

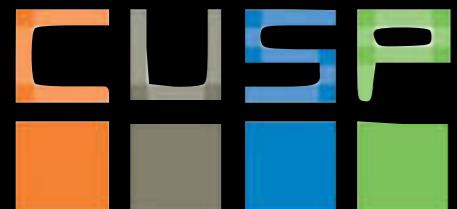
Urban Informatics

Fall 2015

dr. federica bianco fb55@nyu.edu



@fedhere

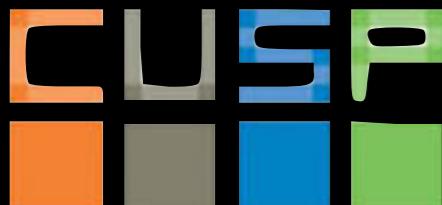


Recap:

- Good practices with data: falsifiability, reproducibility
- Basic data retrieving and munging: APIs, Data formats
- Basic statistics: distributions and their moments
- Hypothesis testing: p -value, statistical significance
- Statistical and Systematic errors
- Goodness of fit tests
- OLS, residual minimization
- Likelihood, chisq

Today:

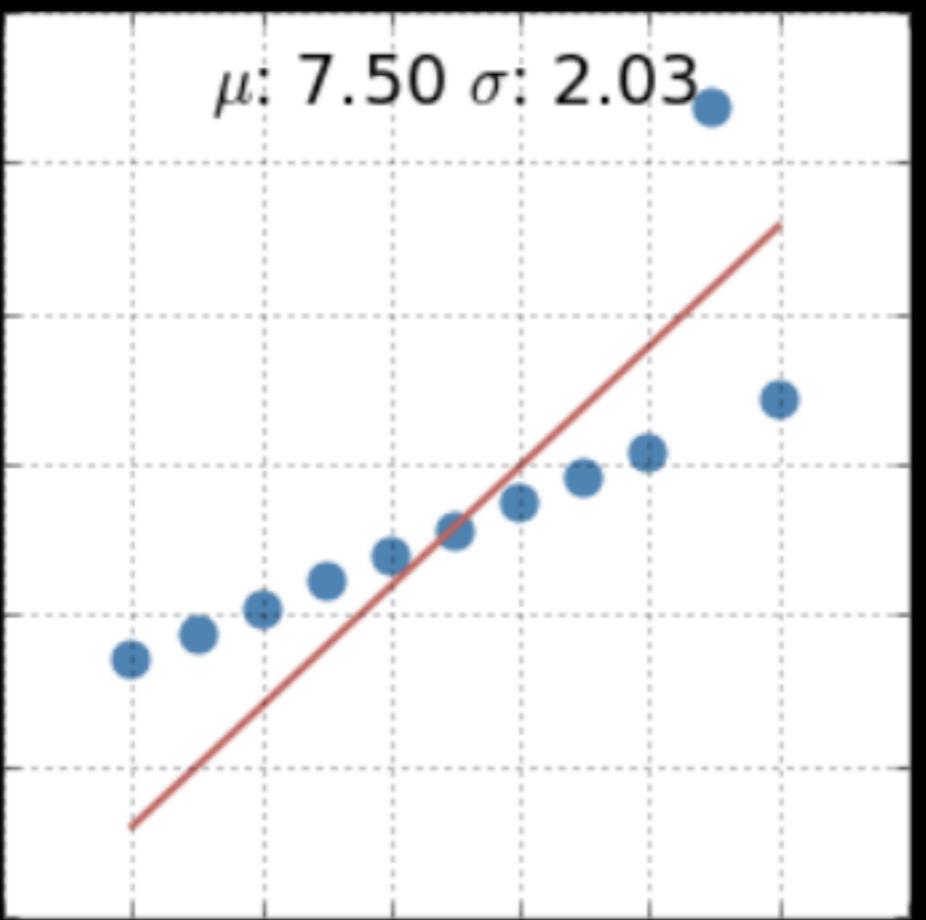
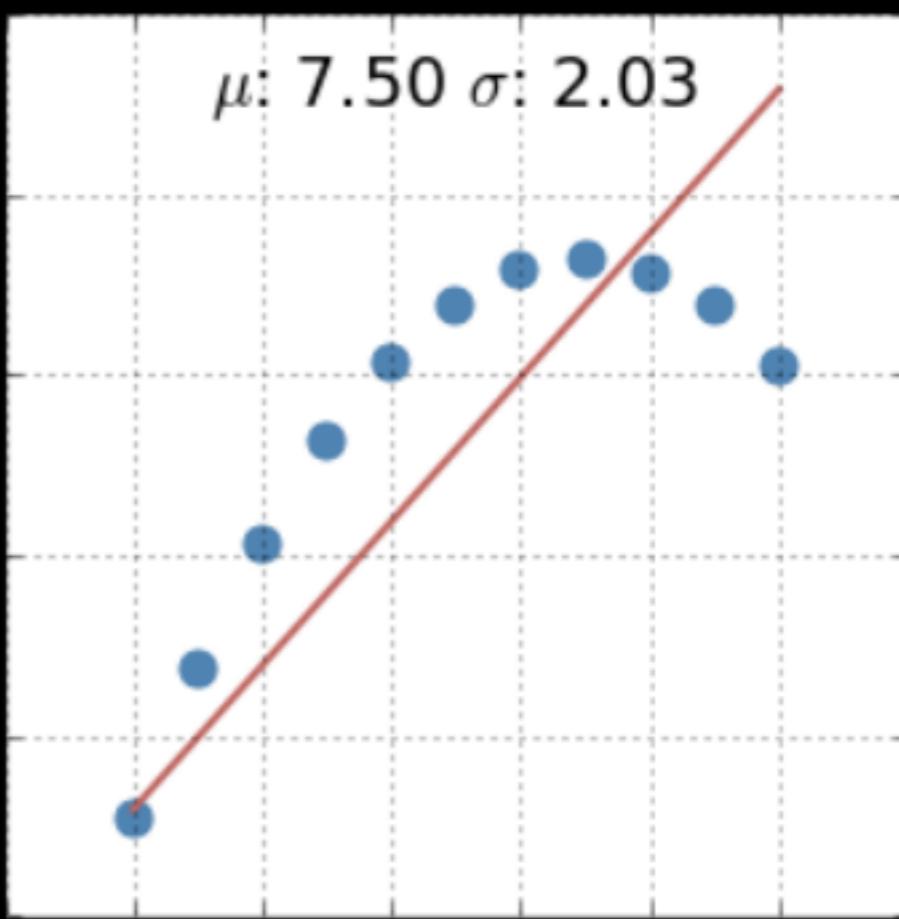
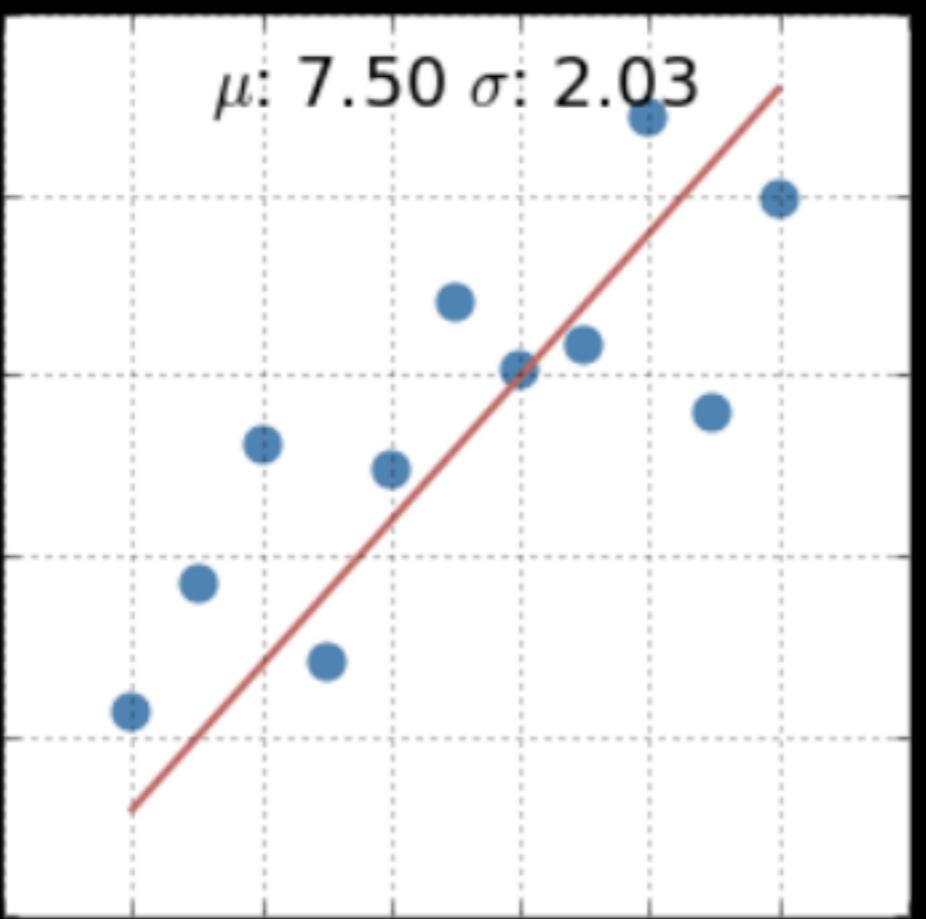
- Visualizations



Why visualize?

	I		II		III		IV	
	X	Y	X	Y	X	Y	X	Y
	10	8.04	10	9.14	10	7.46	8	6.58
	8	6.95	8	8.14	8	6.77	8	5.76
	13	7.58	13	8.74	13	12.74	8	7.71
	9	8.81	9	8.77	9	7.11	8	8.84
	11	8.33	11	9.26	11	7.81	8	8.47
	14	9.96	14	8.1	14	8.84	8	7.04
	6	7.24	6	6.13	6	6.08	8	5.25
	4	4.26	4	3.1	4	5.39	19	12.5
	12	10.84	12	9.13	12	8.15	8	5.56
	7	4.82	7	7.26	7	6.42	8	7.91
	5	5.68	5	4.74	5	5.73	8	6.89

What's this??



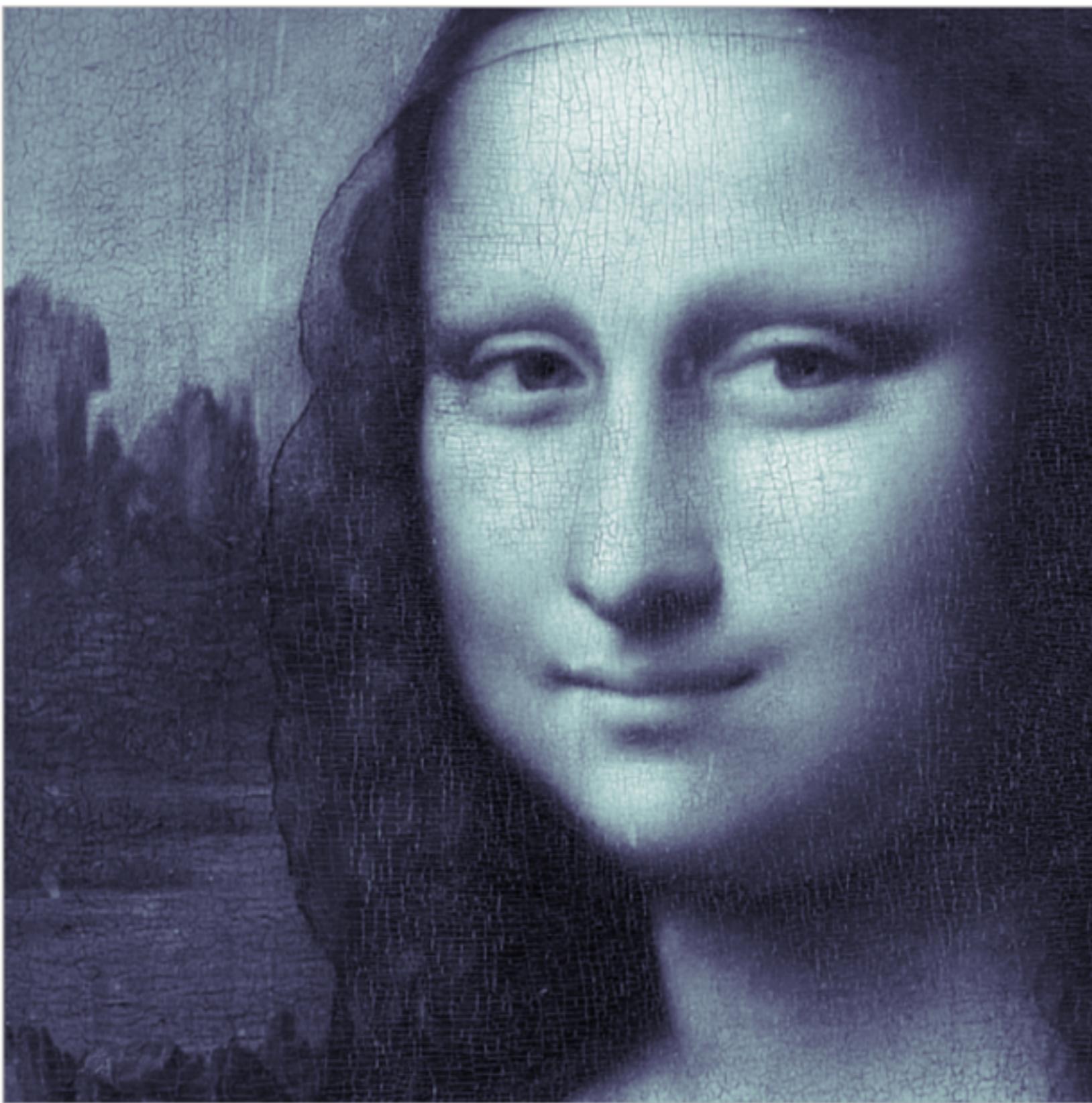
```
from PIL import Image
im = Image.open('sectret.png')
pixels = list(im.getdata())
import numpy as np
data = np.asarray(im)

data[:, :, 0]

array([[38, 35, 39, ..., 25, 33, 39],
       [44, 41, 42, ..., 25, 31, 37],
       [47, 45, 42, ..., 31, 35, 39],
       ...,
       [47, 55, 69, ..., 63, 66, 69],
       [33, 38, 51, ..., 56, 63, 69],
       [26, 20, 28, ..., 39, 44, 48]], dtype=uint8)
```

```
pl.figure(figsize=(10,10))
pl.imshow(data[500:1500,500:1500,0], cmap=plt.get_cmap('bone'))
pl.xticks([])
pl.yticks([])

[], <a list of 0 Text yticklabel objects>)
```

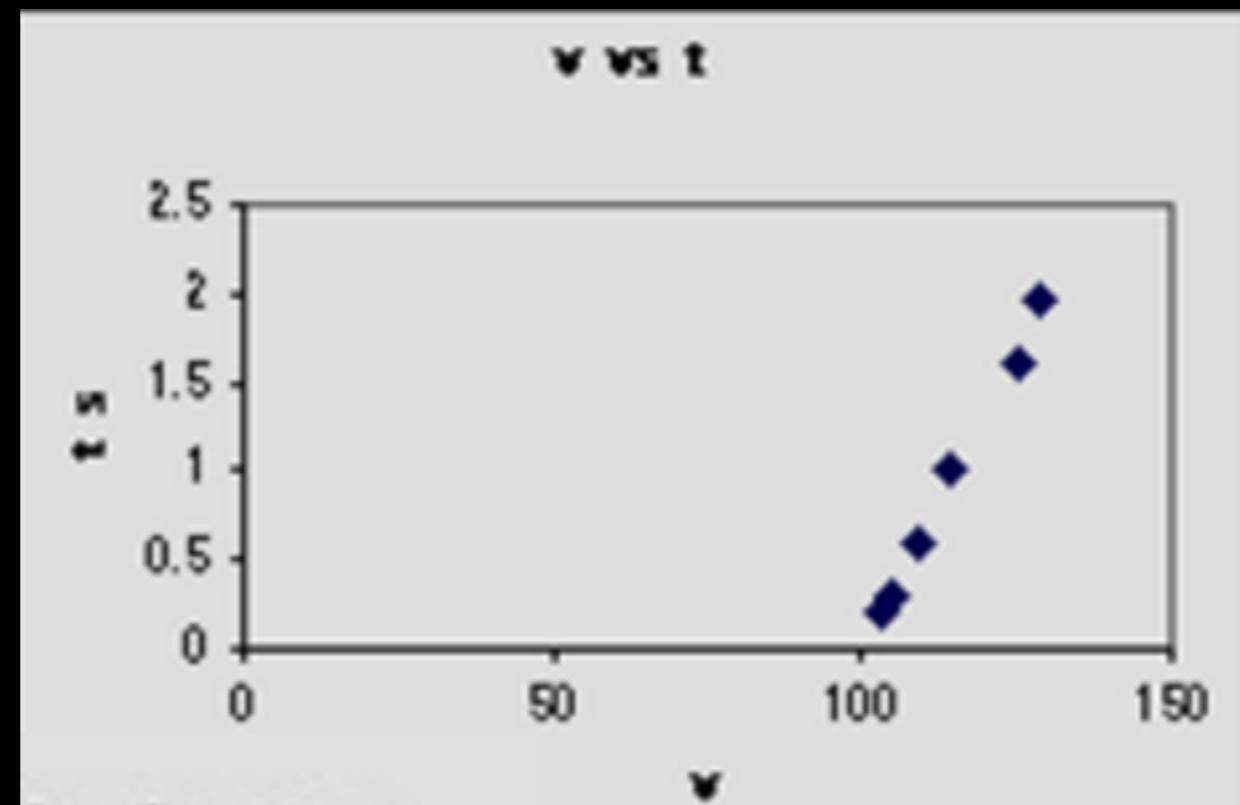


we visualize to
communicate (Tufte)
and
explore (Thorp)

what makes a bad
visualization?

Ambiguity, distortion (misleading), distraction.

<http://slideplayer.com/slide/4956536/>

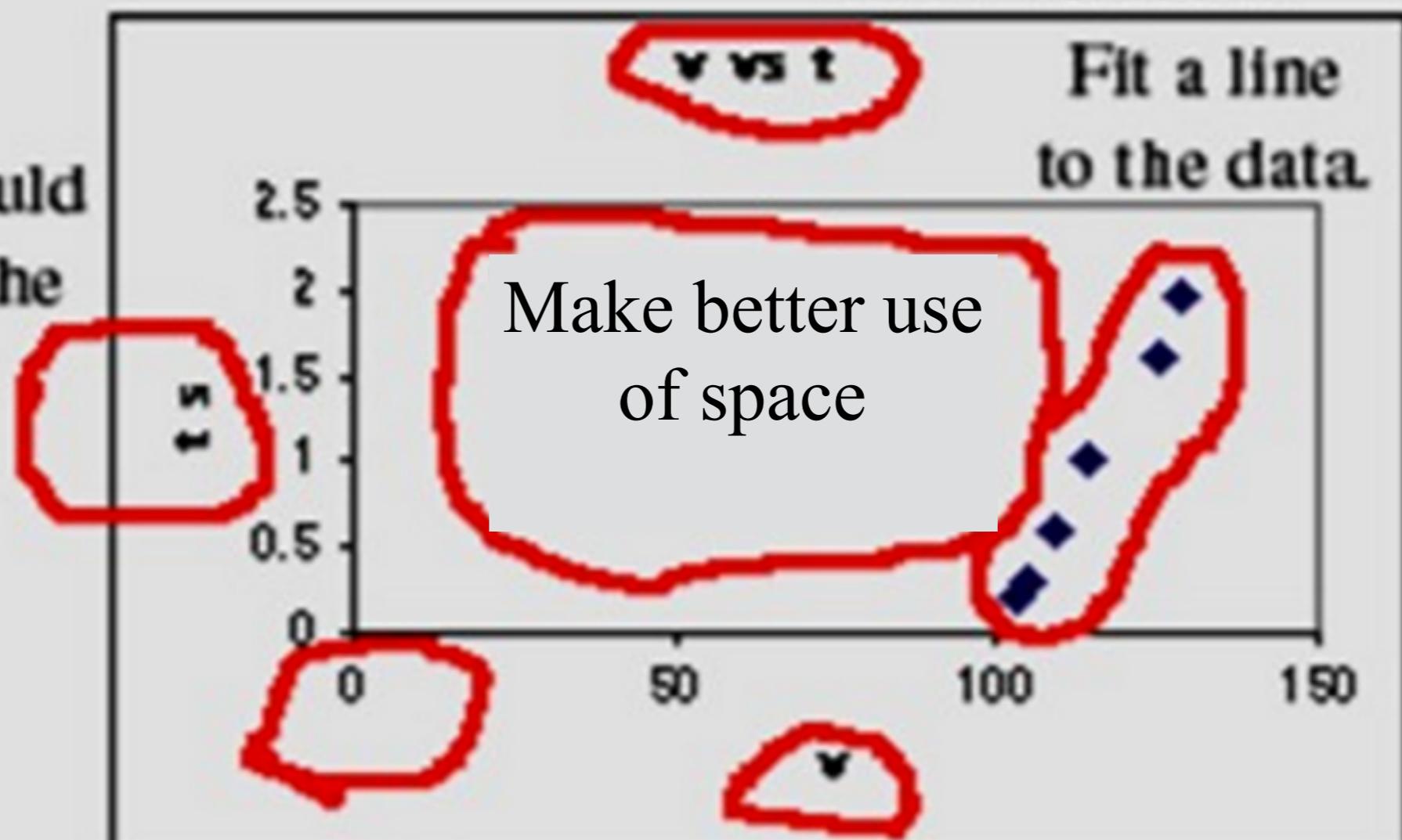


7 wrong things with this plot...

The entire graph is too small.

The title should be better.
This graph is t versus v ,
not v versus t .

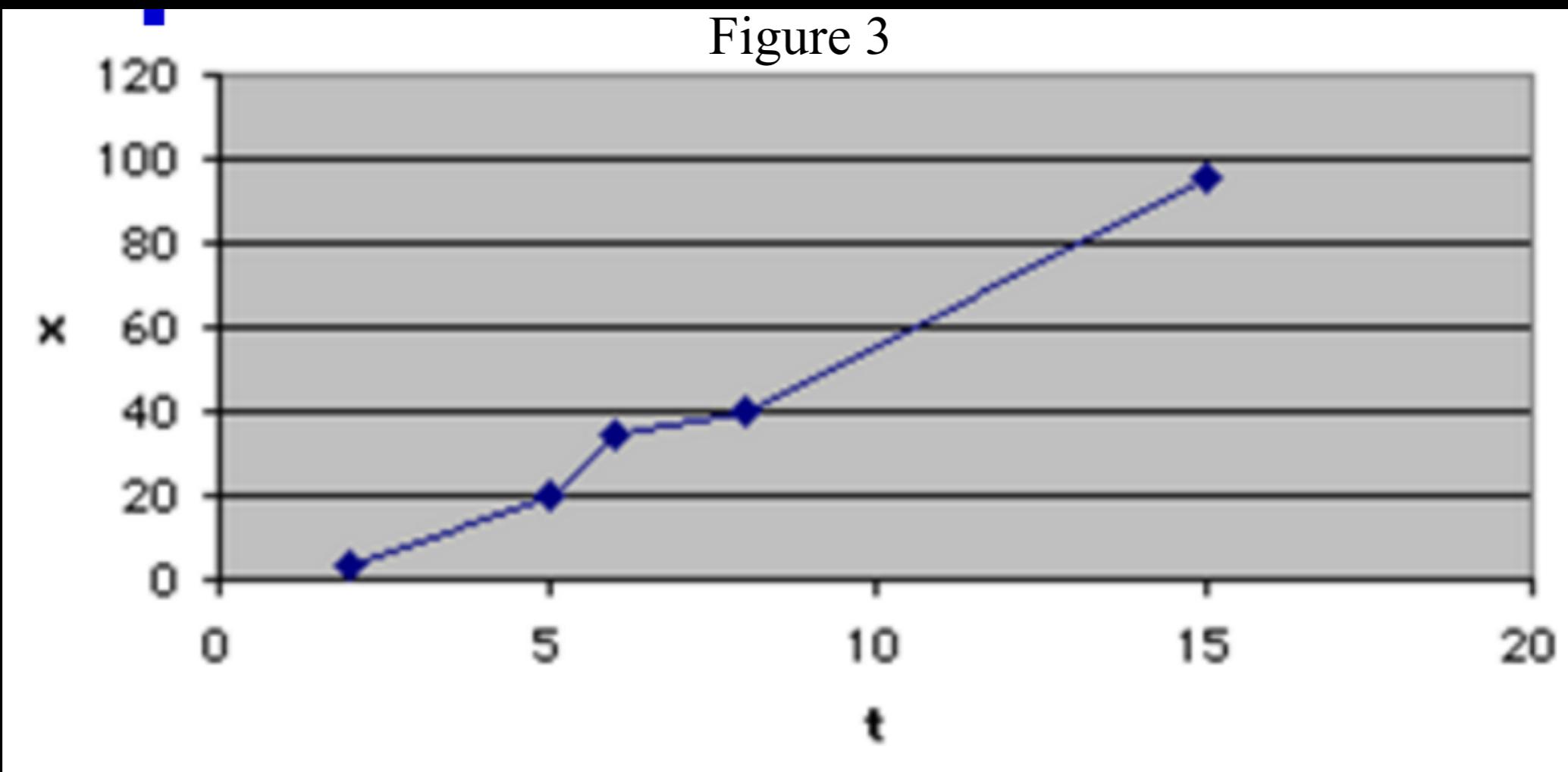
The axis label should have words, and the units should be in parentheses.



The first data occurs at $v = 100$, so the scale can begin at 100.

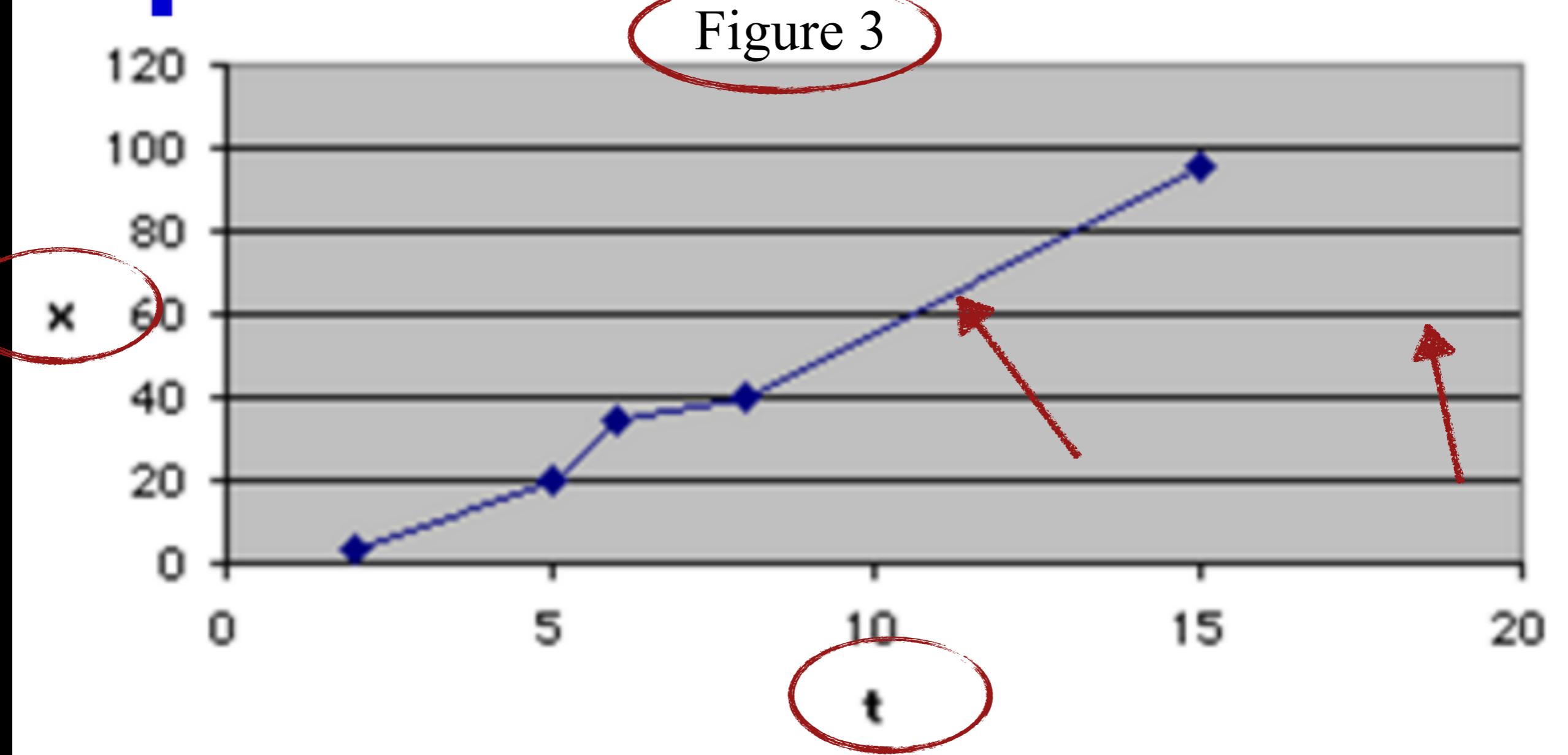
The axis label should have words and units in parentheses.

Figure 3



7 wrong things with this plot...

Figure 3



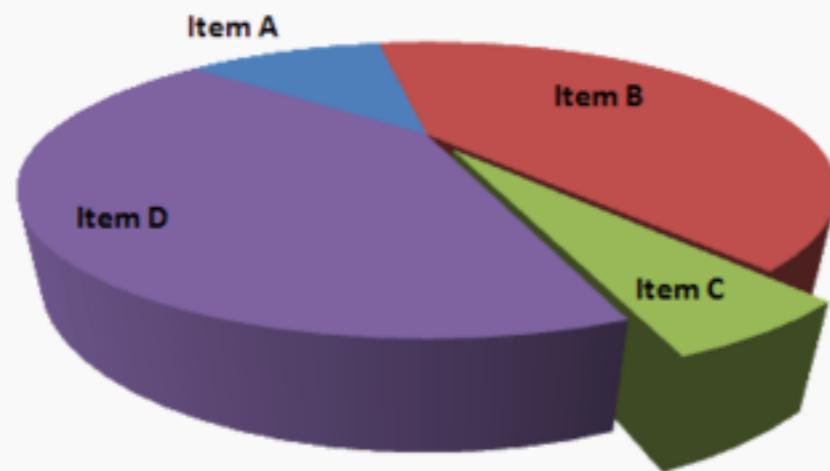
low res and small size!

<http://slideplayer.com/slide/4956536/>

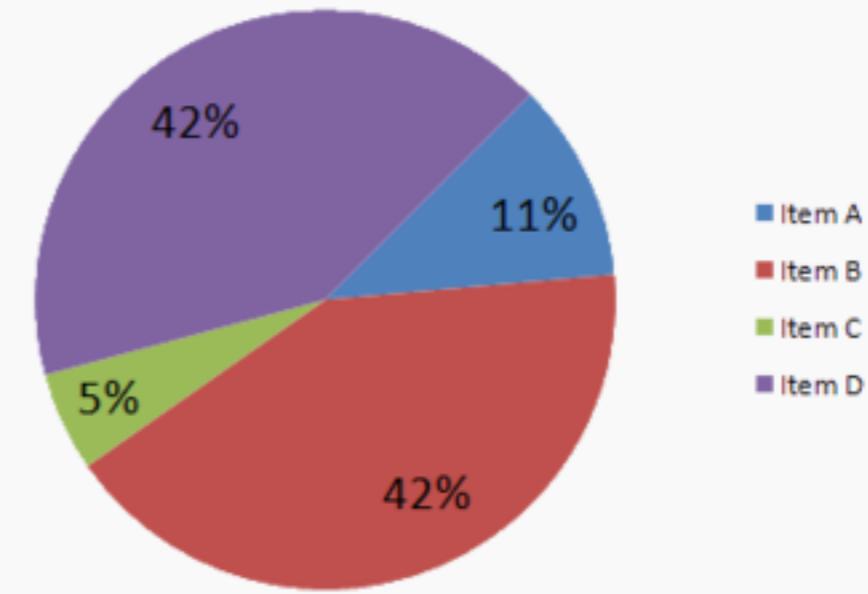
Ambiguity, distortion (misleading), distraction.

Comparison of pie charts

Misleading pie chart

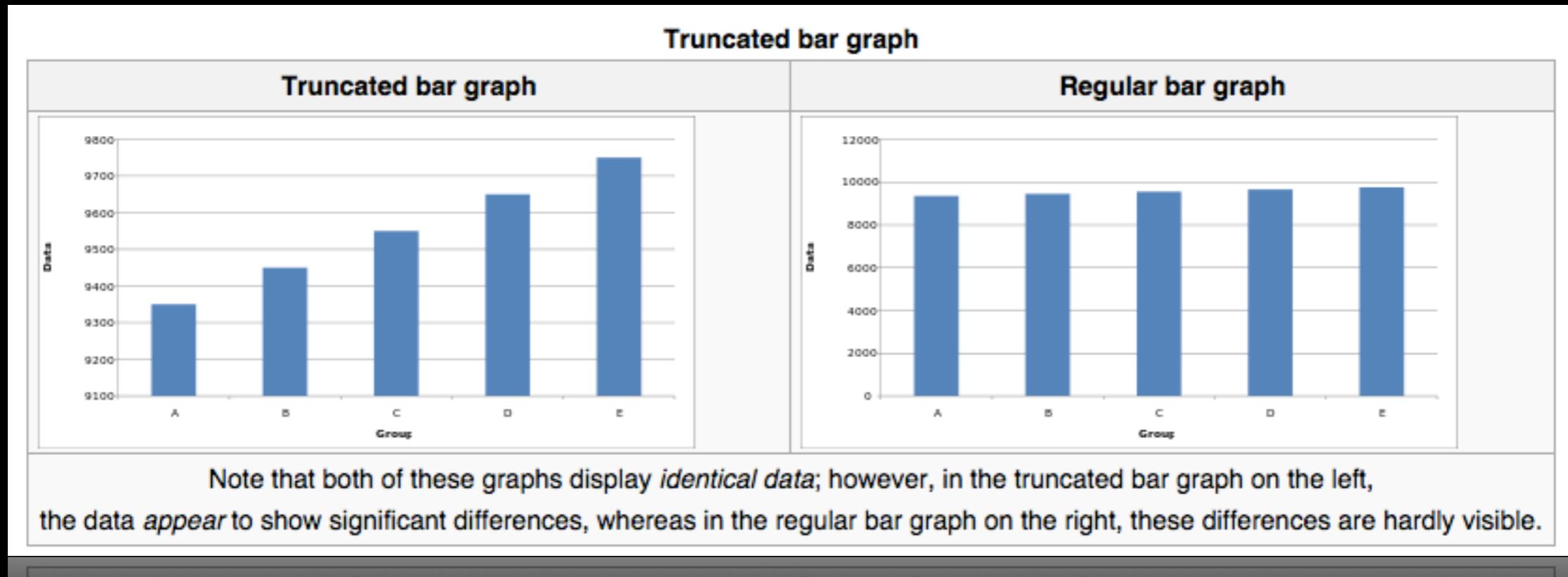


Regular pie chart



In the misleading pie chart, Item C appears to be at least as large as Item A, whereas in actuality, it is less than half as large.

<http://gizmodo.com/how-to-lie-with-data-visualization-1563576606>

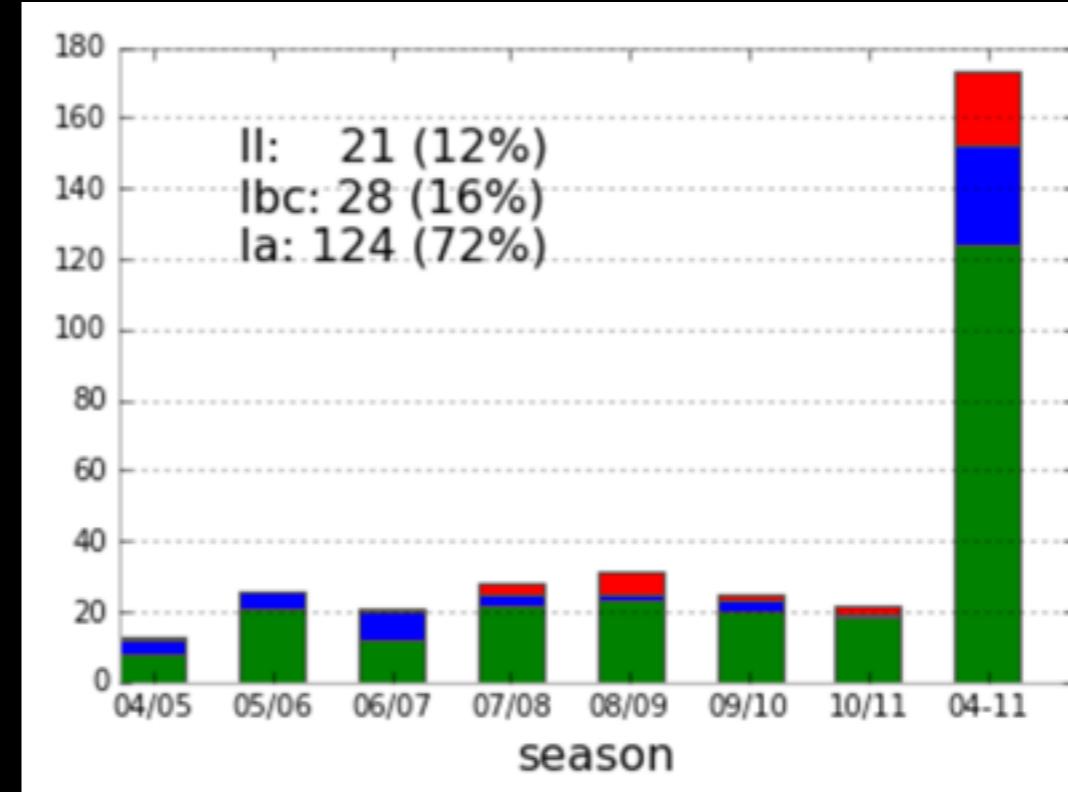
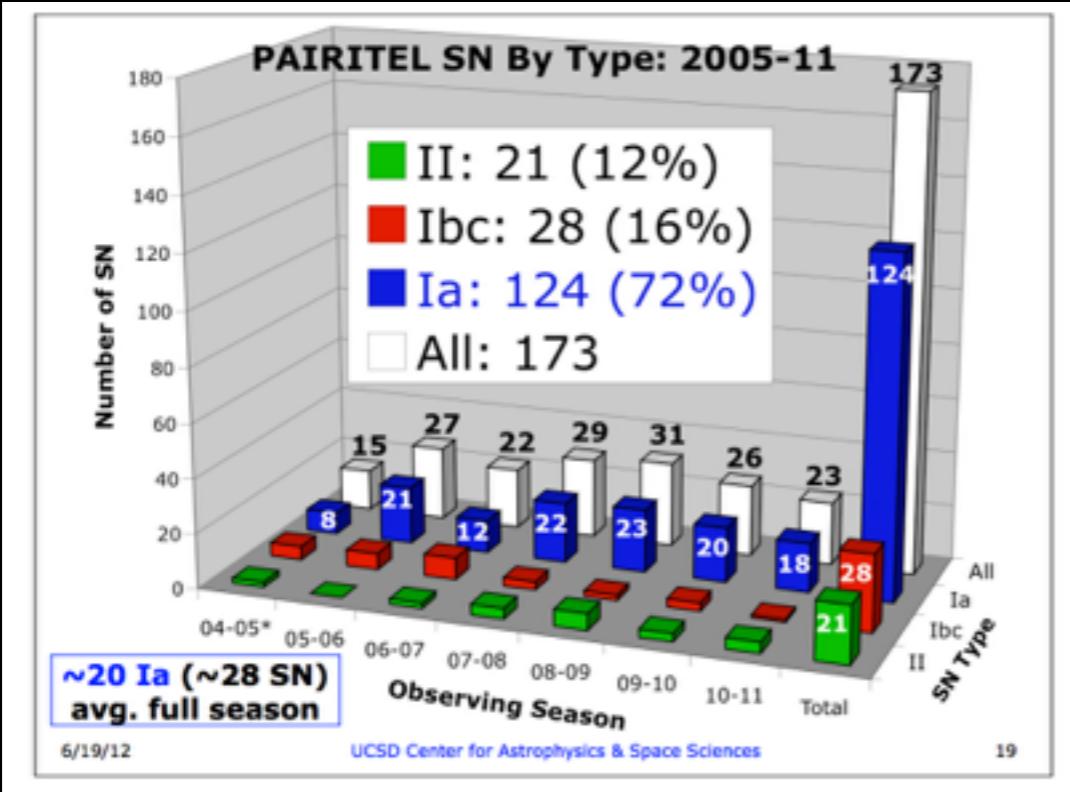


Ambiguity, distortion (misleading), distraction.

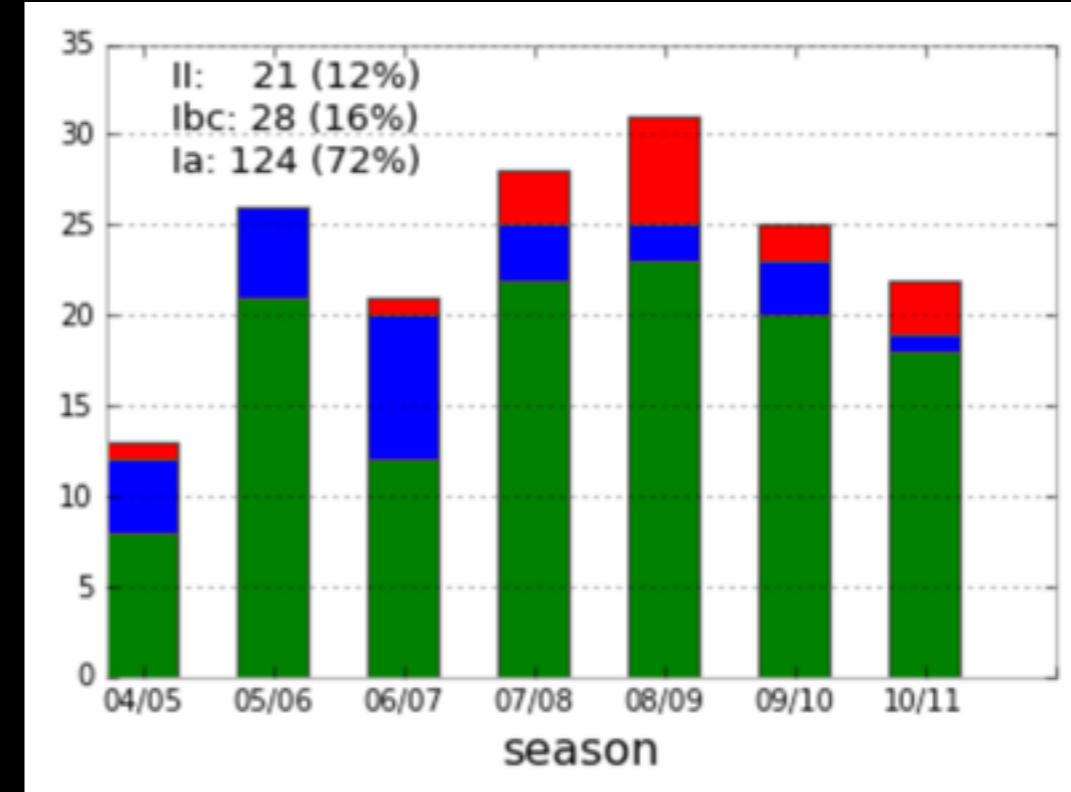
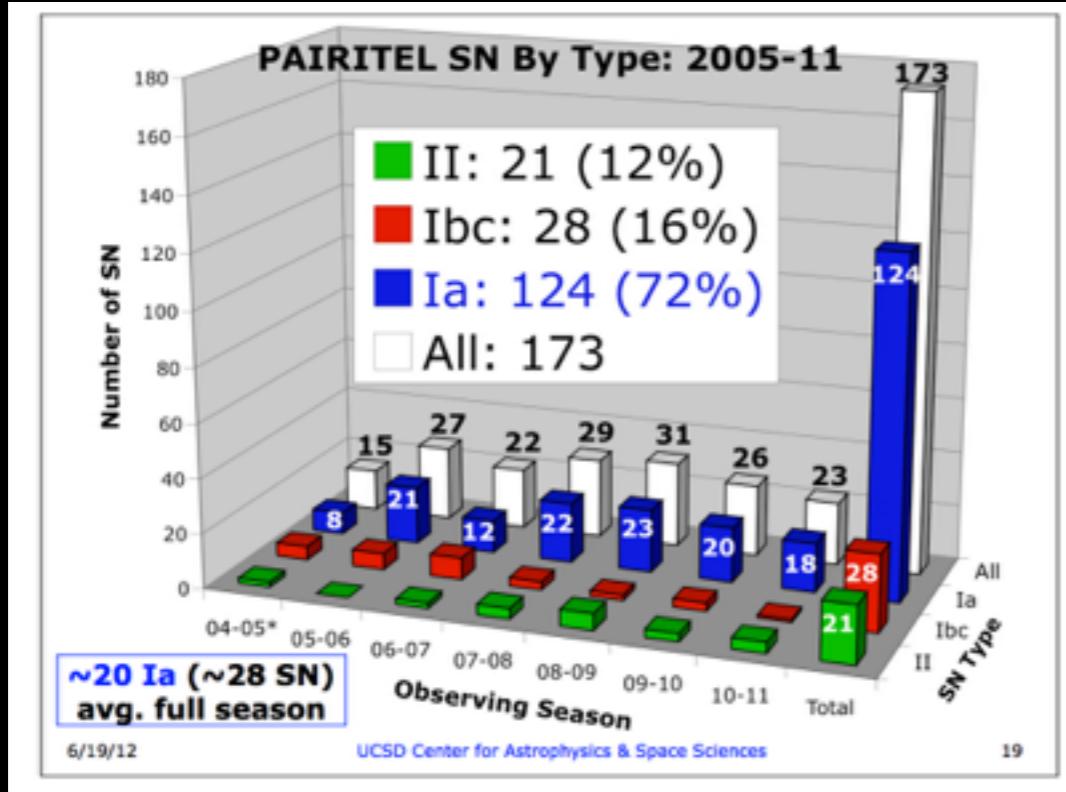
[http://www.nodexlgraphgallery.org/Pages/Graph.aspx?
graphID=56967](http://www.nodexlgraphgallery.org/Pages/Graph.aspx?graphID=56967)



Ambiguity, distortion (misleading), distraction.

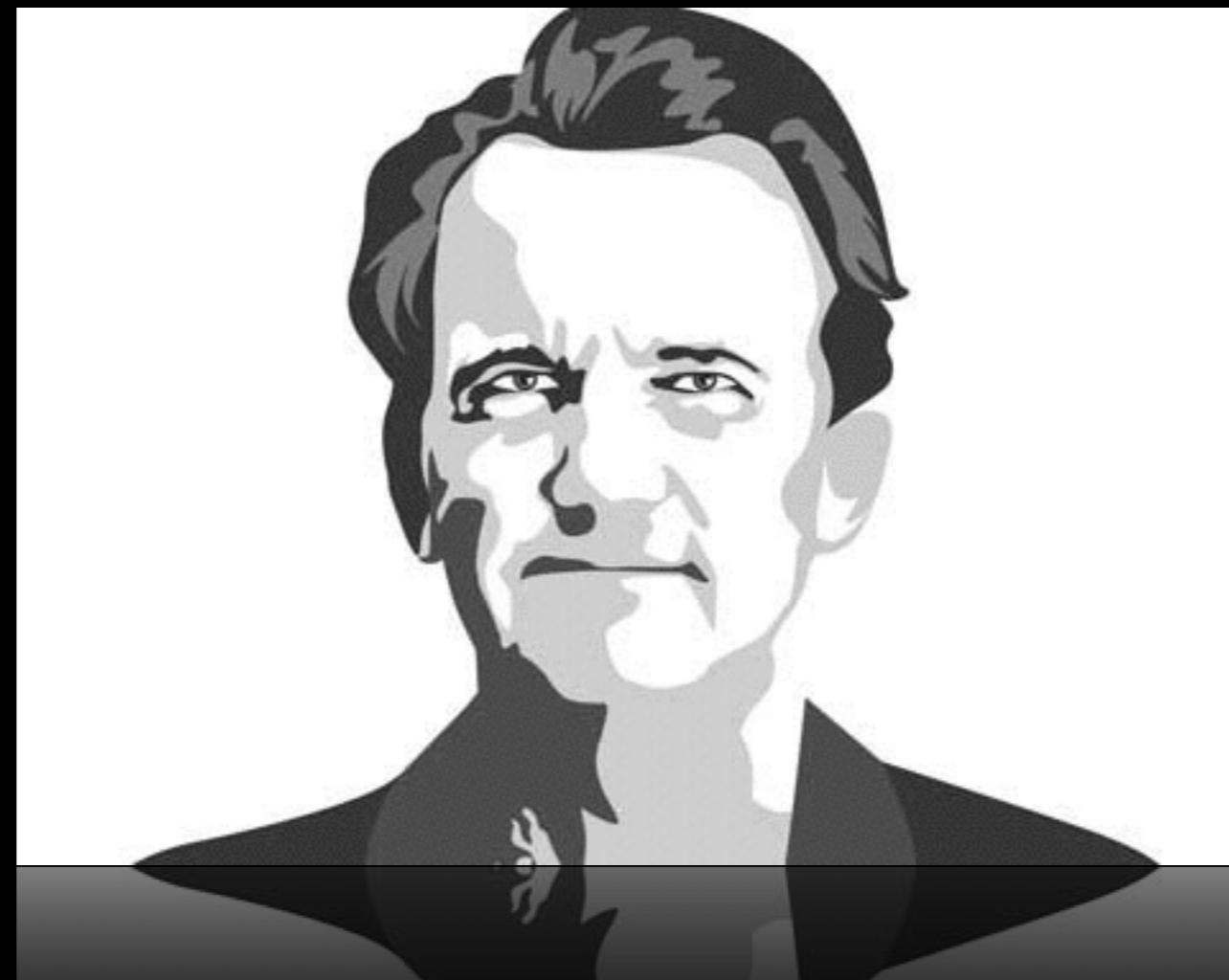


Ambiguity, distortion (misleading), distraction.



- Descriptive data viz
 - Lie with statistics
 - Tufte's rules
- Exploratory data viz
 - Jer Thorp
- Psychophysics
- Esthetics vs(??) functionality
 - color blindness
 - the third dimension
- Interactivity

	1999.1.1	65 months	2004.4.28	low	high		2003.4.28	12 months	2004.4.28	low	high
Euro foreign exchange \$	1.1608		1.1907	.8252	1.2858	\$	1.1025		1.1907	1.0783	1.2858
Euro foreign exchange ¥	121.32		130.17	89.30	140.31	¥	132.54		130.17	124.80	140.31
Euro foreign exchange £	0.7111		0.6665	.5711	0.7235	£	0.6914		0.6665	0.6556	0.7235



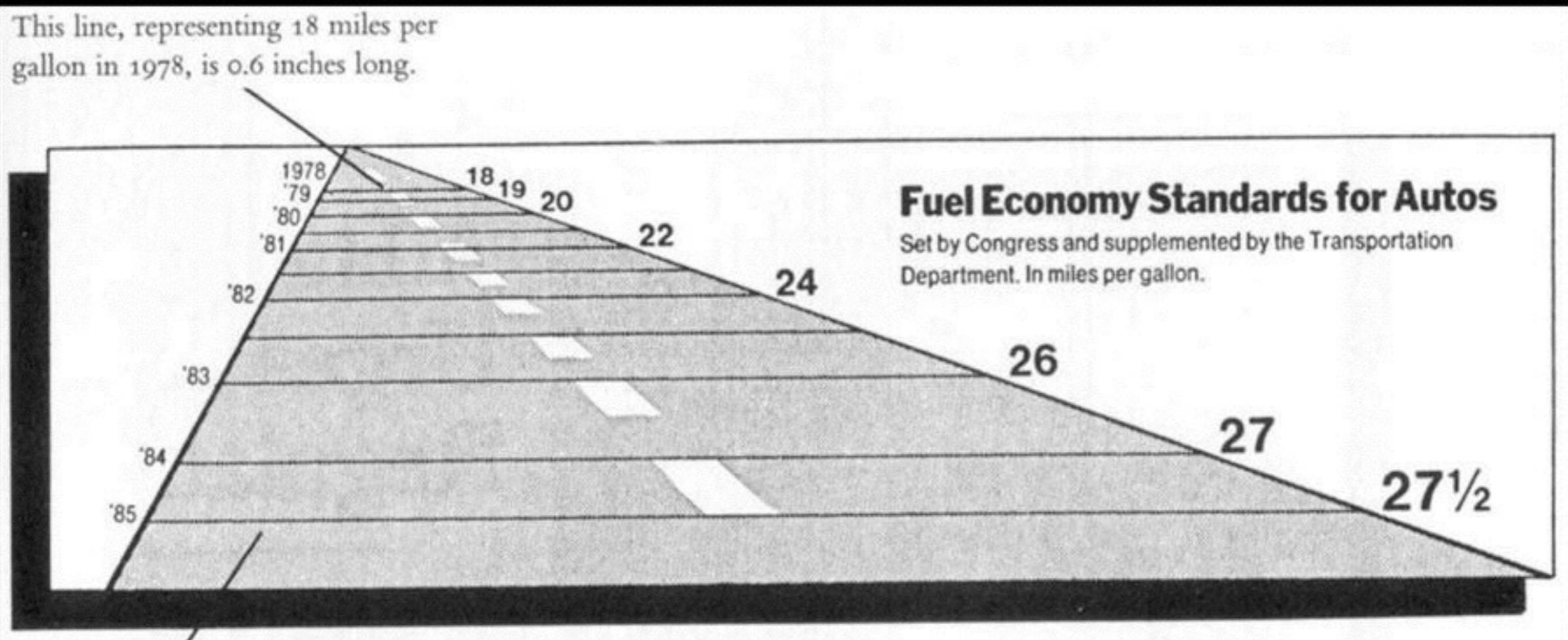
Edward Tufte

Tufte's rules:

Lie factor = $\frac{\text{size of the effect in the graphic}}{\text{size of the effect in the data}}$

Tufte's rules:

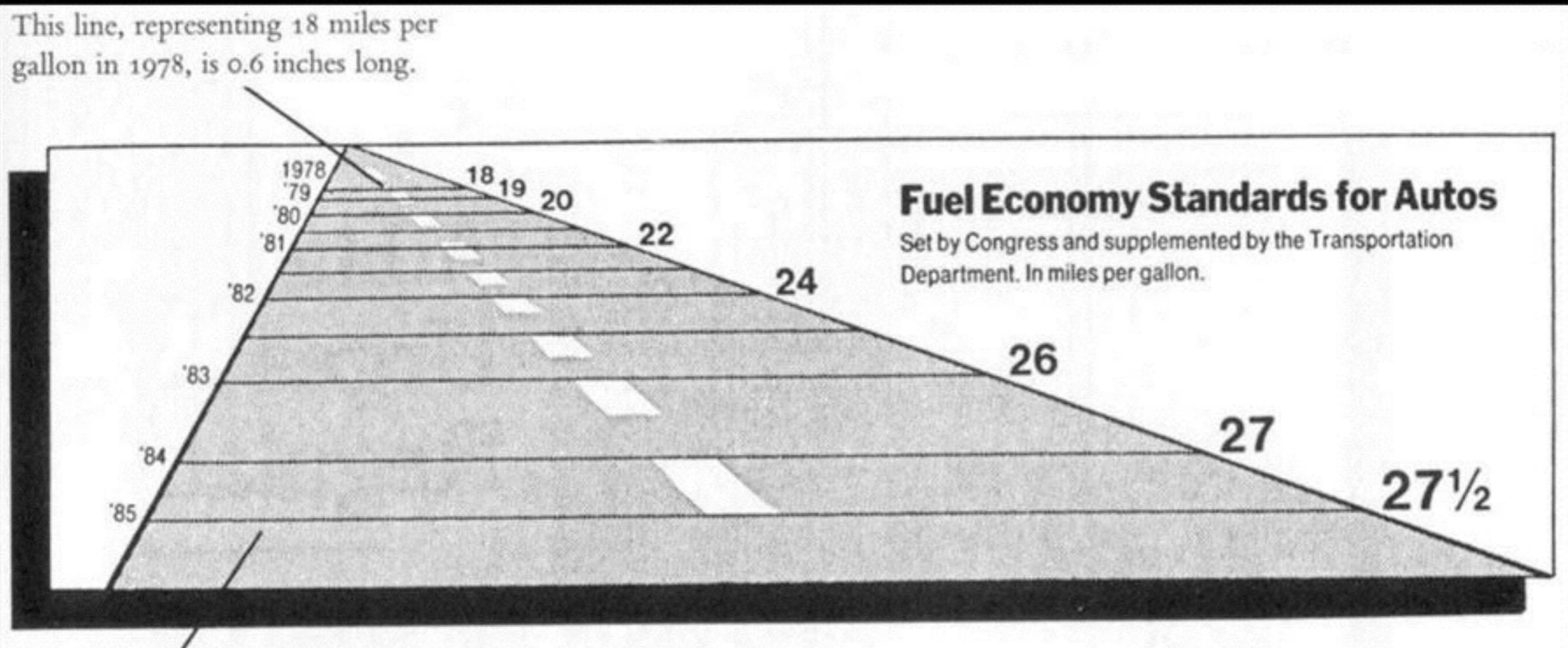
Lie factor = $\frac{\text{size of the effect in the graphic}}{\text{size of the effect in the data}}$



This line, representing 27.5 miles per gallon in 1985, is 5.3 inches long.

Tufte's rules:

$$\text{Lie factor} = \frac{\text{size of the effect in the graphic}}{\text{size of the effect in the data}} = \frac{5.3 / 0.6}{27.5 / 18} = 5.78$$



This line, representing 27.5 miles per gallon in 1985, is 5.3 inches long.

Lie factor = 6



57%

of Europeans are
worried their
personal
information
is not safe.

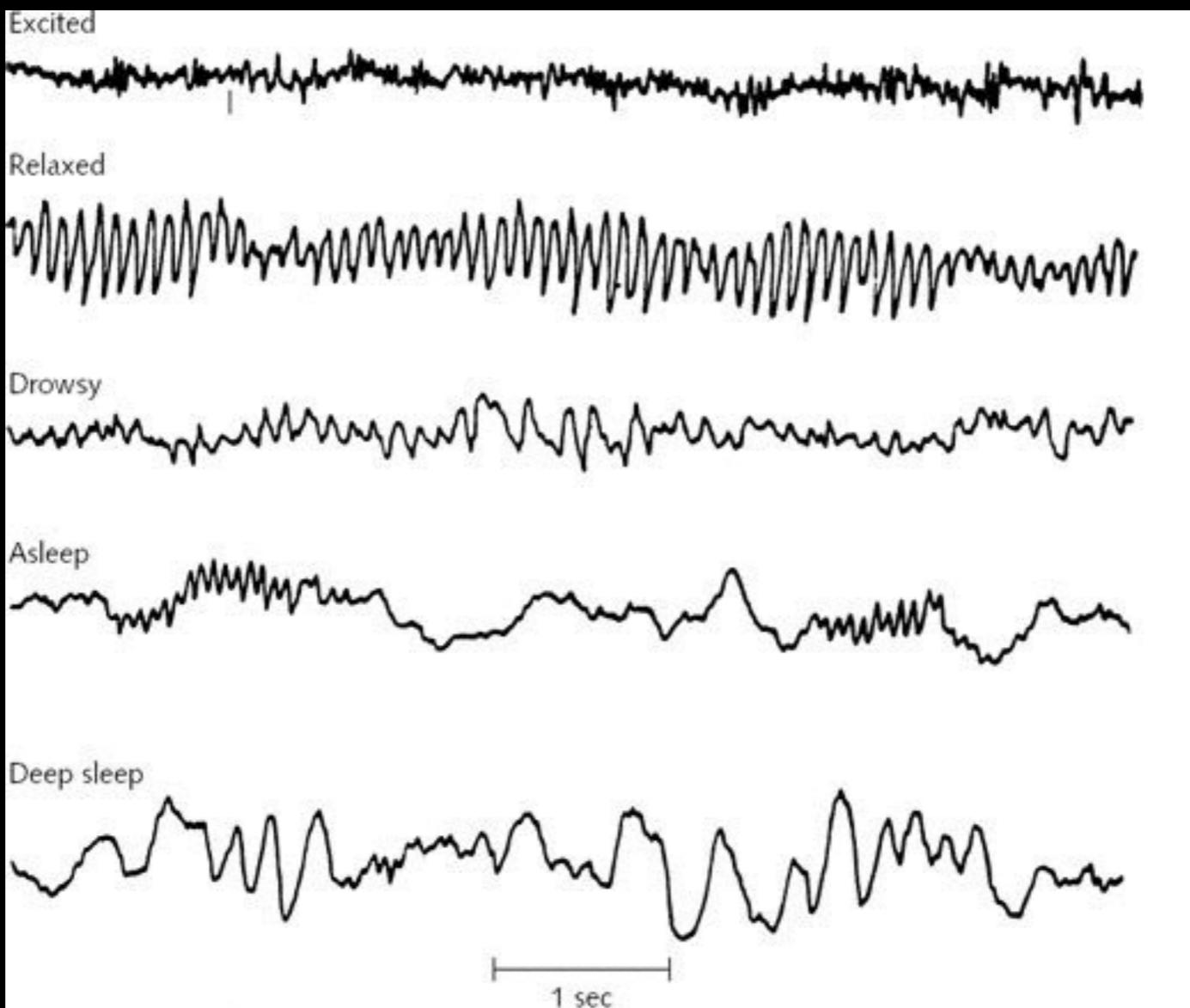


Symantec.

Tufte's rules:

Data-ink ratio

amount of data
amount of ink



STATE OF CREATIVITY IN EDUCATION: AN ADOBE SURVEY



Sample Size: 1014 educators representing 13 countries across Asia Pacific



Attitudes & Aspirations

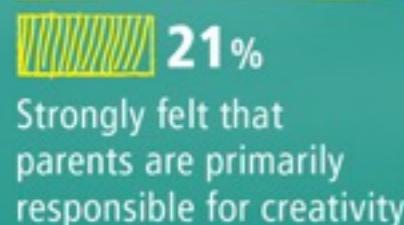
Current and Desired State of Creativity



Educators strongly felt that they should be creative regardless of the subjects they teach



Strongly felt fostering creativity is educators' primary responsibility



Strongly felt that parents are primarily responsible for creativity



58%
Ideally wanted to spend time fostering creativity in the classroom

45%
Educators spent their time fostering creative skills in their classroom in the last one year



Barriers & Enablers

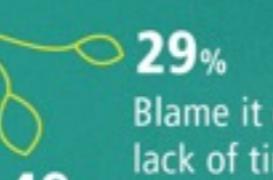
What Hinders and Helps Creativity



57%
Are hamstrung by an education system that is not geared towards creativity



43%
Felt the current education system was either outdated or restrictive or both



29%
Blame it on lack of time



41%
Educators believe tools and training for educators are the most critical need to promote creativity



36%
Believe the biggest barrier to creativity is a system that is heavily reliant on testing and assessment



Tools & Techniques

Methods to Foster Creativity



85%

Respondents felt that technology and digital tools play an important role



34%

Indicated that they were very prepared to adapt their teaching methodology to leverage digital tools



Innovation & Growth

Impact on Country's Success



8.4

Rating on a scale of 1 to 10; on how important it was to infuse creativity in education to ensure their country's long-term success

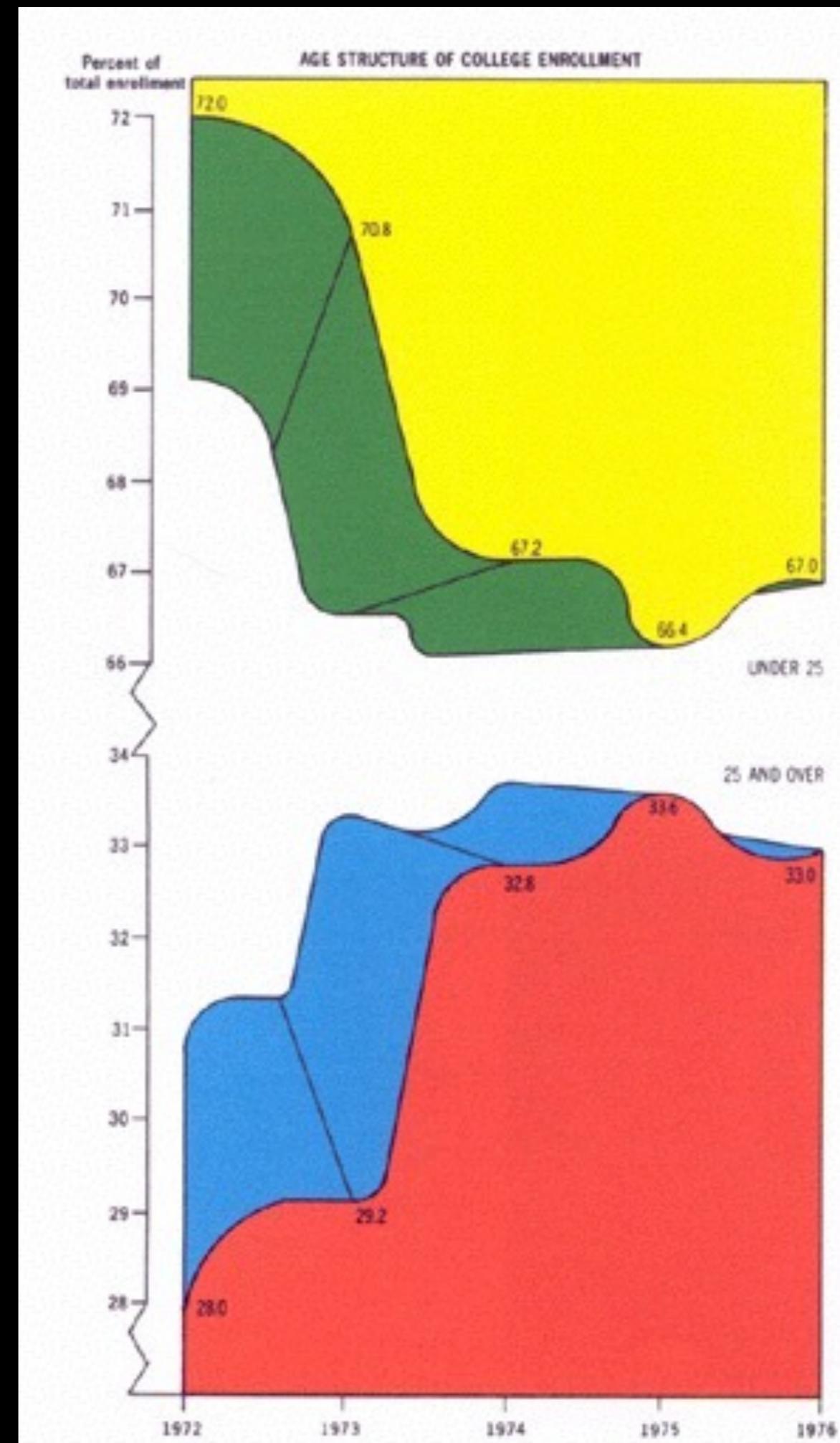


Rating on a scale of 1 to 10; on the efficiency of the current education system in developing a new generation of innovators



Tufte's rules:

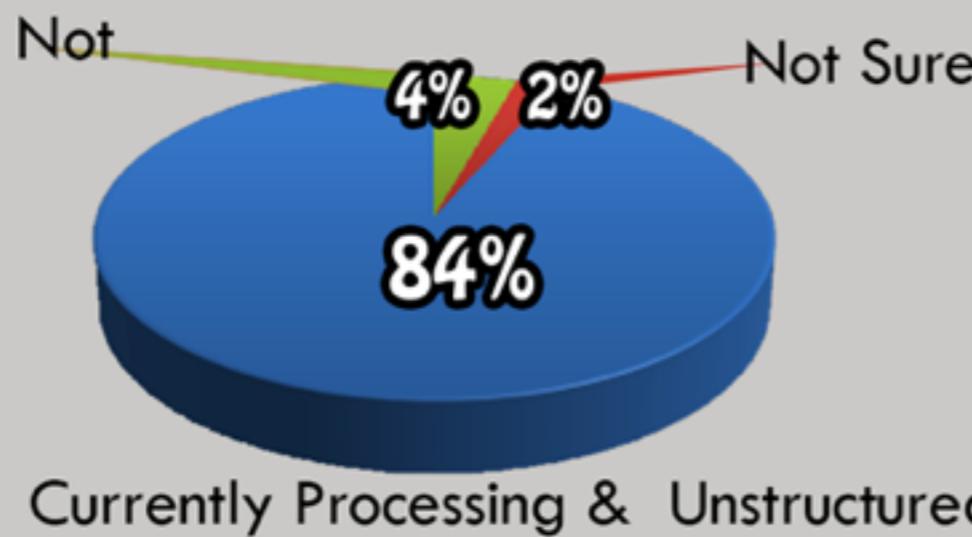
Chart Junk
the excessive and unnecessary
use of graphical effects



4

The Rise of Unstructured and Semistructured Data Analytics

Currently Analyzing Unstructured Data

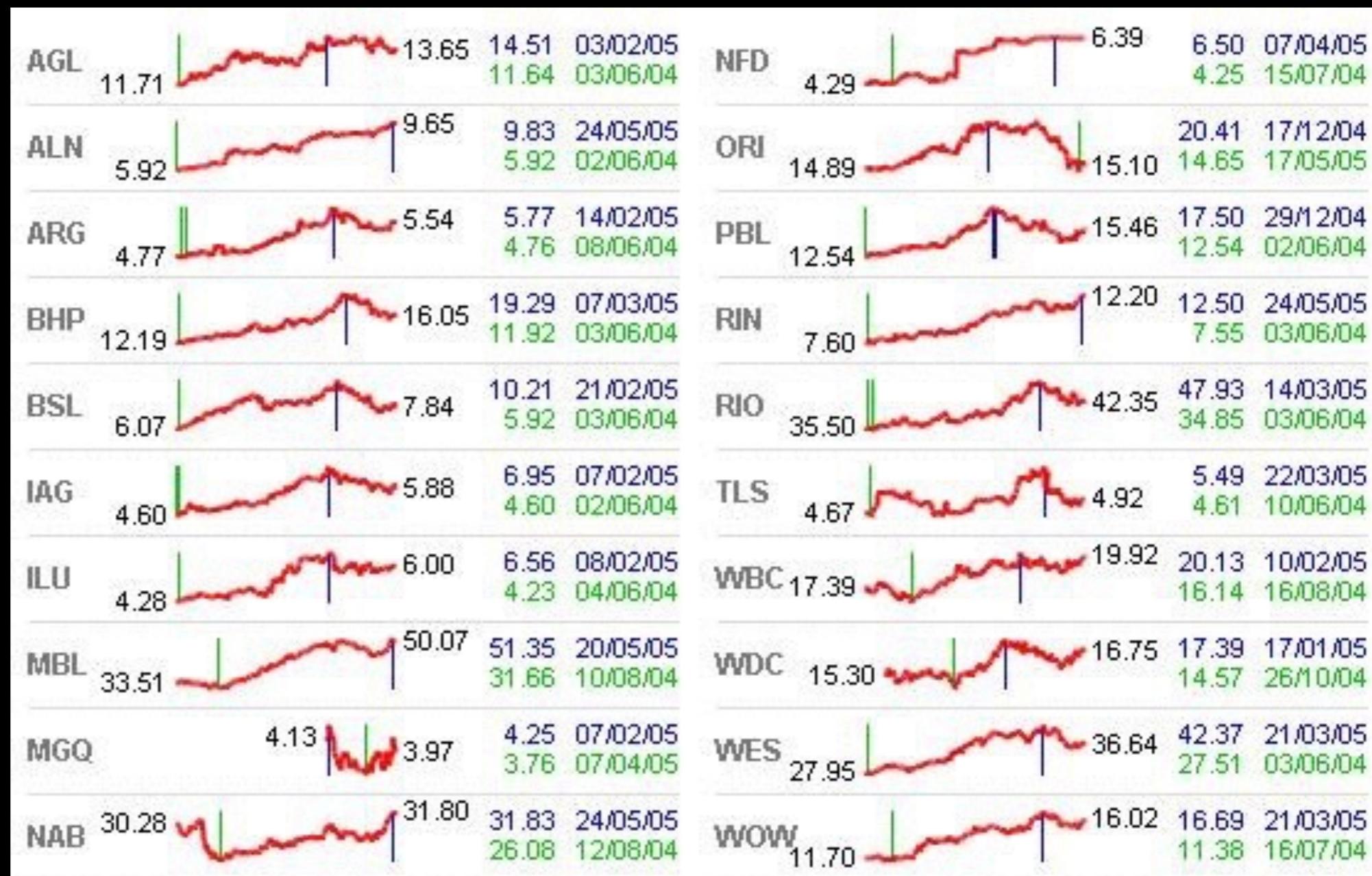


The ‘Peer Research – Big Data Analytics’ survey clearly reports that there is a huge growth when it comes to unstructured & semistructured data analytics.

Tufte's rules:

Small Multiples

encourage comparison



sparkline graph

Active Forces

Who has the most soldiers?



China
2.1m



US
1.5m



India
1.3m



North Korea
1.1m



Russia
1m

InformationIsBeautiful.net

source: Guardian Datablog, milxdata.sipri.org 2008

Active Forces

Who has the most soldiers?



China
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source: Guardian Datablog, milexdata.sipri.org 2008

Number of soldiers per 100,000 people



North Korea
4,711



Eritrea
4,012



Israel
2,482



Djibouti
2,064



Iraq
2,045



US 507
(45th)



UK 263
(93rd)



China 164
(124th)

InformationIsBeautiful.net

source: Guardian Datablog, milexdata.sipri.org 2008

Figurative Map of the successive losses in men of the French Army in the Russian campaign 1812-1813.

Drawn by Mr. Minard, Inspector General of Bridges and Roads in retirement. Paris, 20 November 1869.

The numbers of men present are represented by the widths of the colored zones in a rate of one millimeter for ten thousand men; these are also written beside the zones. Red designates men moving into Russia, black those on retreat. — The

informations used for drawing the map were taken from the works of Messrs. Chiers, de Ségur, de Fezensac, de Chambray and the unpublished diary of Jacob, pharmacist of the Army since 28 October.

In order to facilitate the judgement of the eye regarding the diminution of the army, I supposed that the troops under Prince Jérôme and under Marshal Davoust, who were sent to Minsk and Mobilow and who rejoined near Orscha and Witebsk, had always marched with the army.

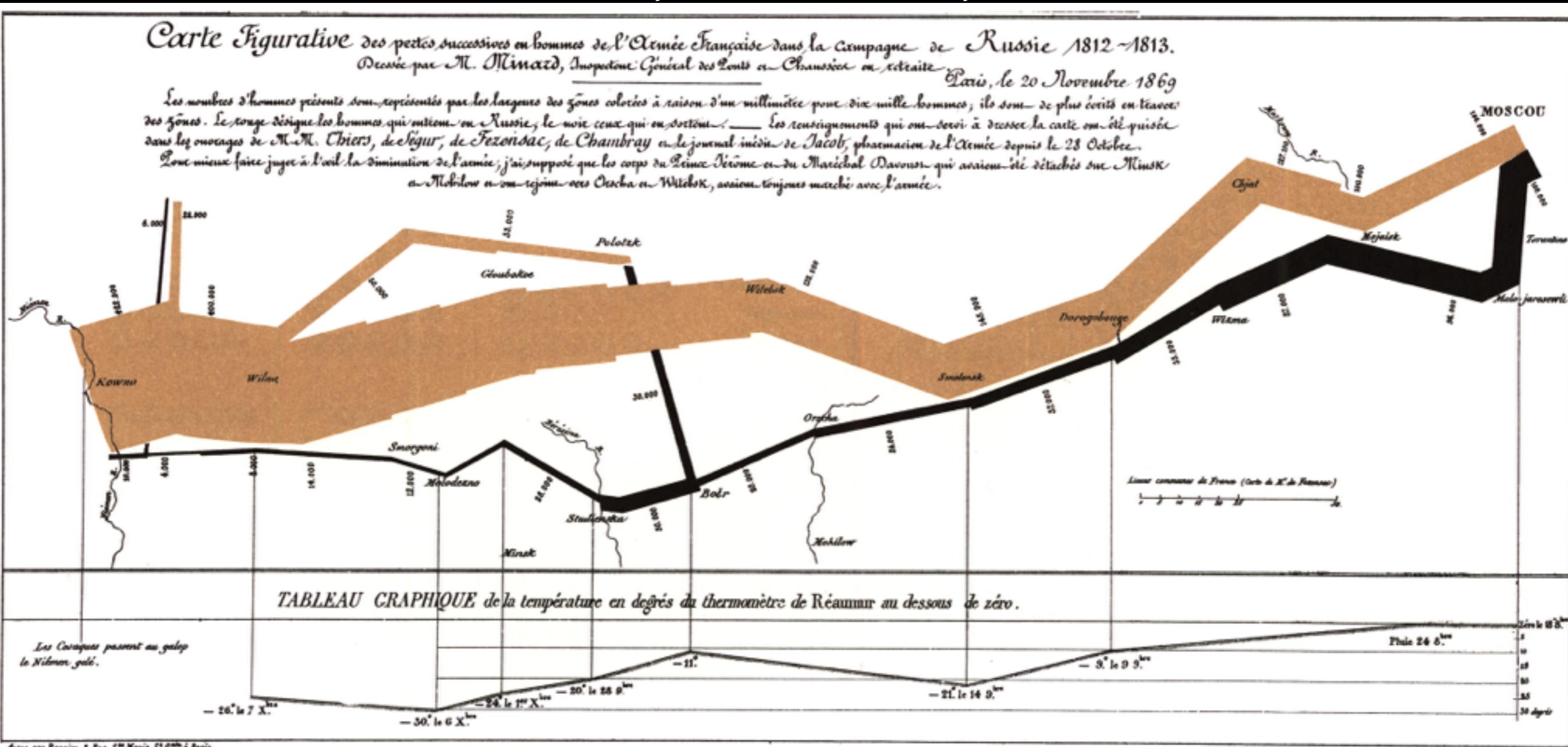
Carte Figurative des pertes successives en hommes de l'Armée Française dans la Campagne de Russie 1812-1813.

Dessiné 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 trèves 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 prisés dans les ouvrages de M. Chiers, de Ségur, de Fezensac, de Chambray et le journal intime 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 Marshal Davoust, qui auraient été détachés sur Minsk et Mobilow au régime vers Orscha et Witebsk, avaient toujours marché avec l'armée.



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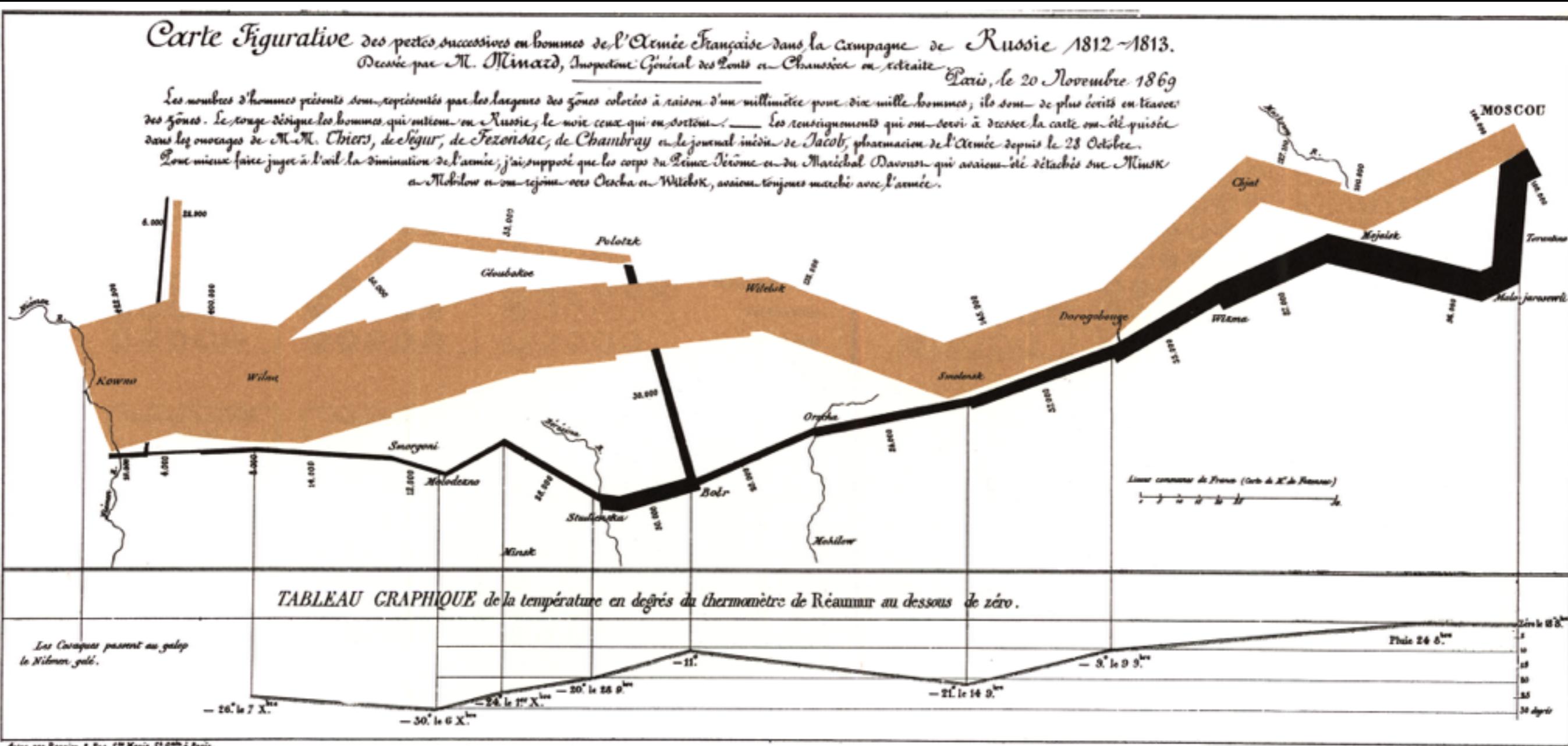
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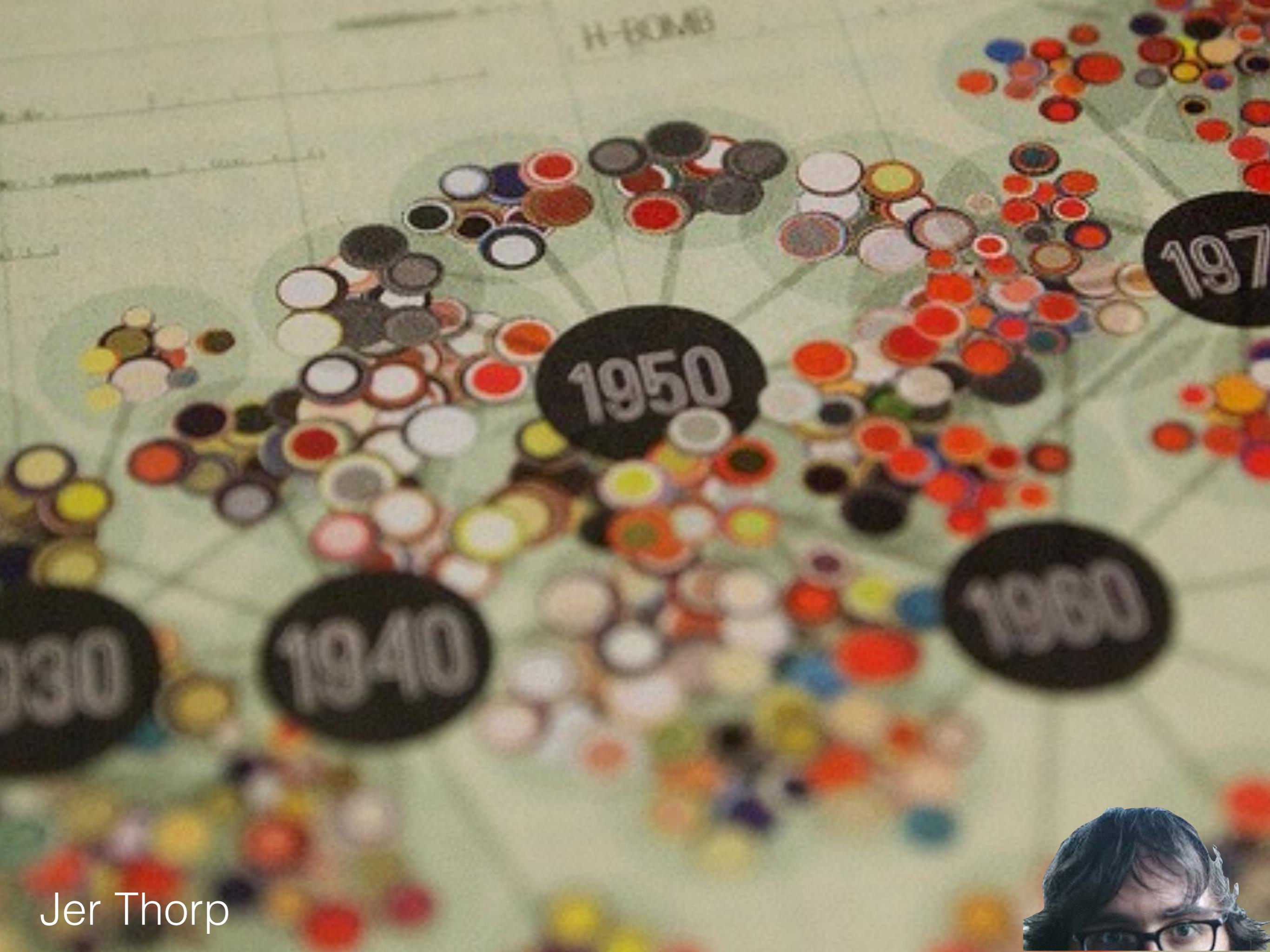
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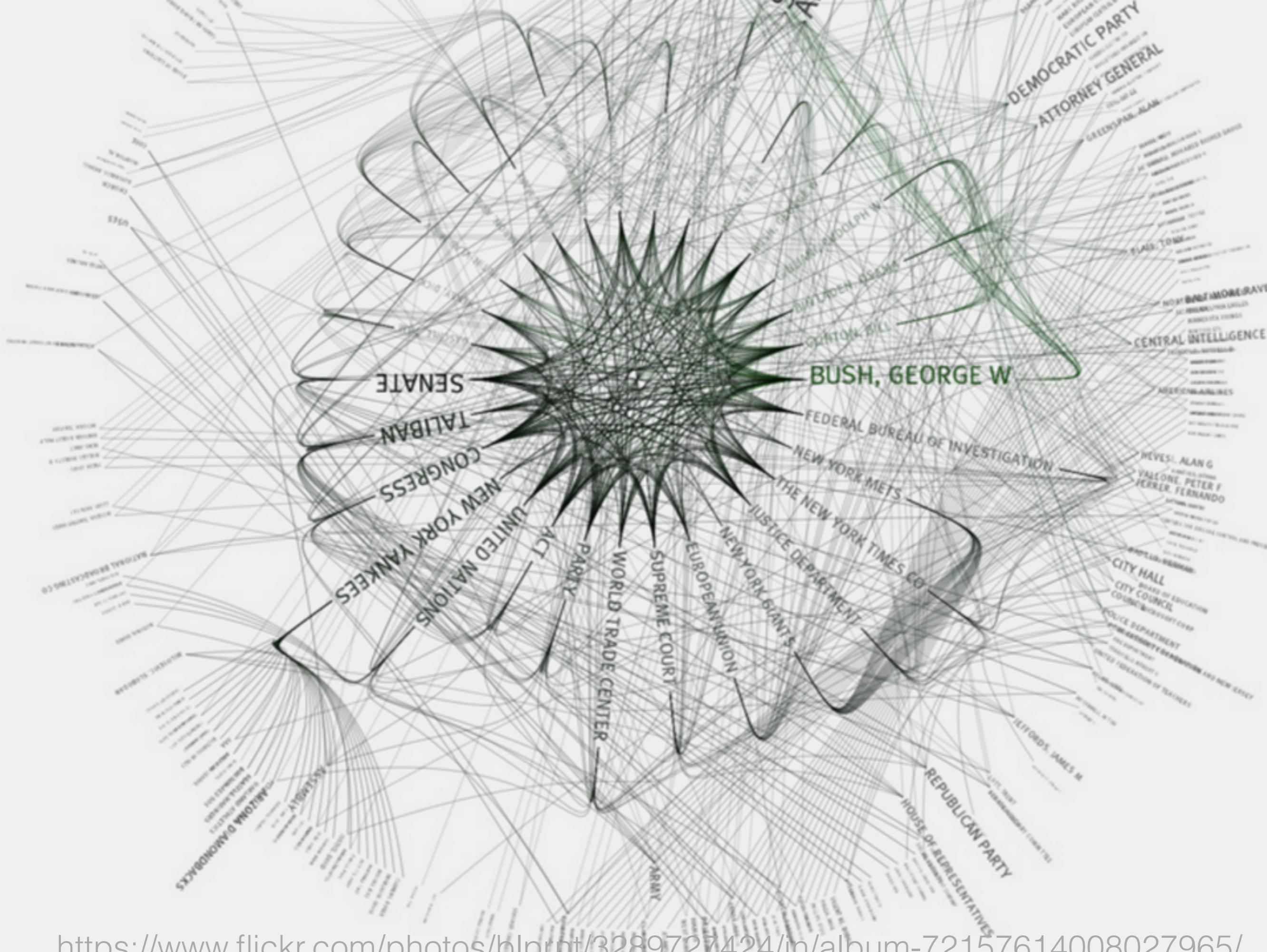


1. The representation of numbers, as physically measured on the surface of the graph itself, should be directly proportional to the numerical quantities represented
2. Clear, detailed and thorough labeling should be used to defeat graphical distortion and ambiguity. *Write out explanations of the data on the graph itself.* Label important events in the data.
3. Show data variation, not design variation.
4. In time-series displays of money, deflated and standardized units of monetary measurement are nearly always better than nominal units.
5. The number of information carrying (variable) dimensions depicted should not exceed the number of dimensions in the data ($ND_{graph} \leq ND_{data}$).
6. Graphics must not quote data out of context.

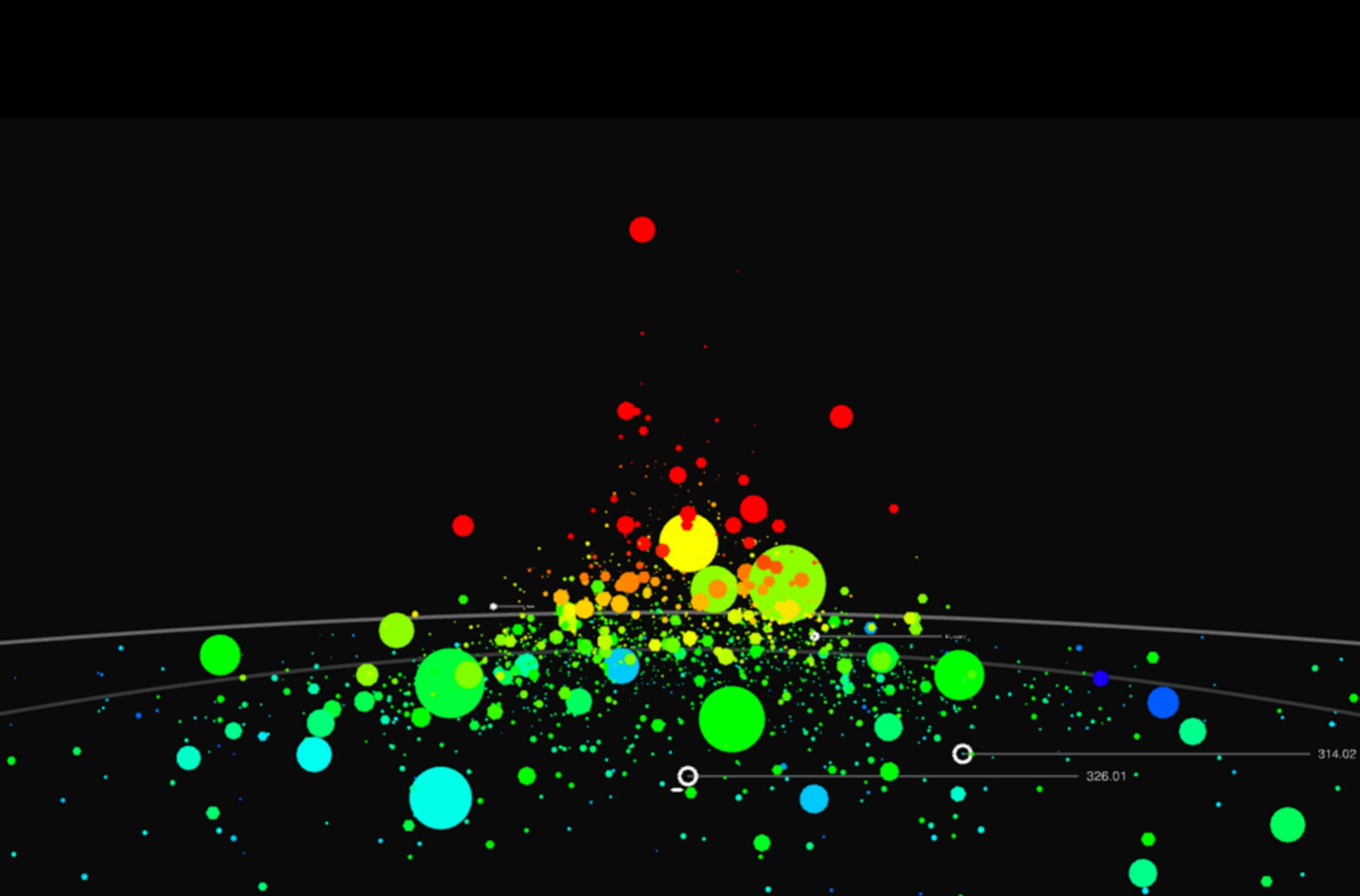


Jer Thorp





<http://nytlabs.com/projects/cascade.html>



<http://blog.blprnt.com/blog/blprnt/data-in-an-alien-context-kepler-visualization-source-code>

making sparklines!

 jupyter

Remove to improve

<http://i.imgur.com/RzYaLZg.gif>

Graphical Vocabulary

LES VARIABLES DE L'IMAGE

	POINTS	LIGNES	ZONES
XY 2 DIMENSIONS DU PLAN	×	12	15 9 14 1 18 21 2 14 15 1 1 21 15 1 2 9
Z TAILLE	—	—	—
VALEUR	—	—	—
LES VARIABLES DE SÉPARATION DES IMAGES			
GRAIN	—	—	—
COULEUR	—	—	—
ORIENTATION	—	—	—
FORME	—	—	—

ÉLOWE

Jacques Bertin: Semiology of Graphics, 1967 Gauthier-Villars,
1998 EHESS

position

size

intensity

texture

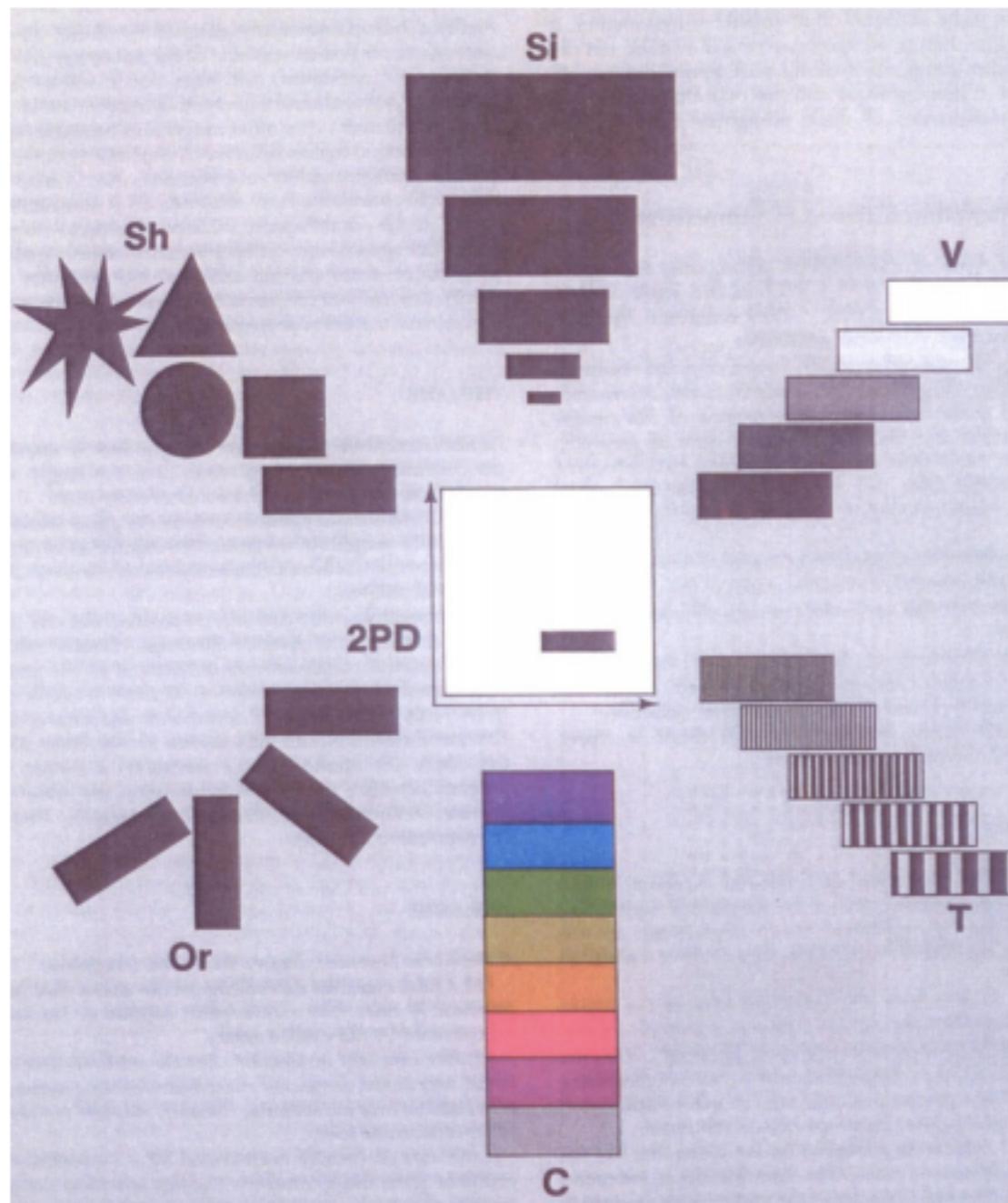
color

orientation

shape

point line area

		LES VARIABLES DE L'IMAGE				
		POINTS	LIGNES	ZONES		
XY 2 DIMENSIONS DU PLAN	Z					
	TAILLE					
LES VARIABLES DE SÉPARATION DES IMAGES						
GRAIN	COULEUR					
	ORIENTATION					
FORME	ÉLOWE					
	ÉLOWE					



- Size
- Value (Density)
- Texture
- Color
- Orientation
- Shape
- 3D
- Animation/Time

Data types

continuous

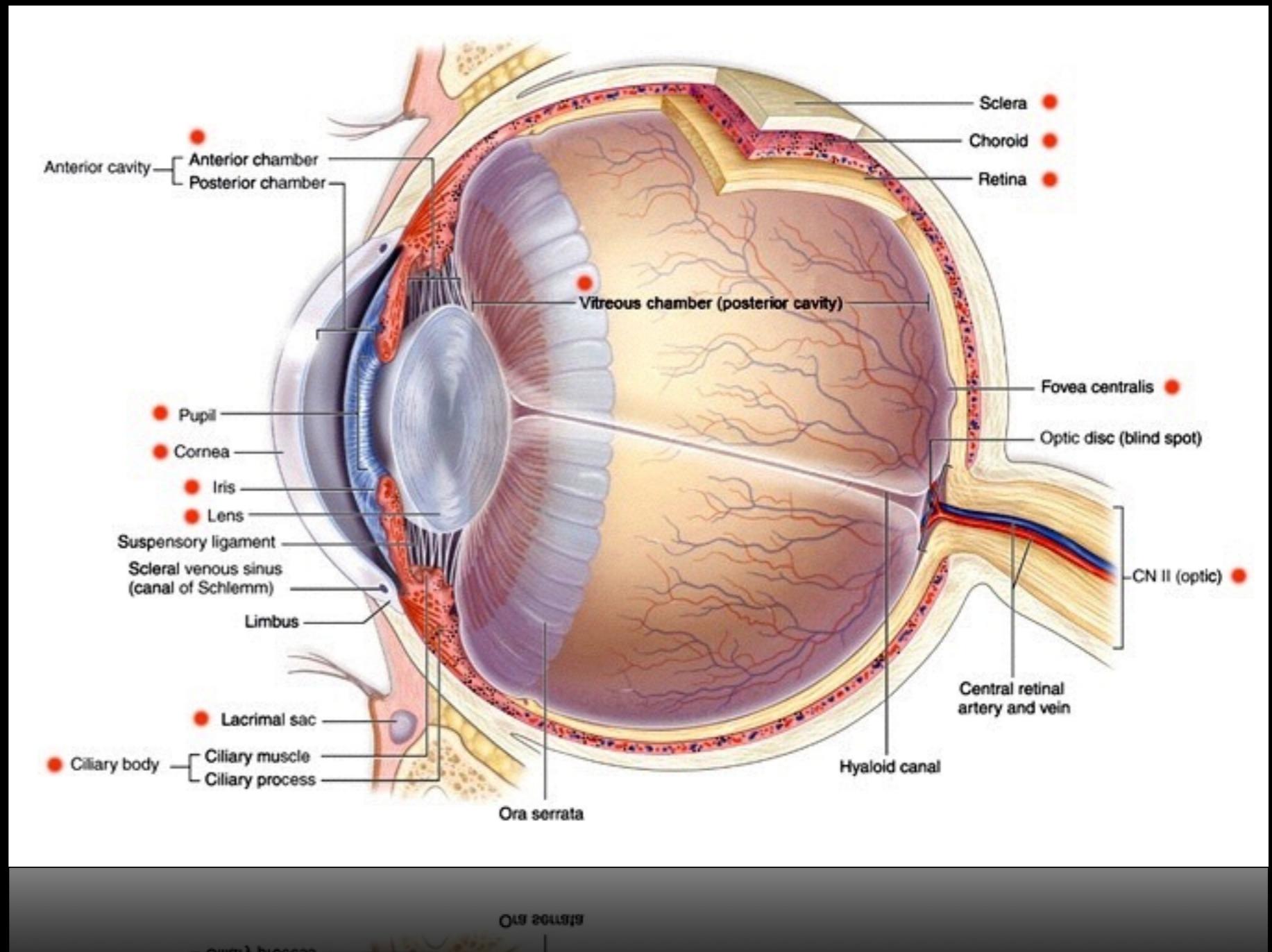
ordered

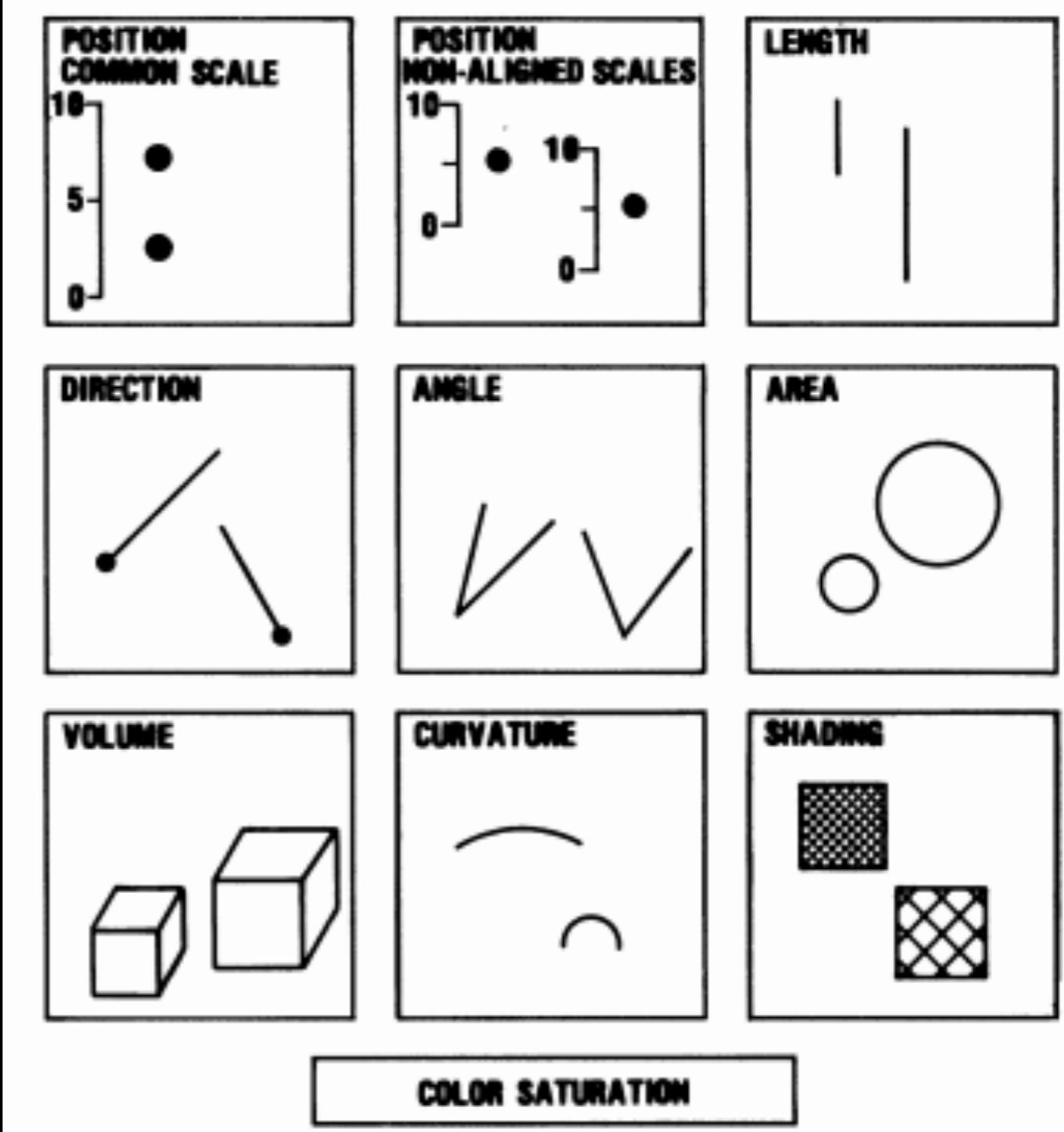
categorical



Psychophysics

The study of human perception





Graphical Perception: Theory, Experimentation, and Application to the Development of Graphical Methods

WILLIAM S. CLEVELAND and ROBERT MCGILL*

Figure 1. Elementary perceptual tasks.

Stevens 1975

Psychophysical power law

The apparent magnitude of all sensory channels follows a power law based on the stimulus intensity

$$S = I^n$$

S sensation, I intensity

Stevens's Psychophysical Power Law: $S = I^n$

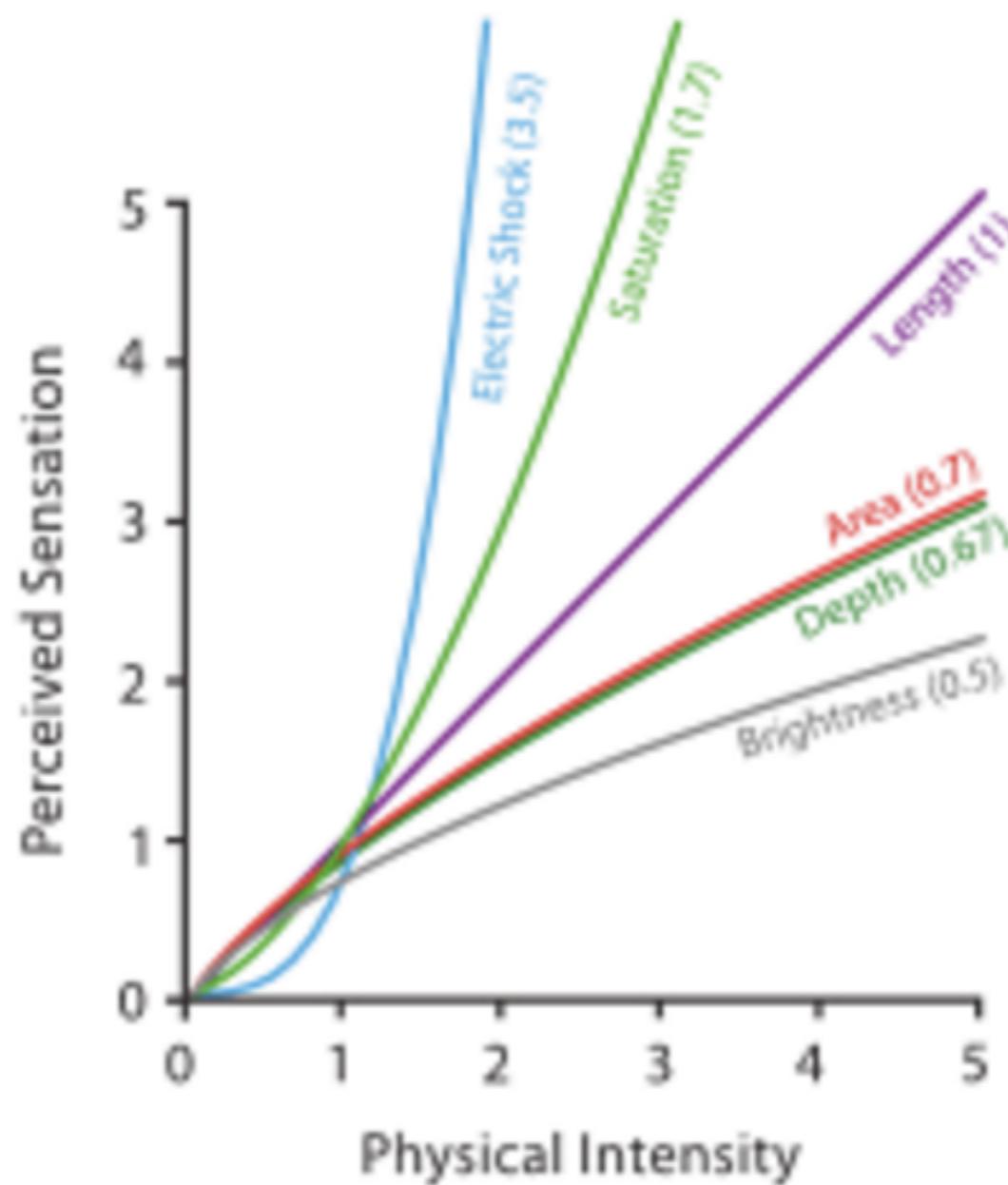


Figure 5.7. Stevens showed that the apparent magnitude of all sensory channels follows a power law $S = I^n$, where some sensations are perceptually magnified compared with their objective intensity (when $n > 1$) and some compressed (when $n < 1$). Length perception is completely accurate, whereas area is compressed and saturation is magnified. Data from Stevens [Stevens 75, p. 15].

Active Forces II

Number of soldiers per 100,000 people



North Korea
4,711

Eritrea
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Israel
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Djibouti
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Iraq
2045

InformationIsBeautiful.net

source: Guardian Datablog, millexdata.sipri.org 2008

Psychophysical Power Law: $S = I^n$

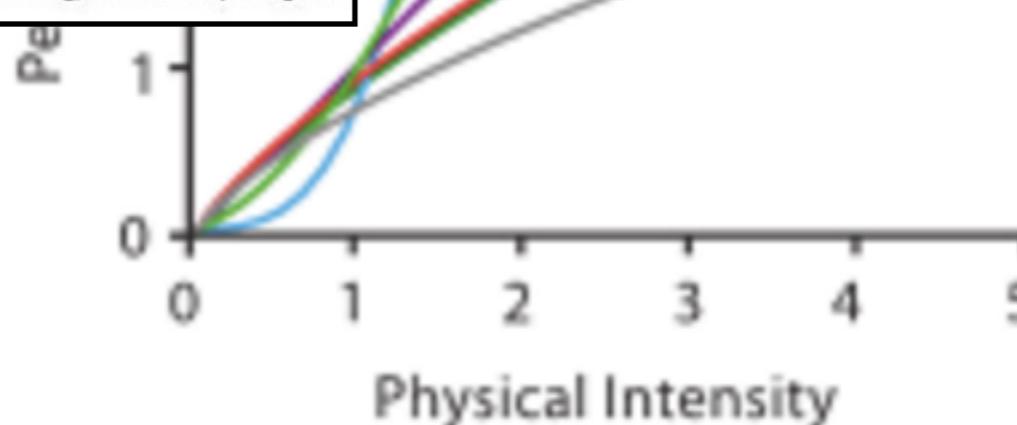
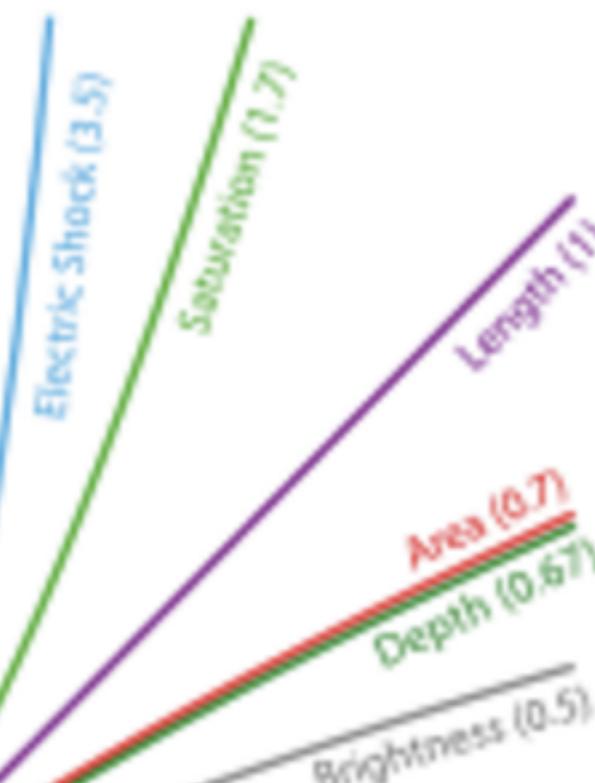
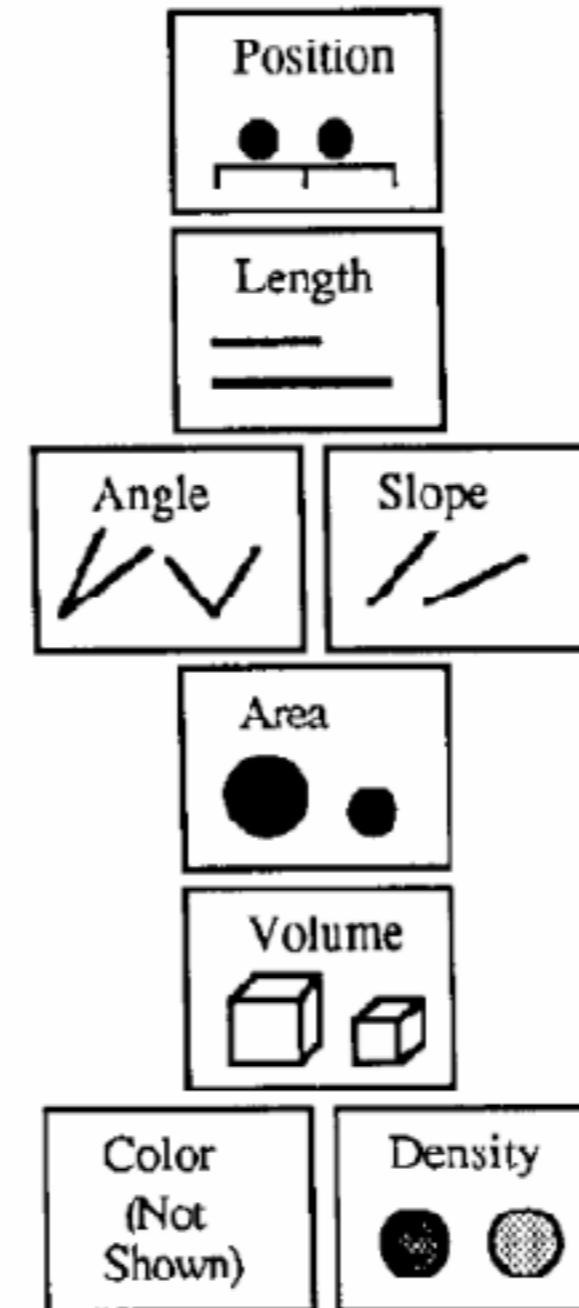


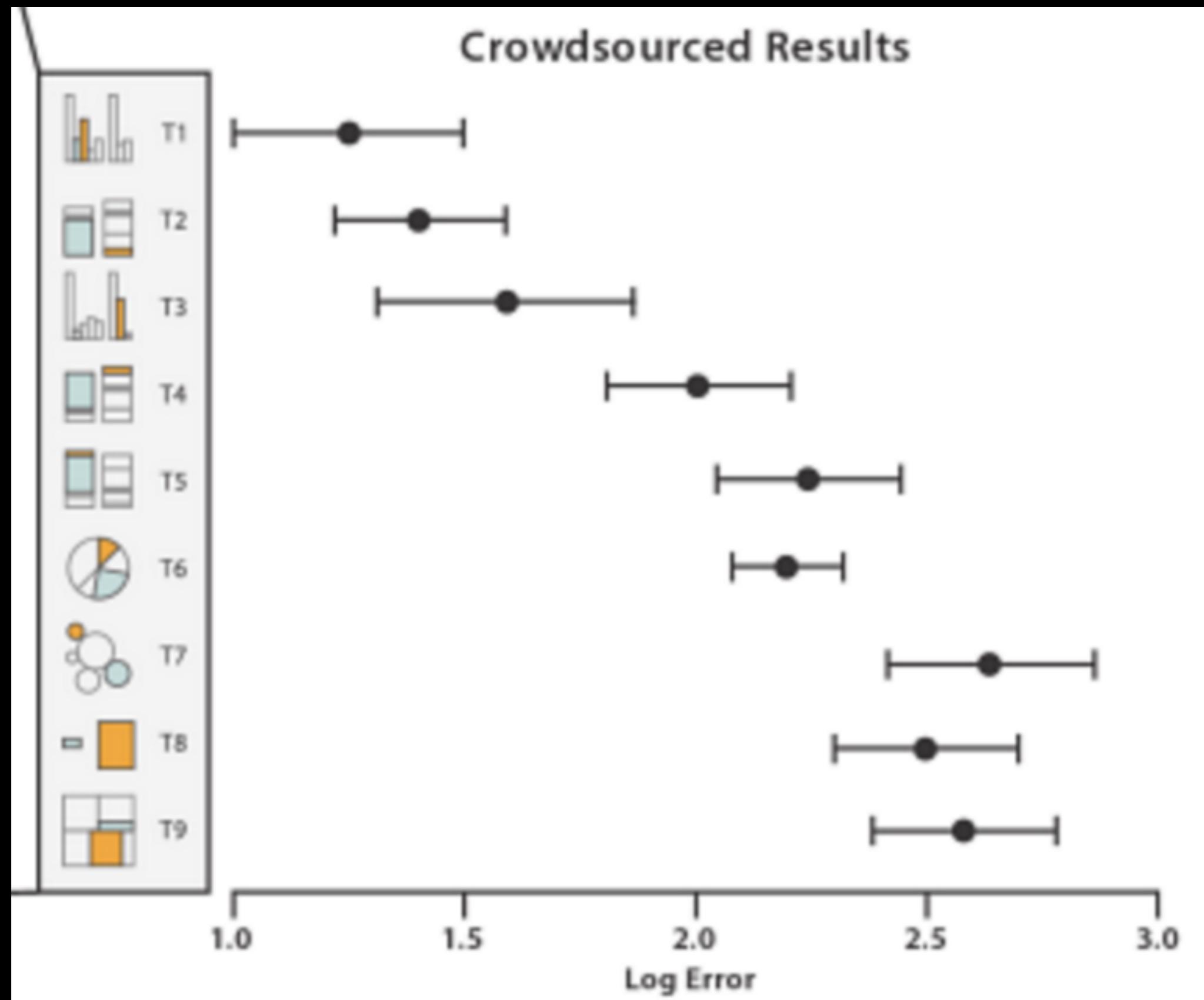
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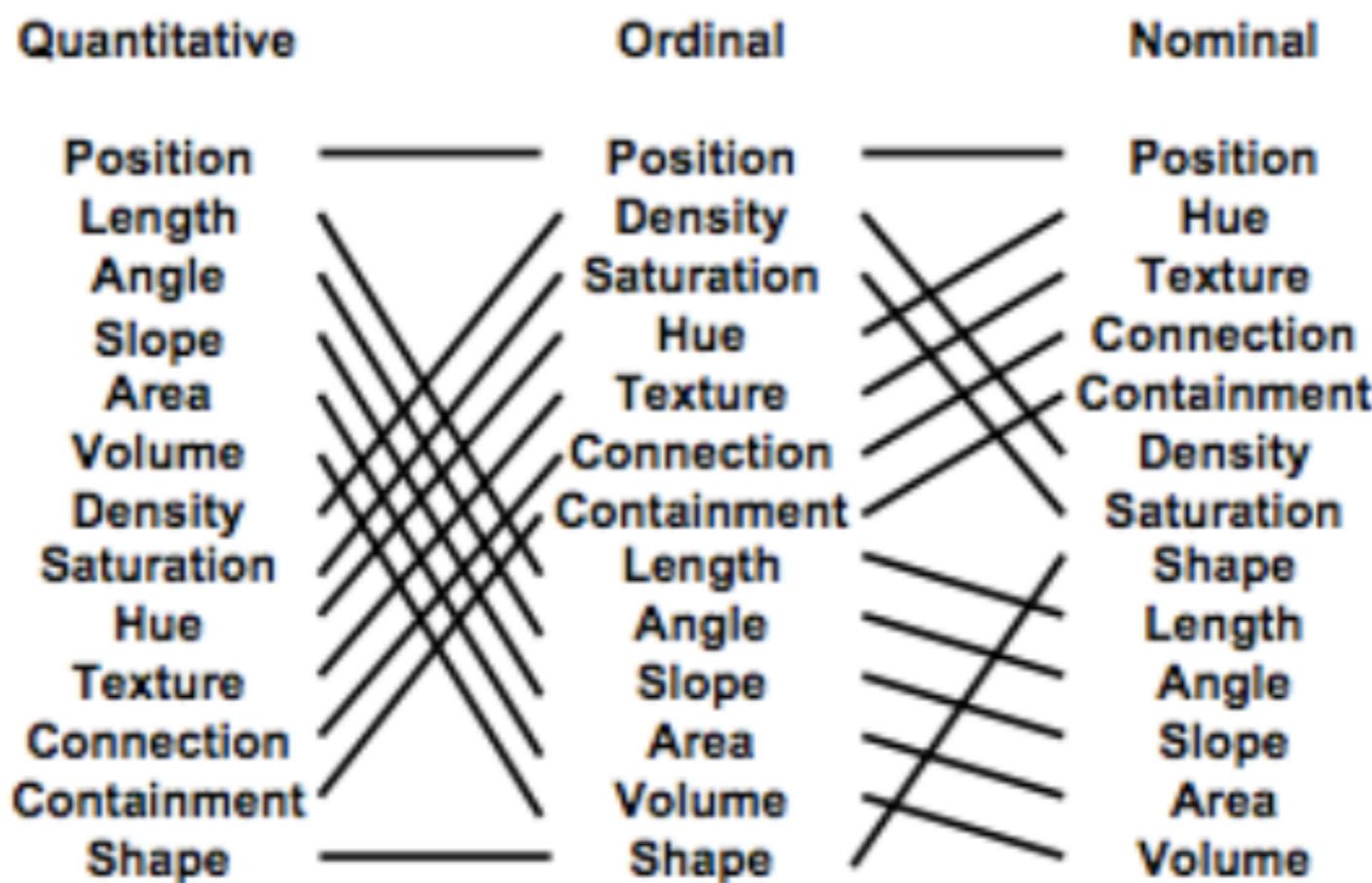
More accurate



Less accurate

Automating the Design of Graphical Presentations of Relational Information ,Jock Mackinlay, ACM Transaction on Graphics, 1986
Cleveland & McGill, Graphical Perception: Theory, Experimentation, and Application to the Development of Graphical Methods 1984





[Mackinlay, Automating the Design of Graphical Presentations of Relational Information, ACM TOG 5:2, 1986]

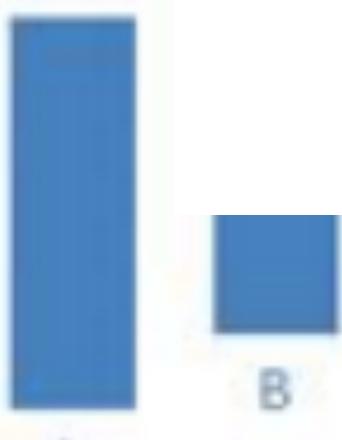
Weber Law

We judge based on relative differences

The detectable difference in stimulus intensity is a fixed percentage of the object magnitude

$$\delta I / I = K$$

I intensity, K constant



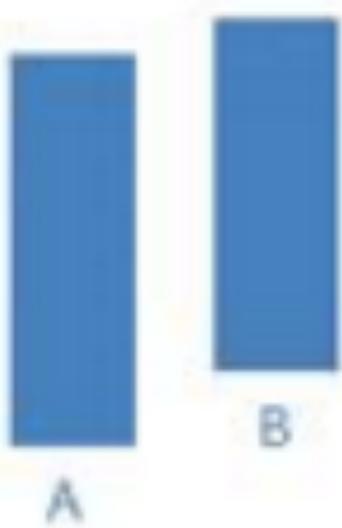
Unframed
Unaligned

(a)



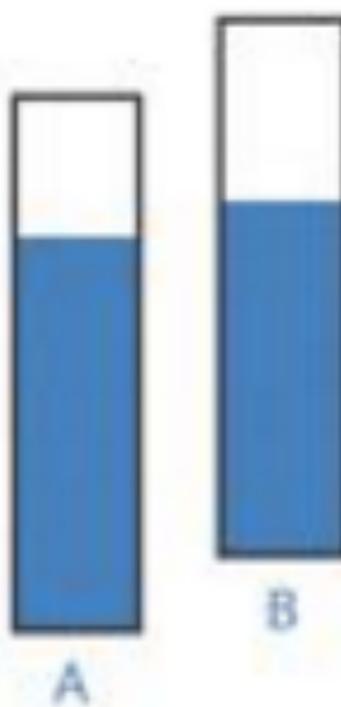
Unframed
Unaligned

(a)



Unframed
Unaligned

(a)



Framed
Unaligned

(b)



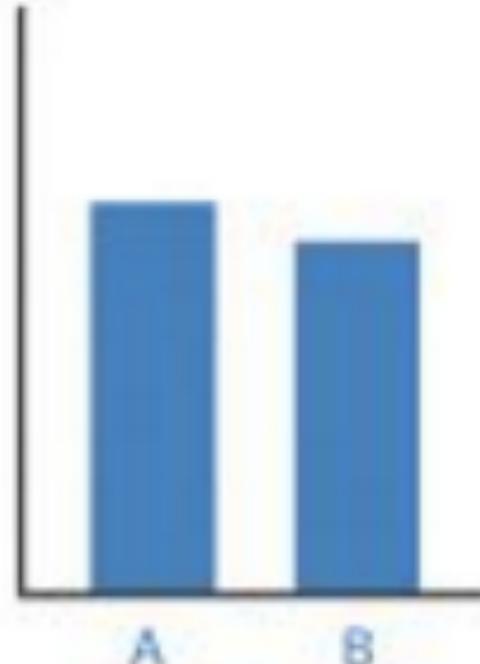
Unframed
Unaligned

(a)



Framed
Unaligned

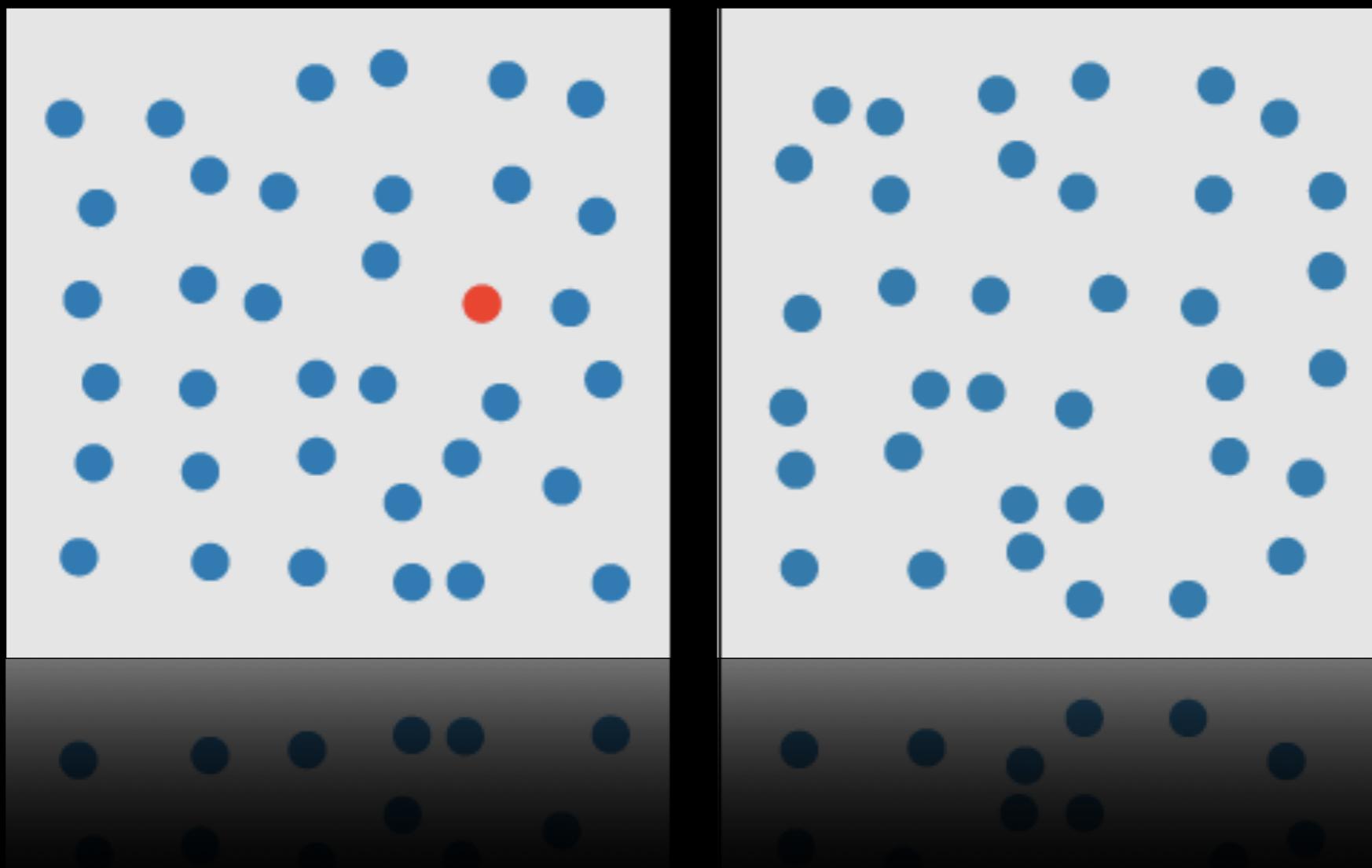
(b)



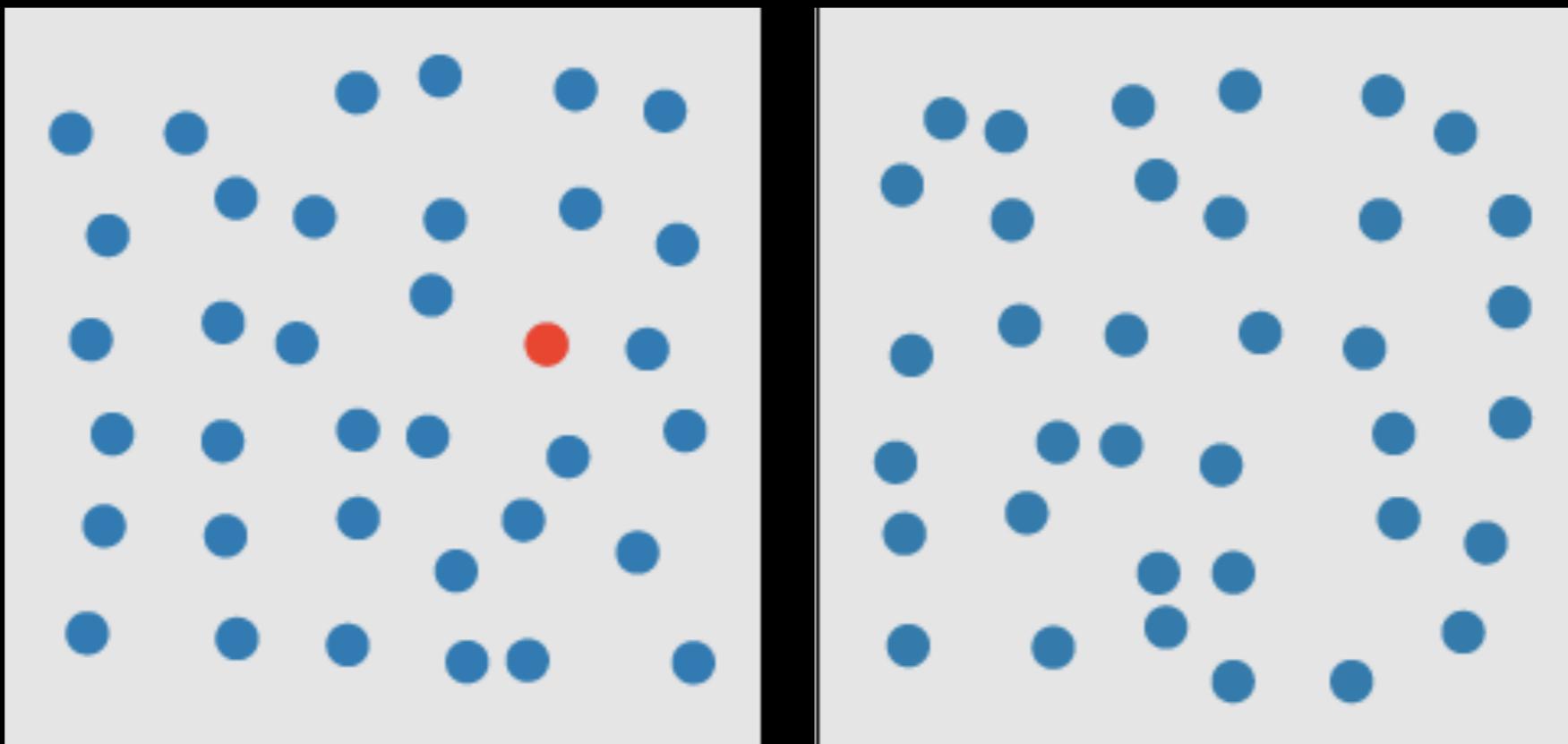
Unframed
Aligned

(c)

Preattentive tasks



Preattentive tasks

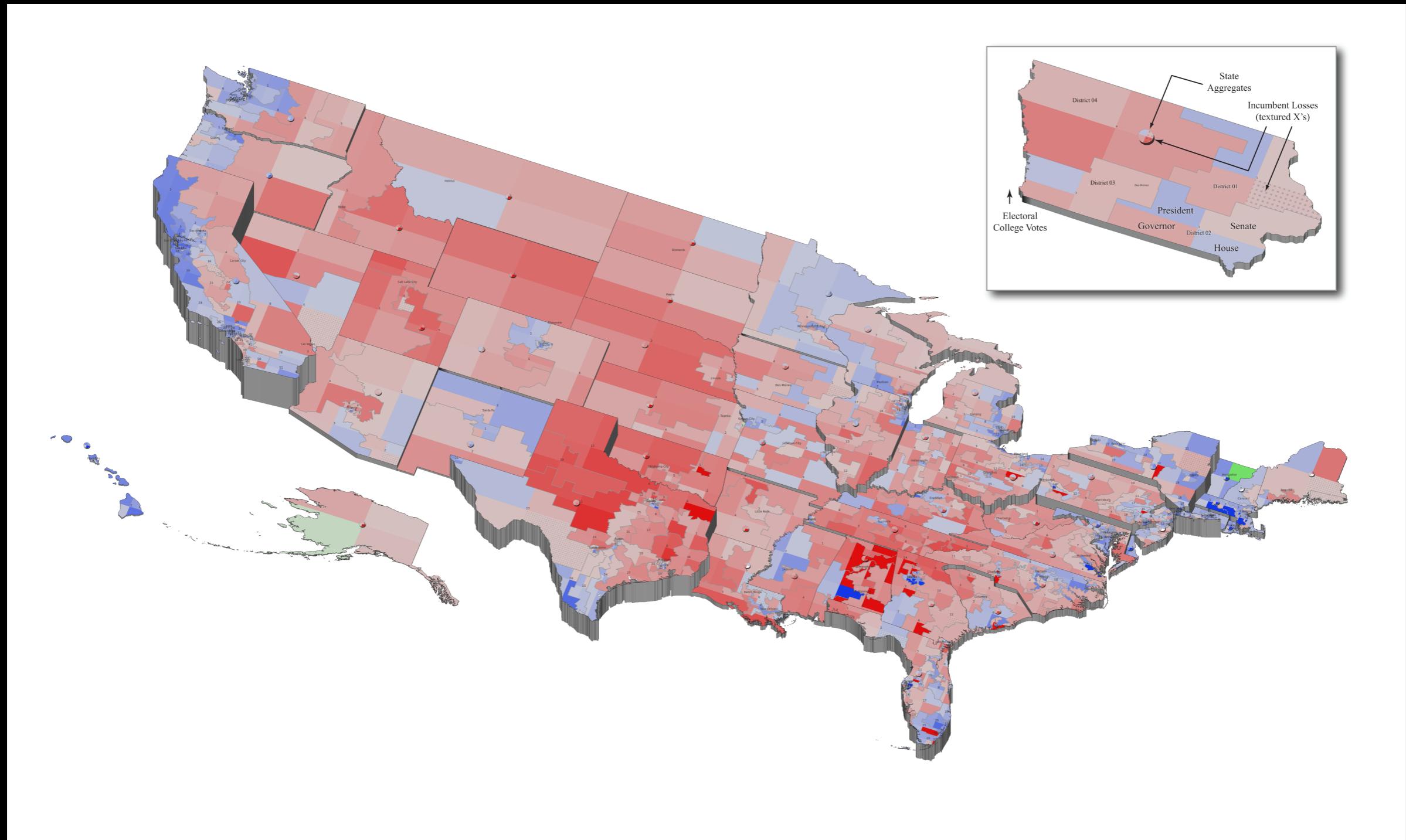


a limited set of visual properties that are detected very rapidly and accurately by the low-level visual system.
(tasks that can be performed on large multi-element displays in less than 200 to 250 milliseconds)

[http://www.csc.ncsu.edu/faculty/healey/PP/
index.html#jscript_search](http://www.csc.ncsu.edu/faculty/healey/PP/index.html#jscript_search)

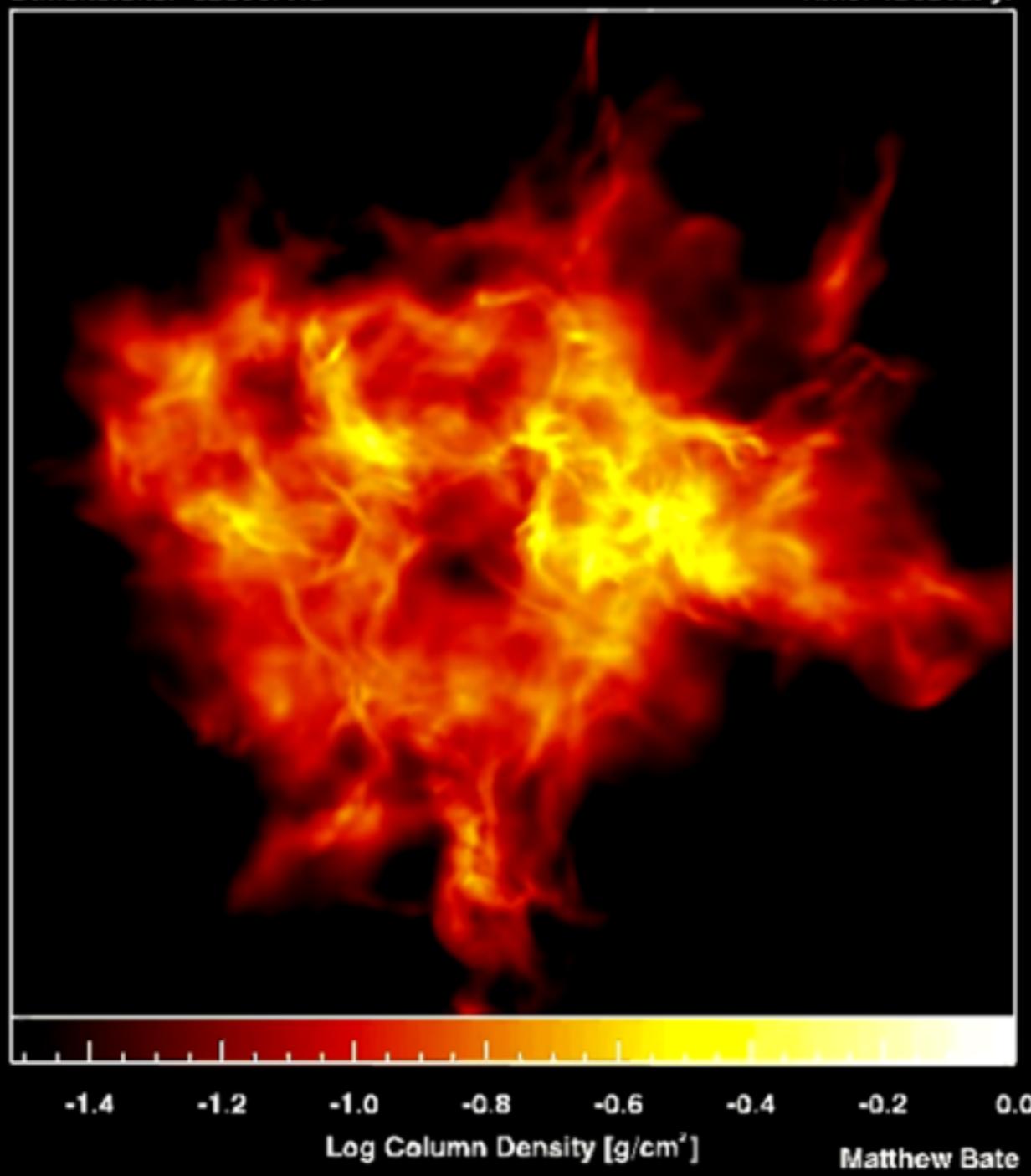
Christopher G. Healey

perceptually-motivated multidimensional visualization of recent U.S. election result



Dimensions: 82500. AU

Time: 120312. yr



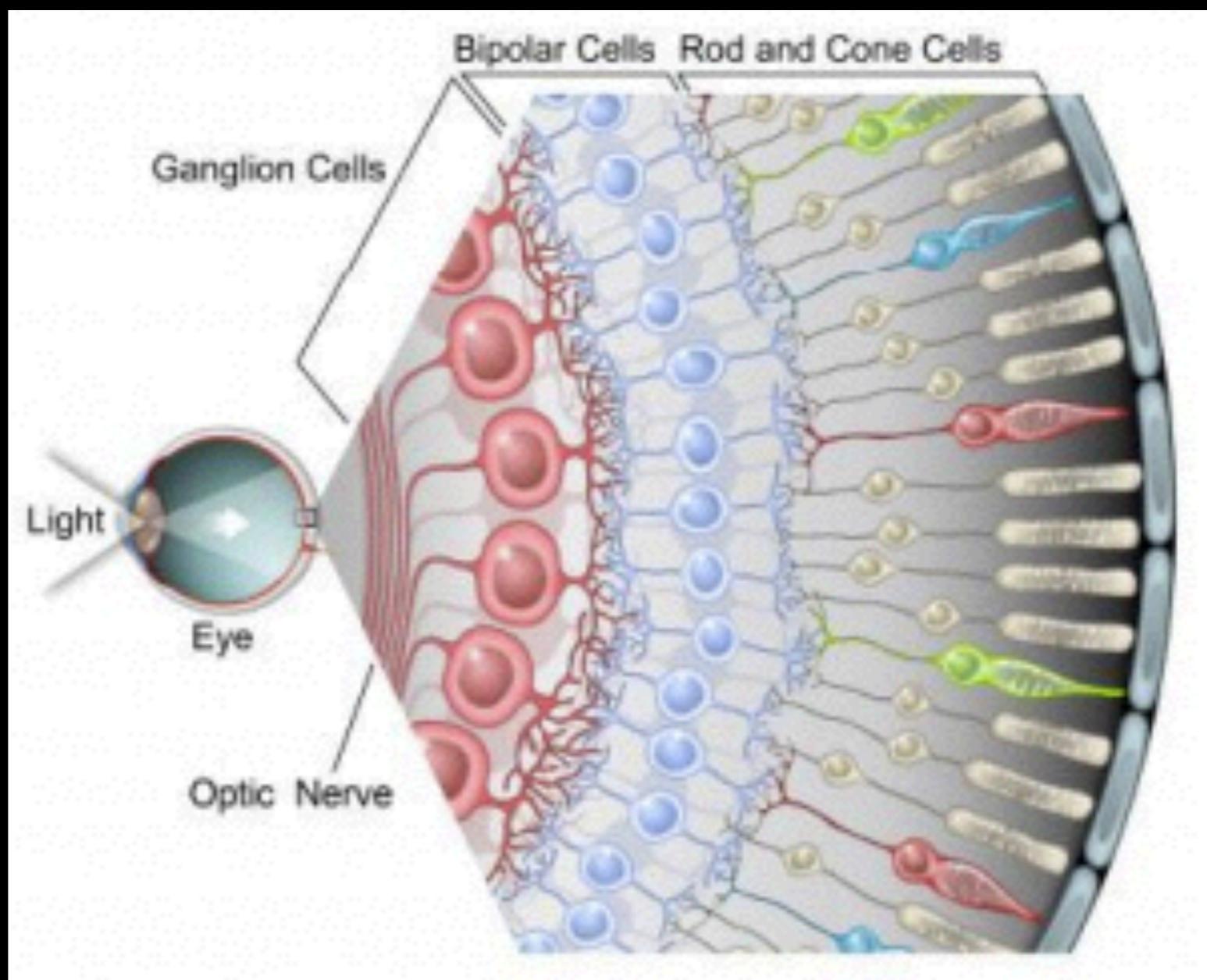
<https://www.youtube.com/watch?v=YbdwTwB8jtc>

<http://morphocode.com/data-city-urban-visualizations/>

<http://www.theinvisiblegorilla.com/videos.html>

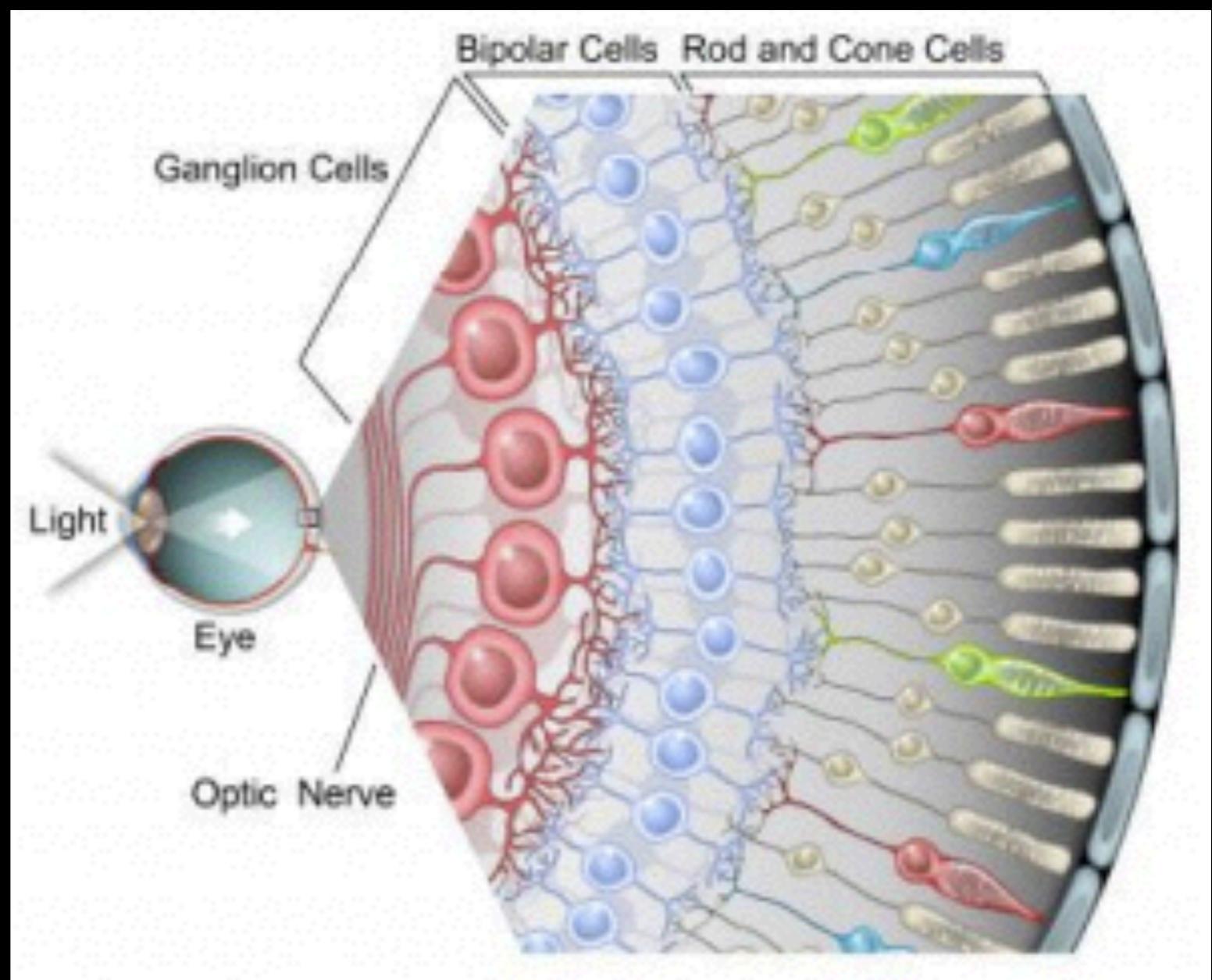
color theory
(and good practice)

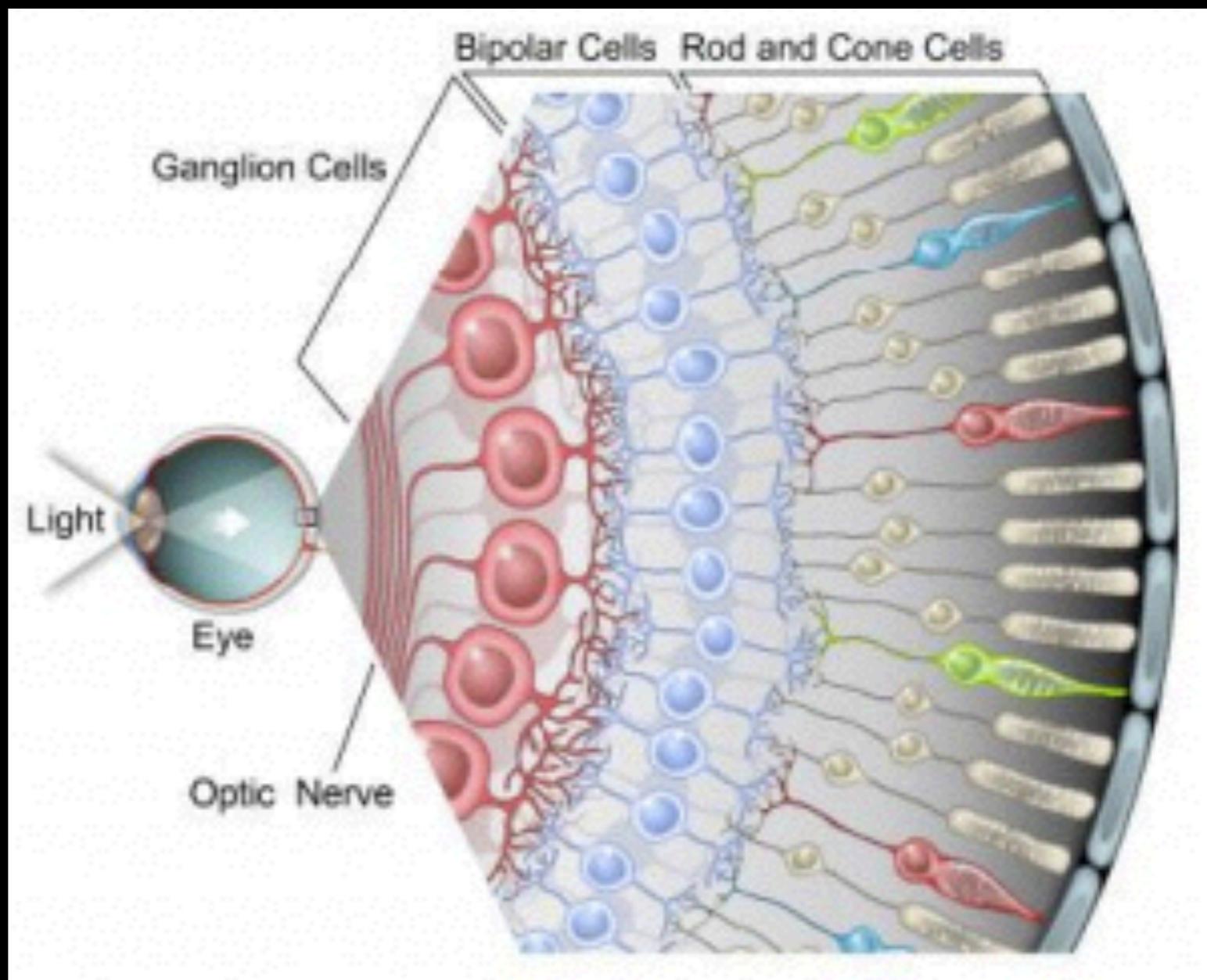
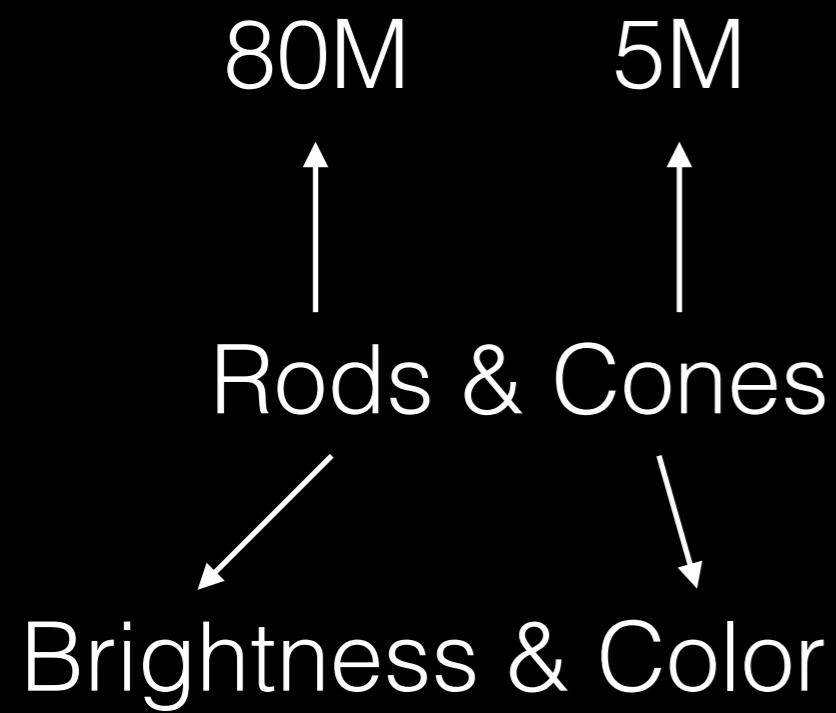
Rods & Cones

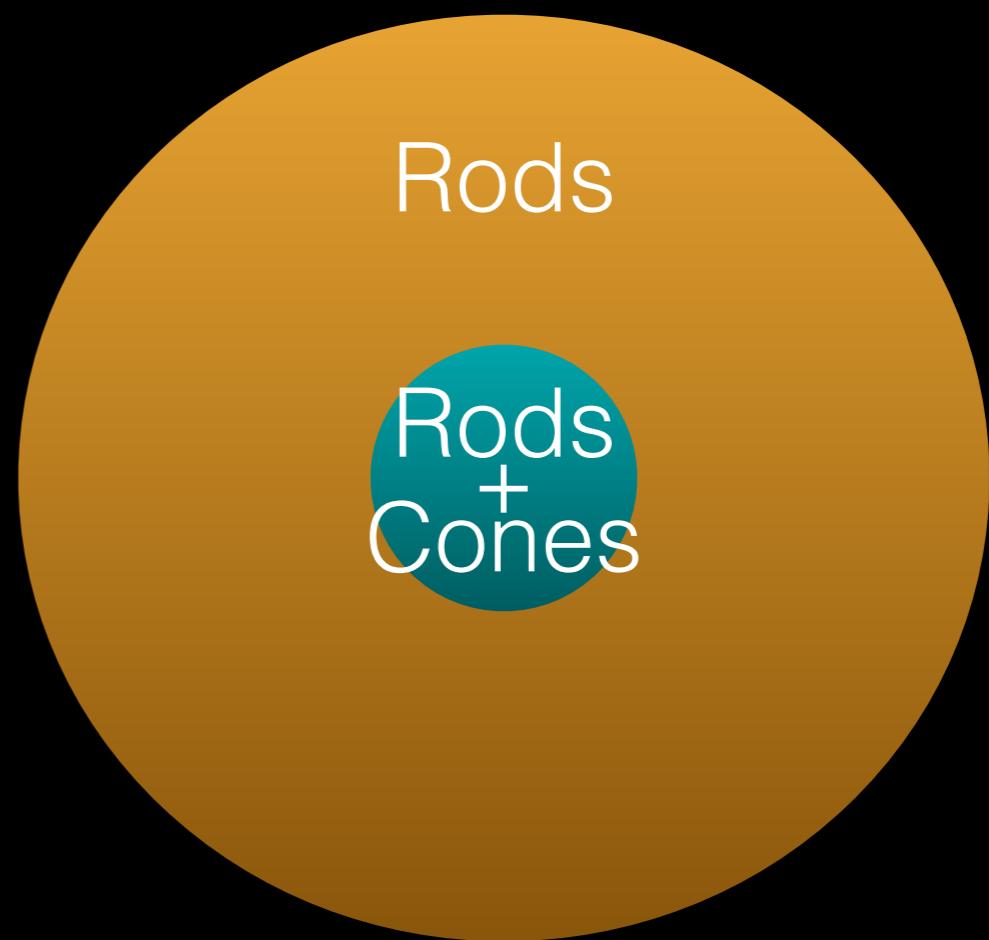
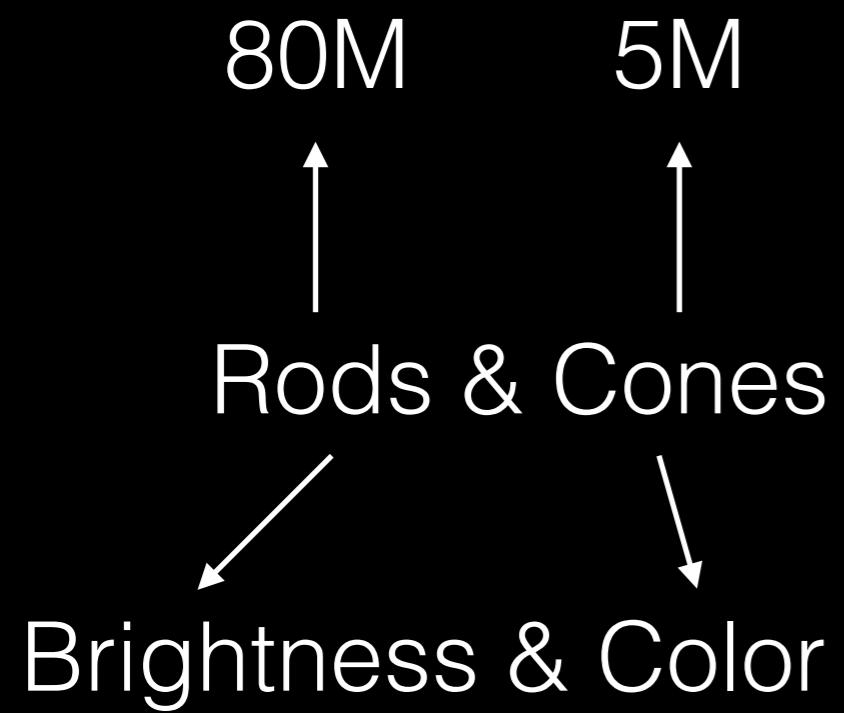


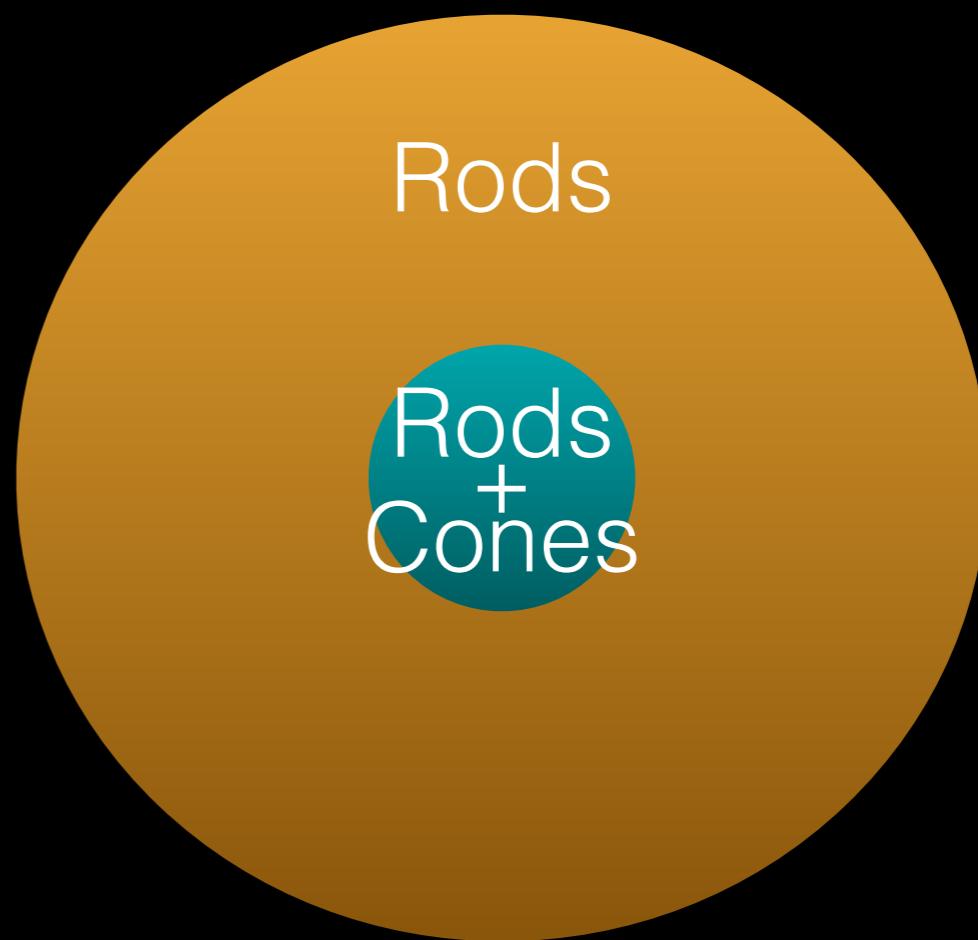
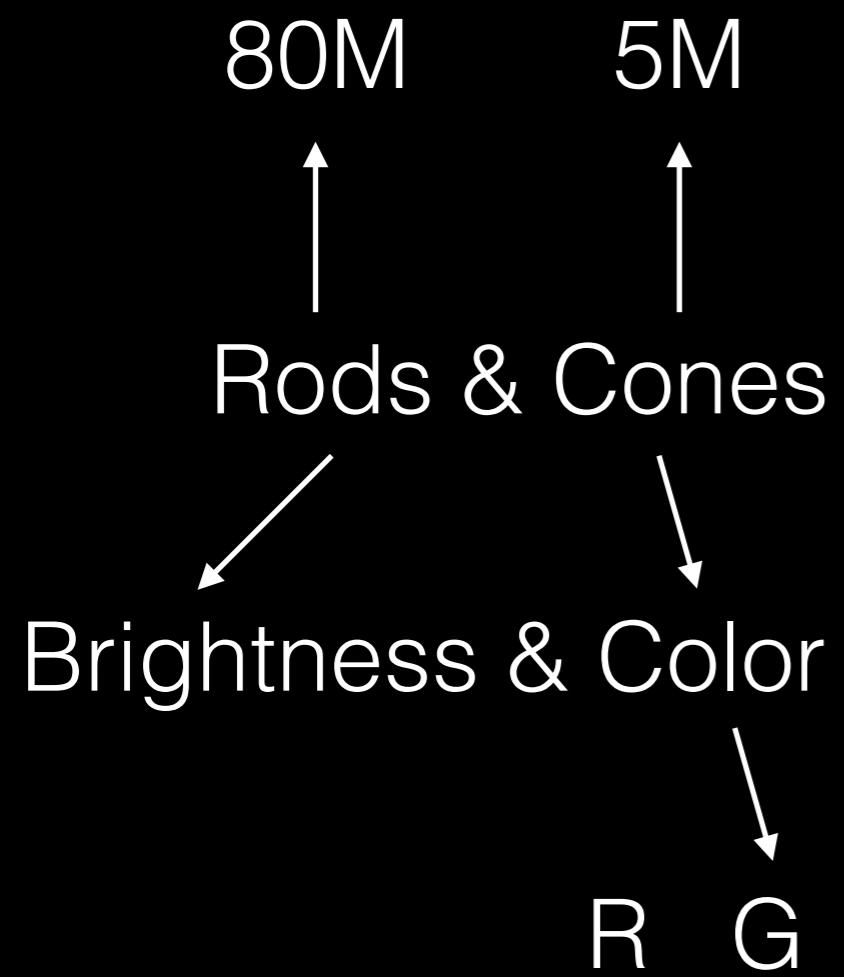
Rods & Cones

Brightness & Color





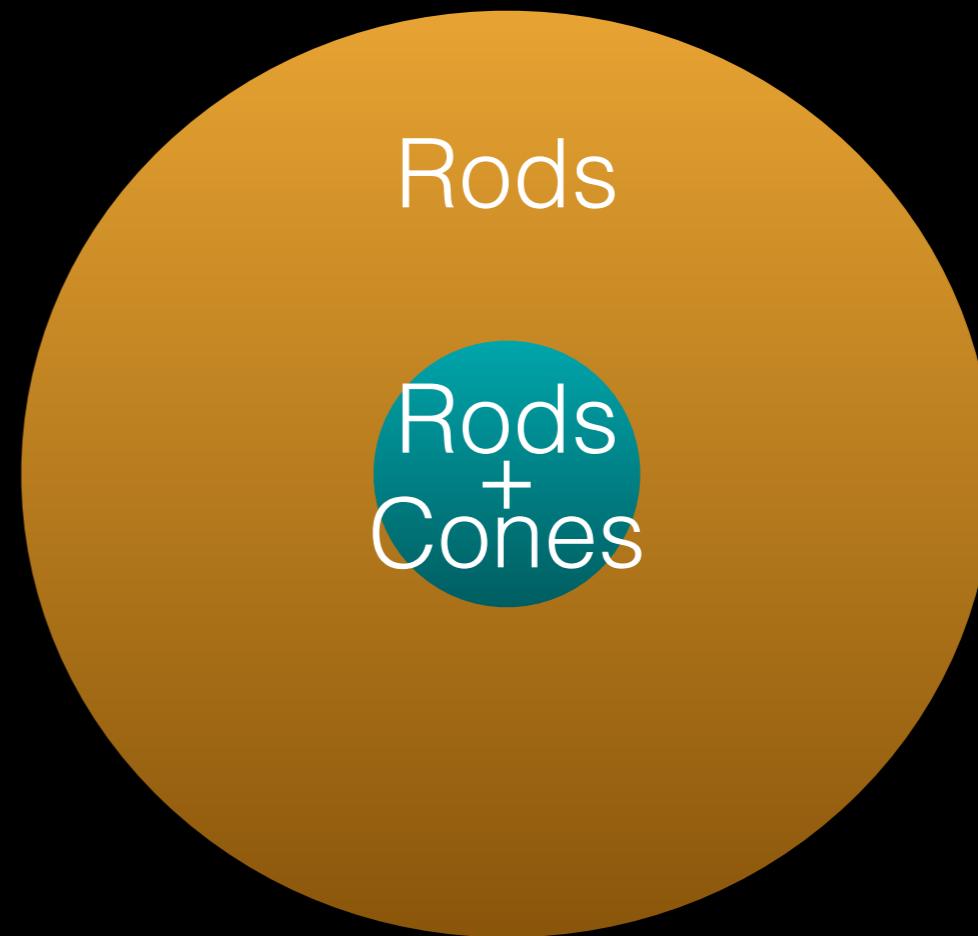
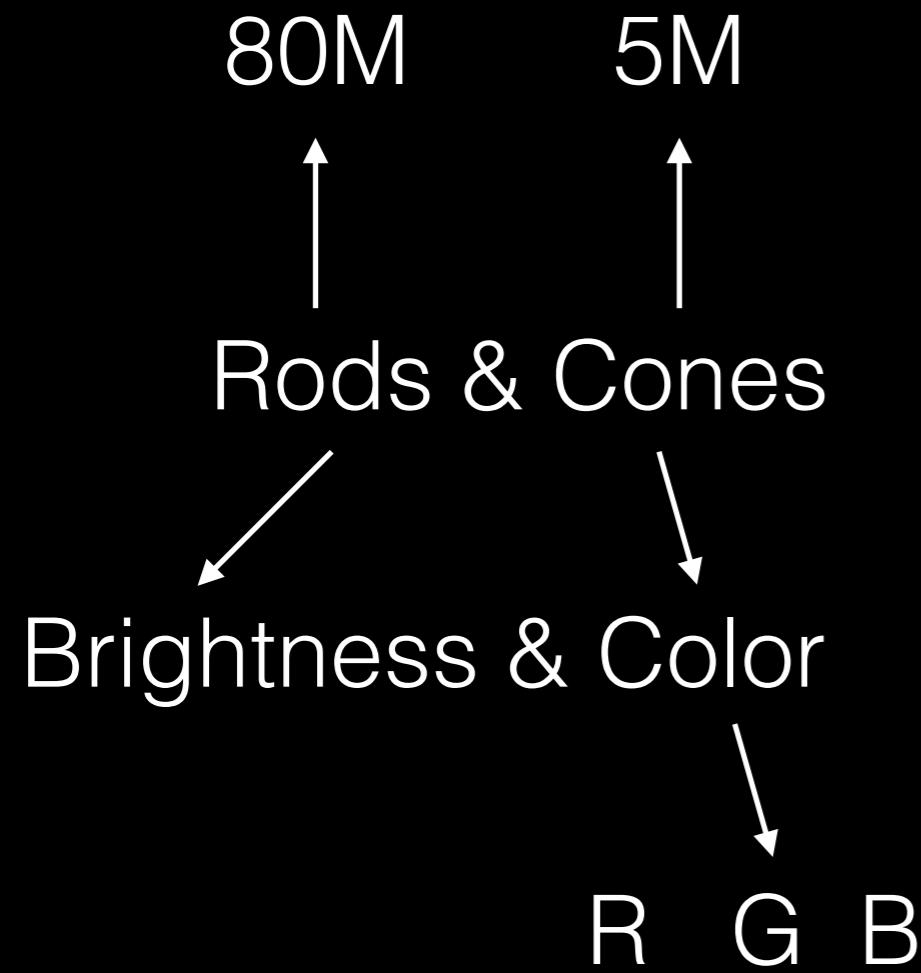




the message to the brain is:

- black \leftrightarrow white
- yellow \leftrightarrow blue
- red \leftrightarrow green

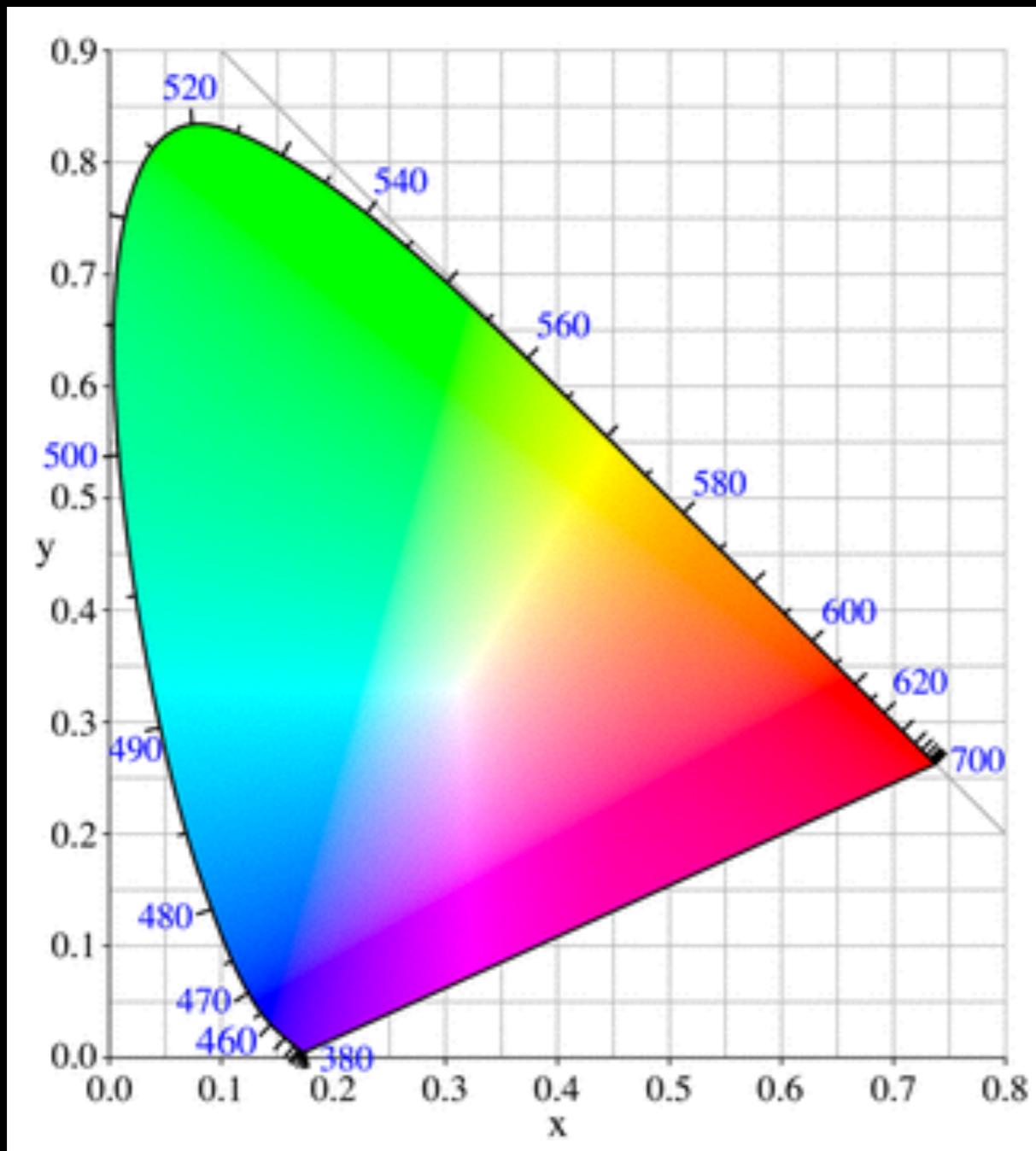
COLOR BLINDNESS



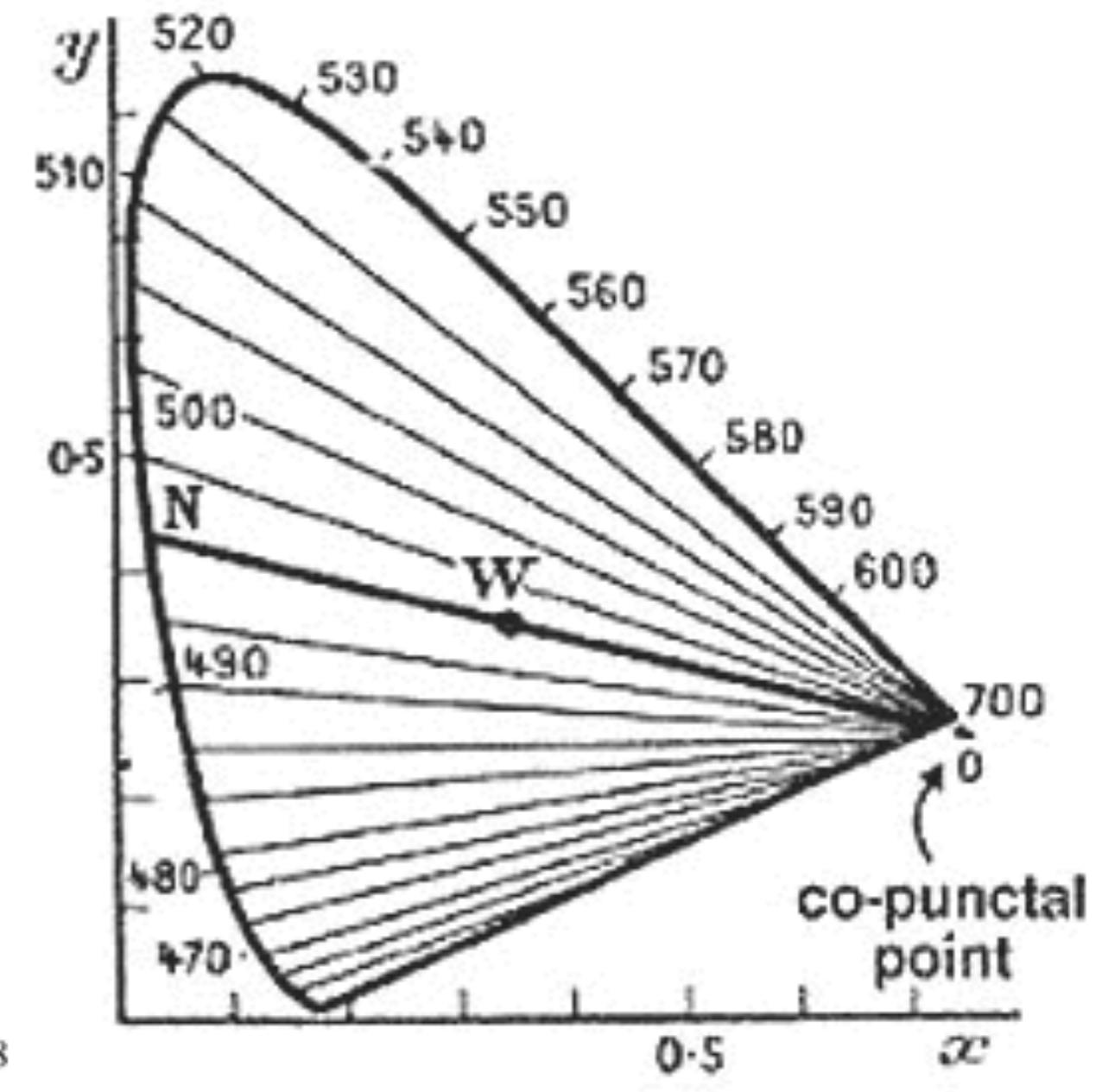
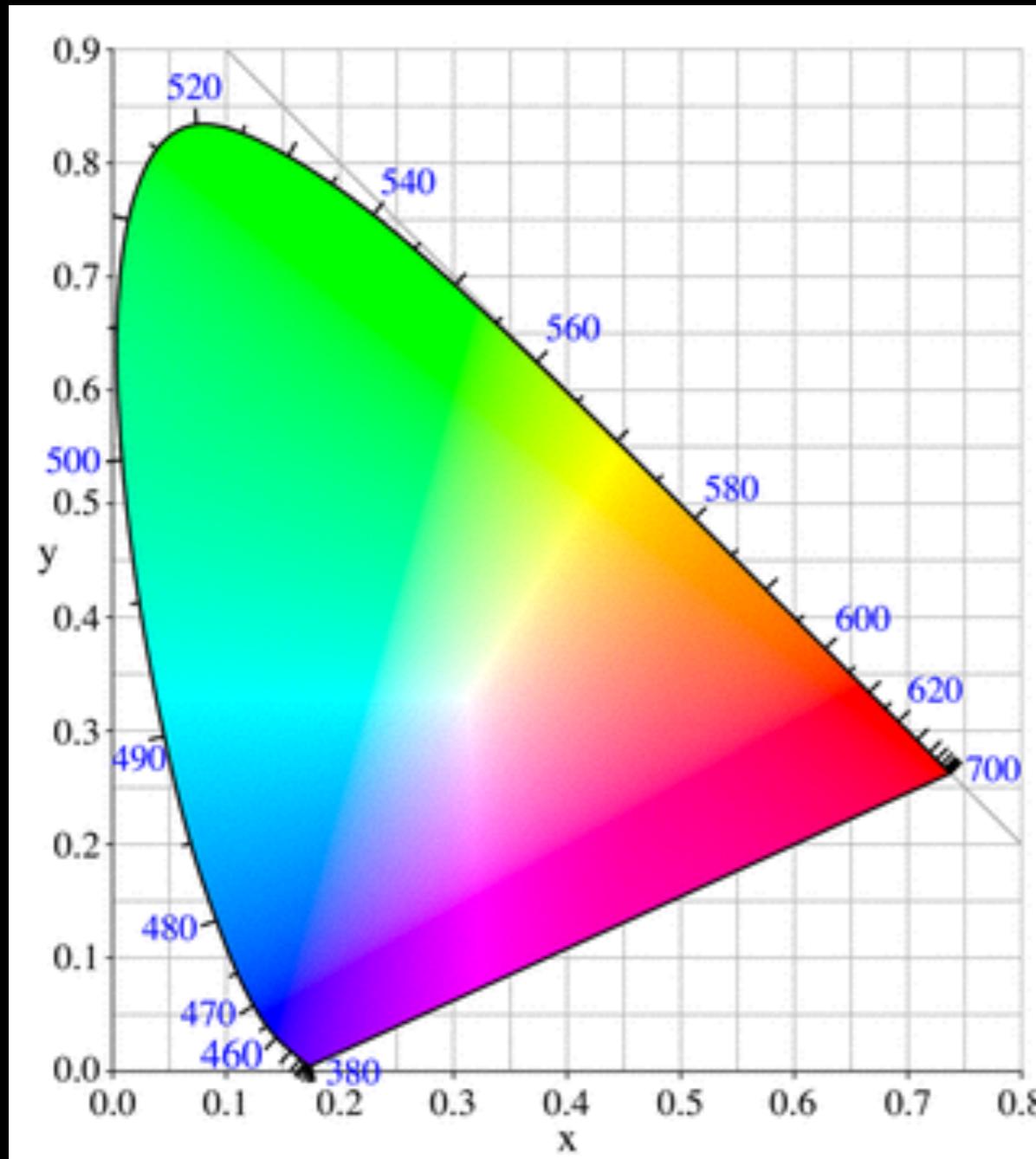
the message to the brain is:

- black \leftrightarrow white
- yellow \leftrightarrow blue
- red \leftrightarrow green

COLOR BLINDNESS

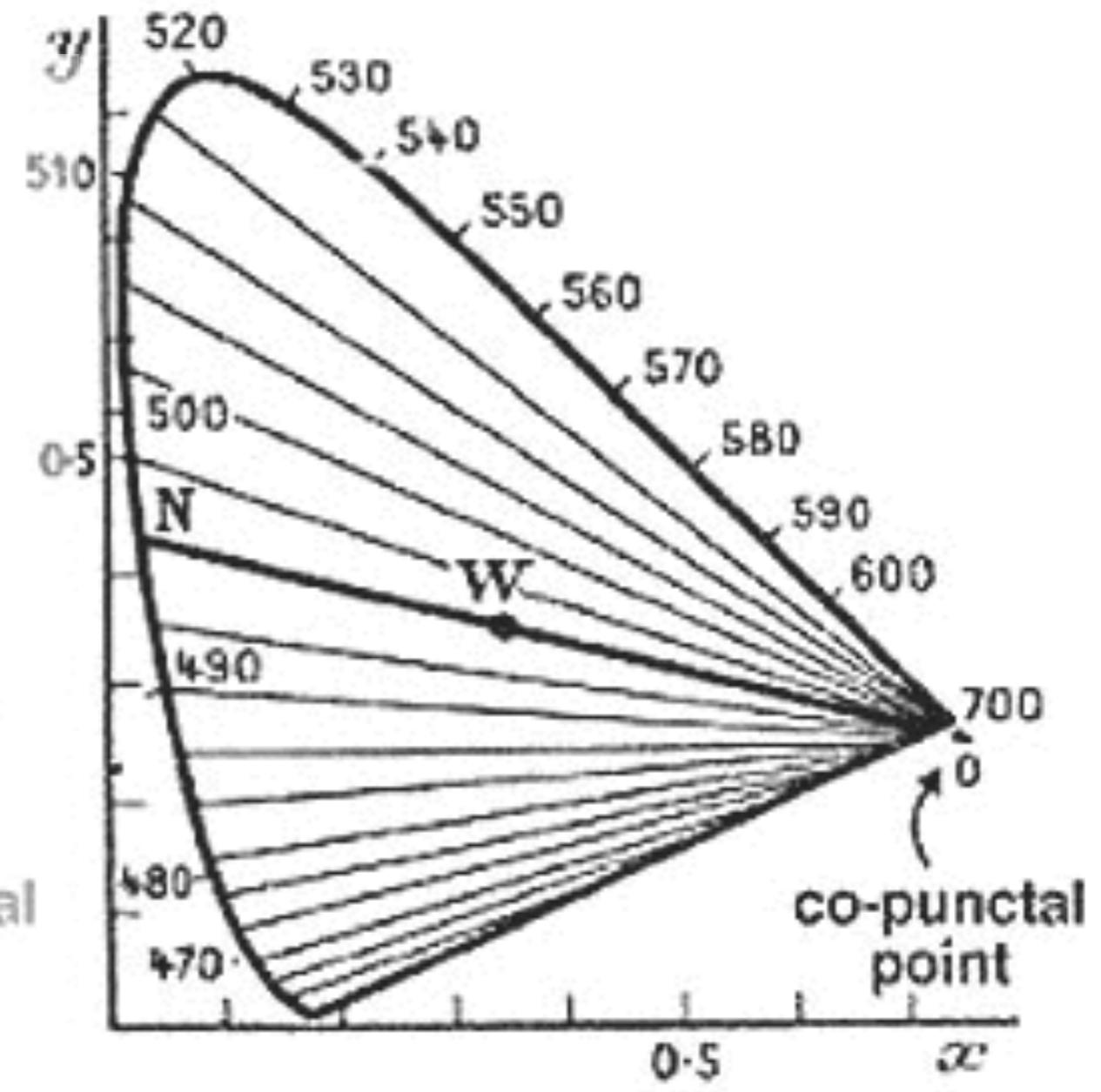
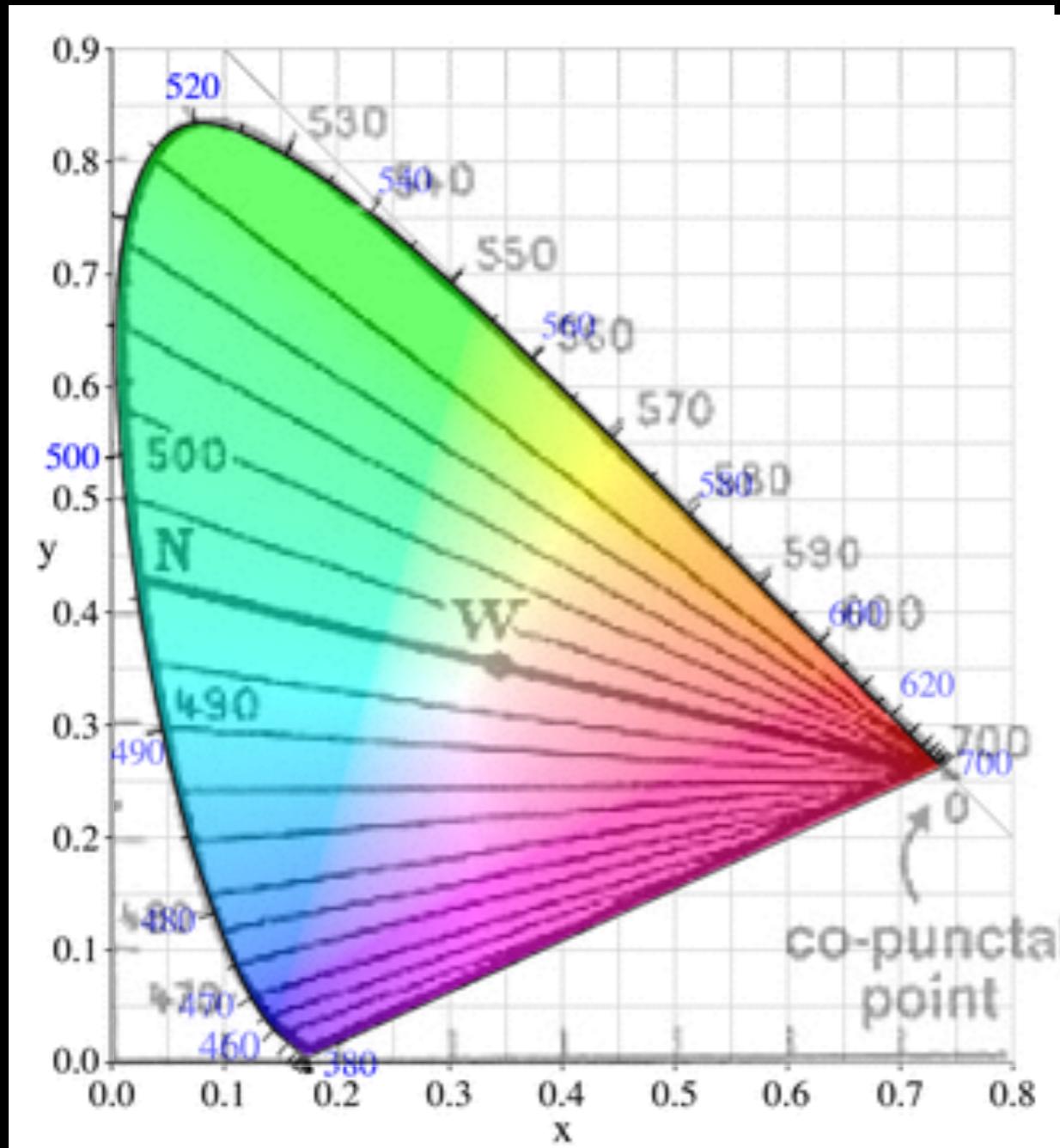


COLOR BLINDNESS



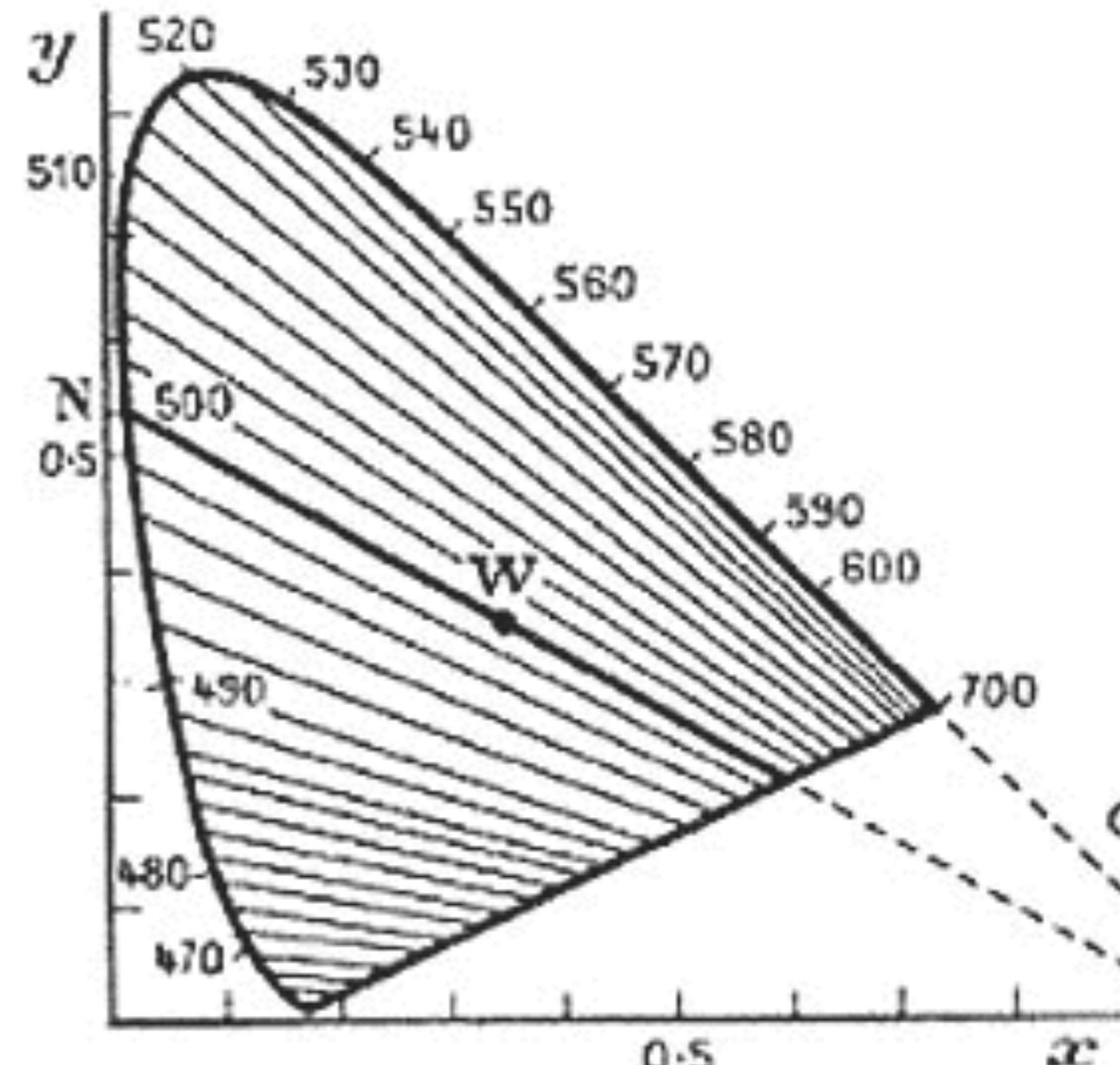
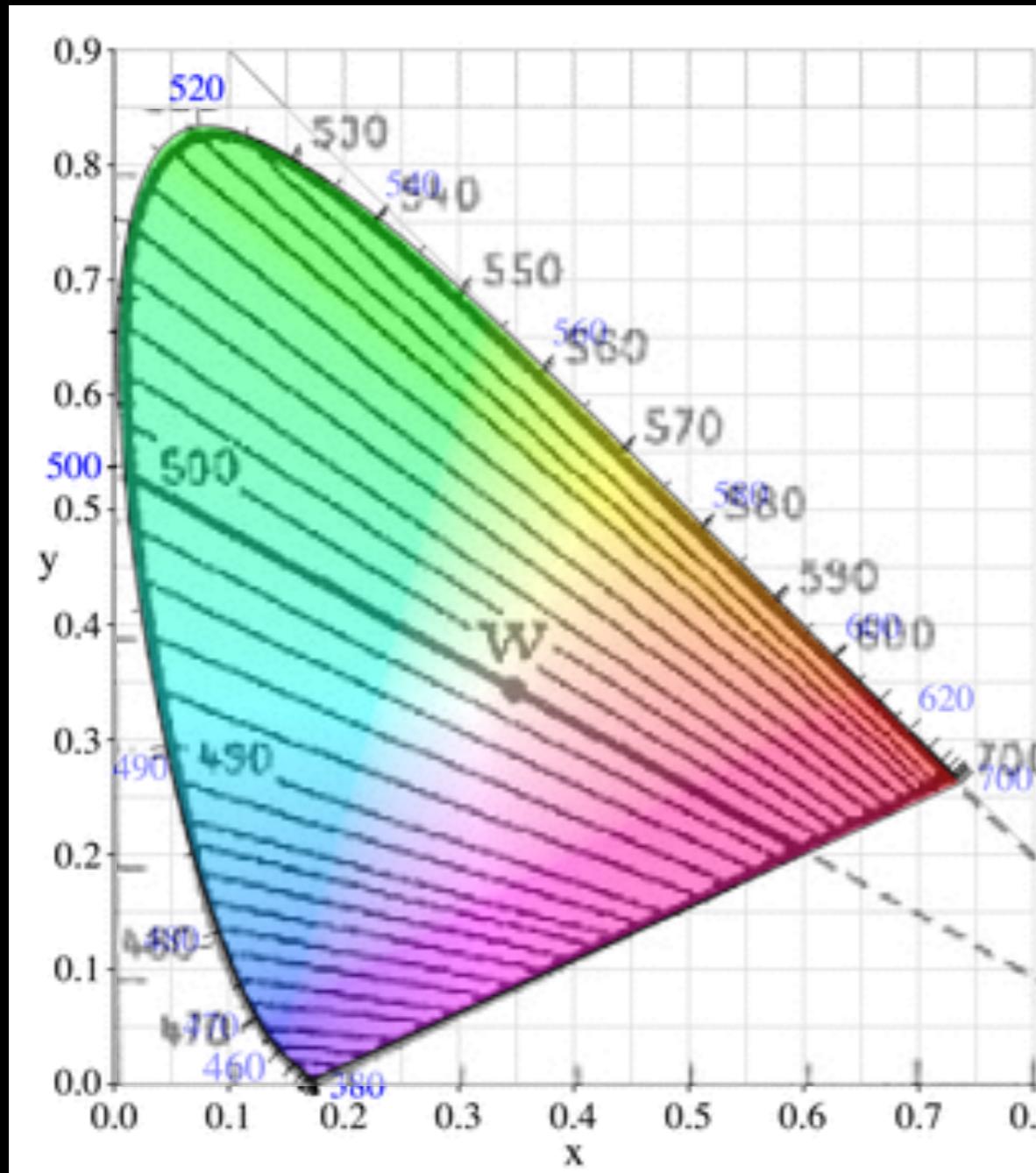
Protanopia

COLOR BLINDNESS



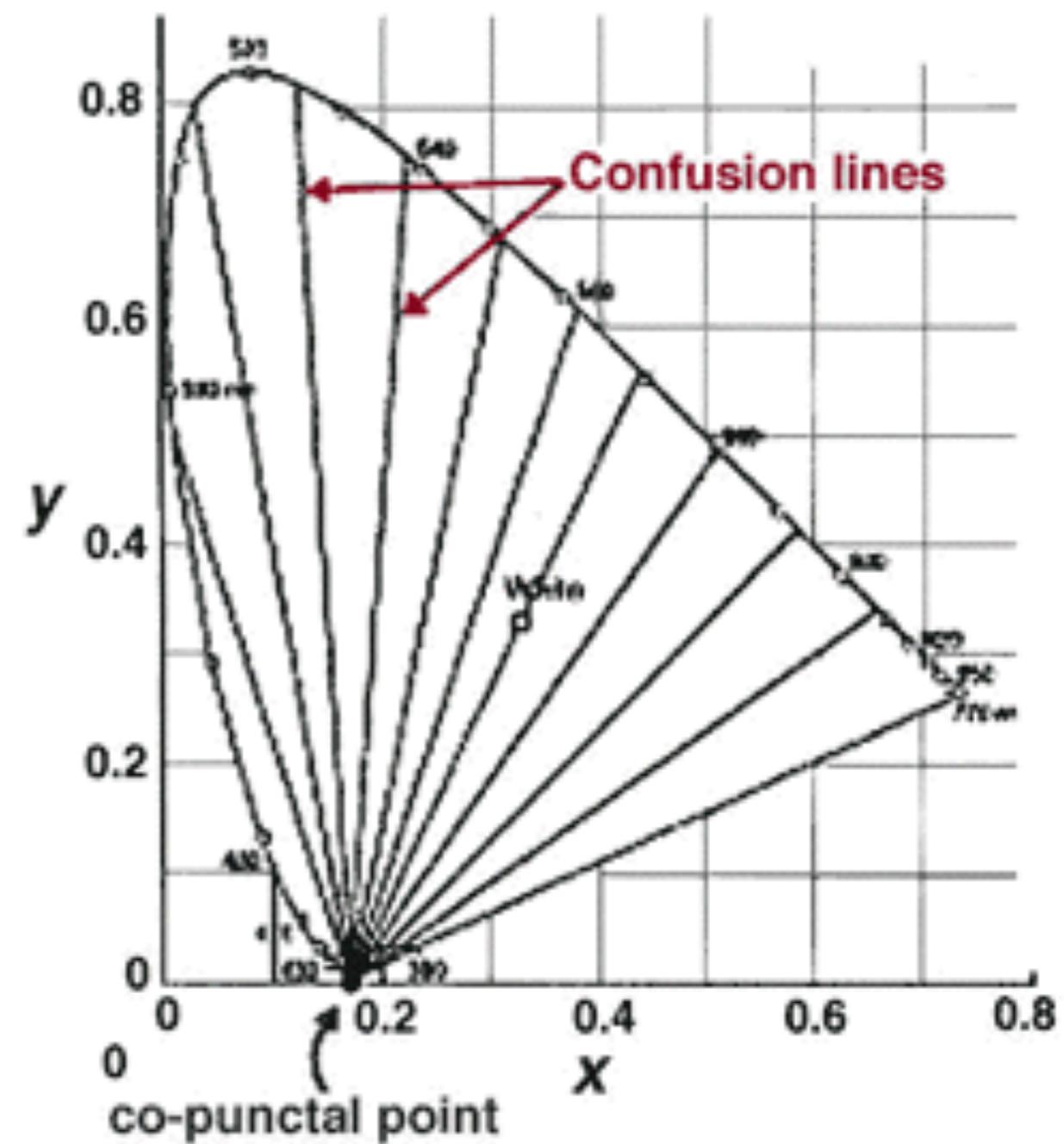
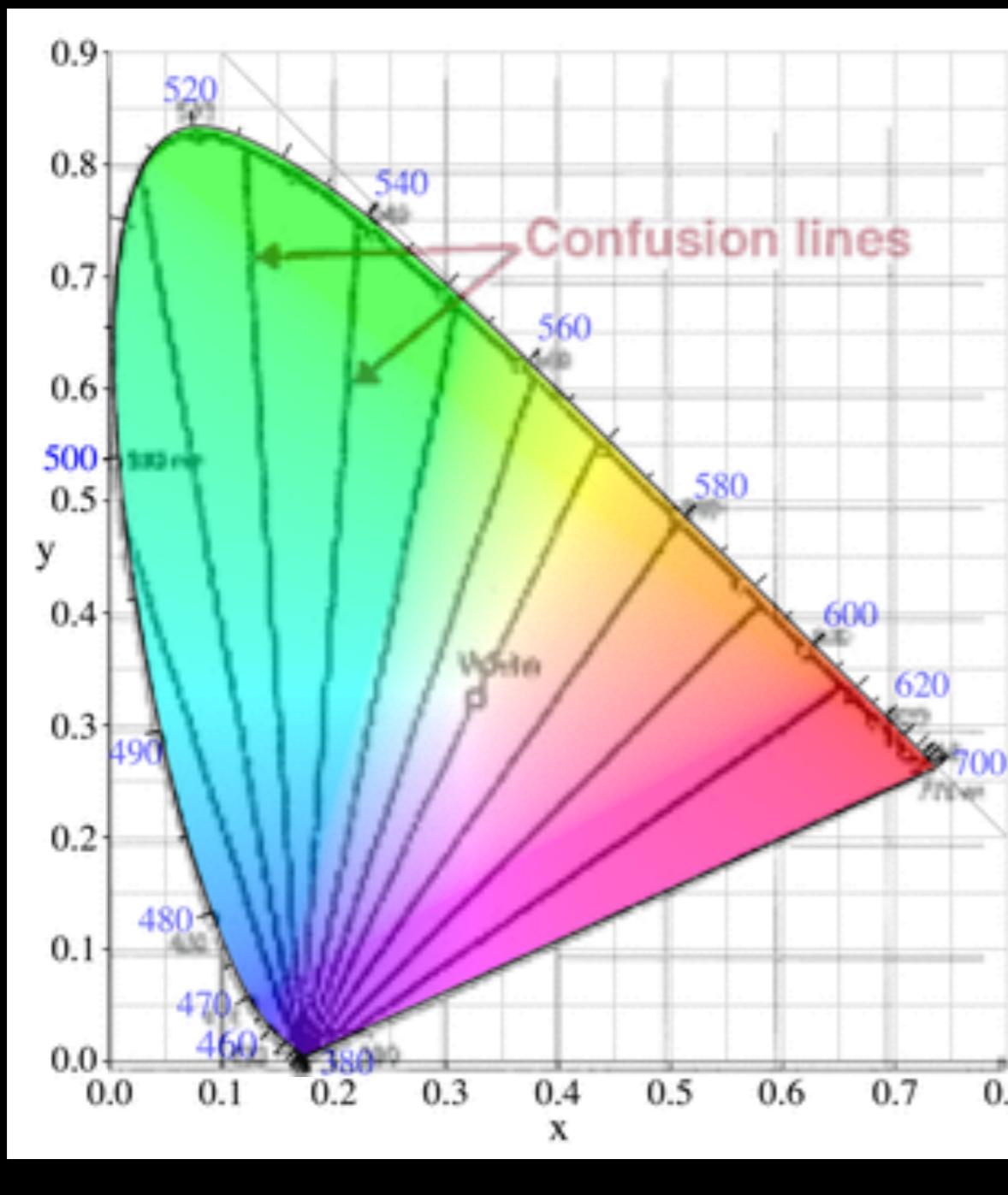
Protanopia
(red-blind)

COLOR BLINDNESS



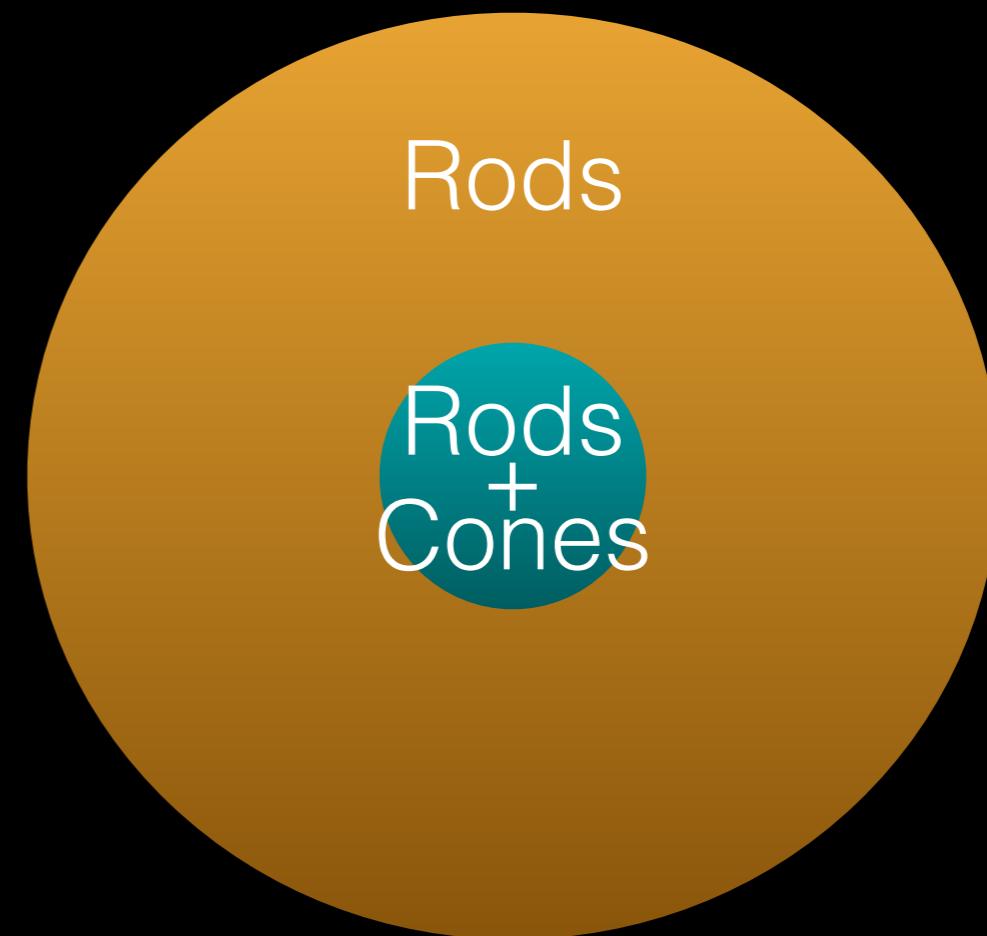
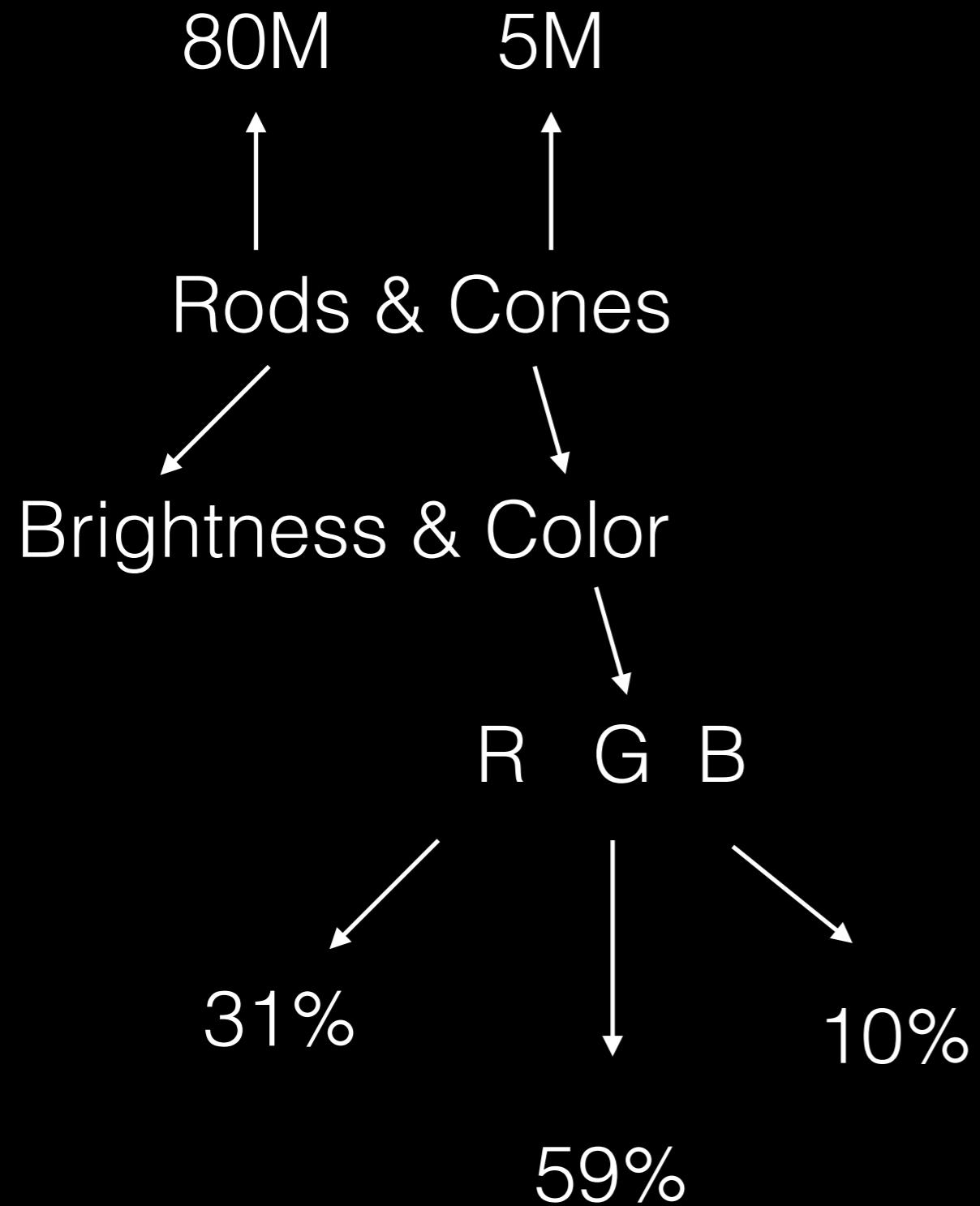
Deutanopia
(green-blind)

COLOR BLINDNESS

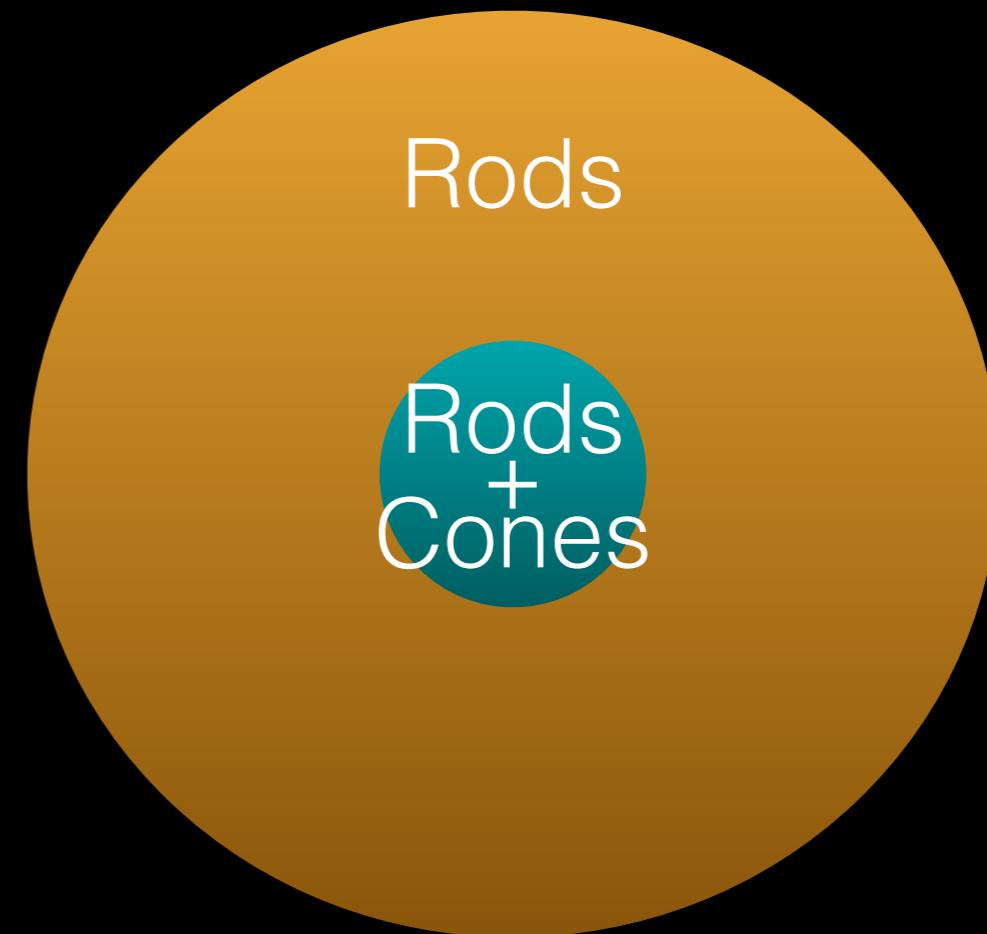
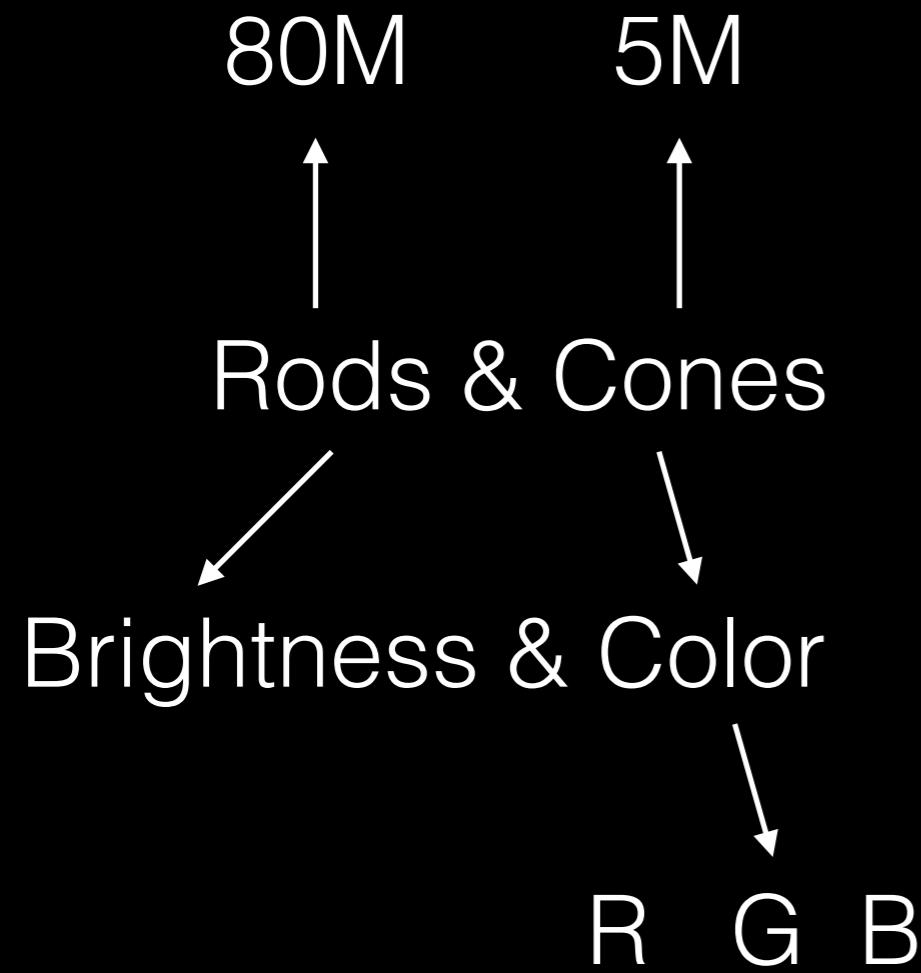


Tritanopia
(blue-blind)

COLOR BLINDNESS



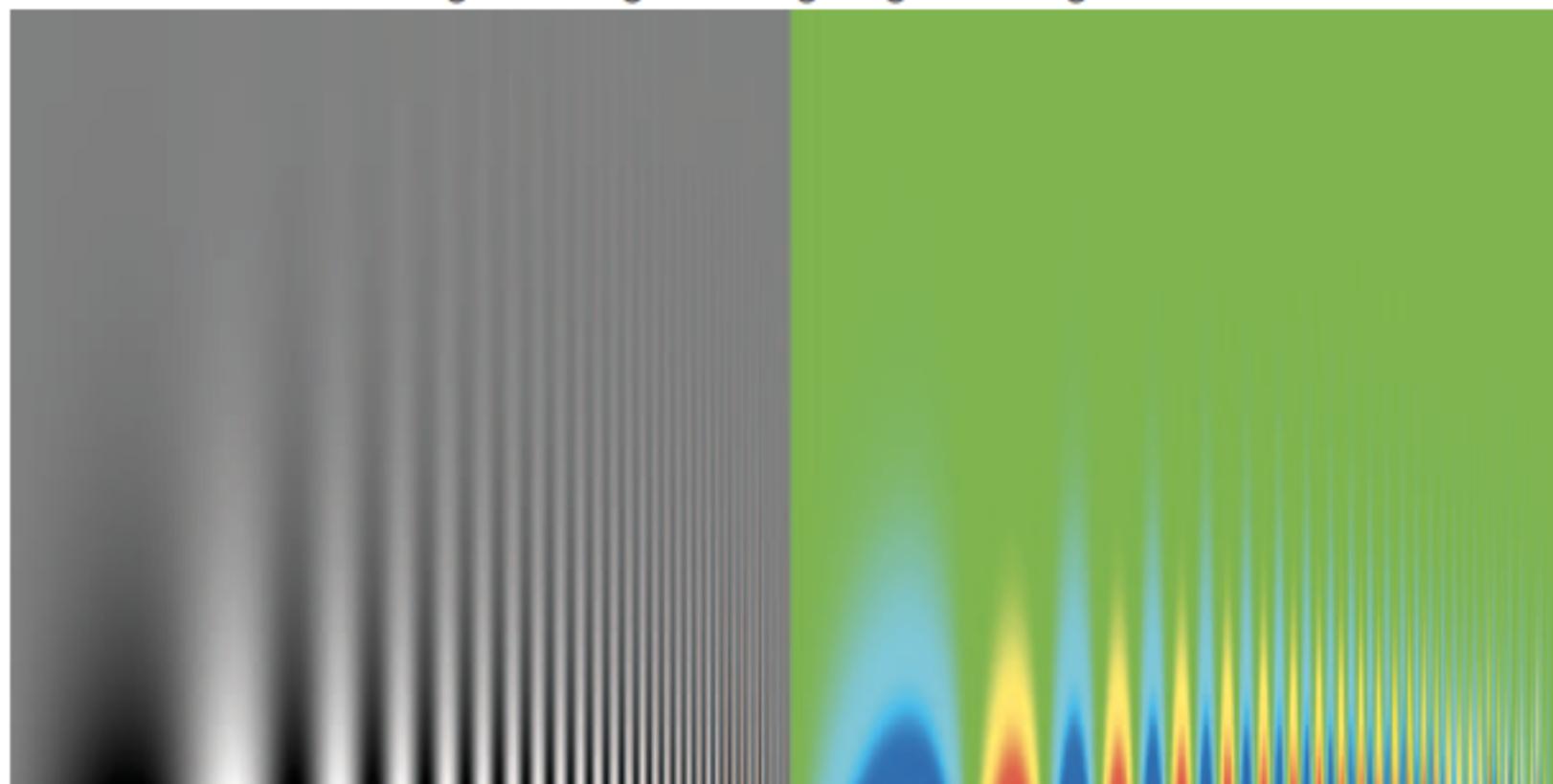
COLOR BLINDNESS



<http://colororacle.org/>

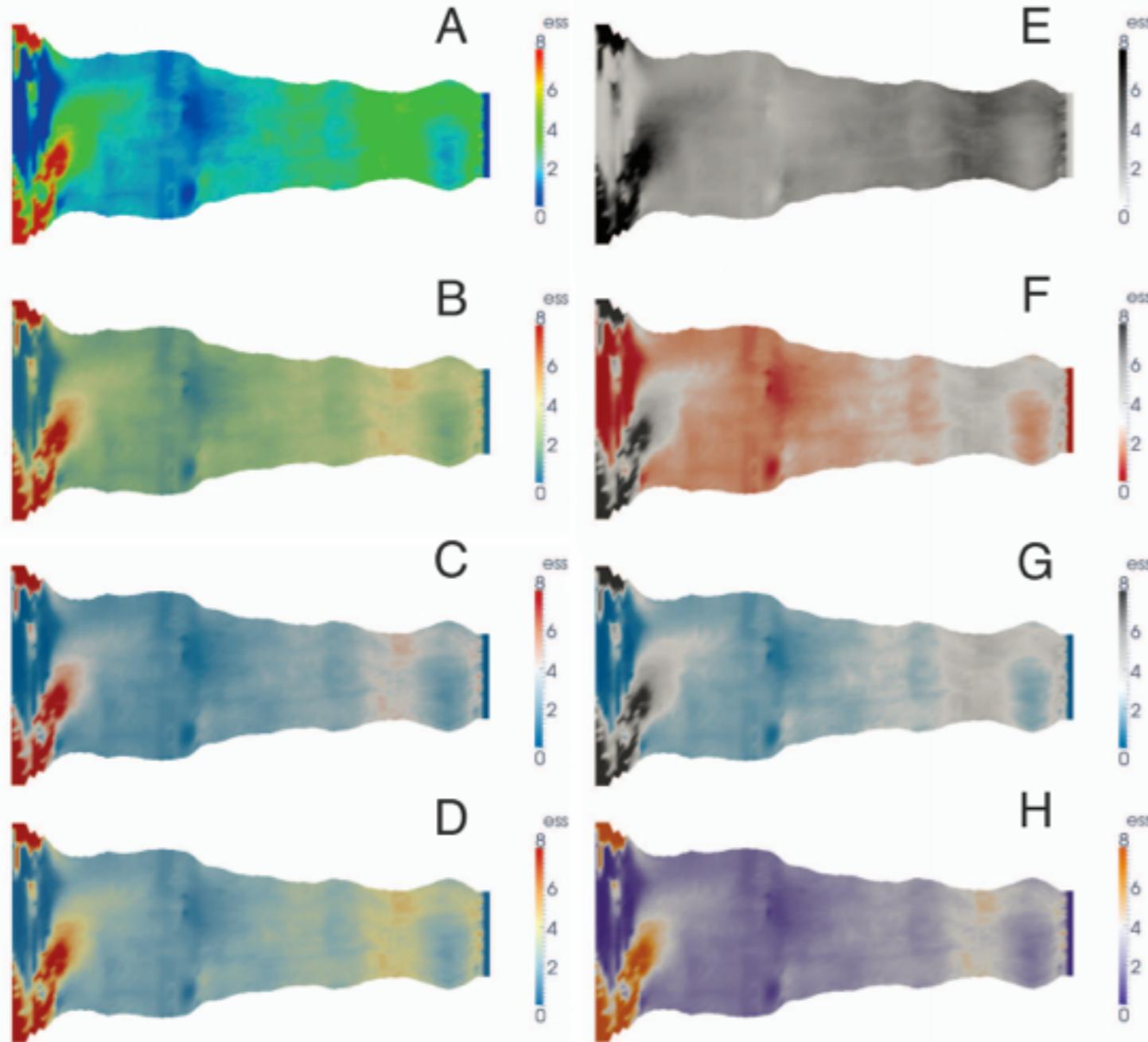
5. Detail is actually harder to see in a rainbow.

The logic that it is easier to see detail in a range when you add colors seems to make sense, but in reality, more detail can be seen in a single hue image with a high brightness range.



(source)

<http://blog.visual.ly/rainbow-color-scales/>



very real
consequences
of the choice
of color maps
(Borkin et al. 2011)

Fig. 4. Color schemes presented during the qualitative user study. The rainbow scheme (A) was preferred by most since it is what they are accustomed to viewing. The next most popular scheme was the red-black diverging scale (F). The grayscale image (E) was unanimously disliked since participants assume black-and-white images to be raw radiological data, while color indicates that the data has been processed or simulated.

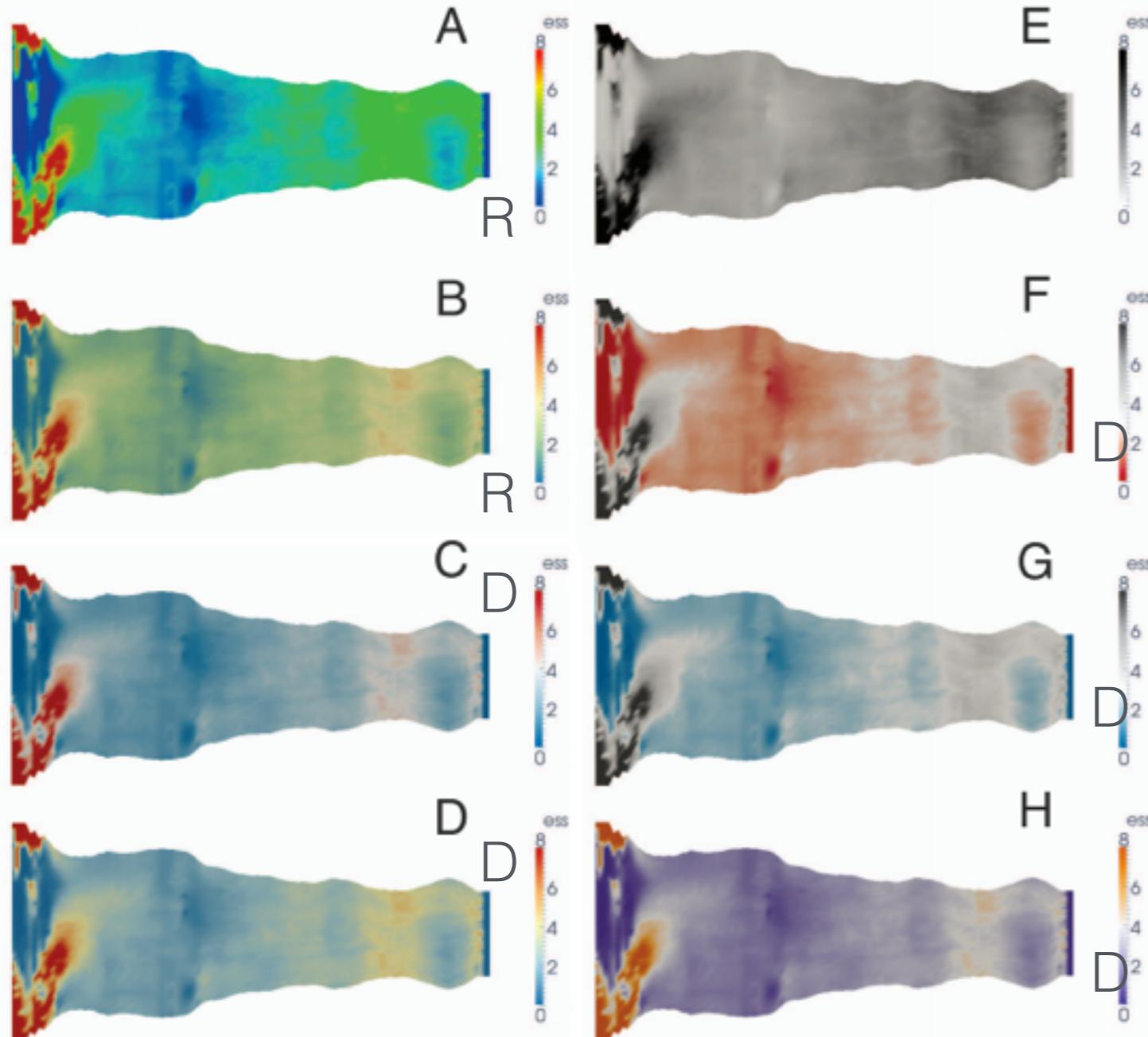


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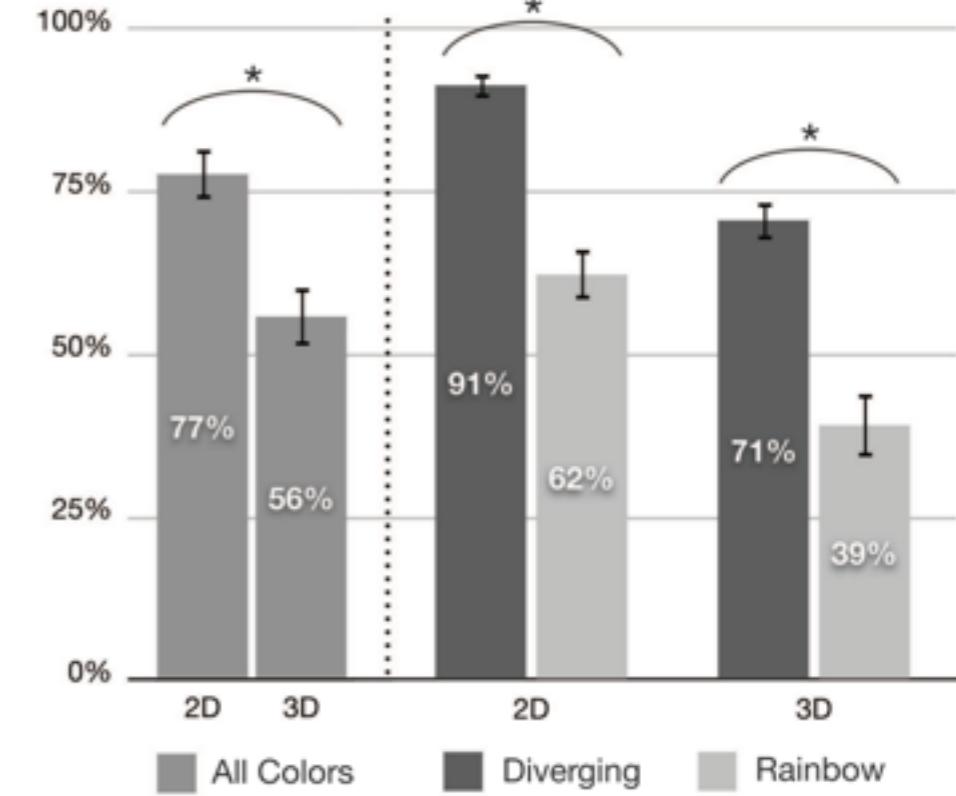


Fig. 7. Average percent of low ESS regions identified broken down by 2D and 3D representation, and color. Error bars correspond to the standard error and the asterisks indicate results of statistical significance. Participants were more accurate in 2D and when using the diverging color map.



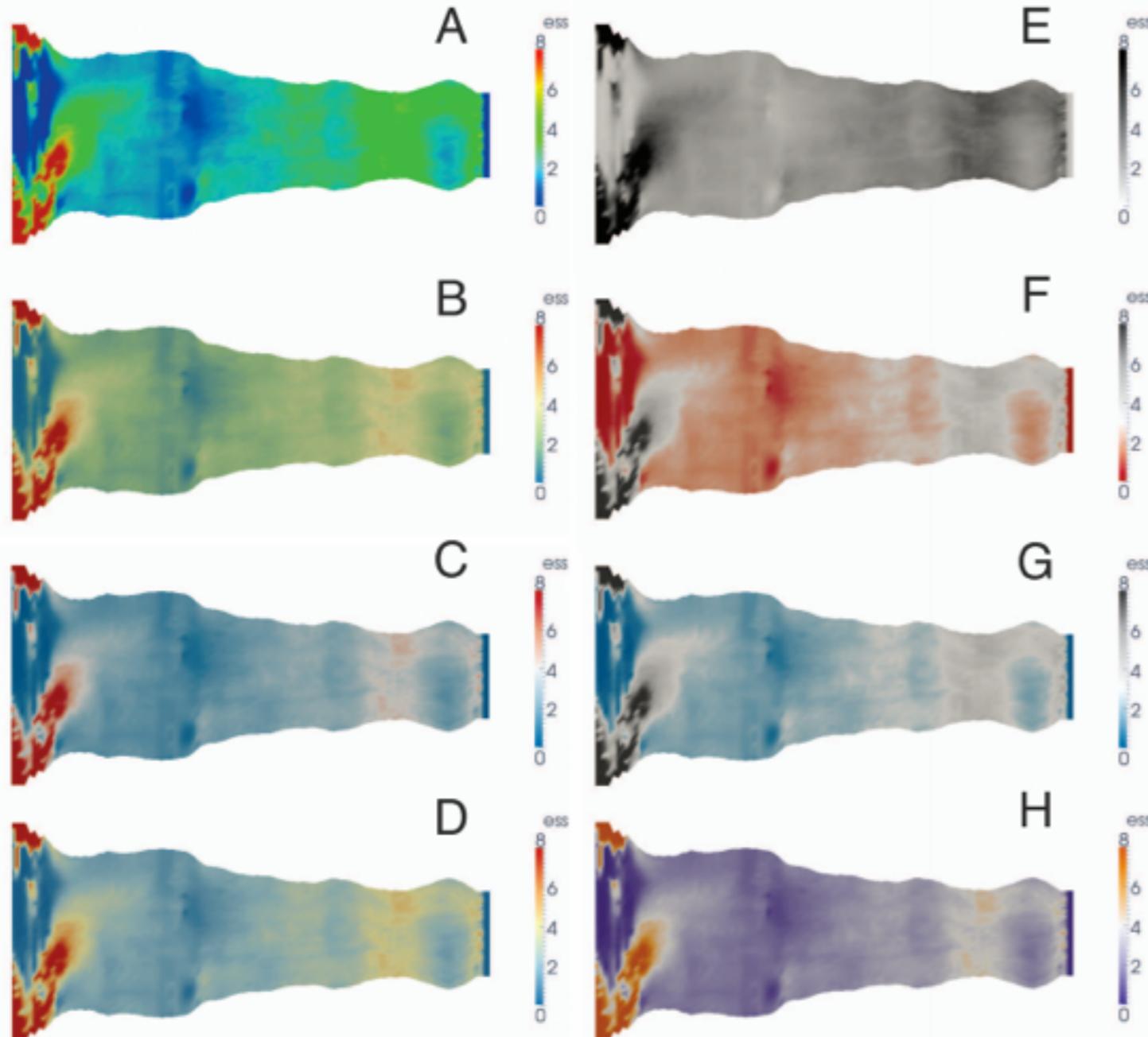


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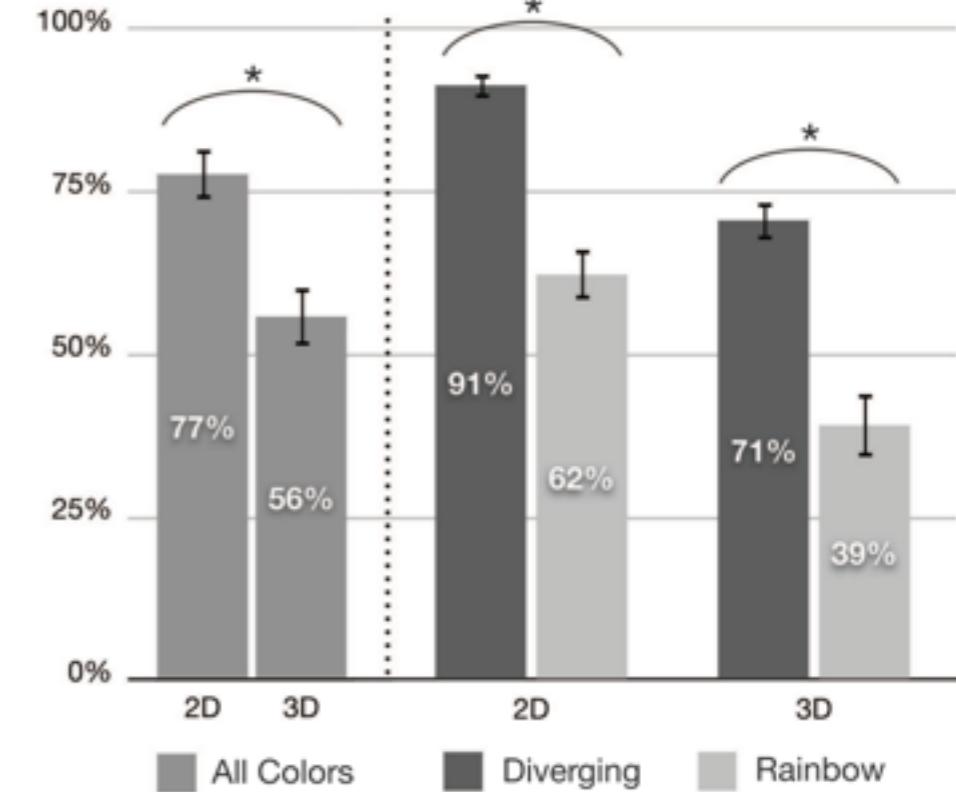


Fig. 7. Average percent of low ESS regions identified broken down by 2D and 3D representation, and color. Error bars correspond to the standard error and the asterisks indicate results of statistical significance. Participants were more accurate in 2D and when using the diverging color map.

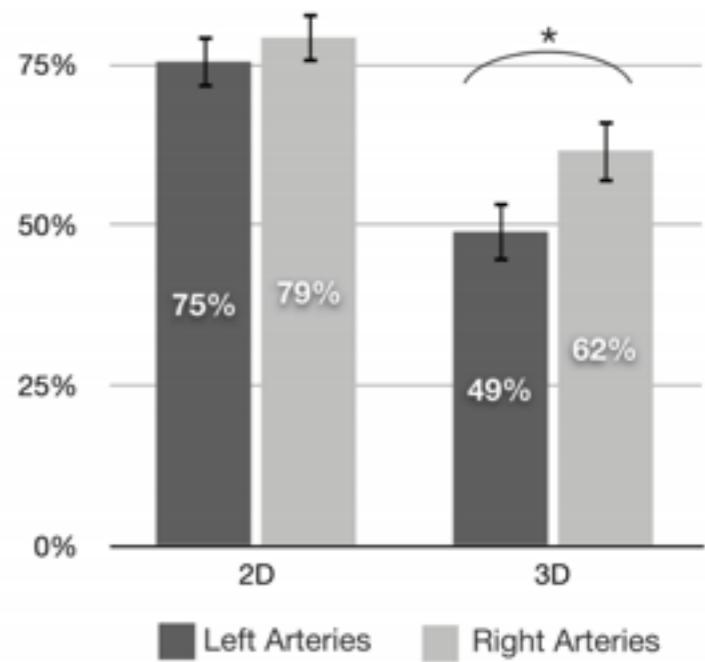
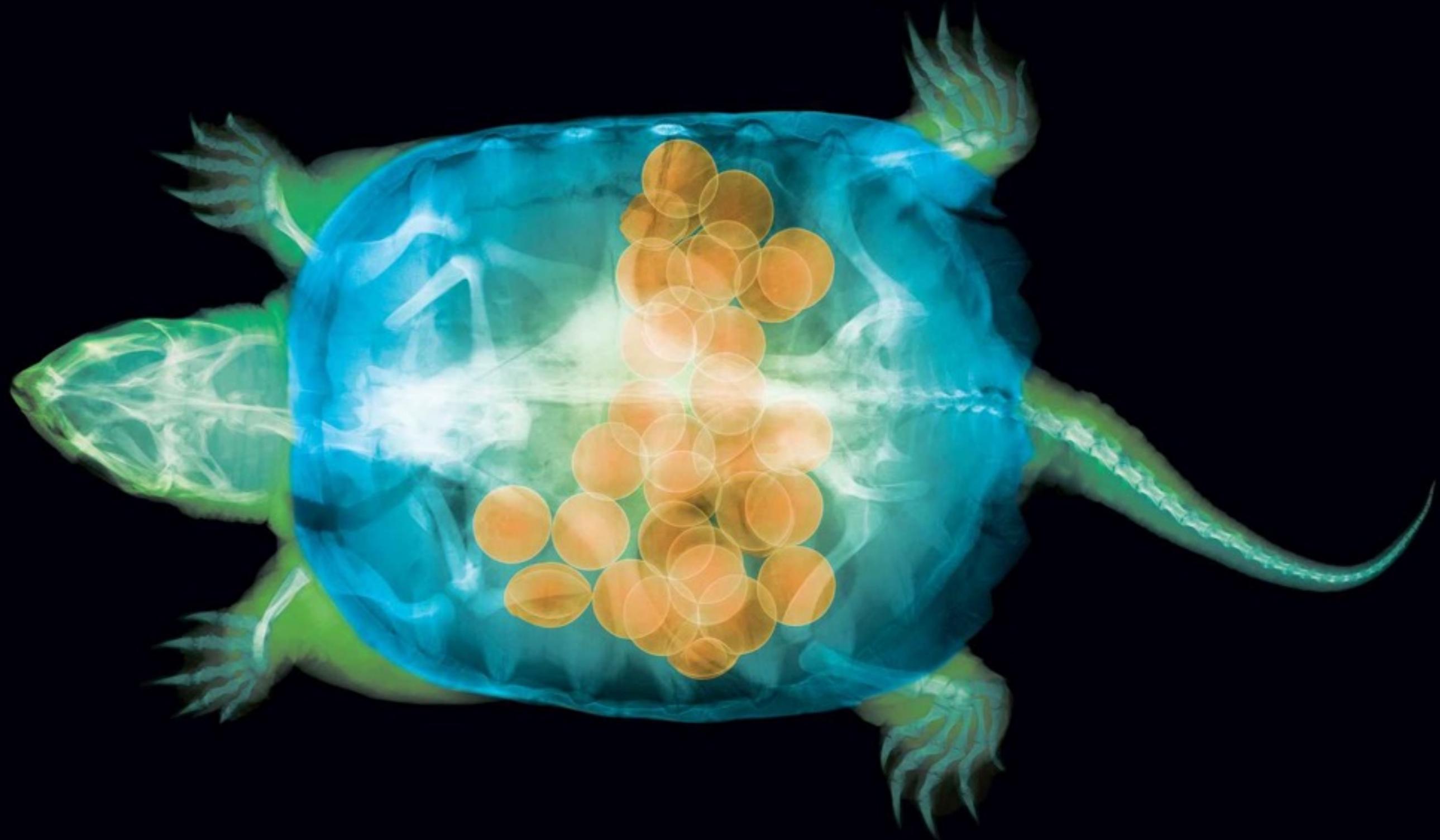
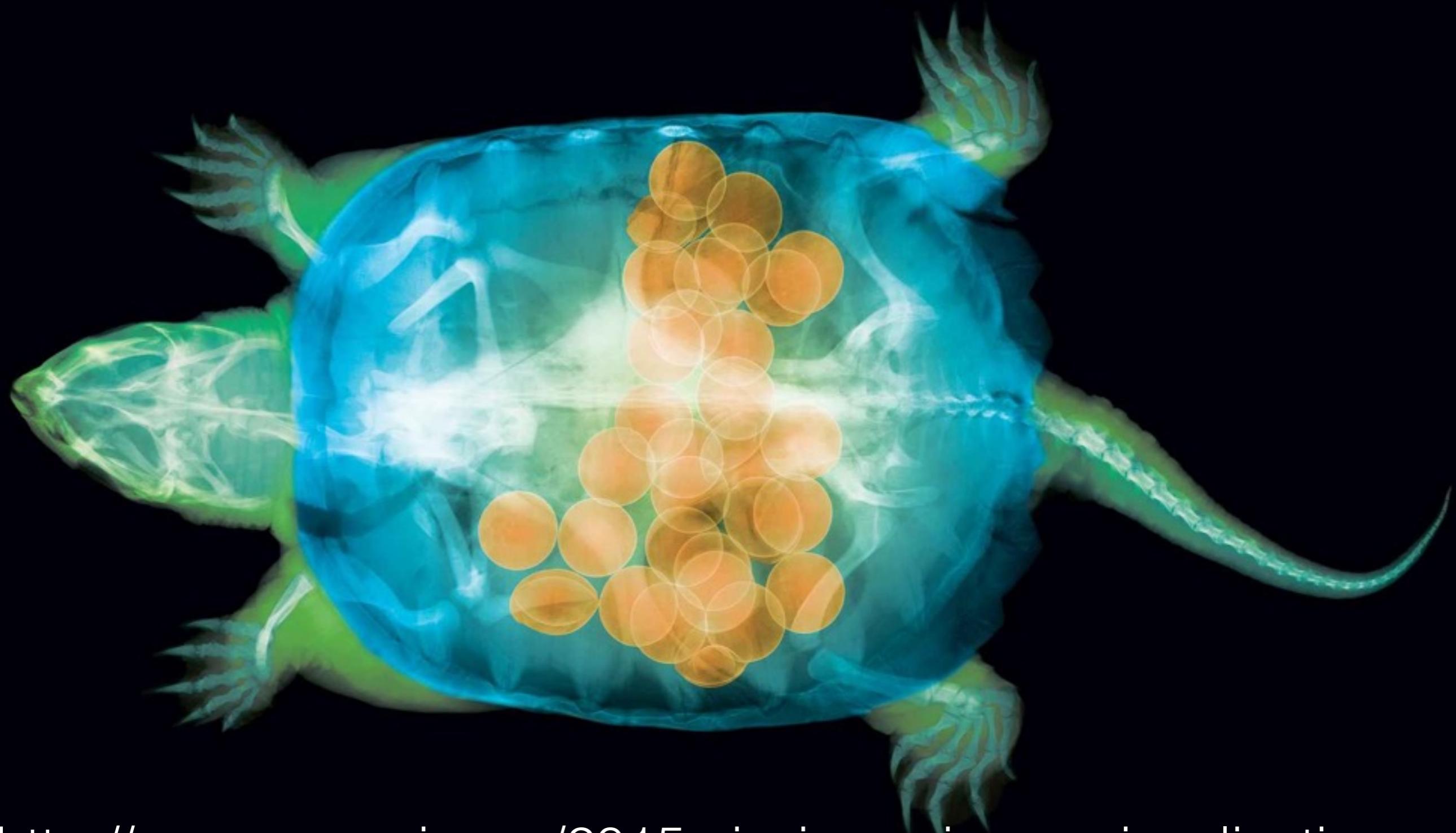


Fig. 8. Average percent of low ESS regions identified broken down by 2D and 3D representation, and left and right artery systems. Error bars correspond to the standard error and the asterisks indicate results of statistical significance. In 3D, users were less accurate identifying regions in the most complex data sets (i.e., left artery systems). Whereas in 2D, performance was the same regardless of task complexity.





<http://www.popsci.com/2015-vizzies-science-visualizations-video-images?image=0>

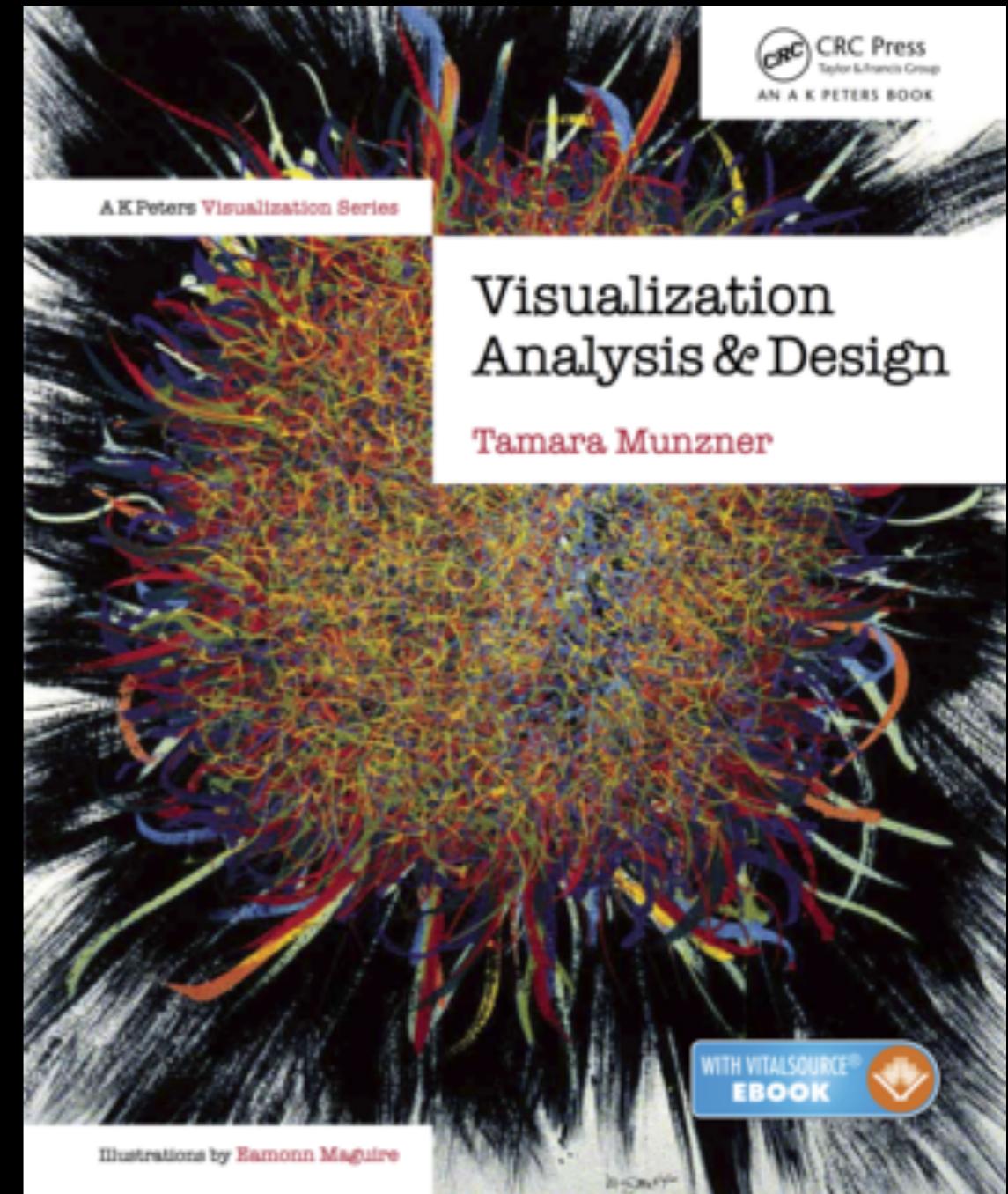
Matplotlib 2.0 color map change

http://matplotlib.org/style_changes.html

Tamara Munzner

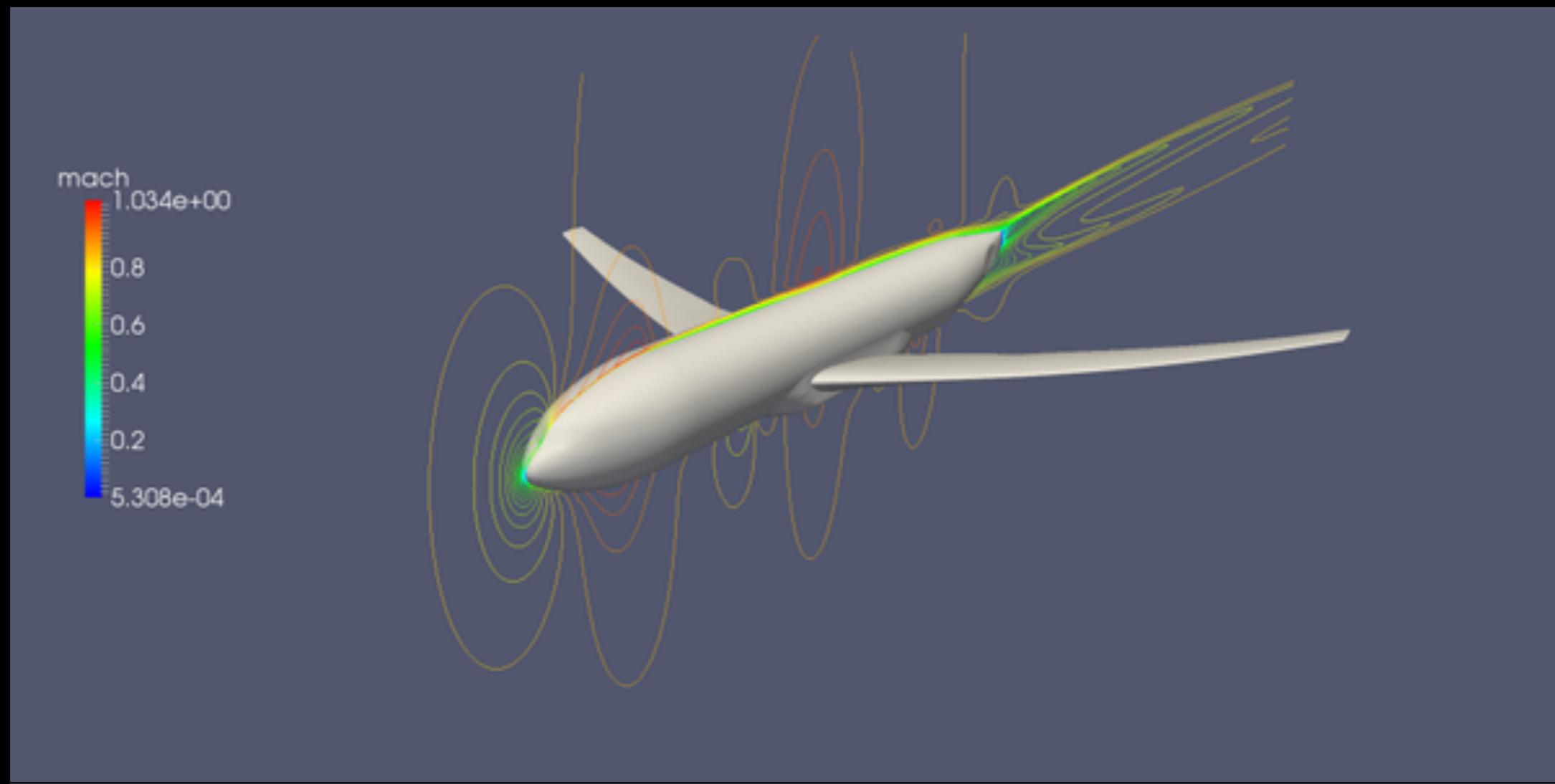
Rules of thumb

Chap 6



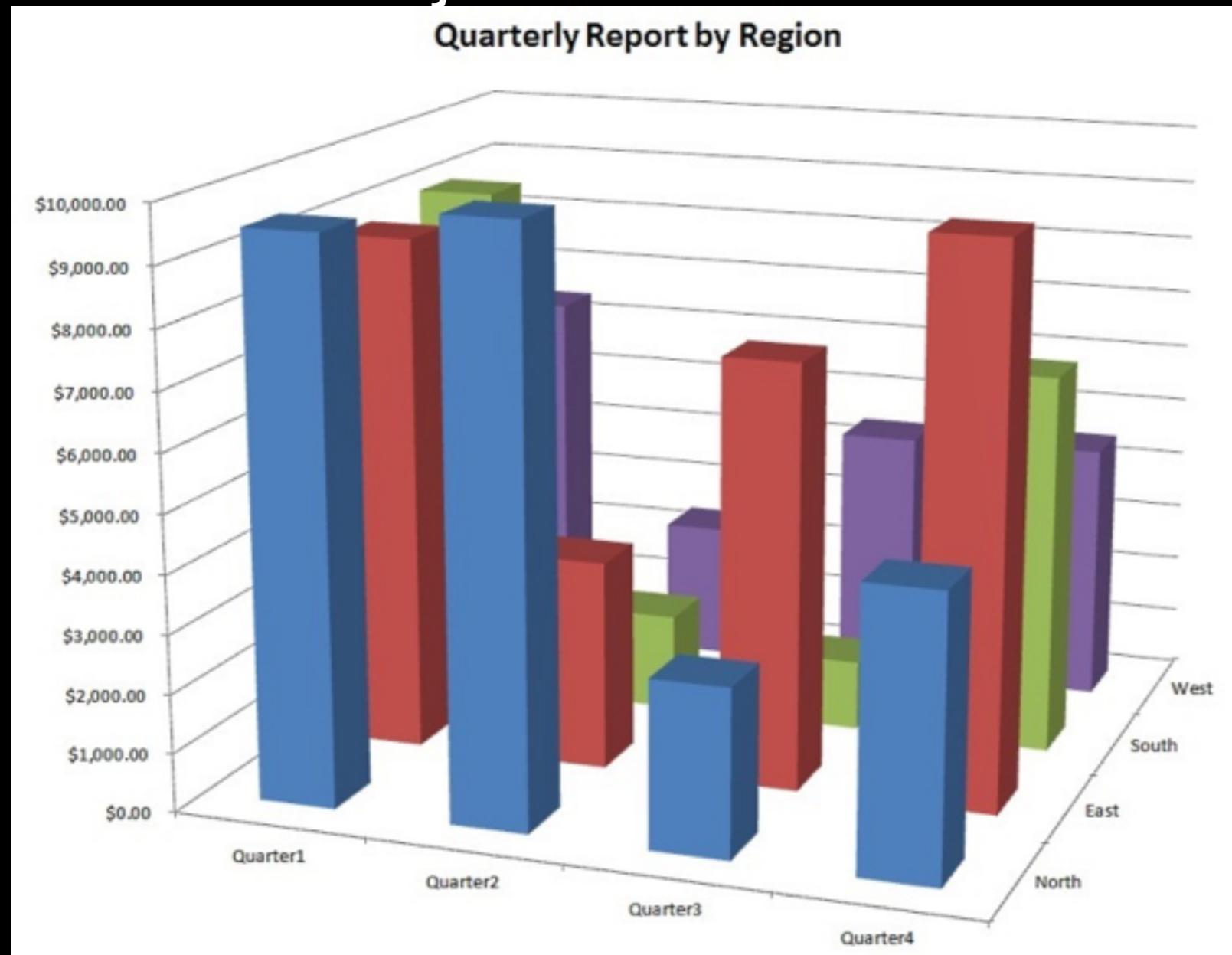
let's improve a plot

No Unjustified 3D

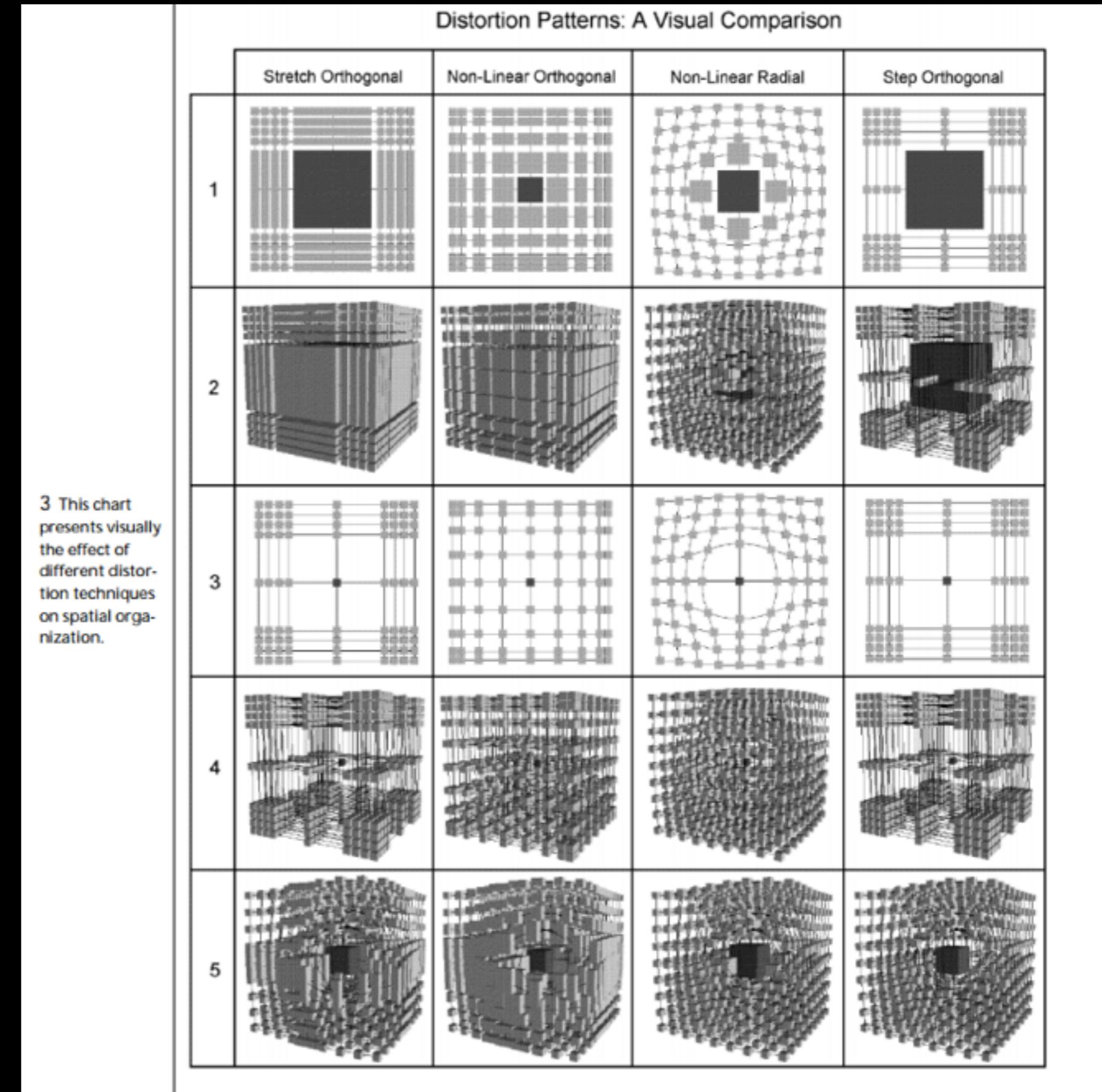


No Unjustified 3D

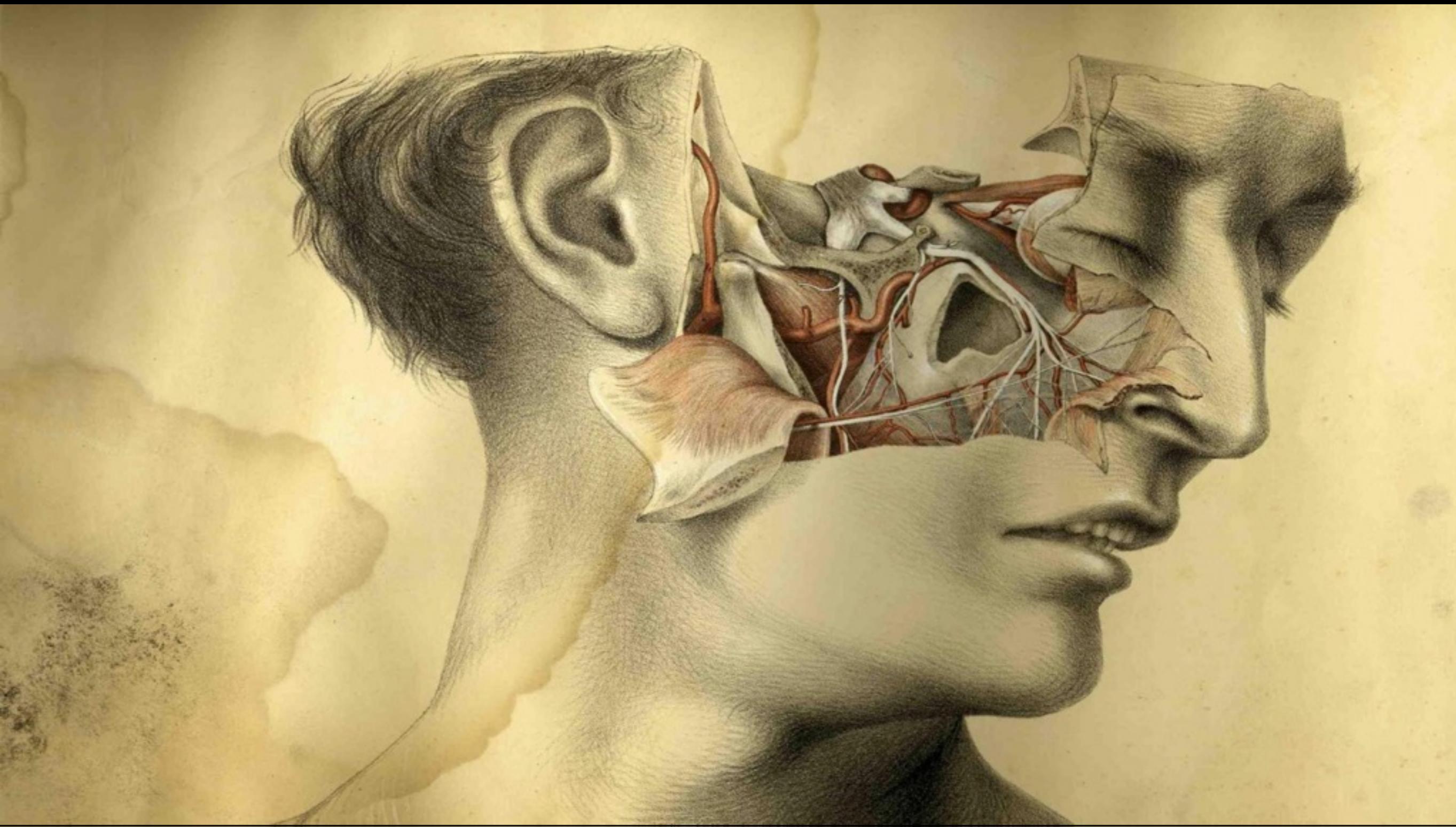
unjustified 3D



distortion techniques



Extending Distortion Viewing Techniques from 2D to 3D Data.
Carpendale et al. CG&A 17(4):42-51, July 1997



distortion
techniques

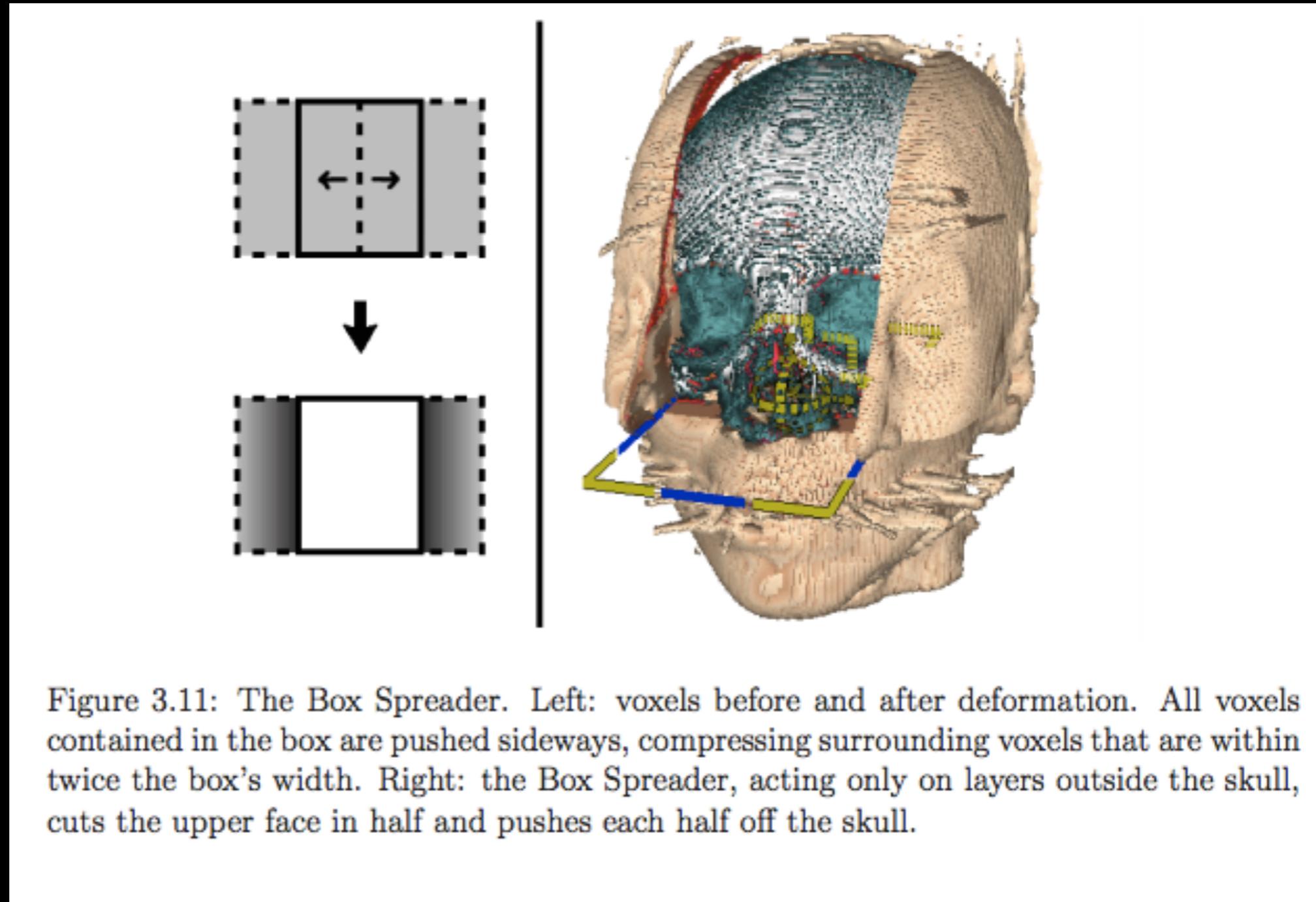
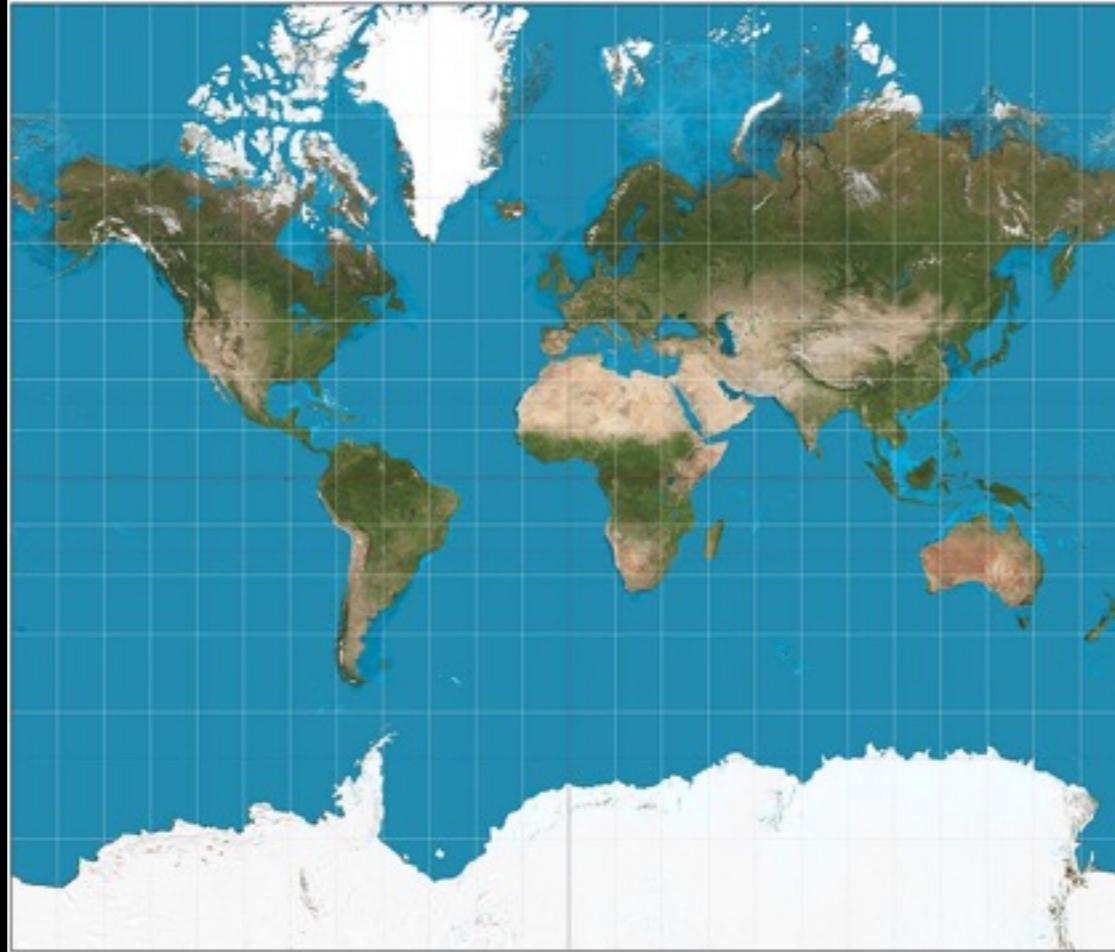


Figure 3.11: The Box Spreader. Left: voxels before and after deformation. All voxels contained in the box are pushed sideways, compressing surrounding voxels that are within twice the box's width. Right: the Box Spreader, acting only on layers outside the skull, cuts the upper face in half and pushes each half off the skull.

distortion techniques

An Investigation of Issues and Techniques in
Highly Interactive Computational Visualization
Michael John McGuffin

Mercator



https://en.wikipedia.org/wiki/List_of_map_projections

Mollweide

distortion
techniques



3D view

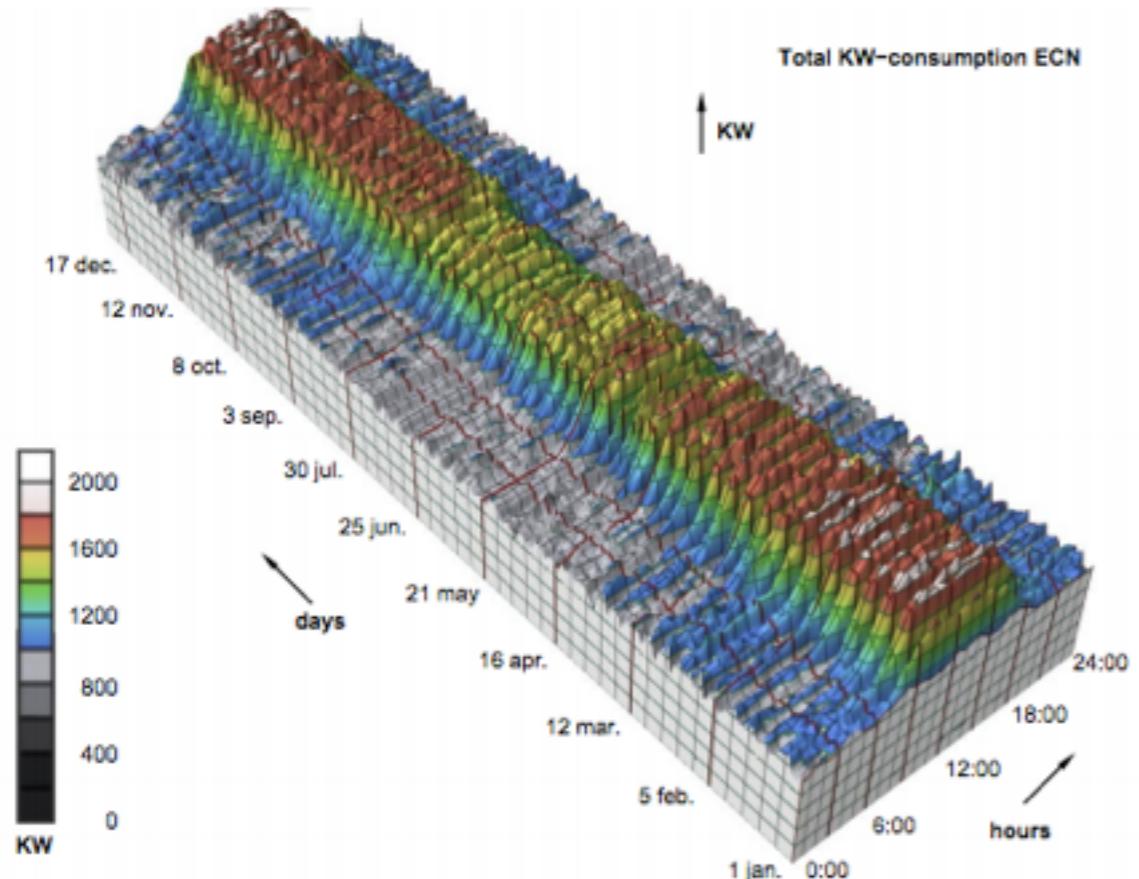
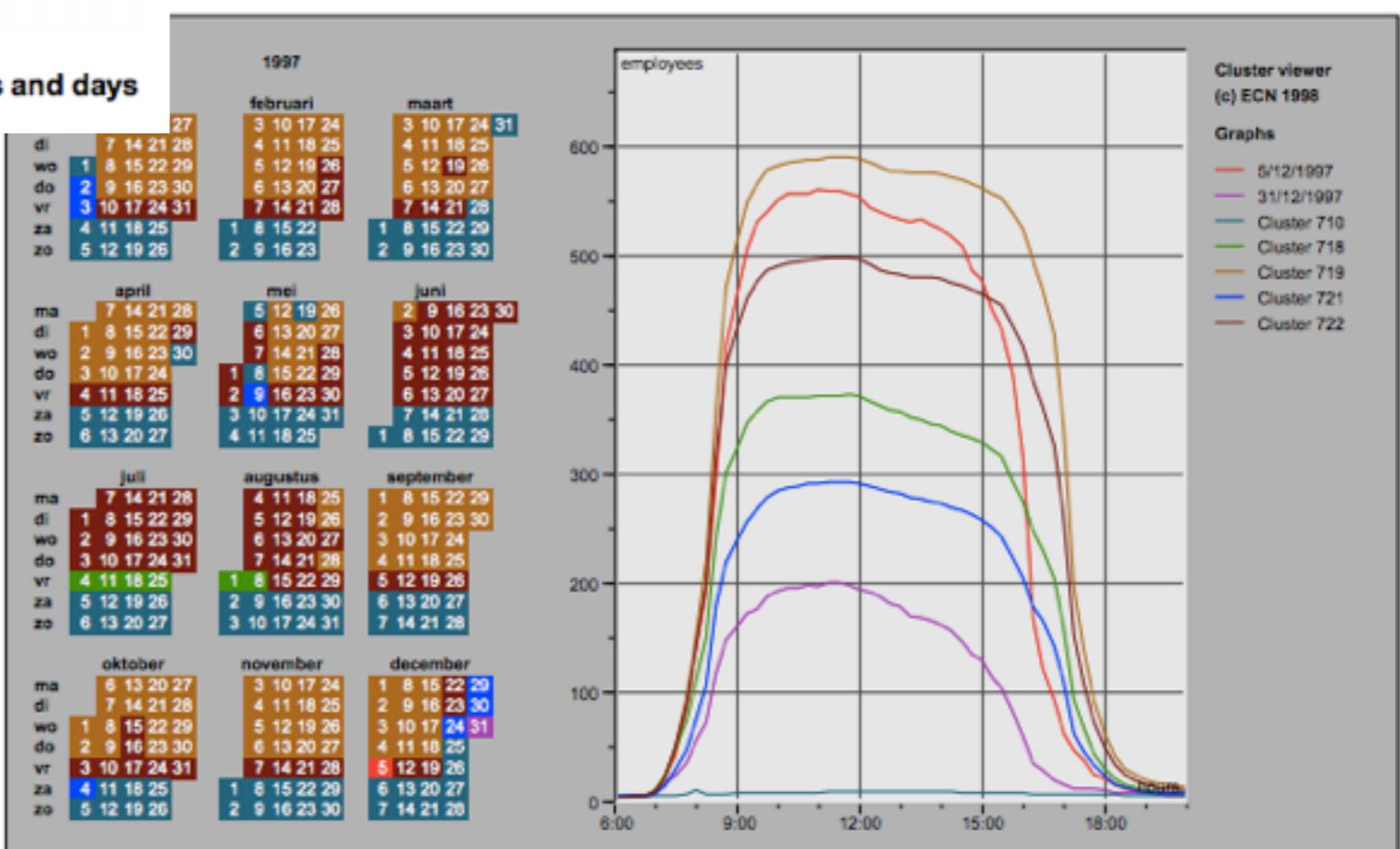


Figure 1. Power demand by ECN, displayed as a function of hours and days

Jarke J. van Wijk & Edward R. van Selow 1999

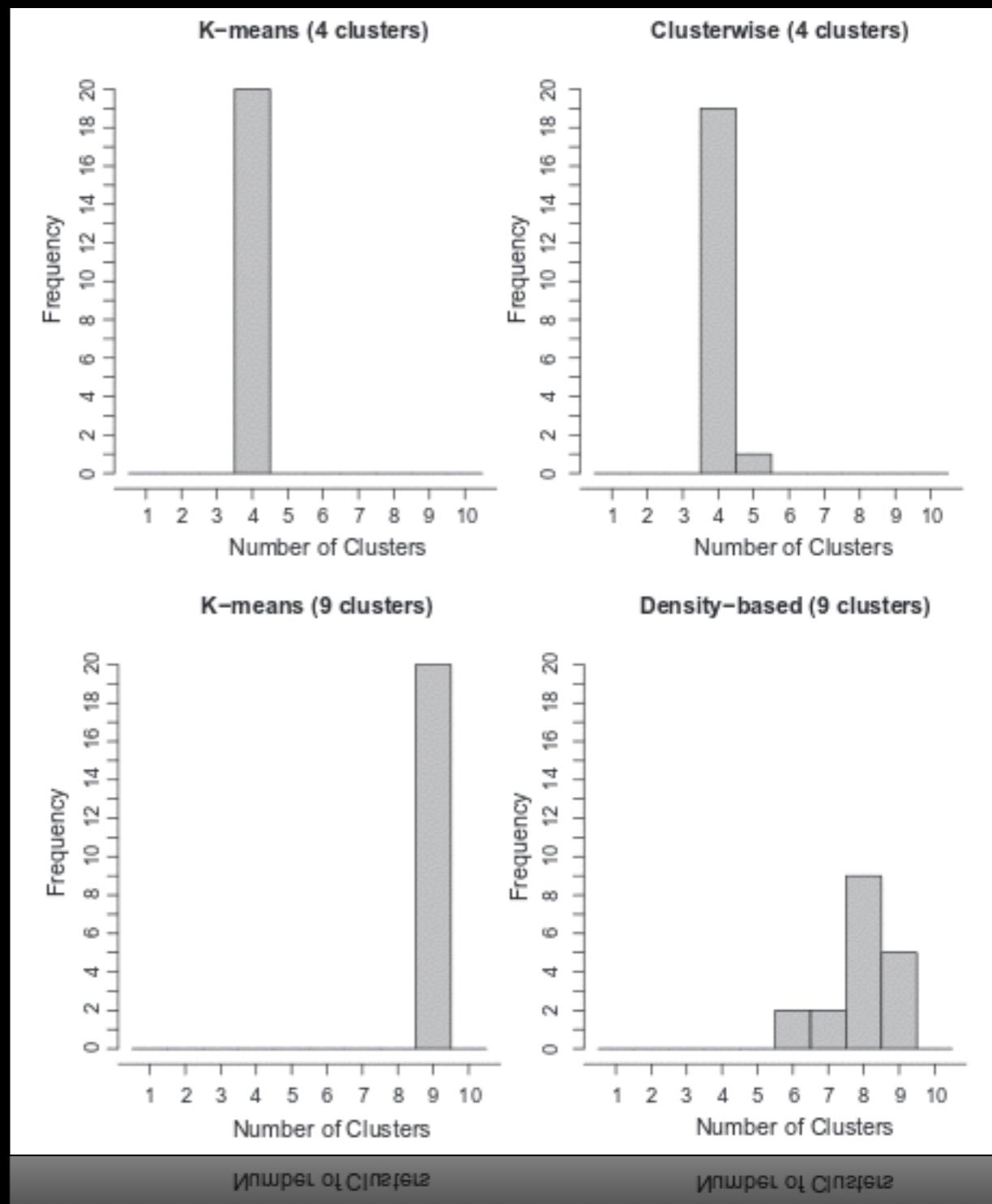


Cluster View

Figure 4. Calendar view of the number of employees

Also: No Unjustified 2D!

consider
lists when
appropriate



Eyes over Memory



Eyes over Memory



Eyes over Memory

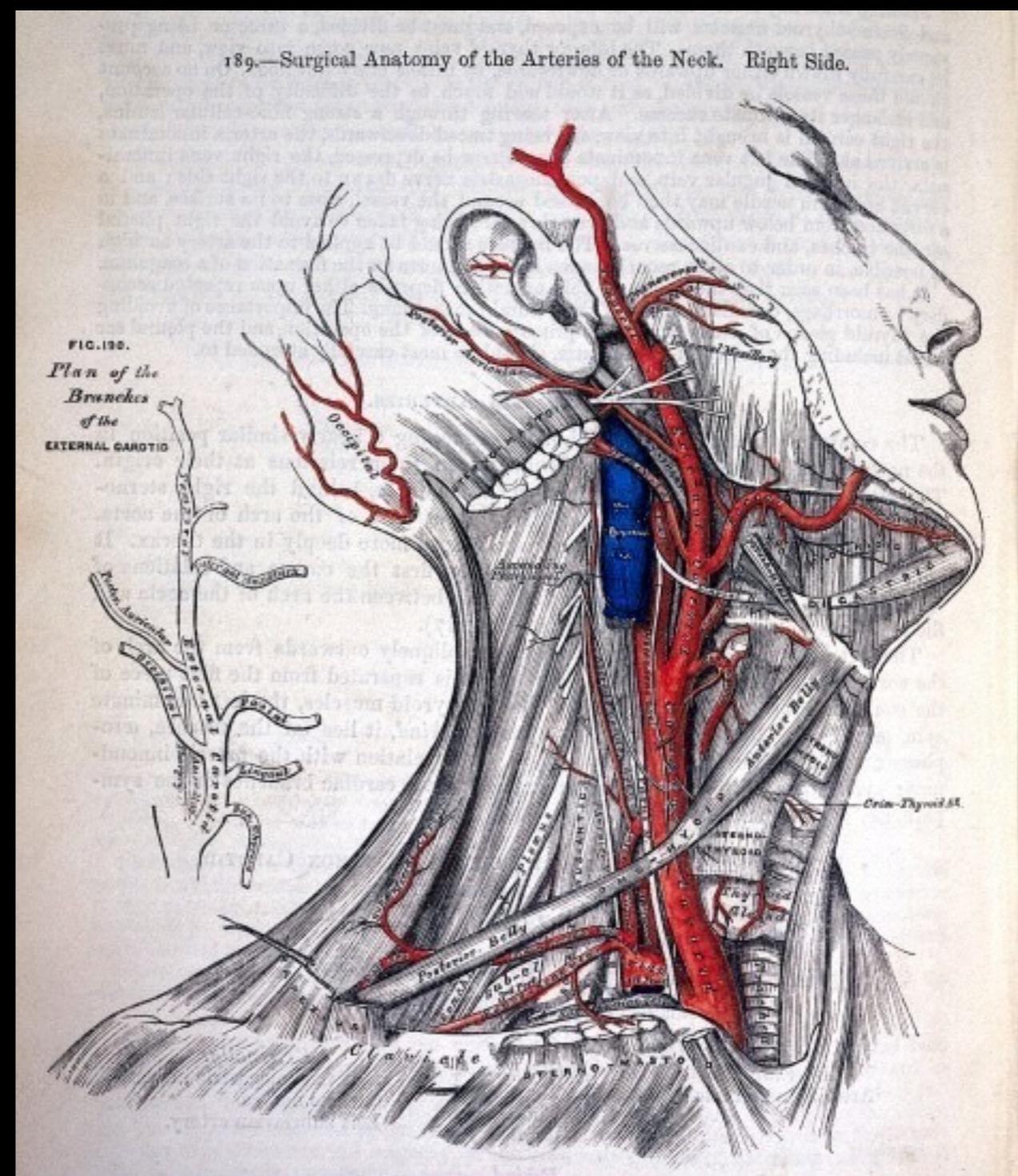
no unjustified animation

Get it right in Black &
White

no unjustified color

Maureen Stone

189.—Surgical Anatomy of the Arteries of the Neck. Right Side.



Maureen Stone



<http://www.columbia.edu/~brennan/subway/SubDia.pdf>

Function first,

Form next

no unjustified beauty

interactive visualization rules of thumb:

Resolution over
immersion

interactive visualization rules of thumb:

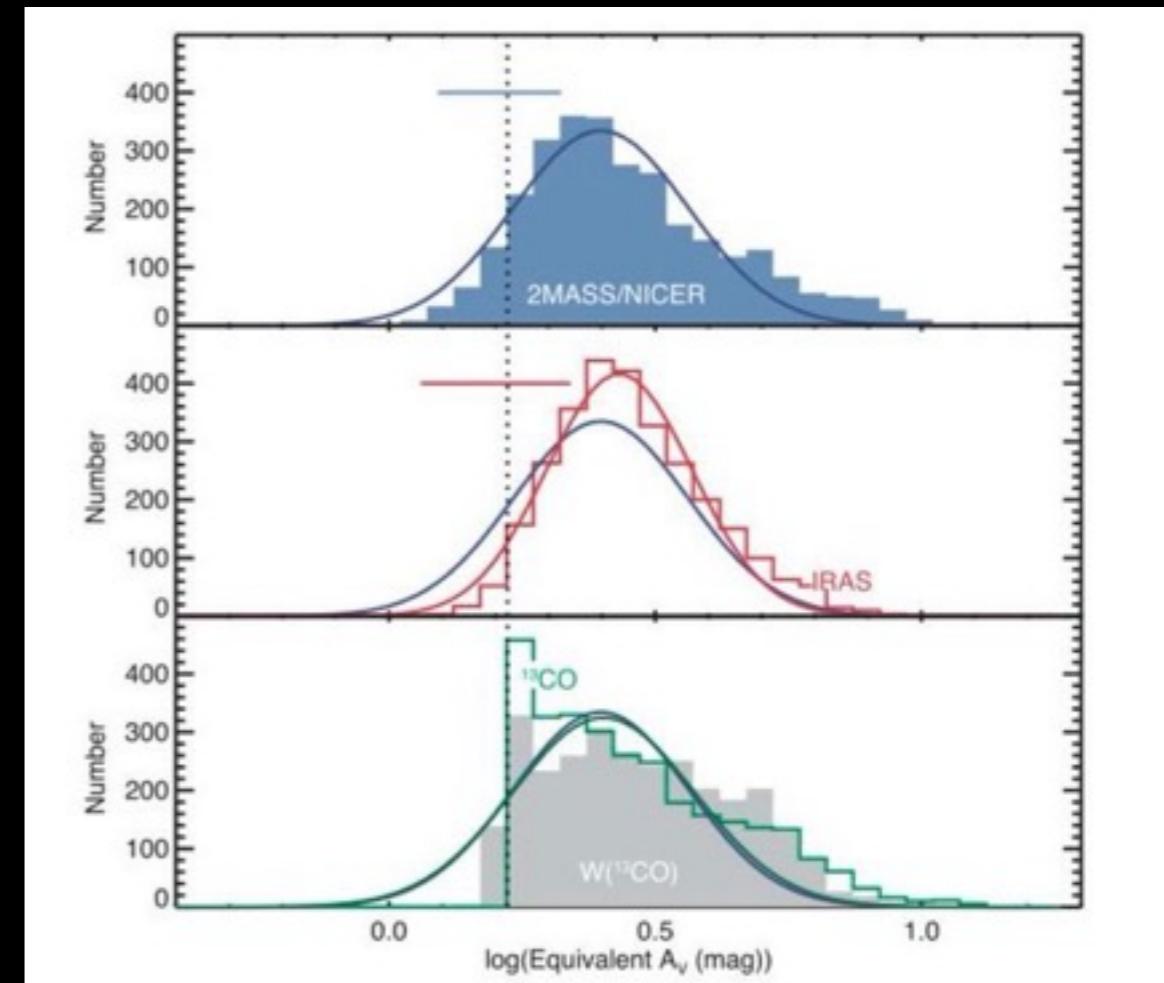
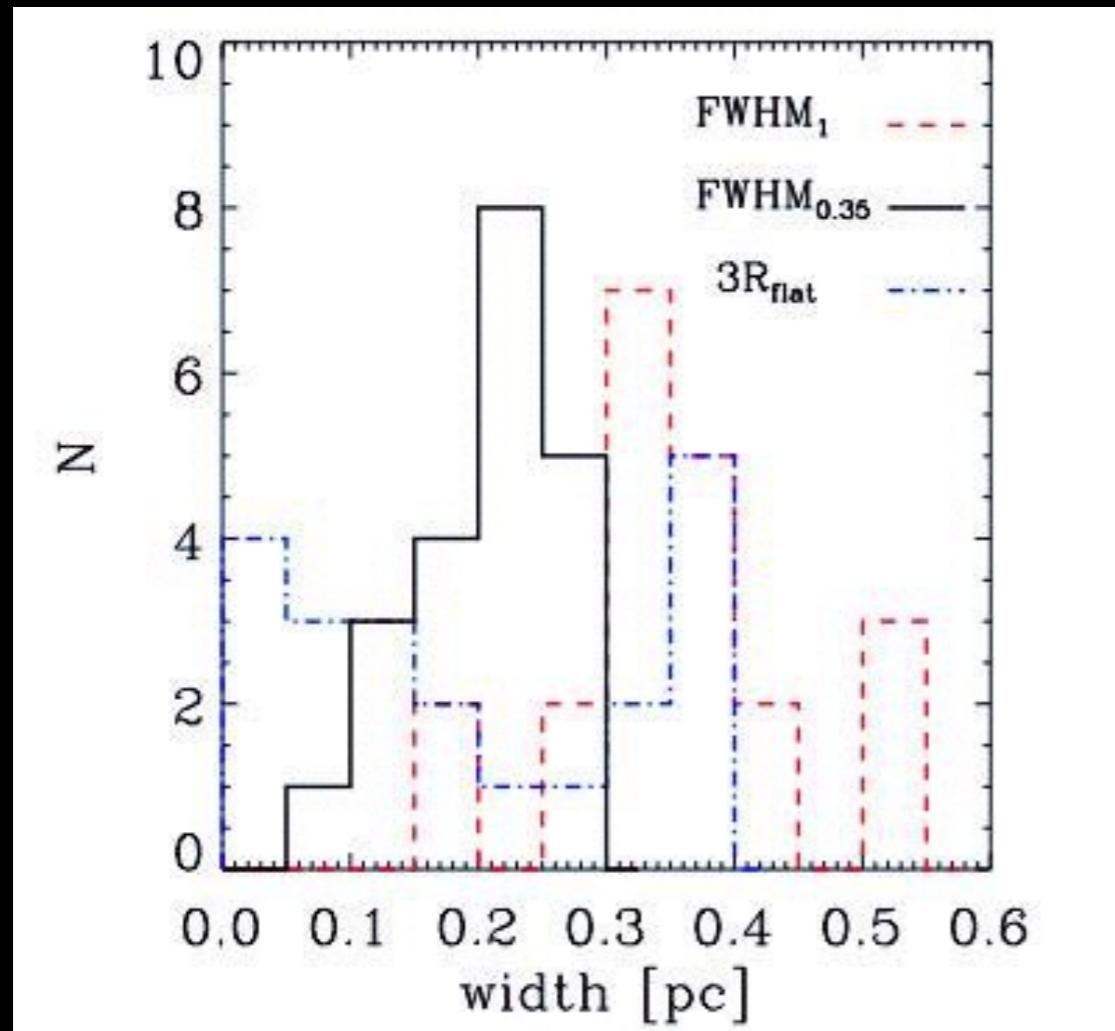
Details on demand

interactive visualization rules of thumb:

Avoid latency

let me add:

AVOID CLUTTER



3D view

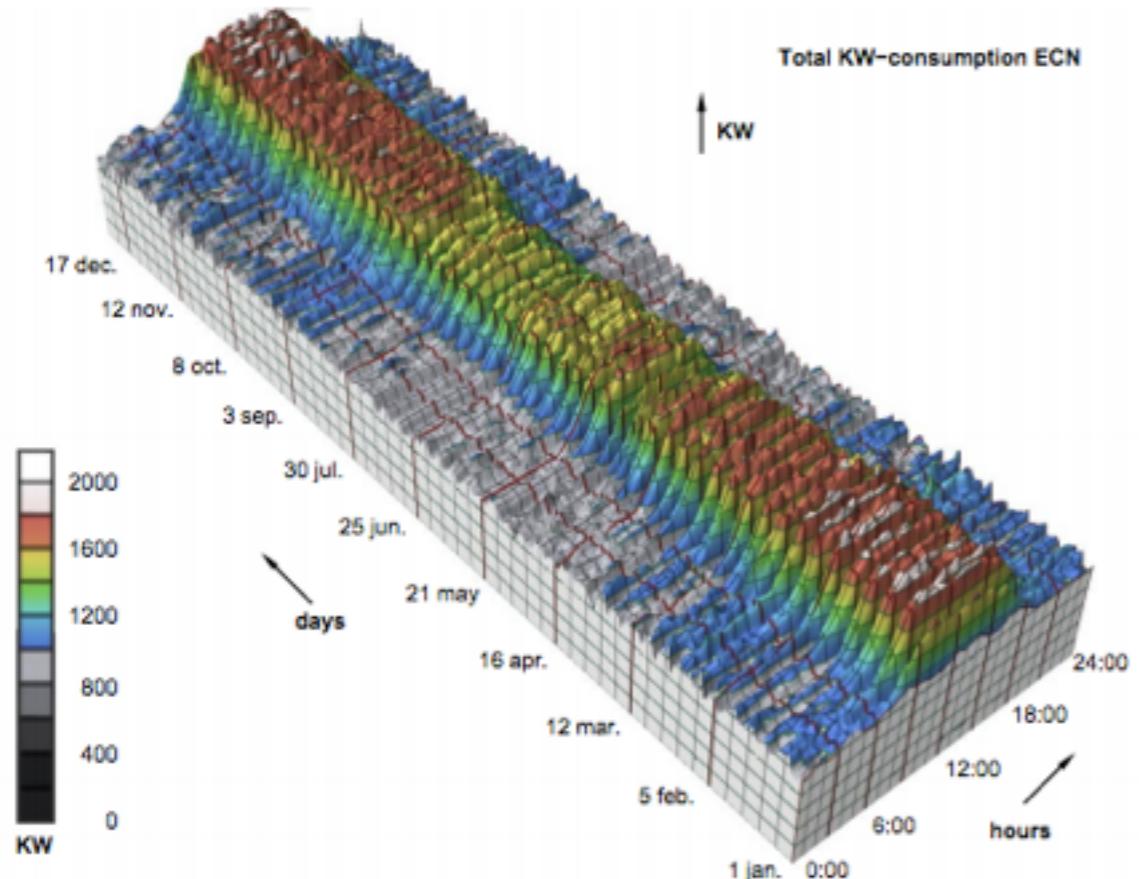
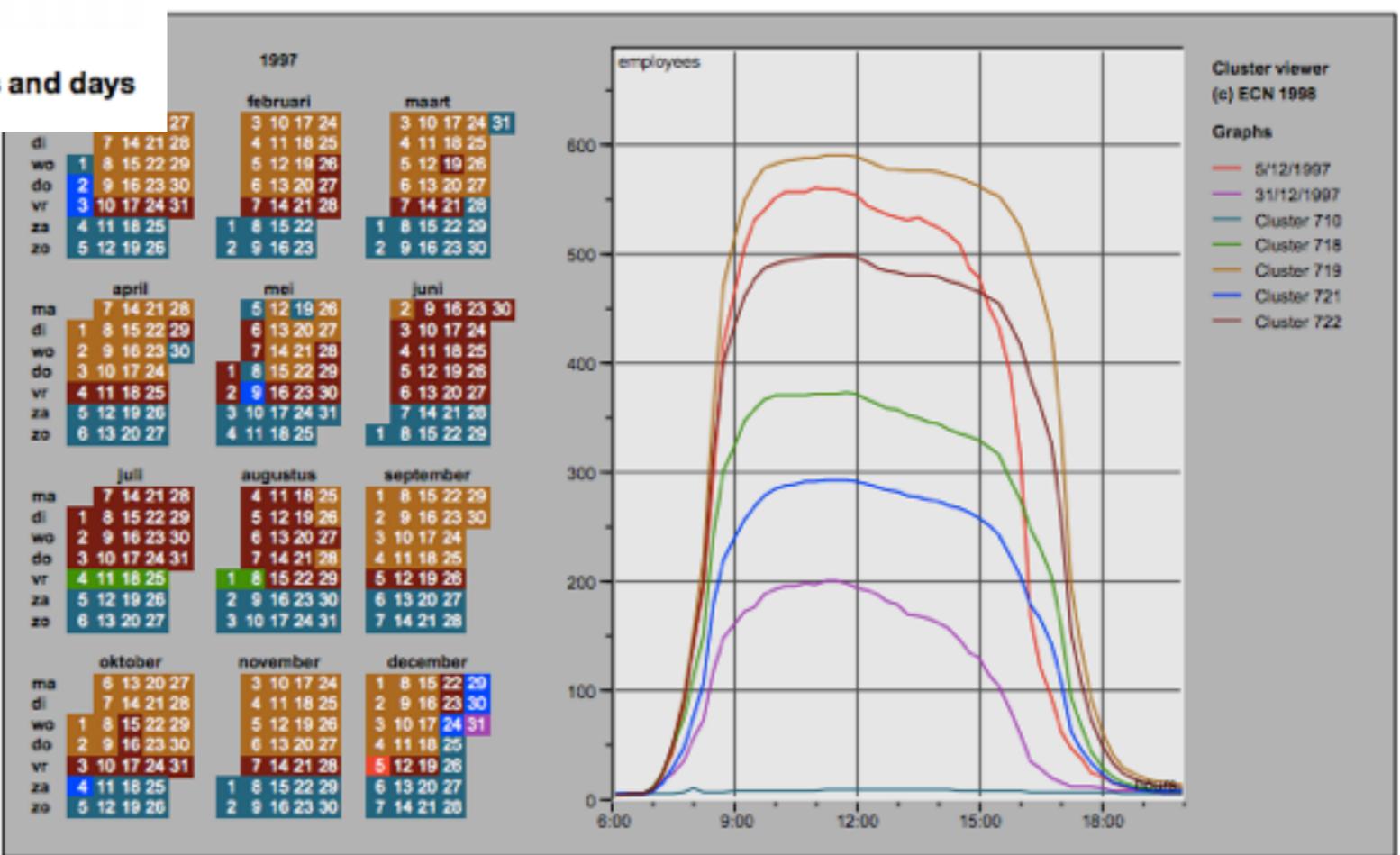
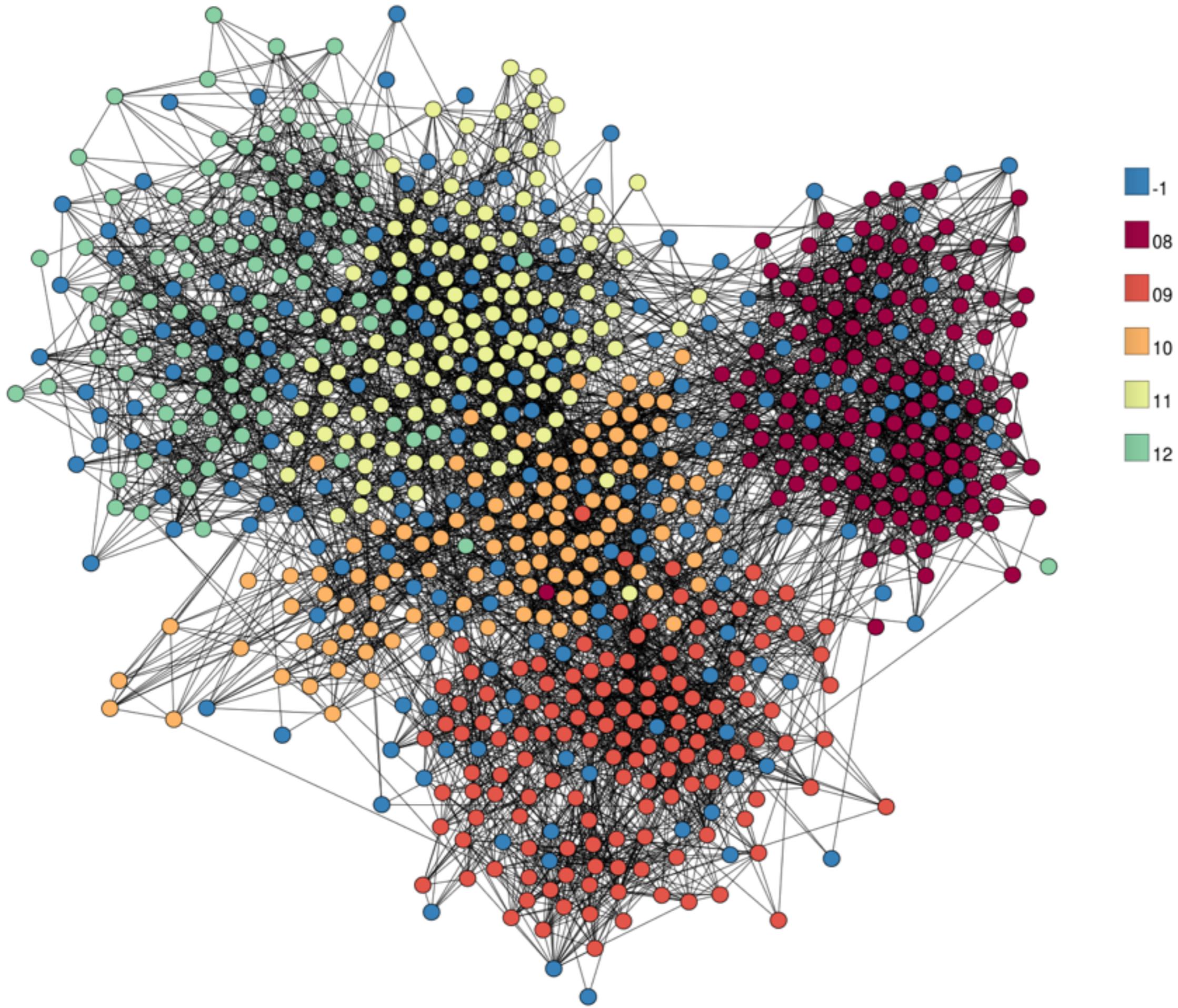


Figure 1. Power demand by ECN, displayed as a function of hours and days



Cluster View

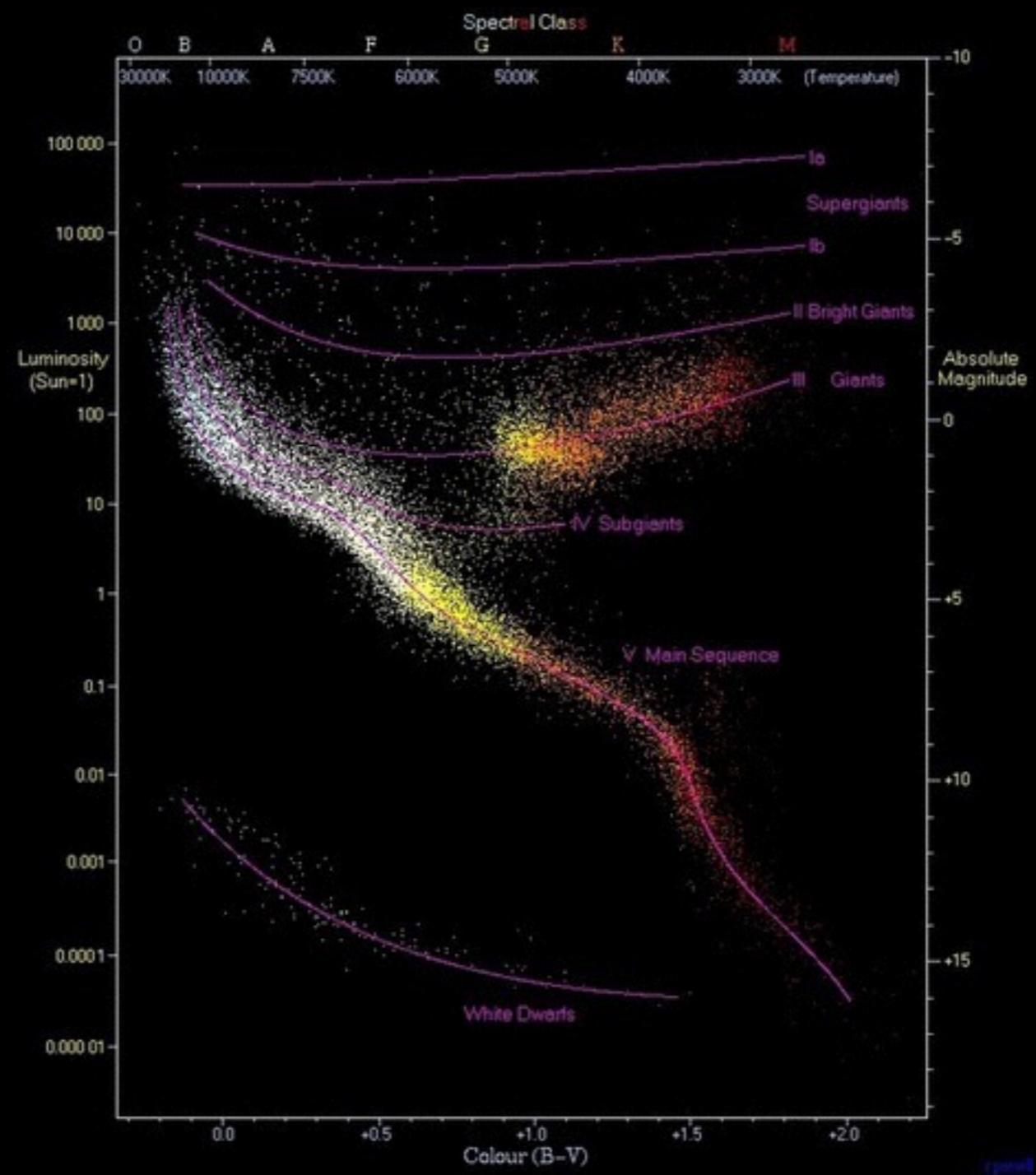
Figure 4. Calendar view of the number of employees

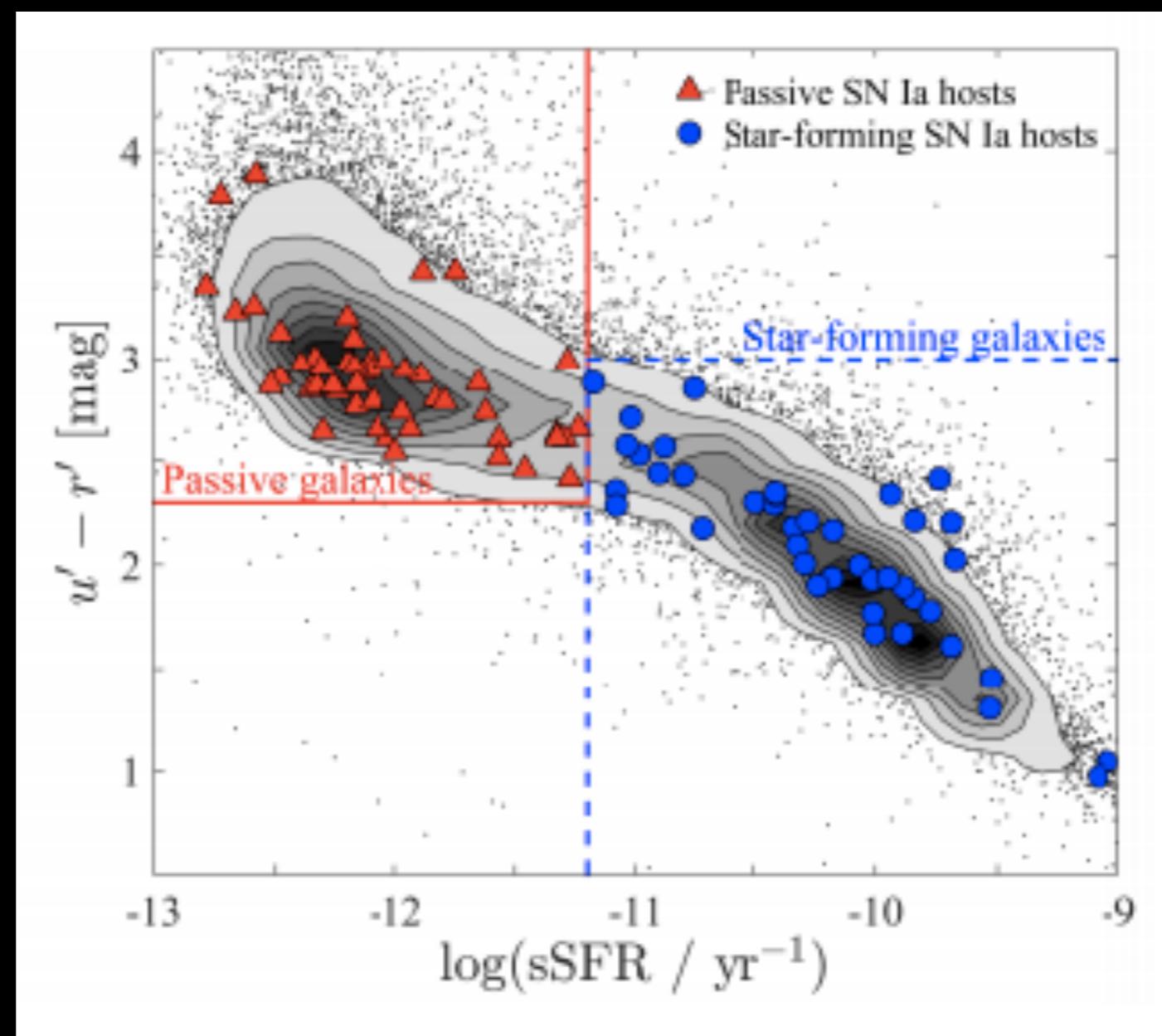


Reduction

<http://cosmo.nyu.edu/~fb55/vizs/astrotrend/arxiv2.html>

Life of a Star





Or, Bianco, Modjaz, ApJ 2014

cornerplot.ipynb

scatter_contour.ipynb

The infamous rule of 7

*The fact that some undergrads payed \$20 cannot repeat more than 7 random words does not mean you should limit your graphic to 7 elements:
to learn how to plot visualize at Nature and Science*



Edward Tufte

Figurative Map of the successive losses in men of the French Army in the Russian campaign 1812-1813.

Drawn by Mr. Minard, Inspector General of Bridges and Roads in retirement. Paris, 20 November 1869.

The numbers of men present are represented by the widths of the colored zones in a rate of one millimeter for ten thousand men; these are also written beside the zones. Red designates men moving into Russia, black those on retreat. — The

informations used for drawing the map were taken from the works of Messrs. Chiers, de Ségur, de Fezensac, de Chambray

and the unpublished diary of Jacob, pharmacist of the Army since 28 October.

In order to facilitate the judgement of the eye regarding the diminution of the army, I supposed that the troops under Prince Jérôme and under Marshal Davoust, who were sent to Minsk and Mobilow and who rejoined near Orscha and Witebsk, had always marched with the army.

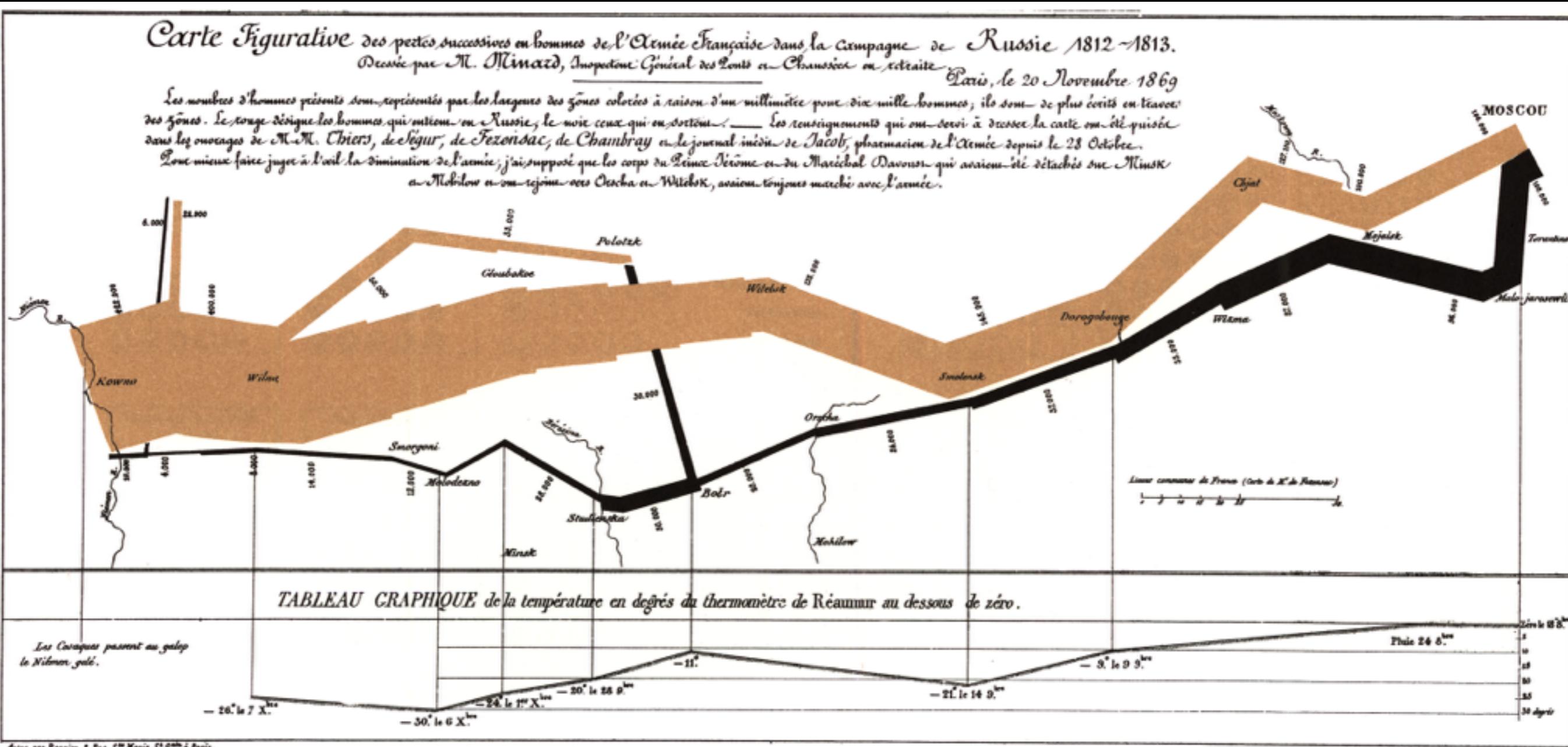
Carte Figurative des pertes successives en hommes de l'Armée Française dans la Campagne de Russie 1812-1813.

Dessiné par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite.

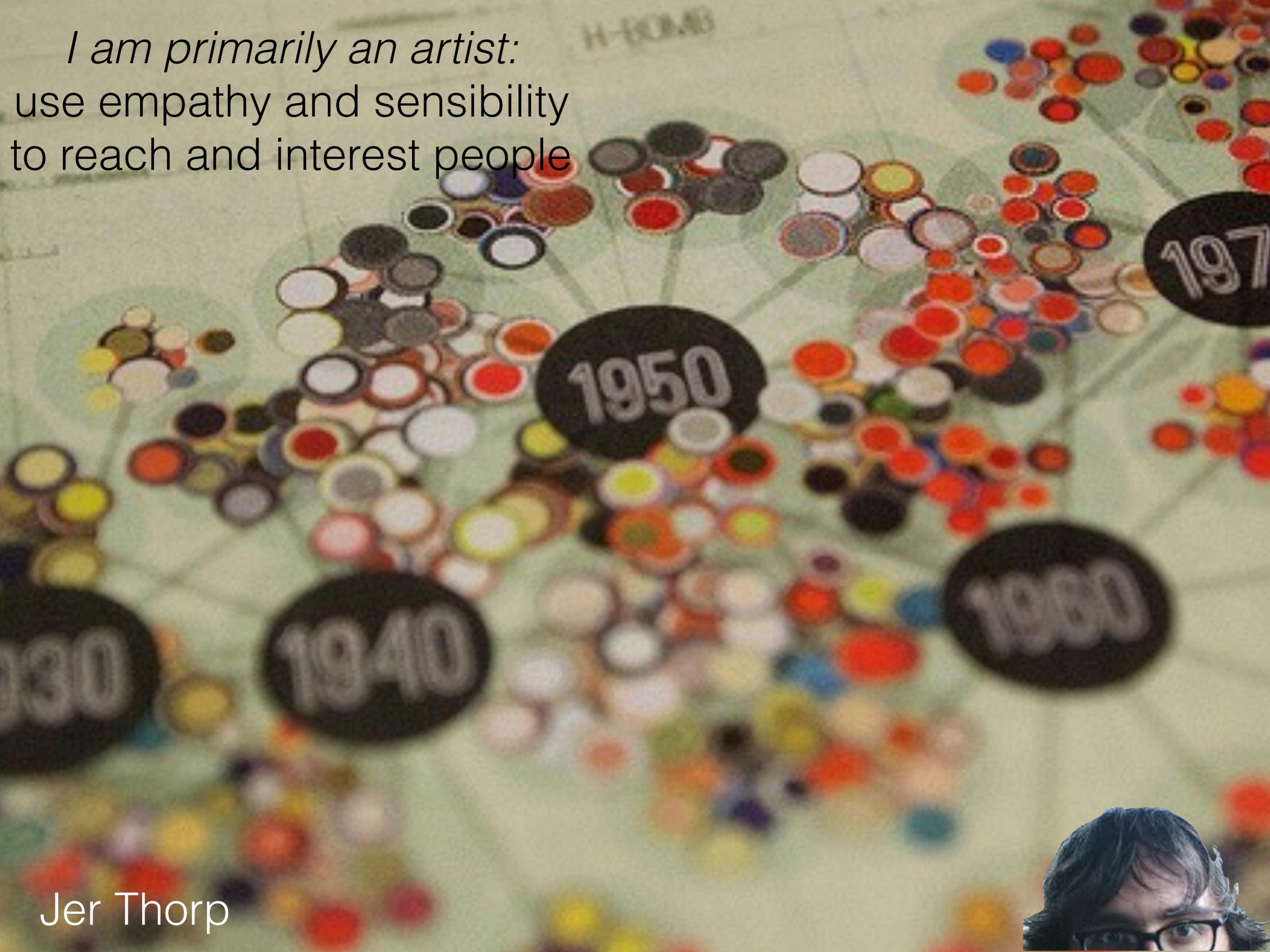
Paris, le 20 Novembre 1869

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 trèves 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 pris dans les ouvrages de M. Chiers, de Ségur, de Fezensac, de Chambray et le journal intime 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 Marshal Davoust, qui auraient été détachés sur Minsk et Mobilow au régime vers Orscha et Witebsk, avaient toujours marché avec l'armée.



*I am primarily an artist:
use empathy and sensibility
to reach and interest people*



Jer Thorp



<https://vimeo.com/4587178>

Key Concepts:

Be thoughtful and make sure your visualizations are (in this order):

honest

clear

convincing

beautiful

Homework:

PHASE 1: Just one plot this week! Choose to plot anything you wish, from the data we used so far. Please make it a good plot.

Put thought into the esthetic of the plot, how clearly the content is communicated, avoid clutter, avoid misleading elements, mind your choice of colors according ly to what was discussed in class.

PHASE 2: The plot is due on next class. Turning in the plot will automatically award you the full 10 points. At that time you will receive 3 plots from your class mates, and you have to evaluate their strengths and weaknesses. Think about it as a pier review, which is something that is normally done on scientific papers in order to accept them or reject them for publication. The revision of the plots is due 4 days later and will be evaluated on a scale (10 points).

Upload your plots to github (before next class) in a new folder HW8. Upload the plots revisions as a README file in the same directory, including the plots as images in the README (4 days later by the end of the day).

Homework:

READING: this reading will help you review your peer's plots

7 Great Visualizations from History

<http://data-informed.com/7-great-visualizations-history/>

Six Lessons from the Bauhaus: Masters of the
Persuasive Graphic

<http://blog.visual.ly/six-lessons-from-the-bauhaus-masters-of-the-persuasive-graphic/>

Resources:

Tamara Munzner
Visualization Analysis & Design, 2014
Chap 6 (photocopies will be in the library)
[http://www.cs.ubc.ca/~tmm/talks/minicourse14/
vad15london.pdf](http://www.cs.ubc.ca/~tmm/talks/minicourse14/vad15london.pdf)

7 classical vis papers
[http://fellinlovewithdata.com/guides/7-classic-
foundational-vis-papers](http://fellinlovewithdata.com/guides/7-classic-foundational-vis-papers)