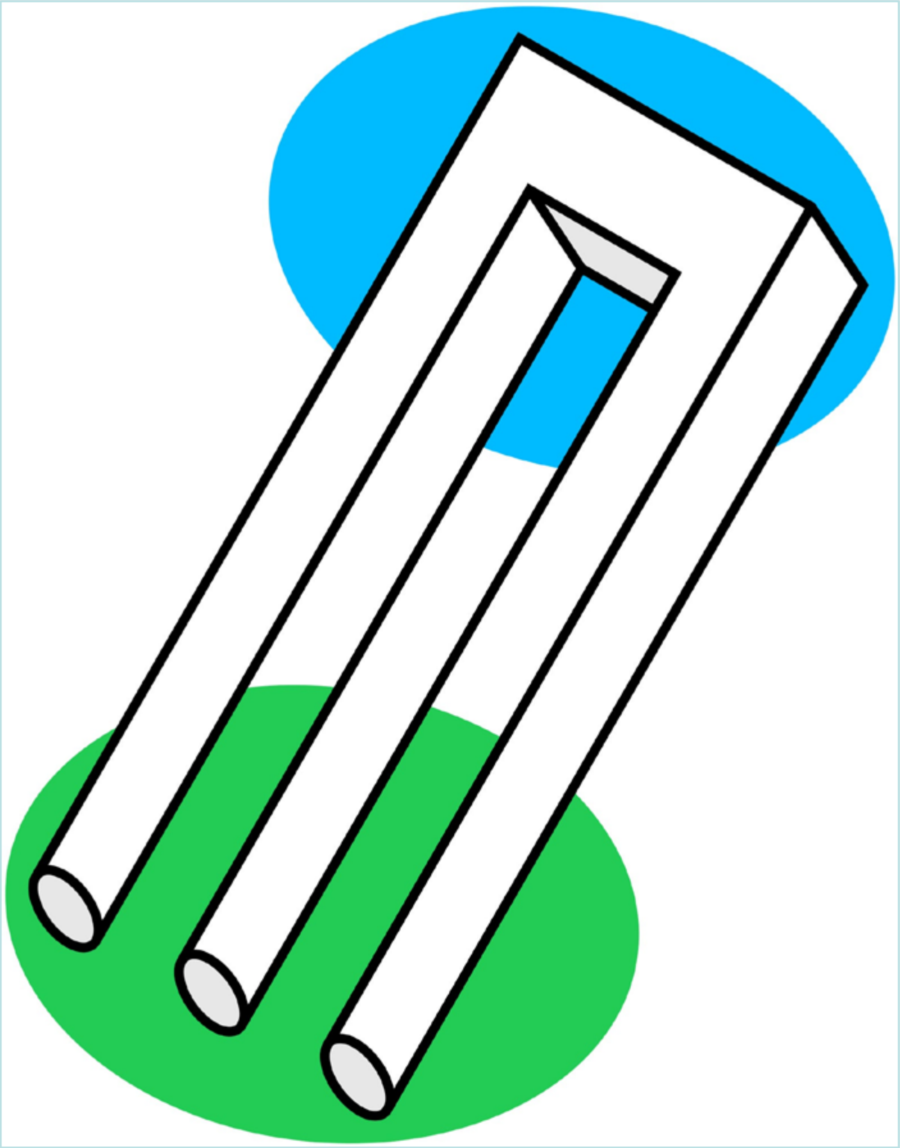


Our brain recalls from memory that, when a 3D object is illuminated, it is shaded.

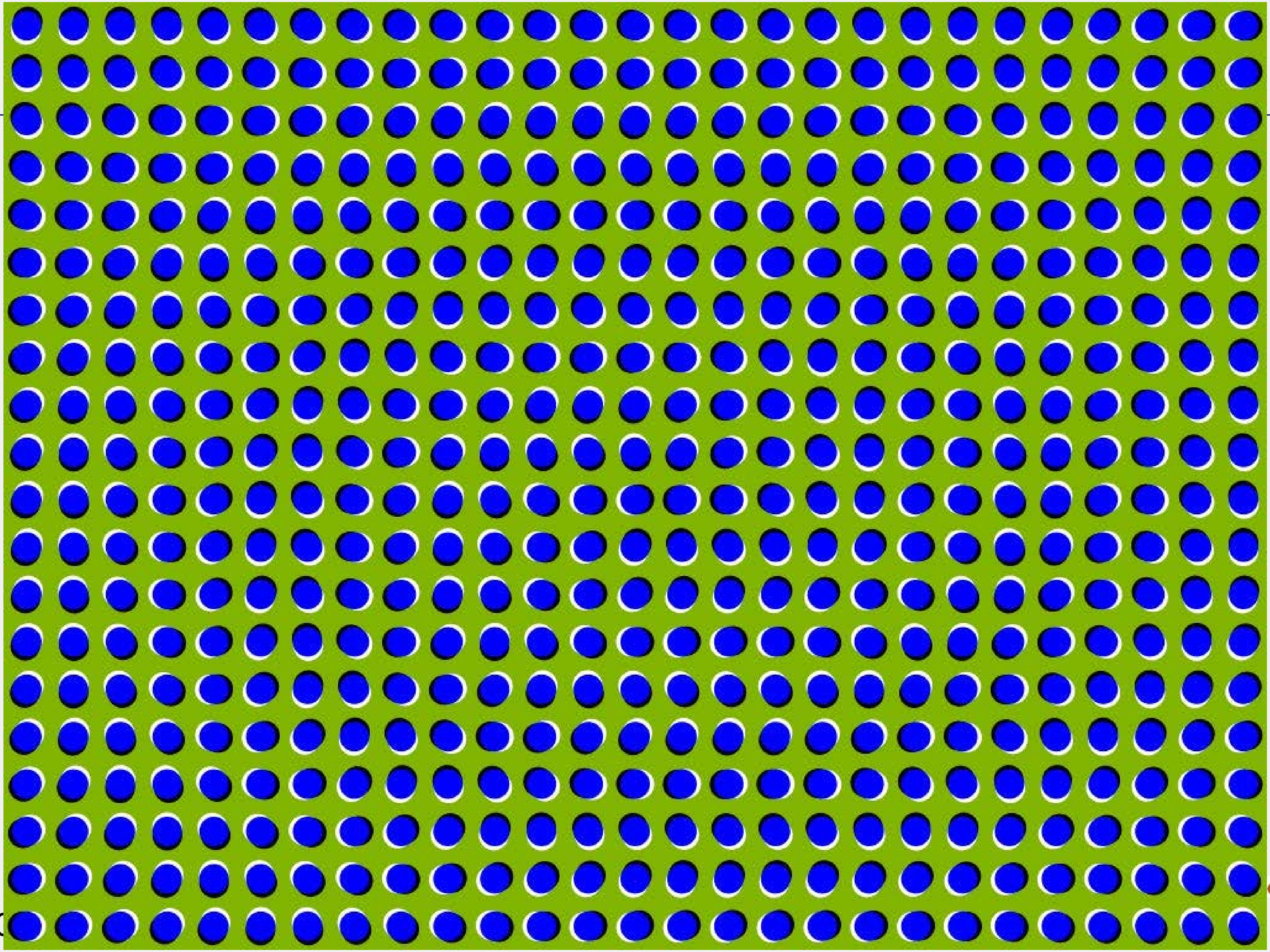
When the brain does not identify the source of light, it thinks thank it comes from the outside, from the sky, from the top of the paper (slide)

[In the past light came from the sun. That’s why we think it come from the top.

In the future experience may change.]



Impossible fork



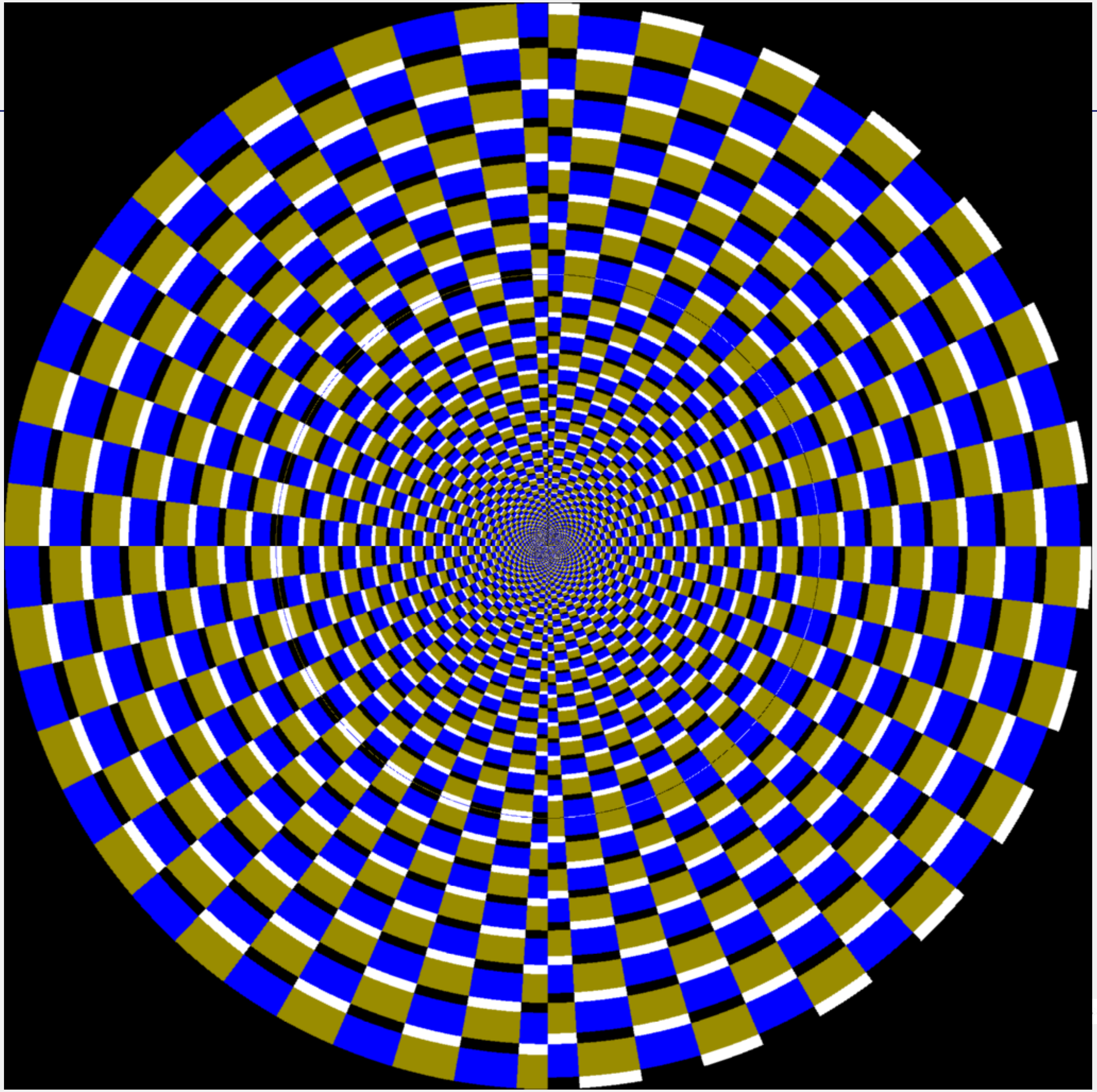
Peripheral drift illusion:

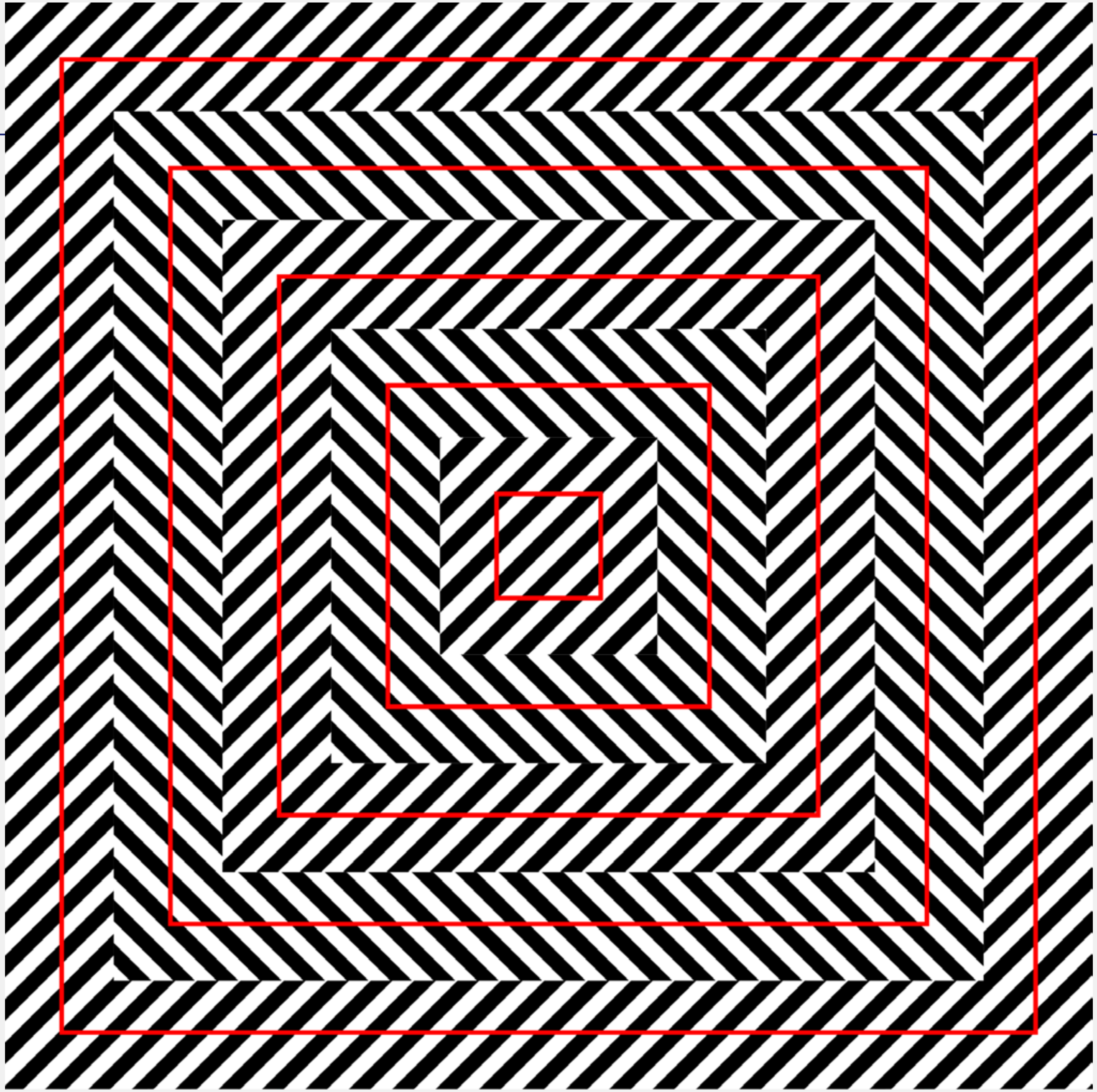
motion illusion in images with asymmetric static patterns.

Two theories. It is due to:

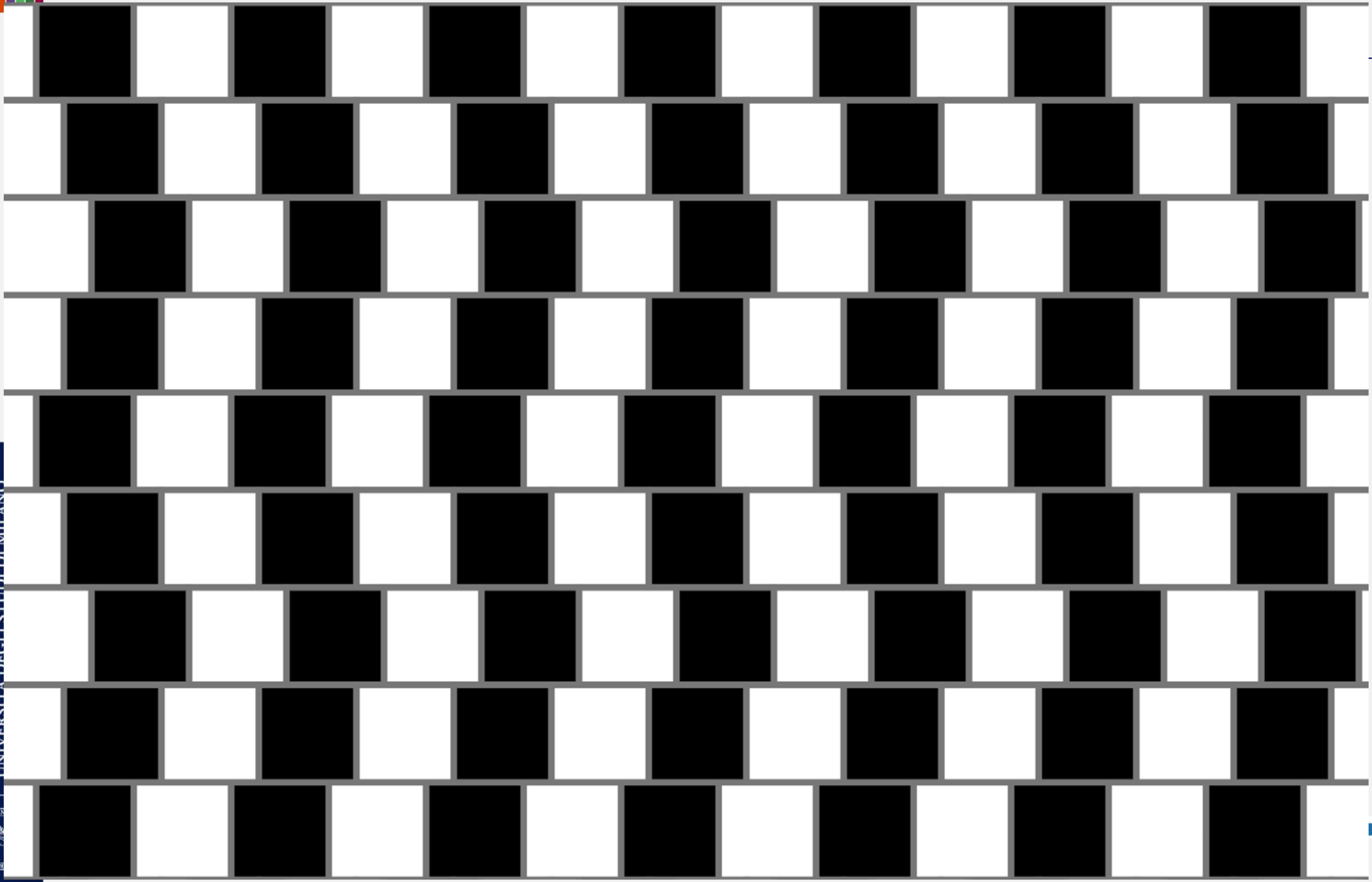
1) Fast saccadic movements due to the high level of details

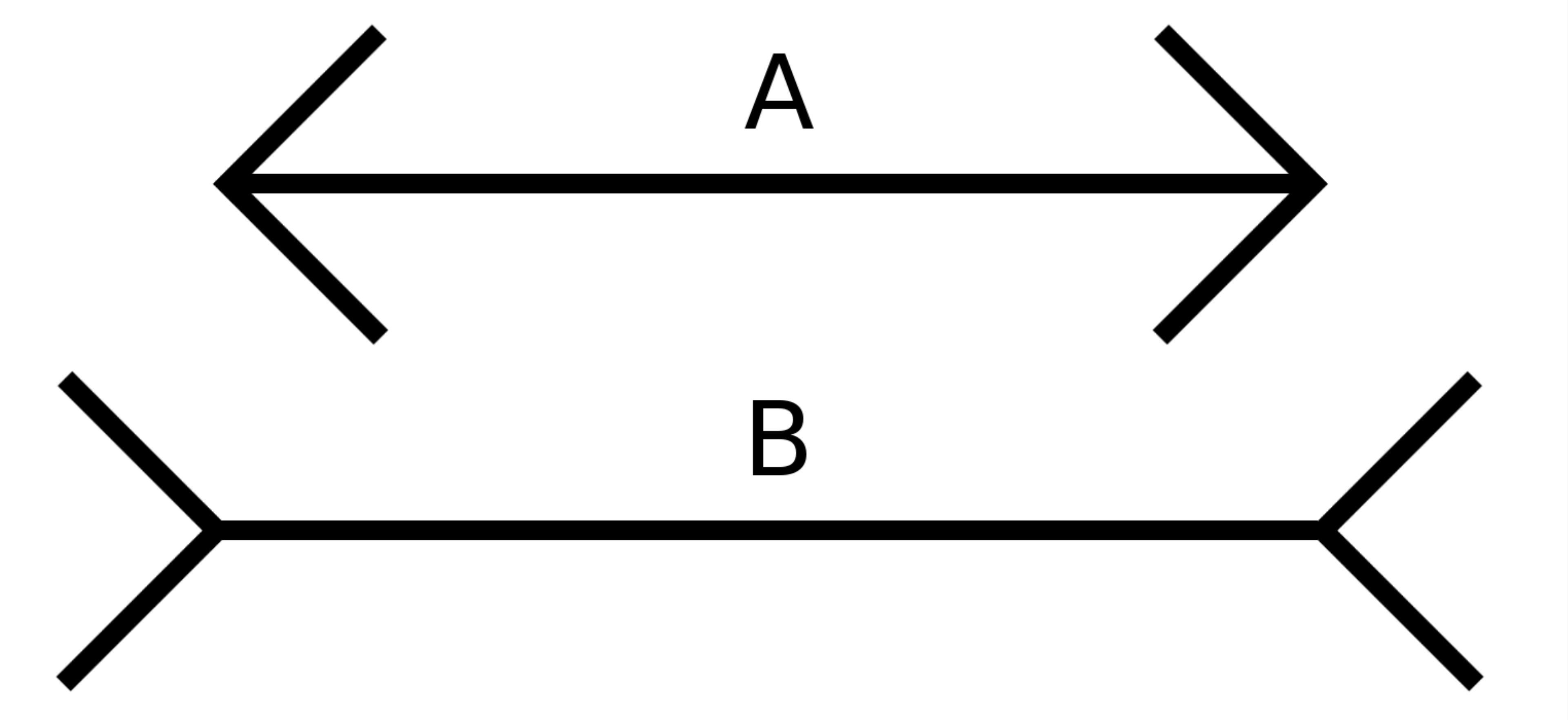
2) Fast contrast change which characterizes moving object (experiments showed that they create a naural activity similar to that of people observing moving objects).



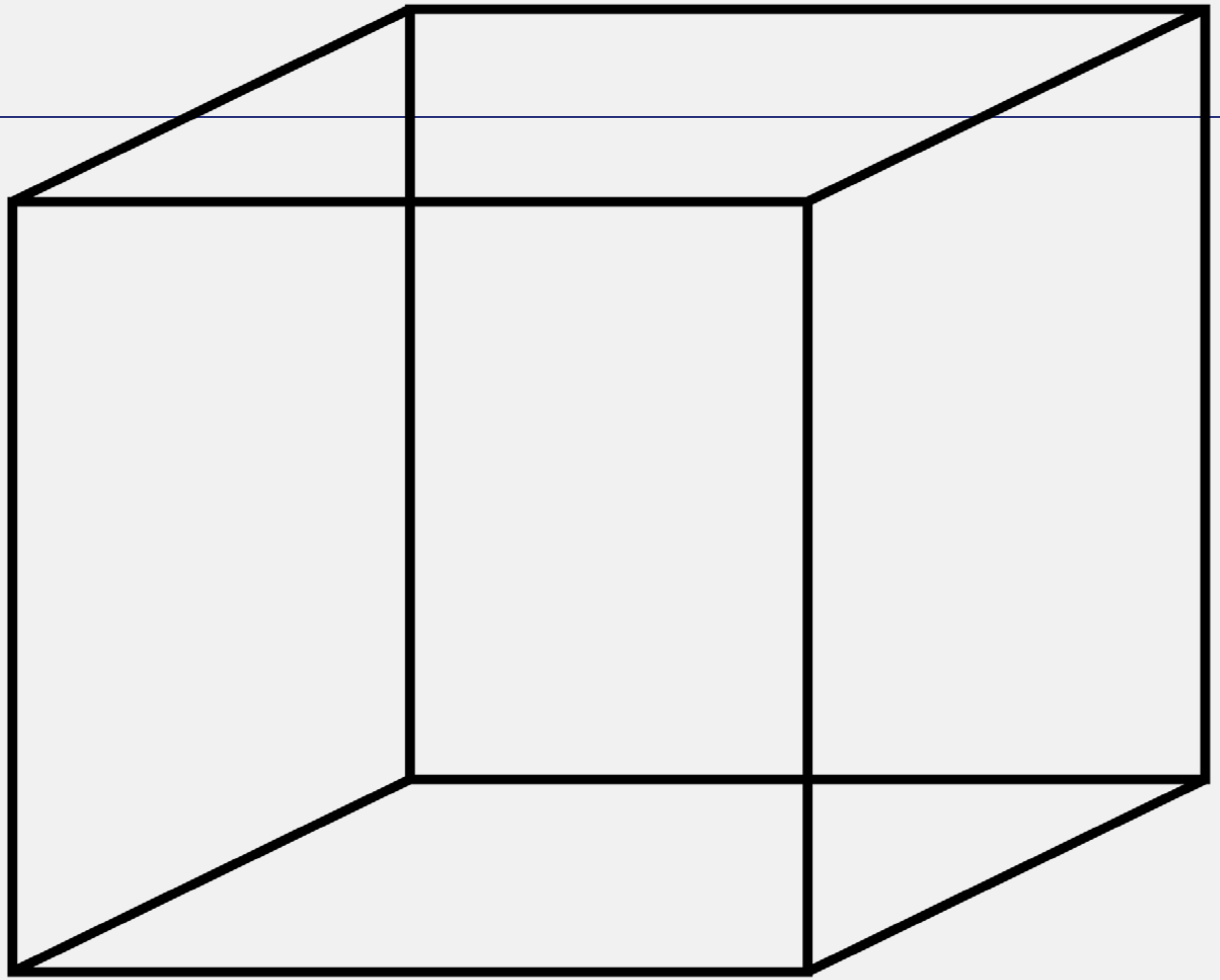


Distorsions:
Squares are
squares?



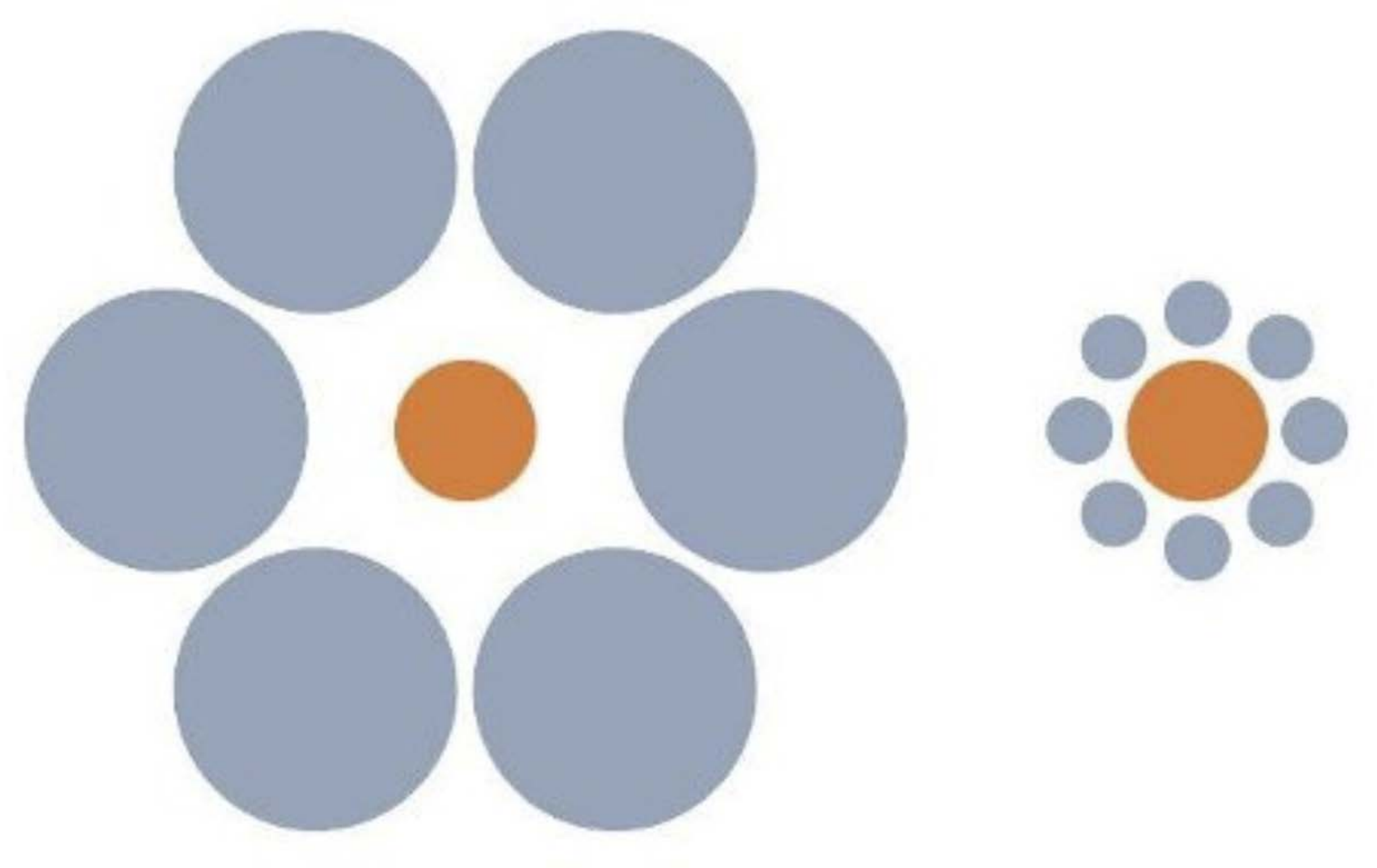


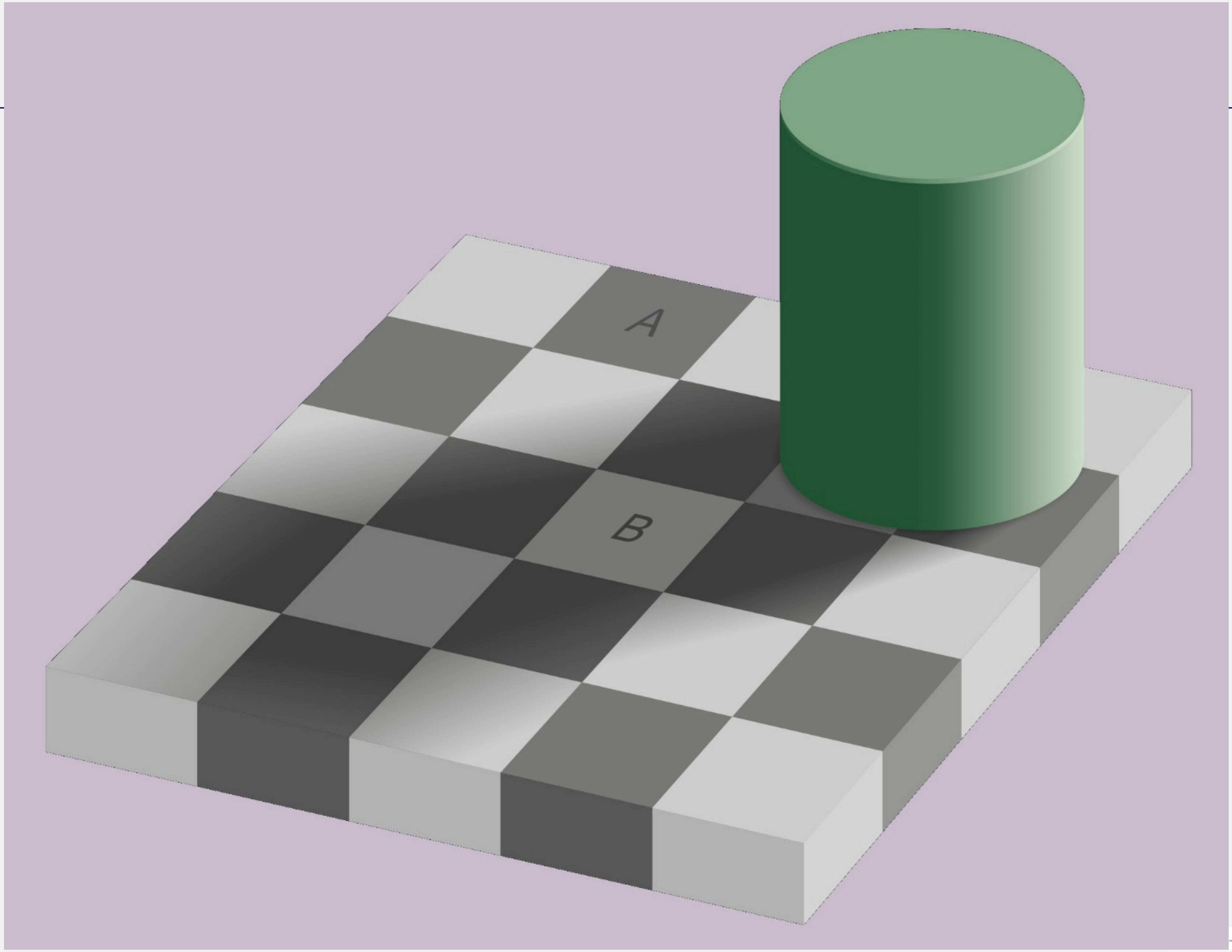
Which is longer?

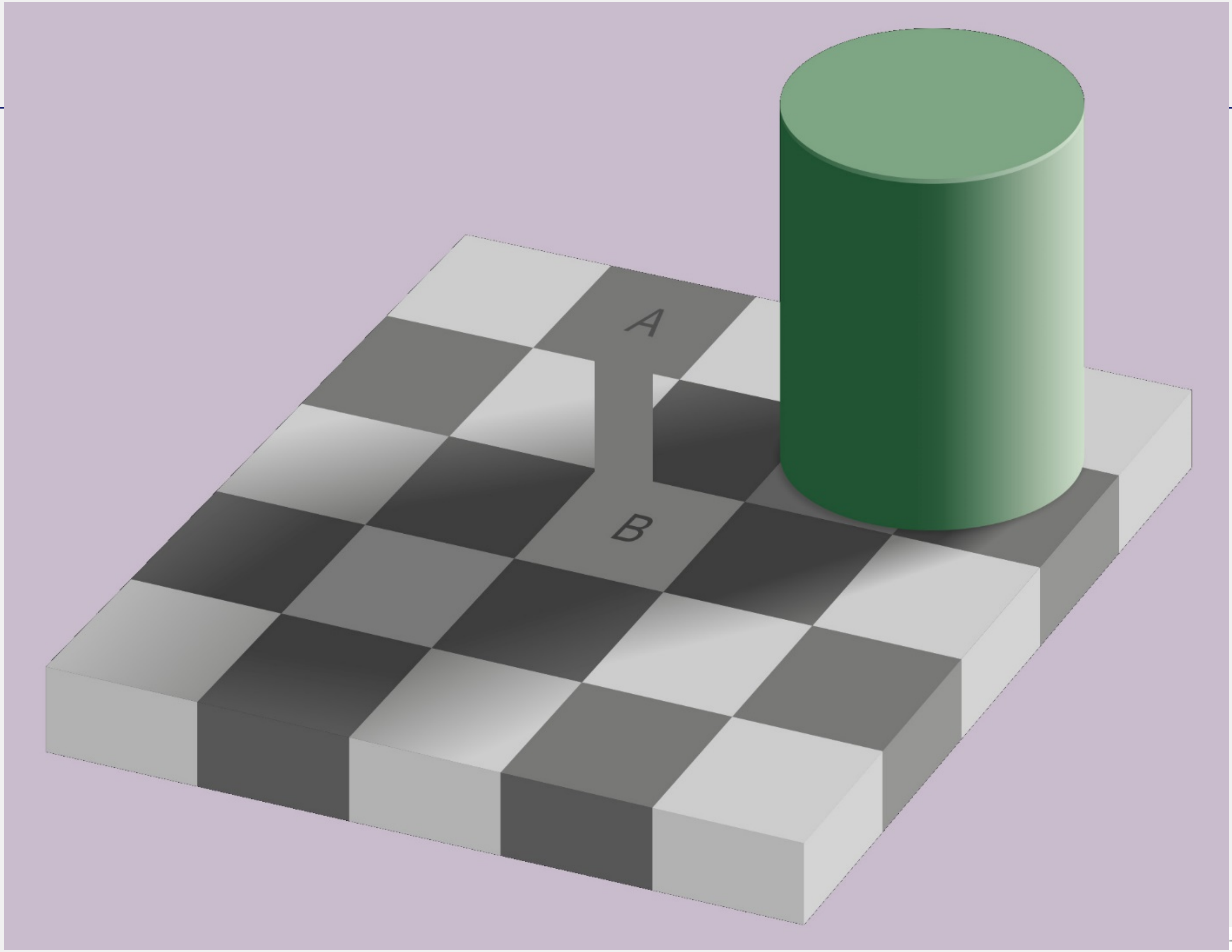


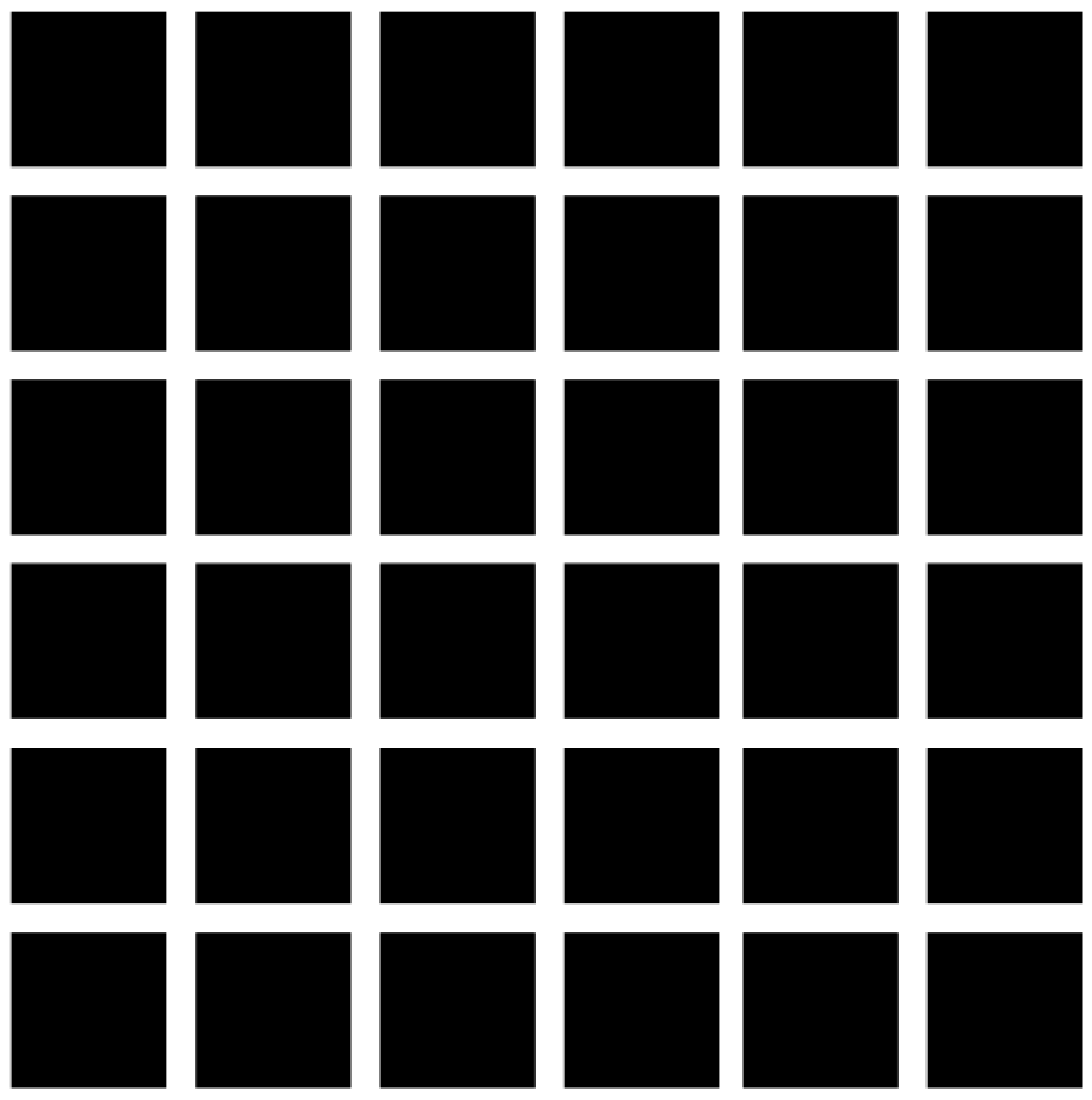
Why you shouldn’t use 3D

Mind the colors. Which circle is bigger??



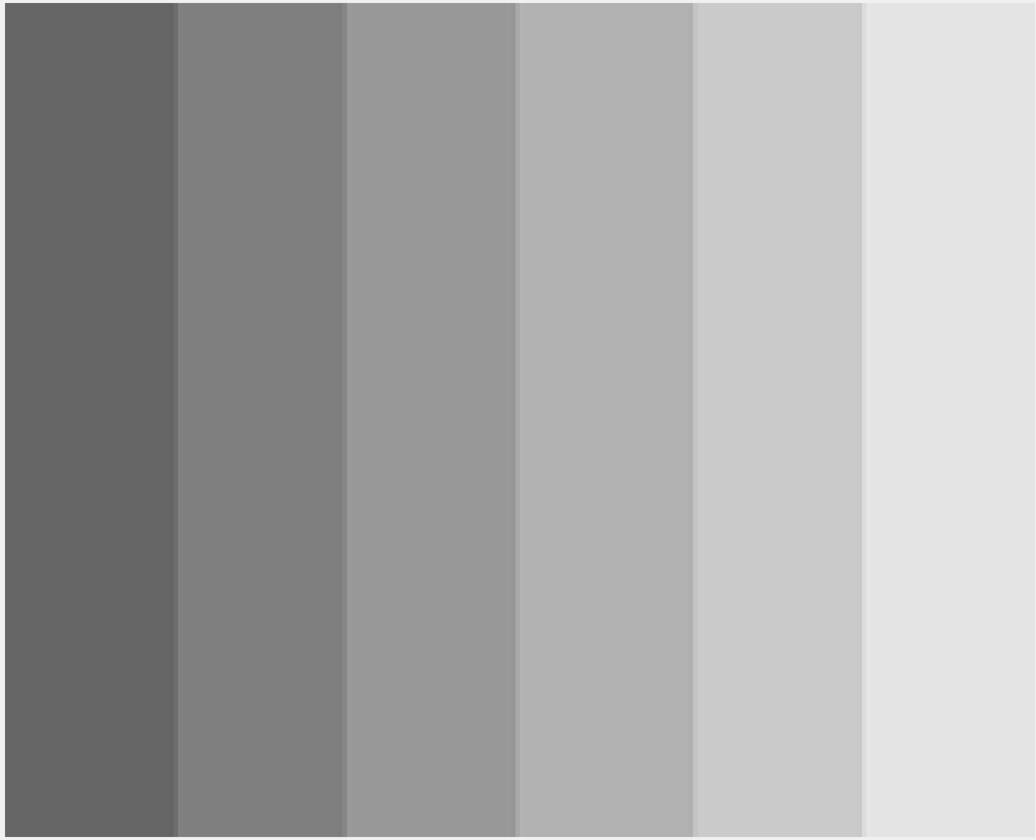

A
B


A
B

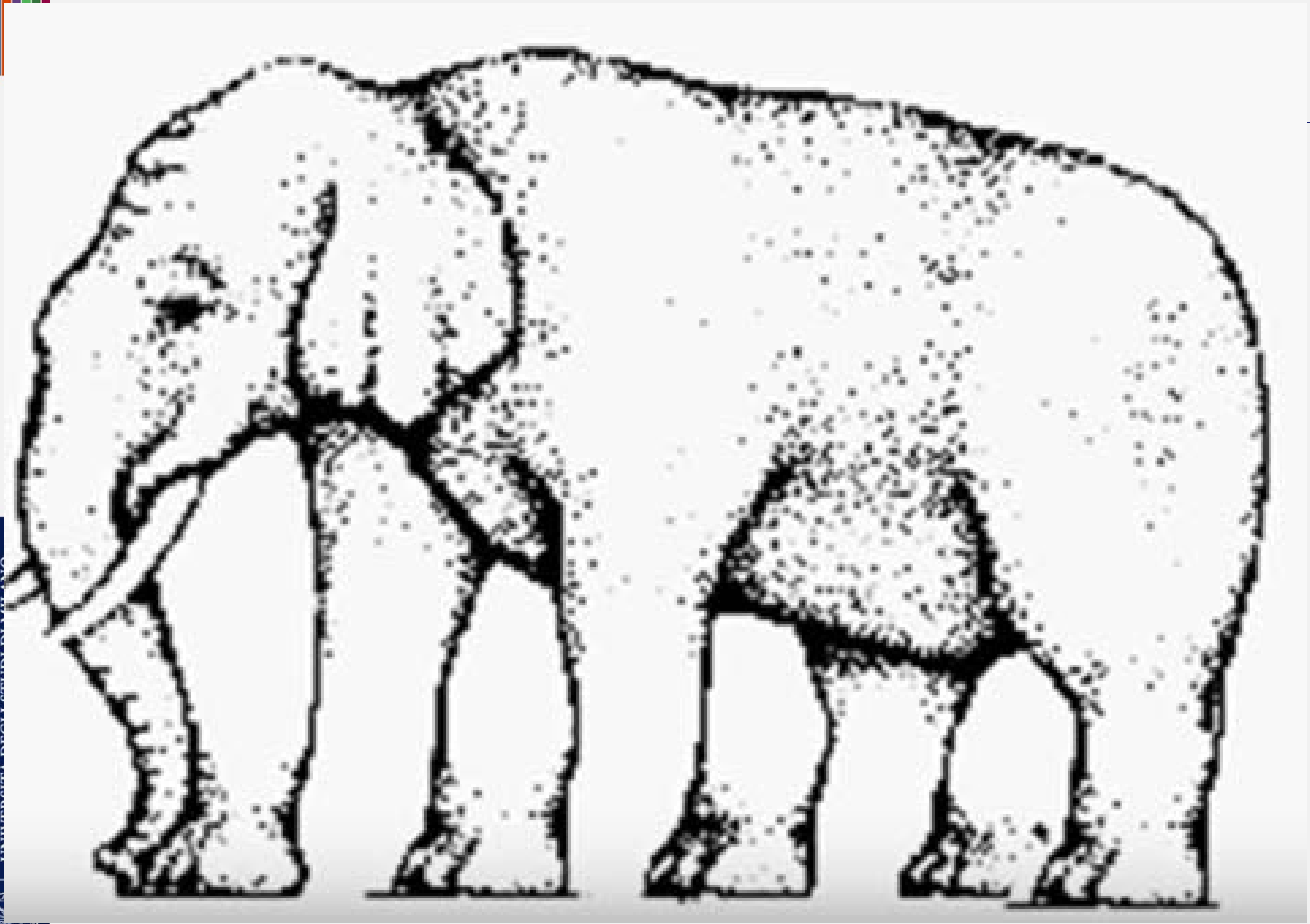


Neural inibition

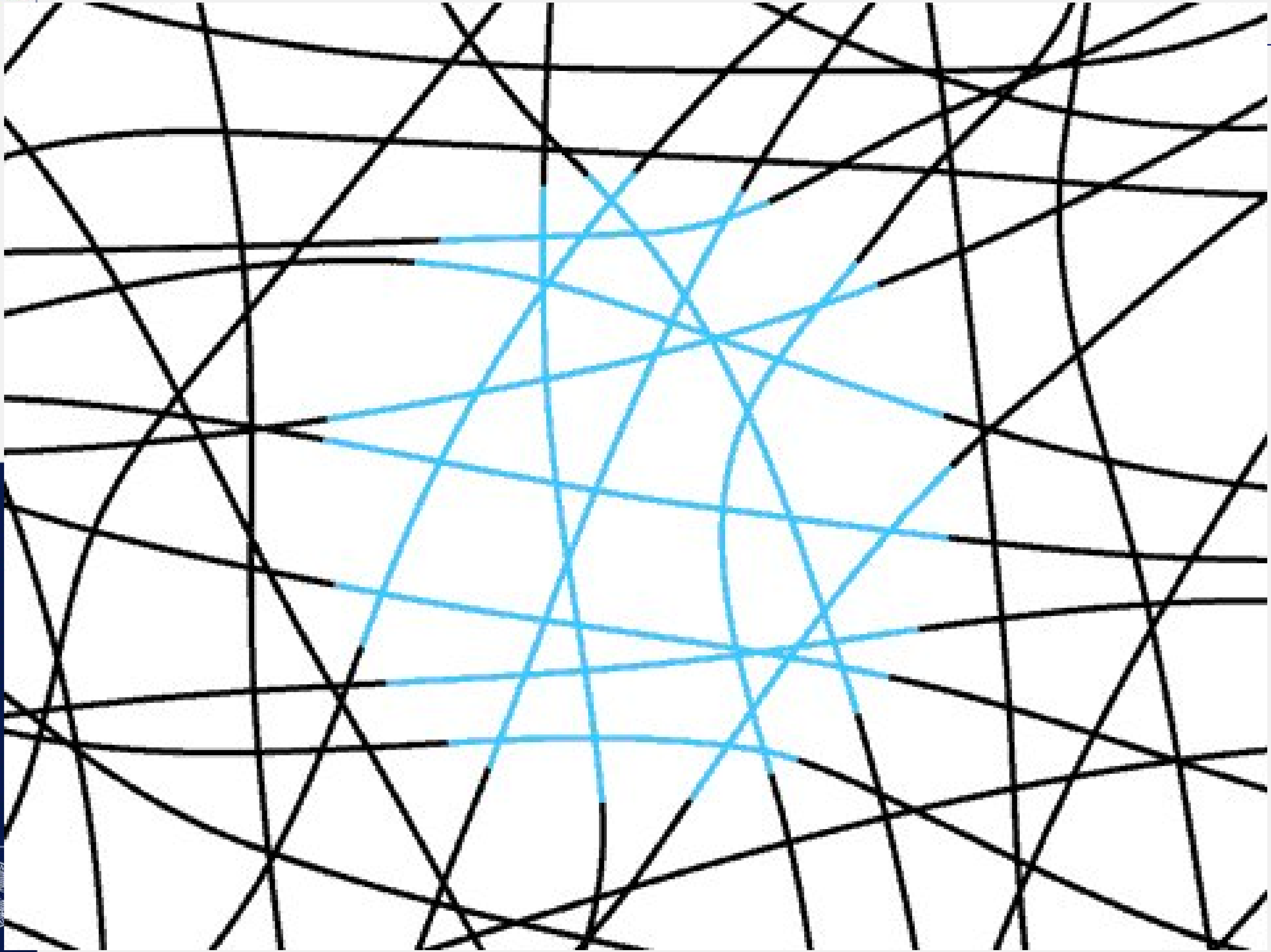
(on/off cells)



Mach Bands…
Mind bar chart put together



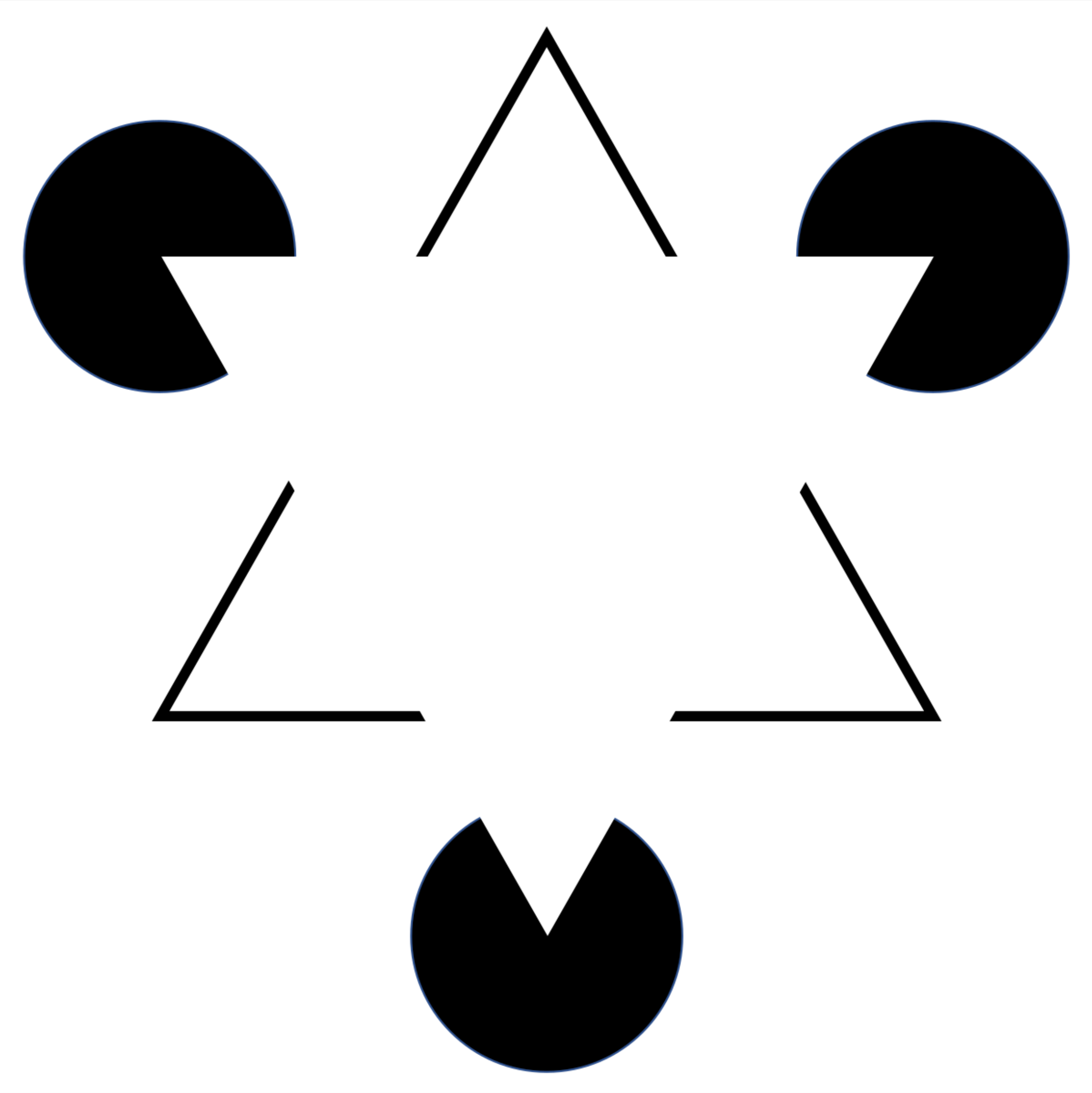
How many legs?



There's light blue circle (with blue stripes)?

Is it true?

Is there a circle?



There is no triangle there!

(Principle of enclosure)

Neuron inibition.

Fix the image for twenty second and then look at a white wall.