
Calvin and Hobbes
by WATTERSON
WOW, HONEY, YOU'RE MISSING A BEAUTIFUL SUNSET OUT HERE!
I'LL COUNT TO 10, AND THEN... POW!
DAD, HOW COME OLD PHOTOGRAPHS ARE ALWAYS BLACK AND WHITE? DIDN'T THEY HAVE COLOR FILM BACK THEN?
SURE THEY DID. IN FACT, THOSE OLD PHOTOGRAPHS ARE IN COLOR. IT'S JUST THE WORLD WAS BLACK AND WHITE THEN.
REALLY?
YEP. THE WORLD DIDN'T TURN COLOR UNTIL SOMETIME IN THE 1930s, AND IT WAS PRETTY GRAINY COLOR FOR A WHILE, TOO.
THAT'S REALLY WEIRD.
WELL, TRUTH IS STRANGER THAN FICTION.
BUT THEN WHY ARE OLD PAINTINGS IN COLOR?! IF THE WORLD WAS BLACK AND WHITE, WOULDN'T ARTISTS HAVE PAINTED IT THAT WAY?
NOT NECESSARILY. A LOT OF GREAT ARTISTS WERE INSANE.
BUT... BUT HOW COULD THEY HAVE PAINTED IN COLOR ANYWAY? WOULDN'T THEIR PAINTS HAVE BEEN SHADES OF GRAY BACK THEN?
OF COURSE, BUT THEY TURNED COLORS LIKE EVERYTHING ELSE DID IN THE '30s.
SO WHY DIDN'T OLD BLACK AND WHITE PHOTOS TURN COLOR TOO?
BECAUSE THEY WERE COLOR PICTURES OF BLACK AND WHITE, REMEMBER?
THE WORLD IS A COMPLICATED PLACE, HOBBES.
WHENEVER IT SEEMS THAT WAY, I TAKE A NAP IN A TREE AND WAIT FOR DINNER.
10-29

VISUALIZATION

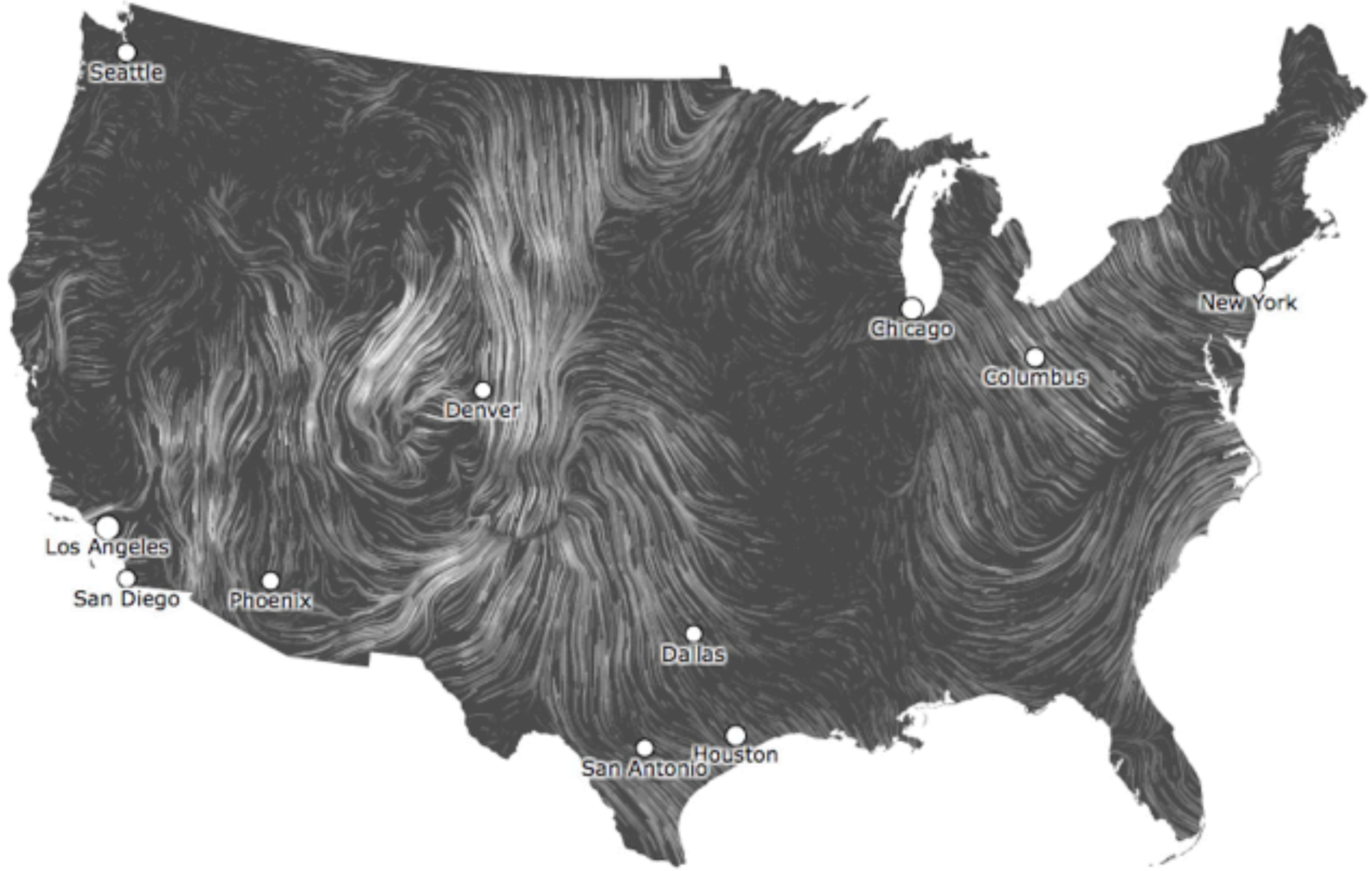
cs2420 | Spring 2015

administrivia…

-assignment 12 is due tonight

-TA office hours

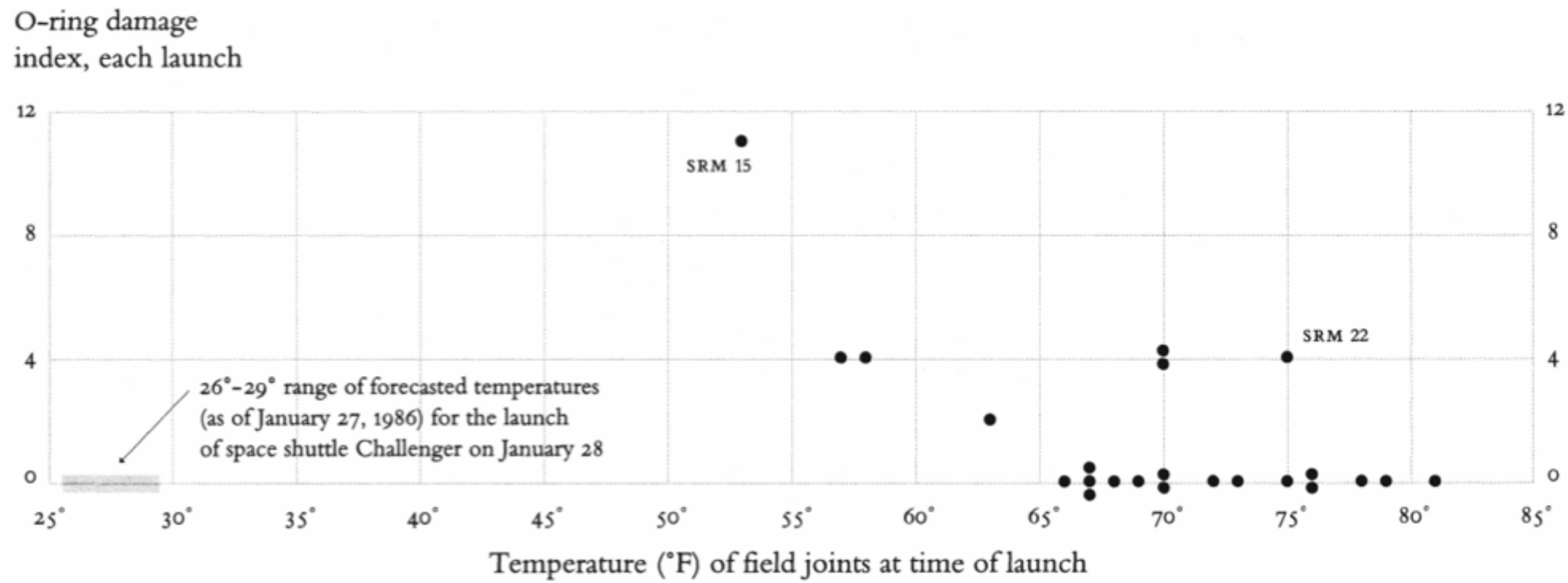
last time…



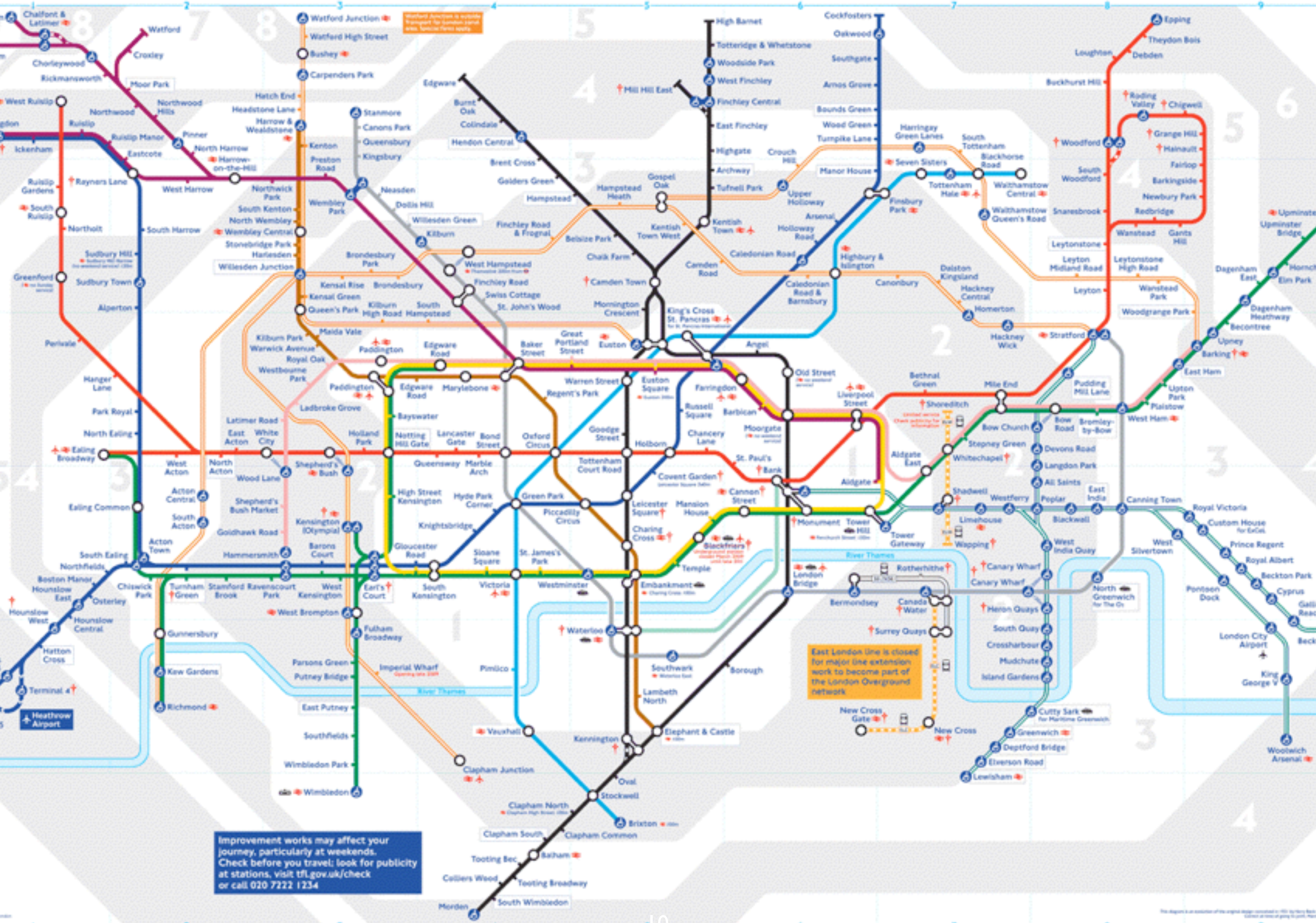
sources: AbyssExplorer, hint.fm/wind, Wordle

visualization
uses perception to point out interesting things.

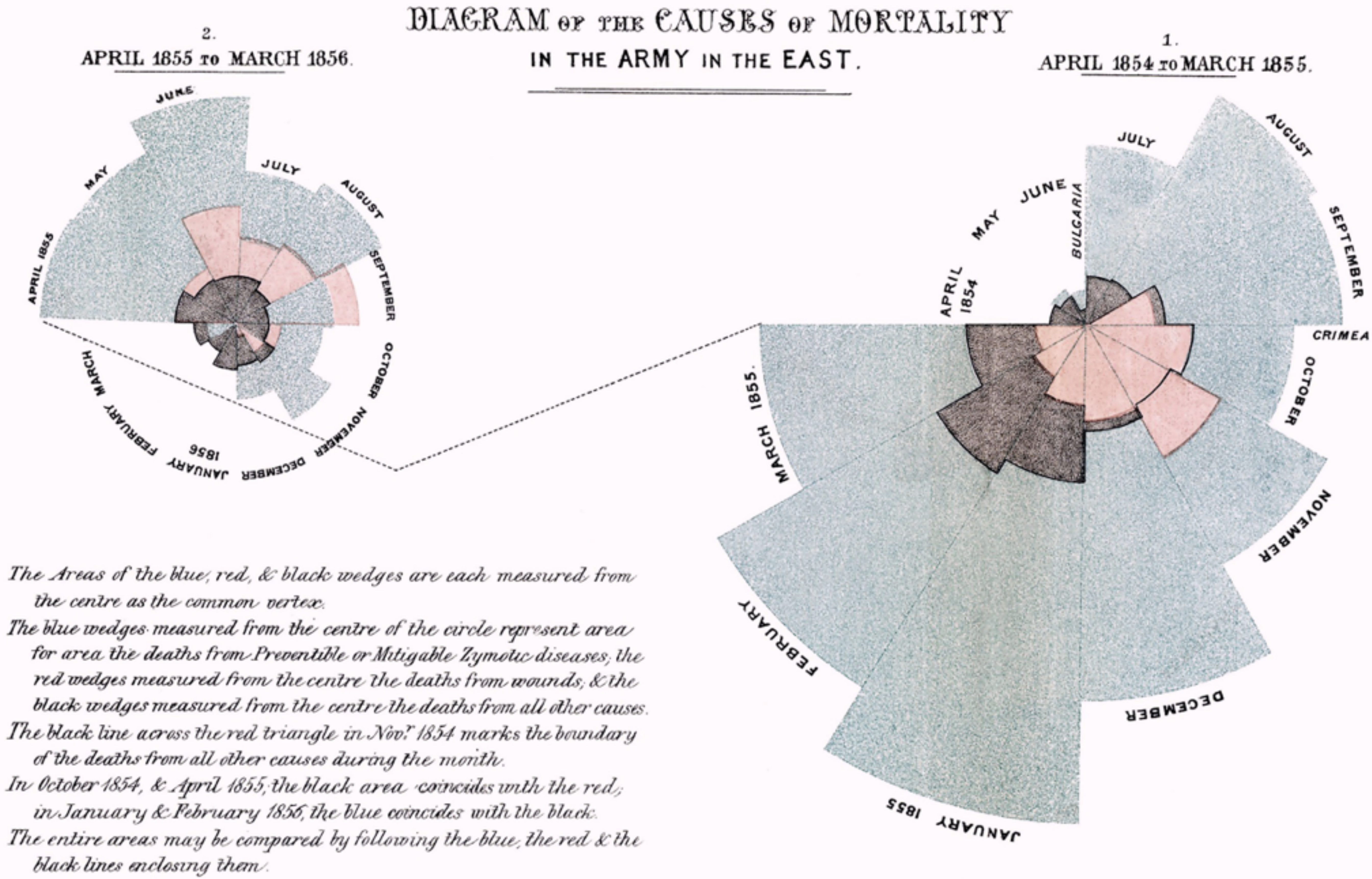
visualization
uses pictures to enhance working memory.



source: E. Tufte



Chalfont & Latimer
Watford
Croxley
Chorleywood
Rickmansworth
Moor Park
Northwood
Northwood Hills
Pinner
North Harrow
Harrow-on-the-Hill
West Harrow
West Ruislip
Ruislip
Ruislip Manor
Eastcote
Ickenham
Ruislip Gardens
Rayners Lane
South Ruislip
Northolt
South Harrow
Sudbury Hill
Greenford
Sudbury Town
Alperton
Perivale
Hanger Lane
Park Royal
North Ealing
Ealing Broadway
Ealing Common
West Acton
North Acton
Acton Central
South Acton
Acton Town
South Ealing
Northfields
Boston Manor
Osterley
Hounslow East
Hounslow Central
Hounslow West
Hatton Cross
Terminal 4
Heathrow Airport
Chiswick Park
Turnham Green
Stamford Brook
Ravenscourt Park
Gunnersbury
Kew Gardens
Richmond
Watford Junction
Watford High Street
Bushey
Carpenders Park
Hatch End
Headstone Lane
Harrow & Wealdstone
Kenton
Preston Road
Northwick Park
Wembley Park
South Kenton
North Wembley
Wembley Central
Stonebridge Park
Harlesden
Willesden Junction
Kensal Rise
Kensal Green
Brondesbury Park
Brondesbury
Queen's Park
Kilburn Park
Kilburn High Road
South Hampstead
Maida Vale
Warwick Avenue
Royal Oak
Westbourne Park
Paddington
Ladbroke Grove
Latimer Road
East Acton
White City
Wood Lane
Shepherd's Bush
Shepherd's Bush Market
Goldhawk Road
Hammersmith
Barons Court
Kensington (Olympia)
West Kensington
West Brompton
Earl's Court
Fulham Broadway
Parsons Green
Putney Bridge
East Putney
Southfields
Wimbledon Park
Wimbledon
Imperial Wharf
Clapham Junction
Stanmore
Canons Park
Queensbury
Kingsbury
Neasden
Dollis Hill
Willesden Green
Kilburn
West Hampstead
Finchley Road
Swiss Cottage
St. John's Wood
Brondesbury Park
Edgware
Burnt Oak
Colindale
Hendon Central
Brent Cross
Golders Green
Hampstead
Finchley Road & Frognal
Belsize Park
Chalk Farm
Hampstead Heath
Gospel Oak
Kentish Town West
Camden Town
Mornington Crescent
Camden Road
Kentish Town
Mill Hill East
High Barnet
Totteridge & Whetstone
Woodside Park
West Finchley
Finchley Central
East Finchley
Highgate
Archway
Tufnell Park
Crouch Hill
Upper Holloway
Holloway Road
Caledonian Road
Caledonian Road & Barnsbury
Highbury & Islington
Canonbury
Dalston Kingsland
Hackney Central
Homerton
Hackney Wick
Stratford
Cockfosters
Oakwood
Southgate
Arnos Grove
Bounds Green
Wood Green
Turnpike Lane
Manor House
Harringay Green Lanes
Seven Sisters
South Tottenham
Blackhorse Road
Tottenham Hale
Walthamstow Central
Walthamstow Queen's Road
Finsbury Park
Arsenal
Epping
Theydon Bois
Debden
Loughton
Buckhurst Hill
Roding Valley
Chigwell
Grange Hill
Hainault
Fairlop
Barkingside
Newbury Park
Woodford
South Woodford
Snaresbrook
Redbridge
Gants Hill
Wanstead
Leytonstone
Leyton Midland Road
Leytonstone High Road
Leyton
Wanstead Park
Woodgrange Park
Upminster
Upminster Bridge
Hornchurch
Elm Park
Dagenham East
Dagenham Heathway
Becontree
Upney
Barking
East Ham
Upton Park
Plaistow
West Ham
Bromley-by-Bow
Bow Road
Bow Church
Pudding Mill Lane
Devons Road
Langdon Park
All Saints
Poplar
East India
Blackwall
Canning Town
Royal Victoria
Custom House for ExCeL
Prince Regent
Royal Albert
Beckton Park
Cyprus
West Silvertown
Pontoon Dock
London City Airport
King George V
Woolwich Arsenal
North Greenwich
West India Quay
Canary Wharf
Heron Quays
South Quay
Crossharbour
Mudchute
Island Gardens
Cutty Sark for Maritime Greenwich
Greenwich
Deptford Bridge
Elverson Road
Lewisham
Westferry
Limehouse
Shadwell
Stepney Green
Whitechapel
Mile End
Bethnal Green
Shoreditch
Wapping
Rotherhithe
Canada Water
Surrey Quays
New Cross Gate
New Cross
Bermondsey
East London line is closed for major line extension work to become part of the London Overground network
Baker Street
Great Portland Street
Euston
King's Cross St. Pancras
Angel
Old Street
Edgware Road
Marylebone
Regent's Park
Warren Street
Euston Square
Farringdon
Barbican
Moorgate
Liverpool Street
Aldgate East
Aldgate
Bayswater
Notting Hill Gate
Holland Park
Lancaster Gate
Bond Street
Oxford Circus
Tottenham Court Road
Goodge Street
Russell Square
Holborn
Chancery Lane
St. Paul's
Bank
Queensway
Marble Arch
High Street Kensington
Hyde Park Corner
Green Park
Piccadilly Circus
Leicester Square
Covent Garden
Mansion House
Cannon Street
Monument
Tower Hill
Tower Gateway
Knightsbridge
Gloucester Road
South Kensington
Sloane Square
Victoria
St. James's Park
Westminster
Charing Cross
Embankment
Temple
Blackfriars
London Bridge
Waterloo
Southwark
Borough
Lambeth North
Elephant & Castle
Pimlico
Vauxhall
Kennington
Oval
Stockwell
Brixton
Clapham North
Clapham Common
Clapham South
Balham
Tooting Bec
Tooting Broadway
Colliers Wood
South Wimbledon
Morden
River Thames
Improvement works may affect your journey, particularly at weekends. Check before you travel; look for publicity at stations, visit tfl.gov.uk/check or call 020 7222 1234



F. Nightingale 1856

June 26, 2014 / Mike Bostock

Visualizing Algorithms

> *The power of the unaided mind is highly overrated… The real powers come from devising external aids that enhance cognitive abilities.* —Donald Norman

Algorithms are a fascinating use case for visualization. To visualize an algorithm, we don't merely fit data to a chart; there is no primary dataset. Instead there are logical rules that describe behavior. This may be why algorithm visualizations are so unusual, as designers experiment with novel forms to better communicate. This is reason enough to study them.

But algorithms are also a reminder that visualization is more than a tool for finding patterns in data. Visualization leverages the human visual system to augment human intellect: we can use it to better understand these important abstract processes, and perhaps other things, too.

This is an adaption of my talk at Eyeo 2014. A video of the talk is available on Vimeo. (Thanks, Eyeo folks!)

Sampling

Before I can explain the first algorithm, I first need to explain the problem it addresses.

Van Gogh's *The Starry Night*

Light — electromagnetic radiation — the light emanating from this screen, traveling through the air, focused by your lens and projected onto the retina — is a continuous signal. To be perceived, we must reduce light to discrete impulses by measuring its intensity and frequency distribution at different points in space.

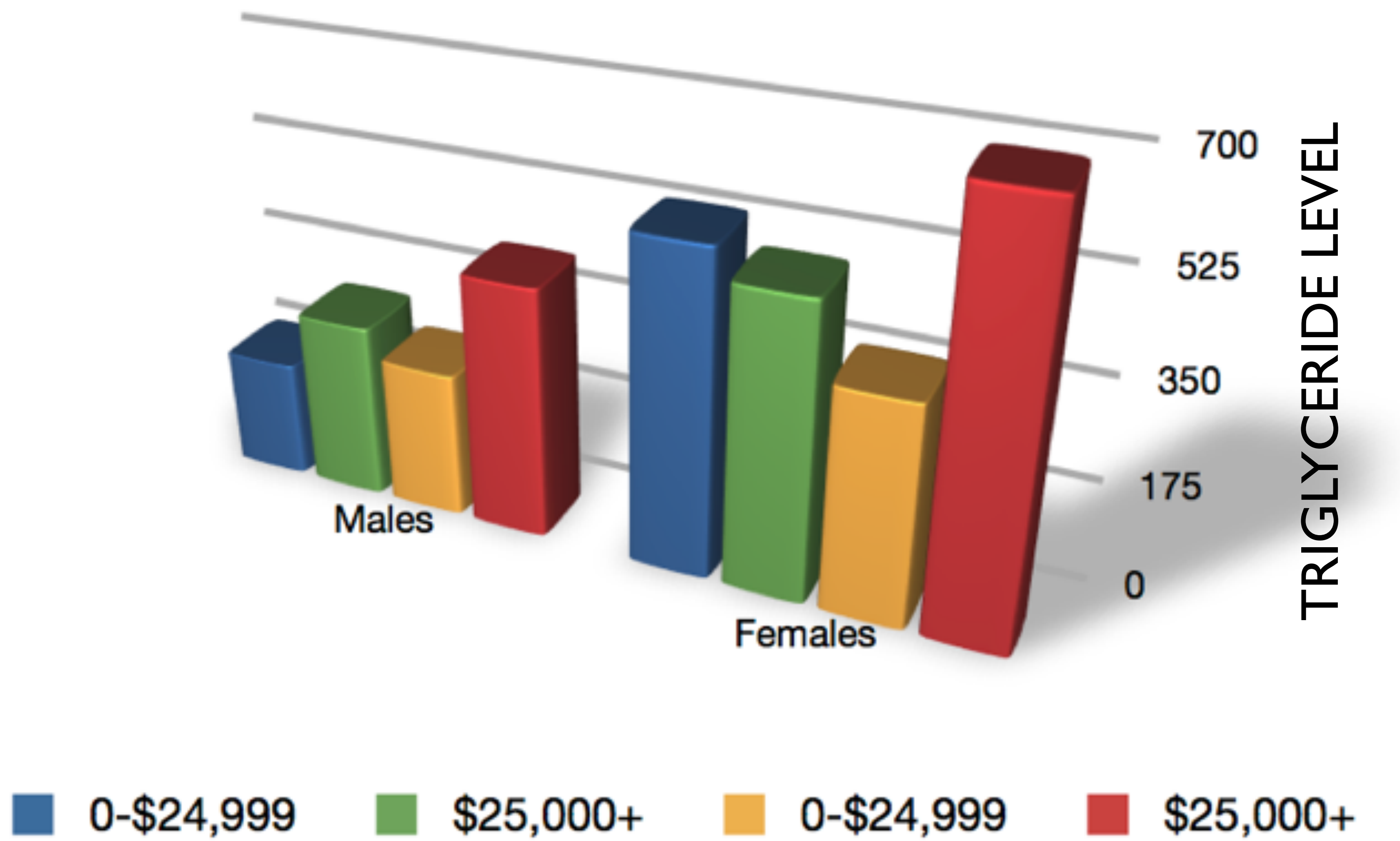
design excellence

"Well-designed presentations of interesting data are a matter of substance, of statistics, and of design."

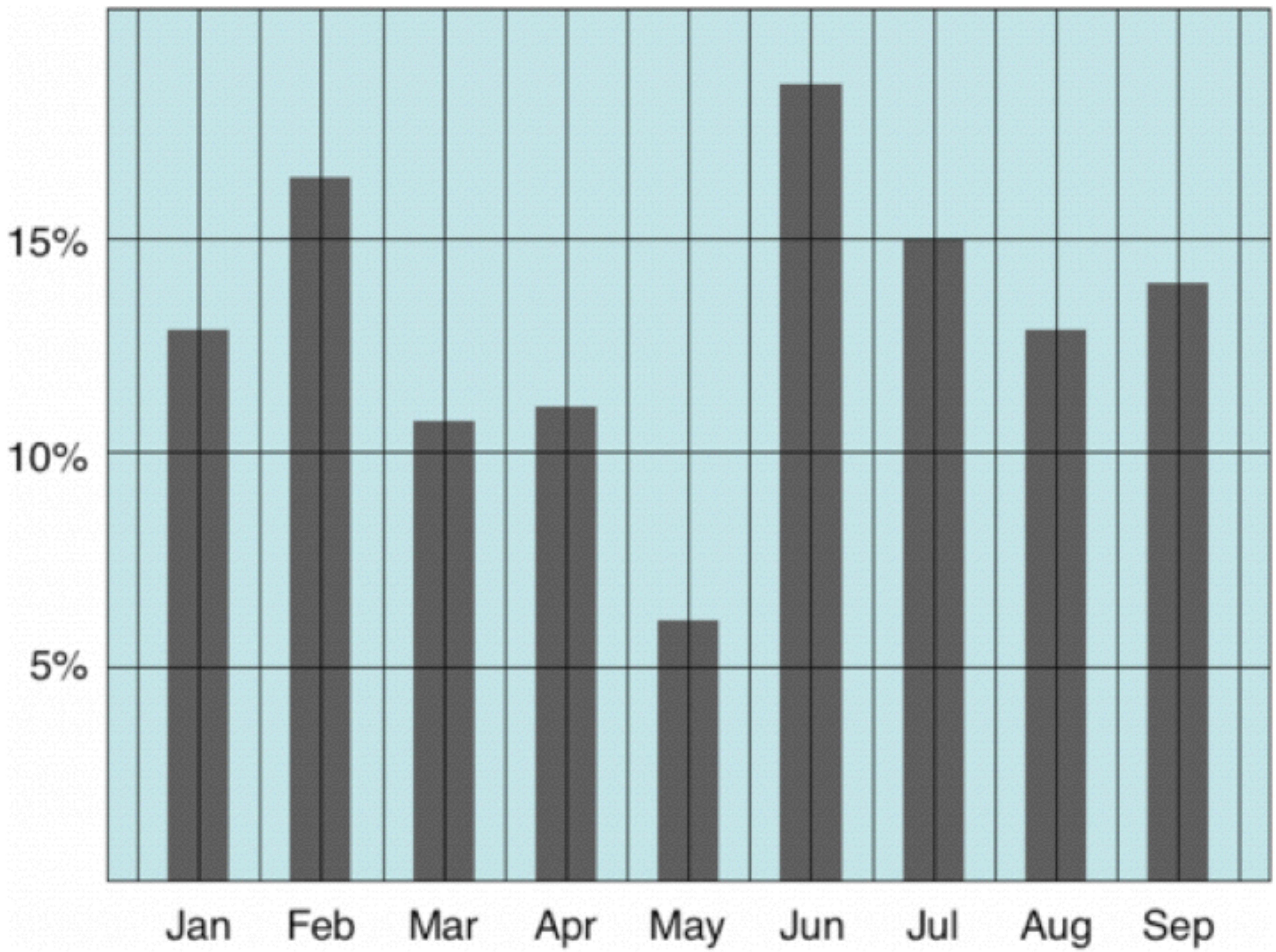
Edward Tufte

maximize the

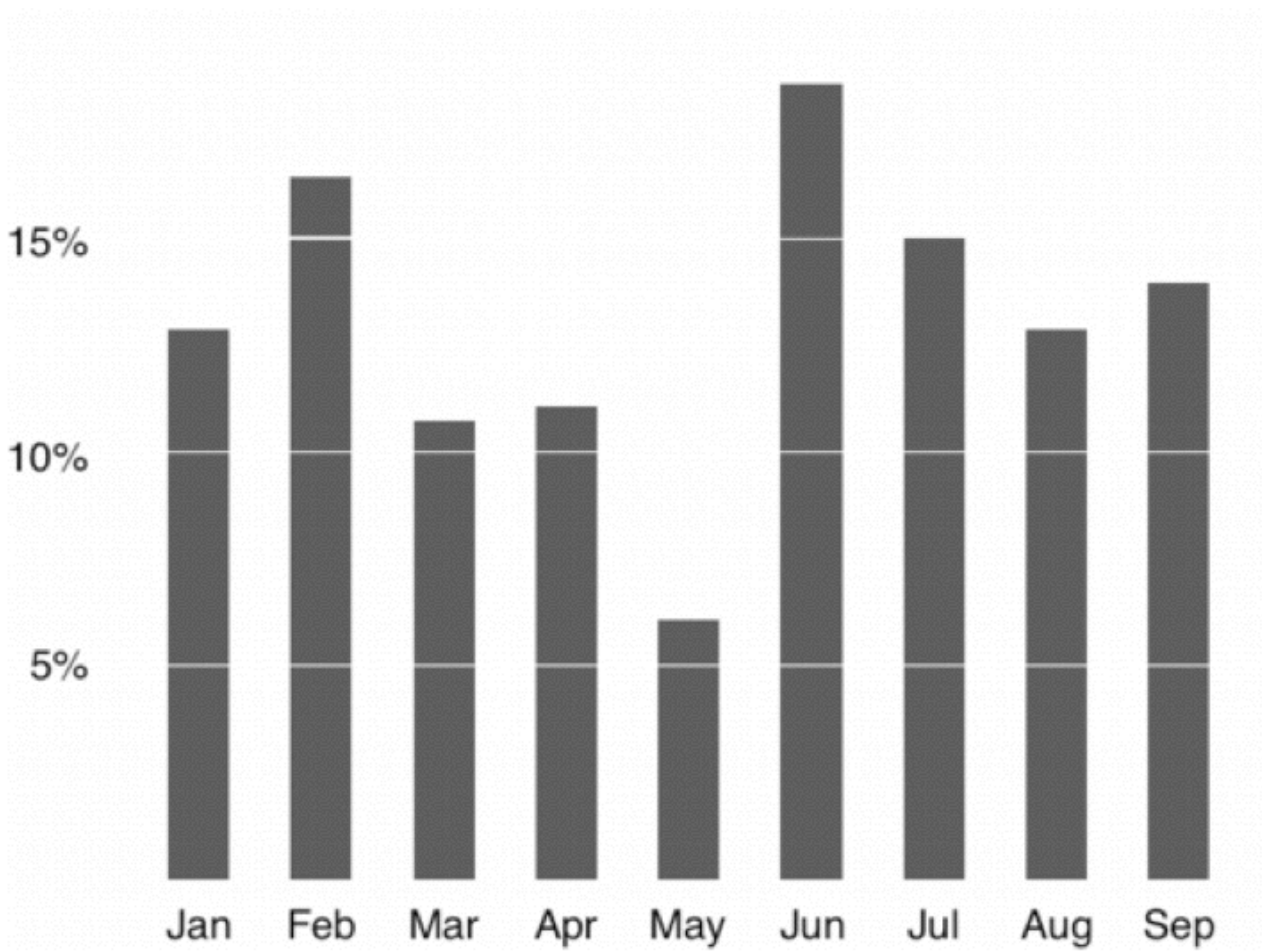
Data-ink Ratio $= \dfrac{\text{data-ink}}{\text{total ink used in graphic}}$



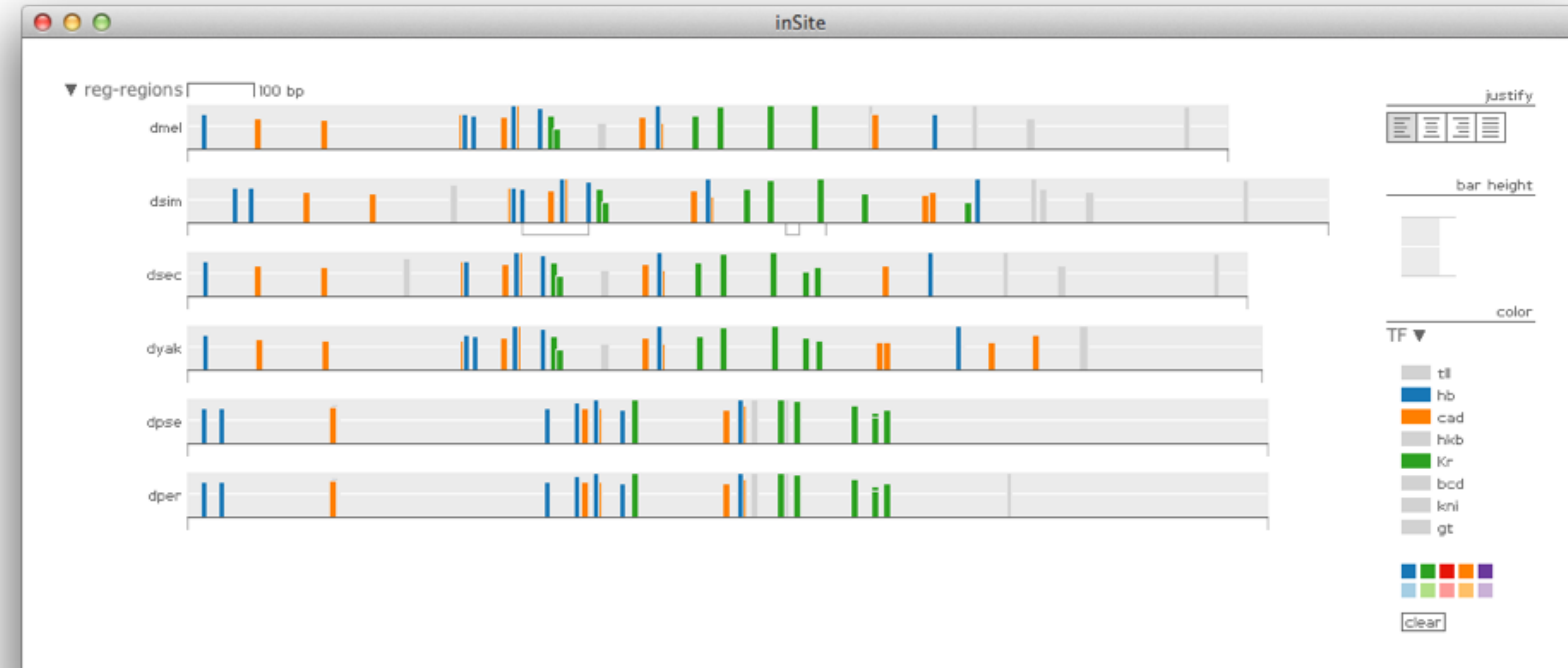
AVOID CHART JUNK



AVOID CHART JUNK



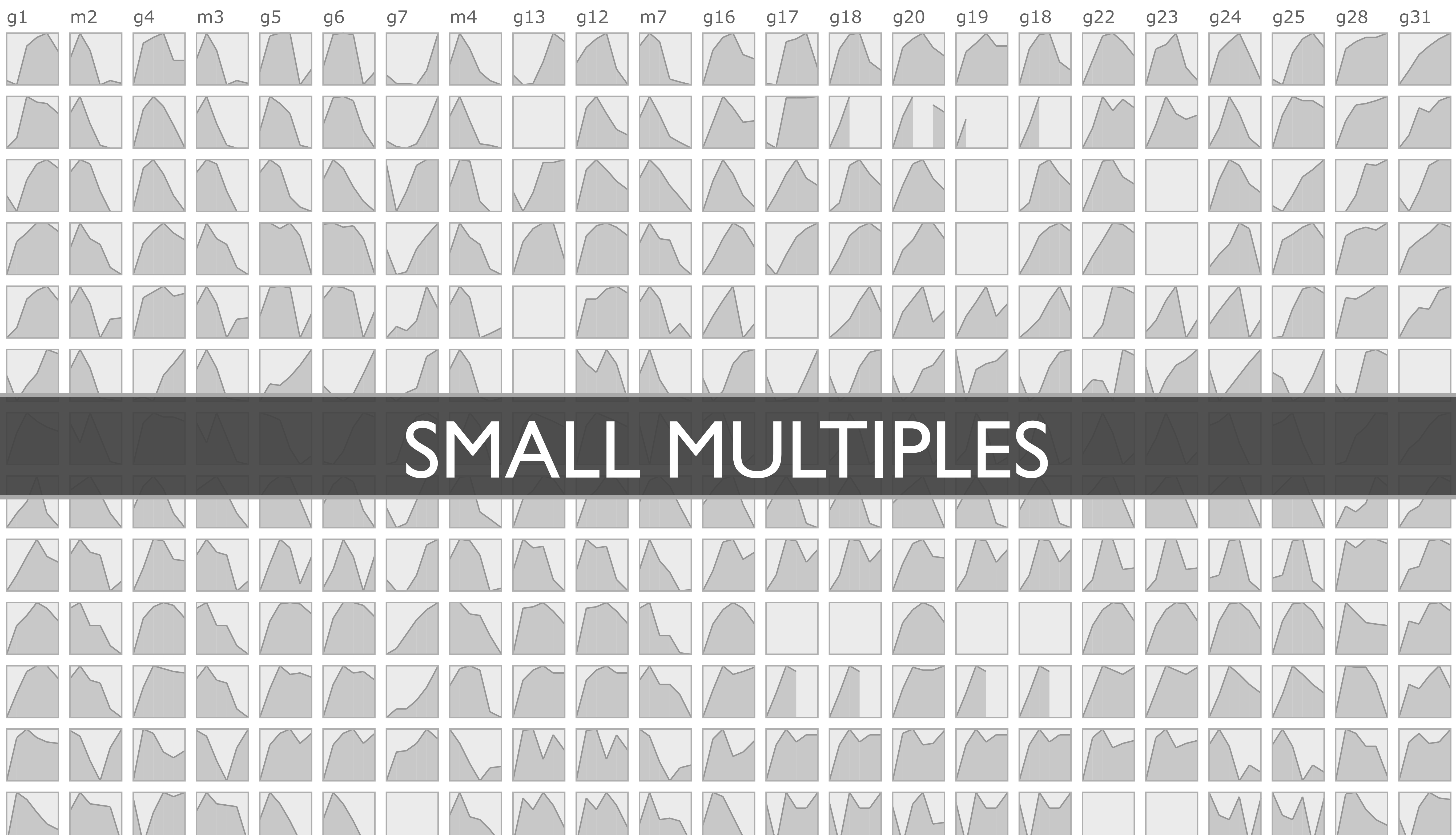
multifunctioning elements



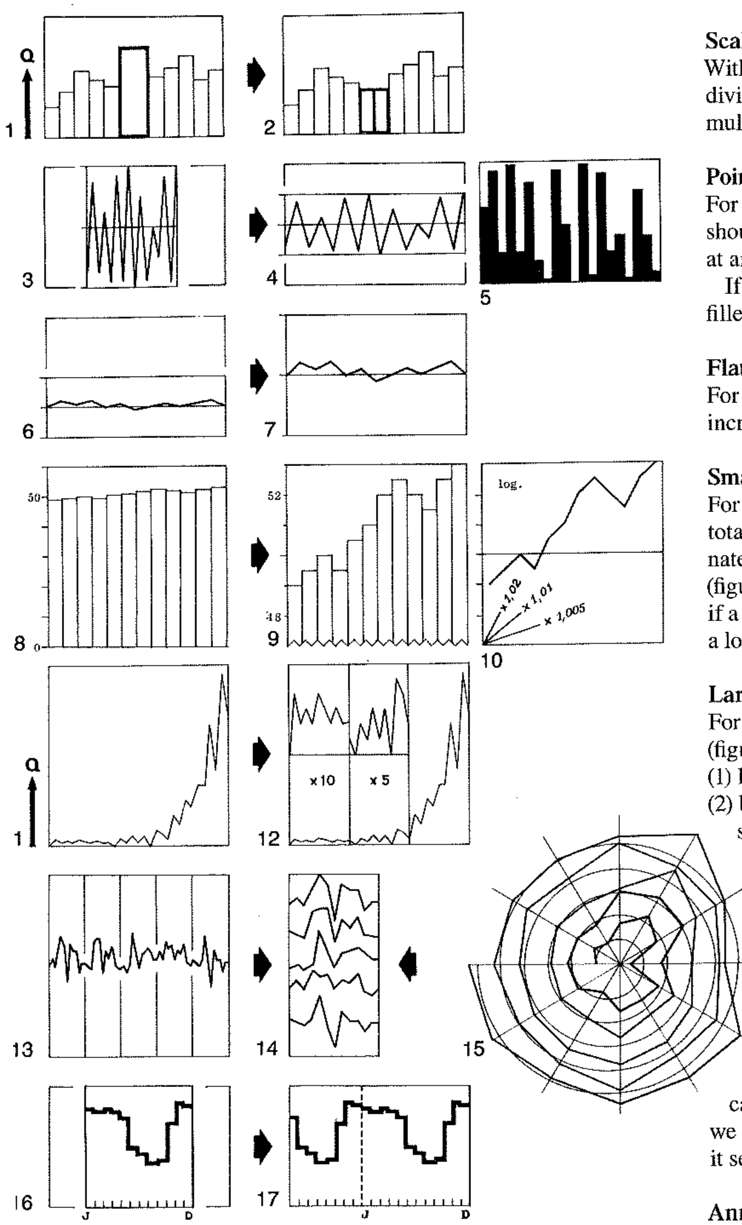
maximize the

$$\textbf{Data Density} = \frac{\text{number of entries in data array}}{\text{area of data graphic}}$$

SHRINK THE GRAPHICS



SHRINK THE GRAPHICS



GRAPHIC PROBLEMS POSED BY TIME SERIES

Scale in years
With a scale in years, a two-year total (figure 1) should be divided by 2 (figure 2). A total for six months should be multiplied by 2.

Pointed curves
For overly pointed curves (figure 3), the scale of the Q should be reduced; optimum angular perceptibility occurs at around 70 degrees (figure 4).
If the curve is not reducible (large and small variations), filled columns can be used (figure 5).

Flat curves
For overly flat curves (figure 6), the scale of the Q should be increased (figure 7).

Small variations
For small variations in relation to the total (figure 8), the total loses its importance, and the zero point can be eliminated, provided the reader is made aware of this elimination (figure 9). The graphic can be interpreted as an acceleration if a precise study of the variations is necessary; here, we use a logarithmic scale (figure 10). (See also page 240.)

Large range
For a very large range between the extreme numbers (figure 11), we must either:
(1) leave out the smallest variations;
(2) be concerned only with relative differences (logarithmic scale), without knowing the absolute quantities;
(3) select different parts (periods) within the ordered component and treat them on different scales above the common scale (figure 12).

Obvious periodicity
If there is obvious periodicity (figure 13), and the study involves a comparison of the phases of each cycle, it is preferable to break up the cycles in order to superimpose them (figure 14). A polar construction can be used, preferably in a spiral shape (figure 15), but we should not begin with too small a circle. As striking as it seems, it is less efficient than an orthogonal construction.

Annual curves
For annual curves of rainfall or temperature, if a cycle has two phases (figure 17), why depict only one (figure 16)?

A contrast
Unlike what we see in figure 18, the pertinent or "new" information must be separated from the background or "reference" information. The background involves: (a) the invariant, highlighted by a heading (Port St. Michel); (b) the highly visible identification of each component (tonnage and dates). The new information (the curve) must stand out from the background (figure 19).

Reference points
It is impossible to utilize a graphic such as figure 20, except in a general manner. There is confusion concerning the position of the points, and no potential comparison is possible, as it is in figure 21.

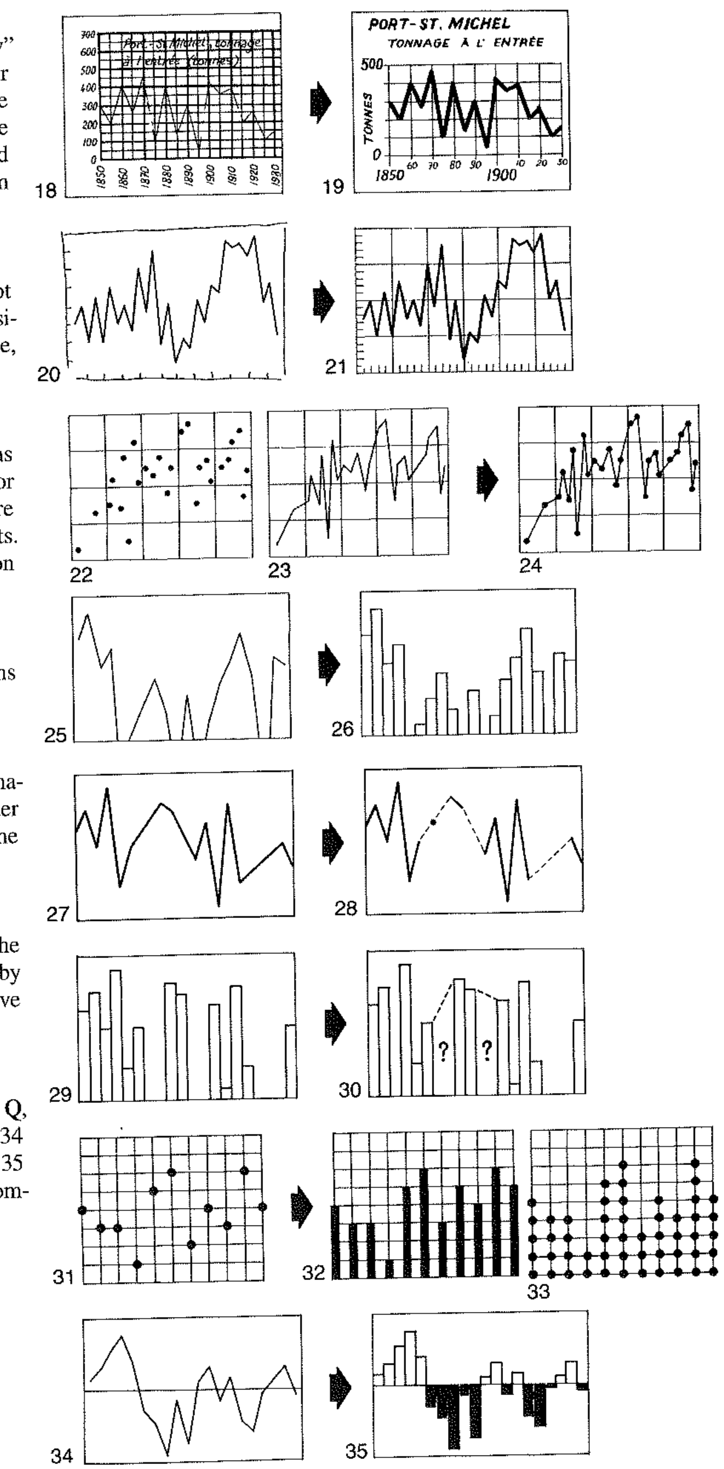
Precision reading
A precision reading (utilization on the elementary level, as in figure 24) is difficult in figure 22, which results in a poor reading of the order of the points, and in figure 23, where there is ambiguity concerning the position of the points. On the other hand, figure 22 does favor overall vision (correlation).

Null boxes
Curves accommodate null boxes poorly (figure 25). Columns (figure 26) are preferable.

Unknown boxes
The drawing must indicate the unknowns of the information in an unambiguous way (figures 28 and 30).The reader might interpret figure 27 as a change in the structure of the curve and figure 29 as involving null values.

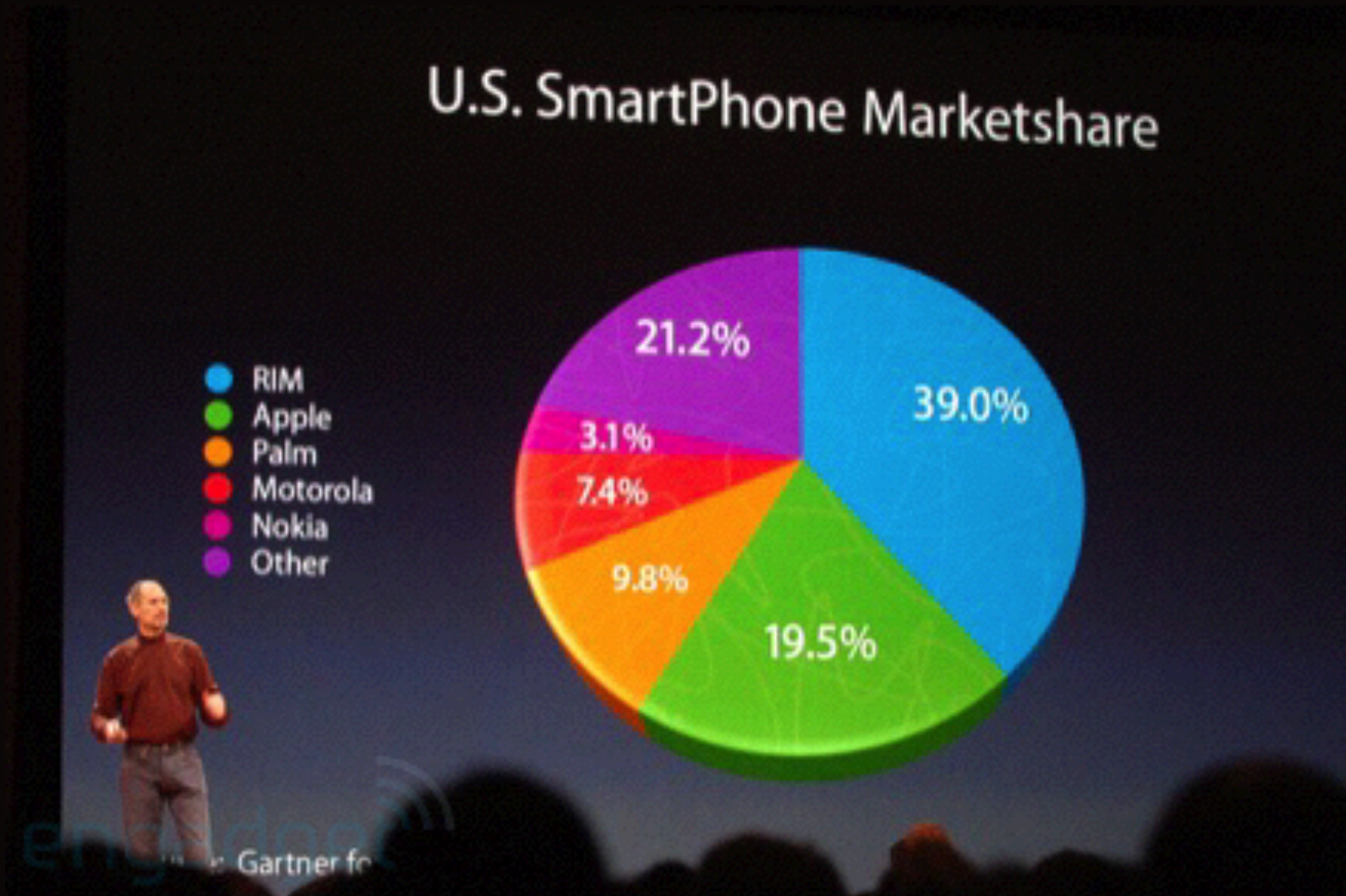
Very small quantities
Except in seeking a correlation (quite improbable here) the number of ships entering into a port is represented better by figure 33 than by figures 31 or 32. The reader can perceive the numerical values at first glance.

Positive-negative variation
This is in fact a problem involving three components O, Q, ≠ (+ –), and it must be visually treated as such. Figure 34 can be improved by utilizing a retinal variable (in figure 35 a value difference: black–white) to differentiate the ≠ component and thus highlight positive-negative variation.



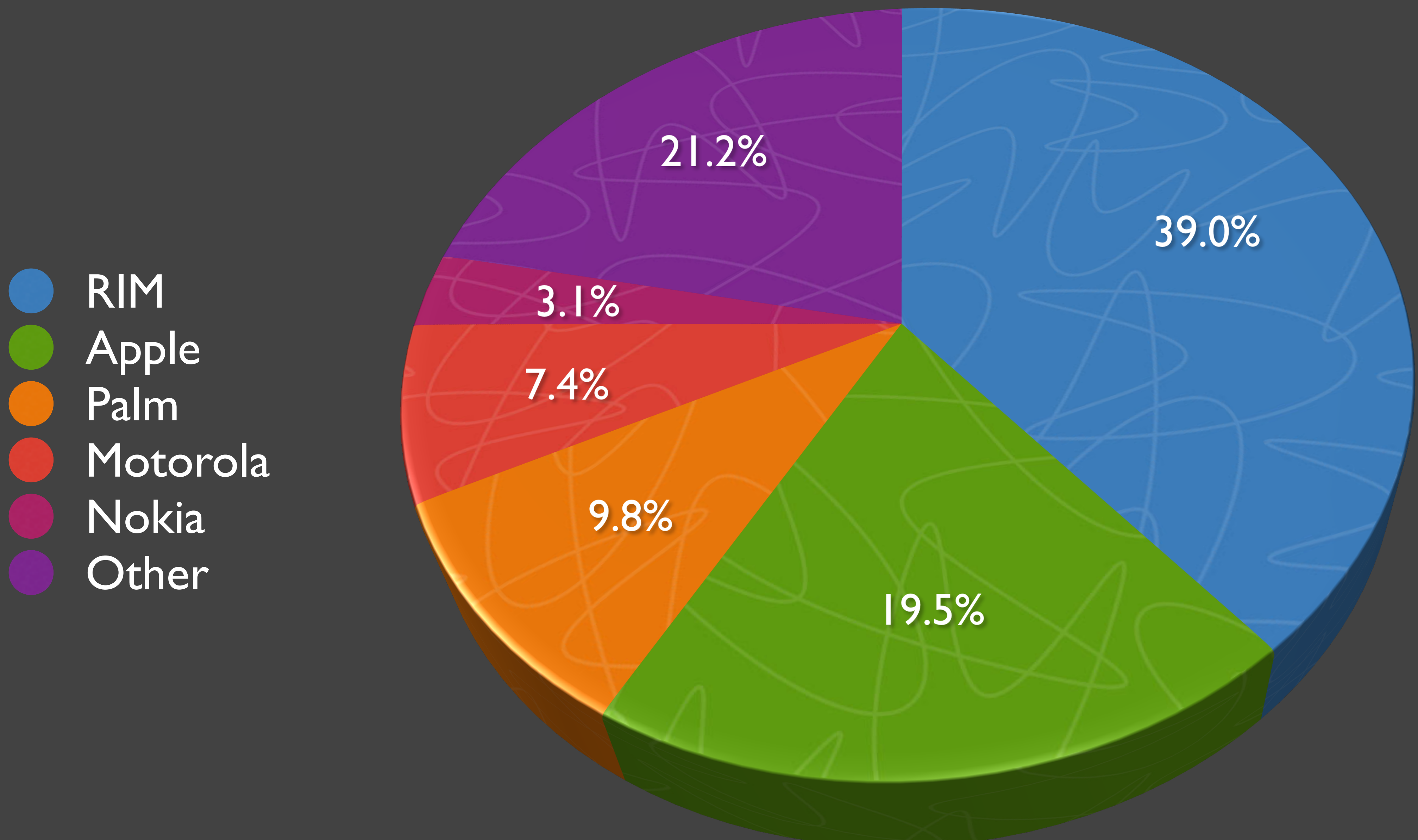
Bertin 1967

critiques...

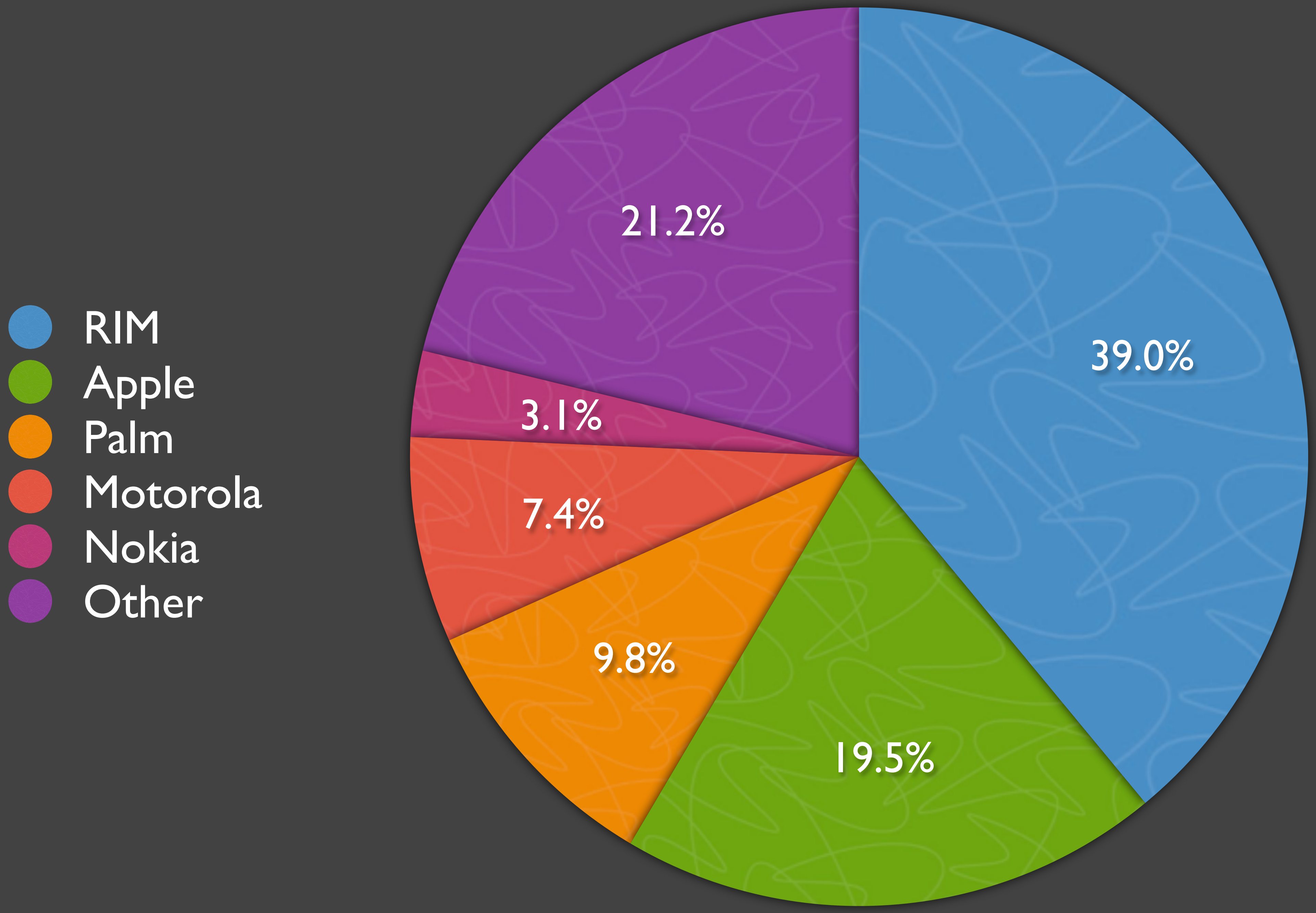


http://www.guardian.co.uk/technology/blog/2008/jan/21/liesdamnliesandstevejob

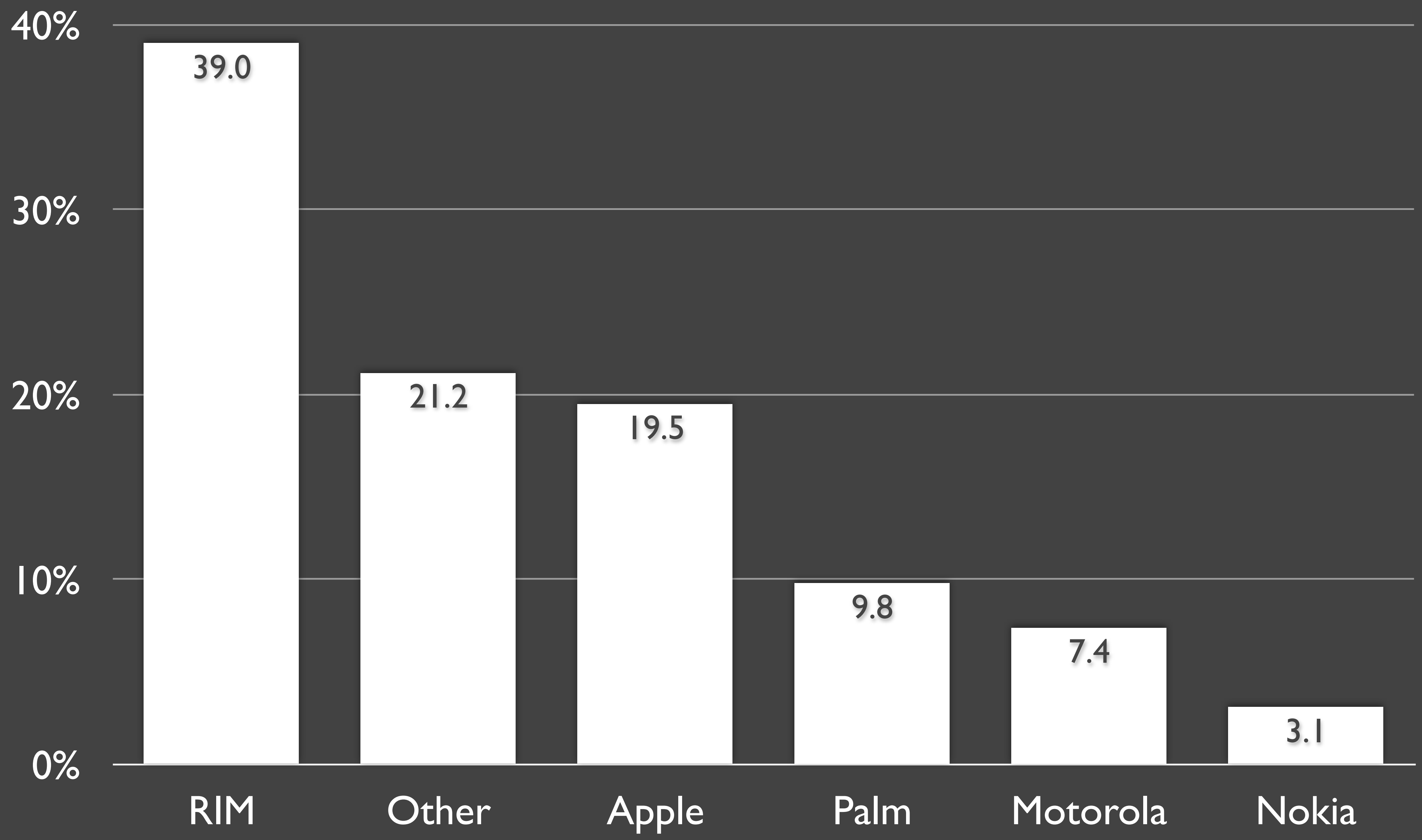
U.S. SmartPhone Marketshare



U.S. SmartPhone Marketshare



U.S. SmartPhone Marketshare




Wheels UP

"The cliché that you're going to come out here and be stuck in your car in traffic the whole time is not as true as it used to be." —Eric Garcetti

Five Minutes With //

Eric Garcetti Mayor of Los Angeles

Eric Garcetti envisions a Los Angeles where you don't need a car to live well. No car? In LA? Seriously? But the city—and its new mayor—offers many surprises. Elected in May 2013 and assuming the mayor's office in July, Garcetti is a fourth-generation Angeleno whose background—Mexican and Jewish—befits an ethnically complex city where 220 languages are spoken. A Rhodes Scholar, the 42-year-old served on the city council for more than a decade, representing the district that includes Hollywood, before becoming the city's youngest mayor in a century.

// How do you want to make Los Angeles better?
One, I want to reduce our city's unemployment rate and make this a business-friendly city—a place where you can't afford not to do business; a place where the best-trained workforce exists; a place where the best infrastructure is built; and a place that you feel is your platform. Two, I want to make city government work again. I'm a high-tech guy, and I want to build a high-tech city hall that's focused on the basics, like customer service and fixing potholes, but which brings government to you in an unexpected way—whether it's smartphone apps or by sharing data about your city with the public. In my first 100 days, I launched a new website that has performance metrics so that people can actually track what we're doing well and what we're not doing well.

But what I would like to see is a Los Angeles where you don't need a car—where you can get to a neighborhood via various modes of transport, but then you can walk around that neighborhood, shopping, eating, going to farmers markets. In the car capital of America, if we can show a reduction in pollution and a reduction in traffic by a combination of technology and other disruptive forces like new car-share enterprises, I think people will say: If LA can do it, we can do it, too.

// Talk about your transportation initiatives.
I think this is a kind of golden age of transportation in LA. The voters passed measures in recent years to build out what is now the third-largest public transportation system in the country, to improve the roads and highways and to reduce traffic.

// What are some attributes that people might find surprising about your hometown?
Our economy is one of the most diverse and reflects the most creative people. It's not just Hollywood and TV. We've got three top-25 universities here—no other city has that. We have a collection of incredible neighborhood "villages," where people are inventing food in a new way, mashing up cultures so that Korean short rib tacos are the latest craze. I think also that a lot of people don't realize how much Los Angeles has become the art capital of the world. There are more artists that live and create here—almost what happened to New York in the '70s and '80s is going on in LA now, because artists still can afford to live here. People would be very surprised at how many of our neighborhoods are walkable, are bikeable. The cliché that you're going to come out here and be stuck in your car in traffic the whole time is not as true as it used to be. —*Gene Rebeck*

Conference Call //

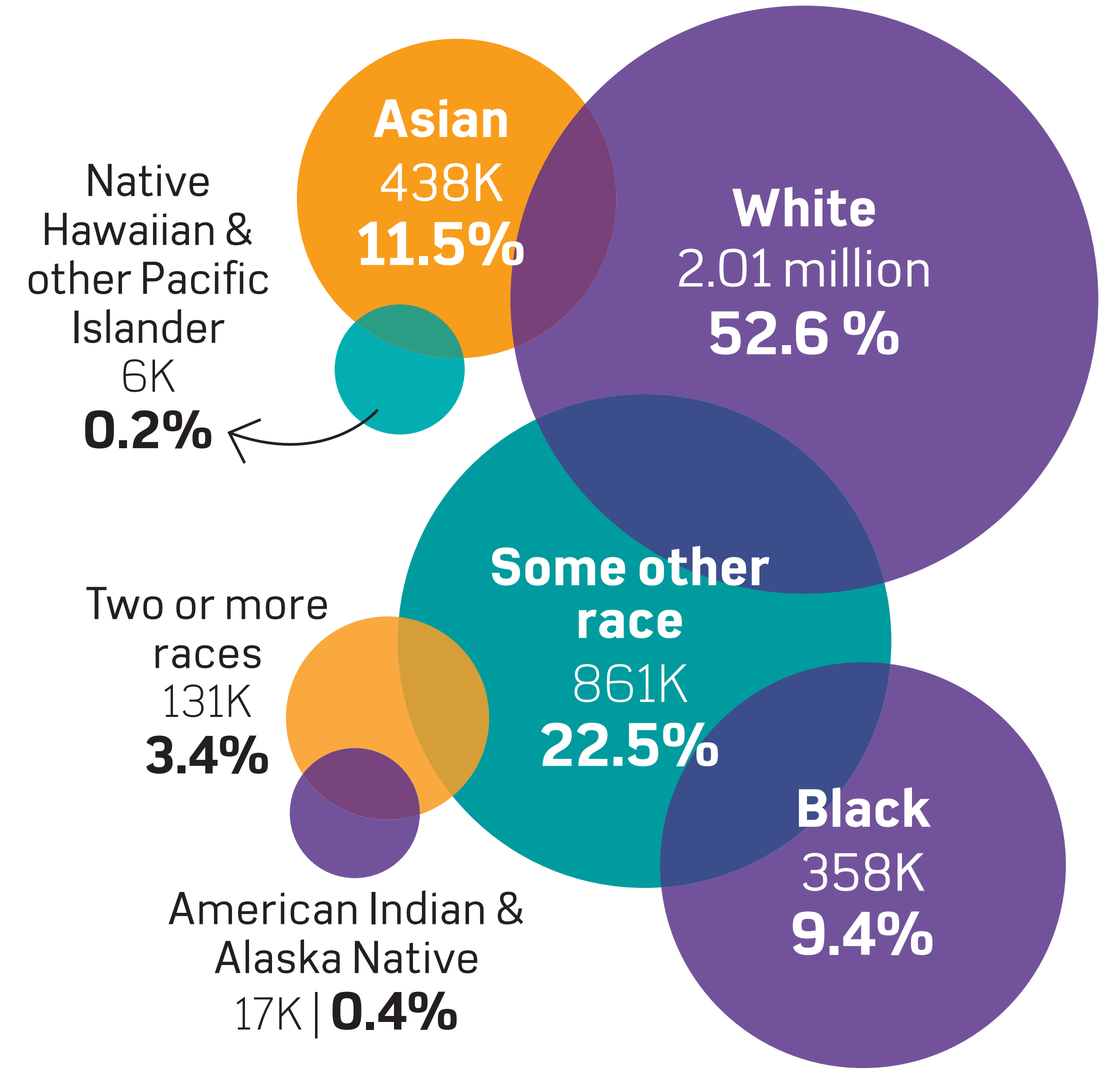
New Media Expo
Las Vegas, January 4–6—Digital content creators will meet to talk about boosting their visibility and better monetizing their industry. *Rio All-Suites Hotel & Casino, nmxlive.com/2014-lv*

World Economic Forum Annual Meeting
Davos Klosters, Switzerland, January 22–25—This famed skull session brings together global celebrities in business, politics, academia and media. *Multiple venues, weforum.org/events*

iFX Expo Asia
Macau, January 22–23—The currency-trading world comes together to talk shop and learn what's next for the sector's future. *The Venetian Macao, ifexpo.com/macau2014*

28 JANUARY 2014 deltaskymag.com

Los Angeles Population By Race



Source: United States Census Bureau, 2012 estimates. *Note:* The concept of race is separate from the concept of origin; 48 percent of respondents identified themselves as "Hispanic or Latino" but fall into one of the above groups.

today…

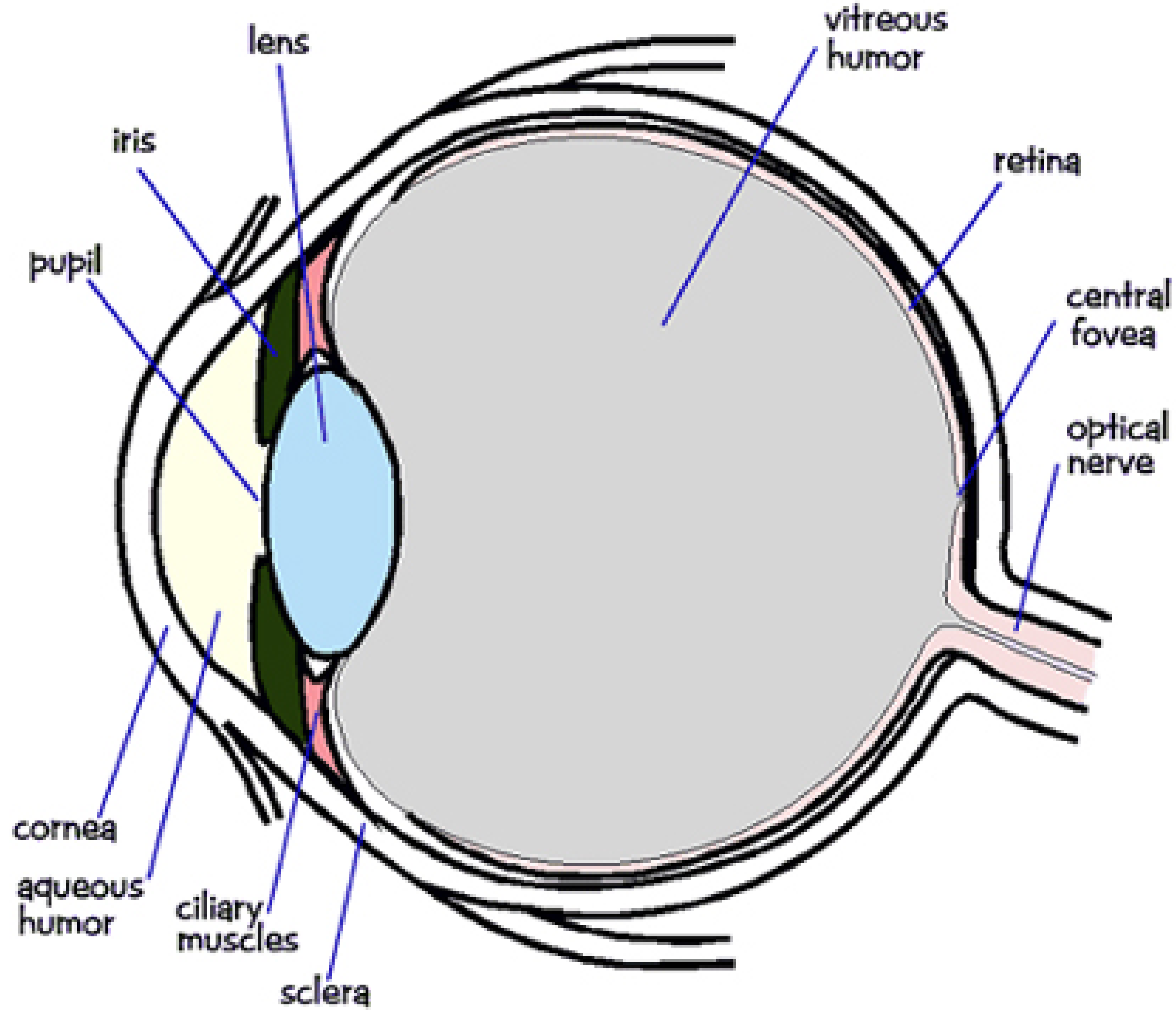
-perception basics

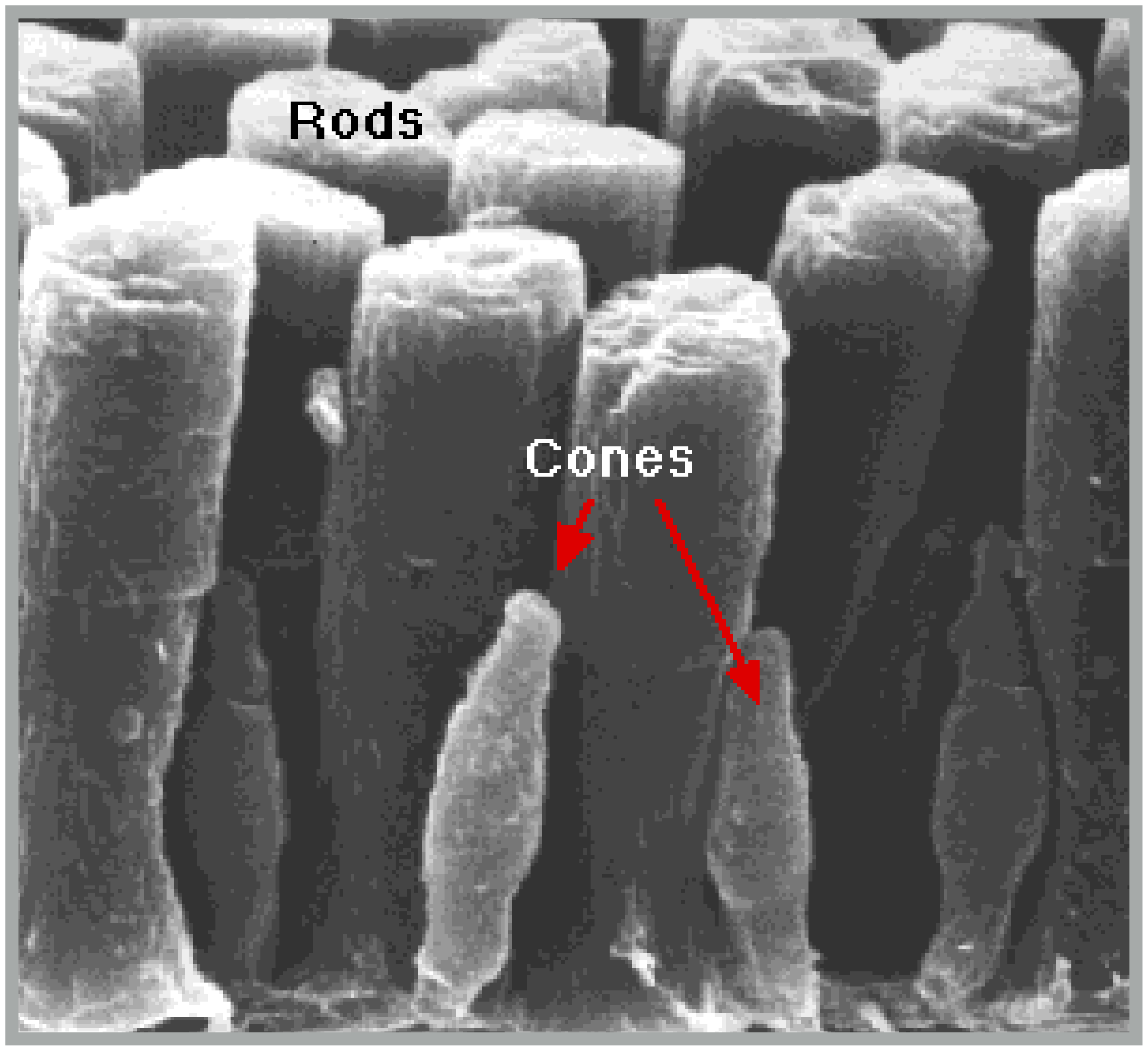
- -the eye
- -Weber’s law
- -pre-attentive processing

-encoding channels

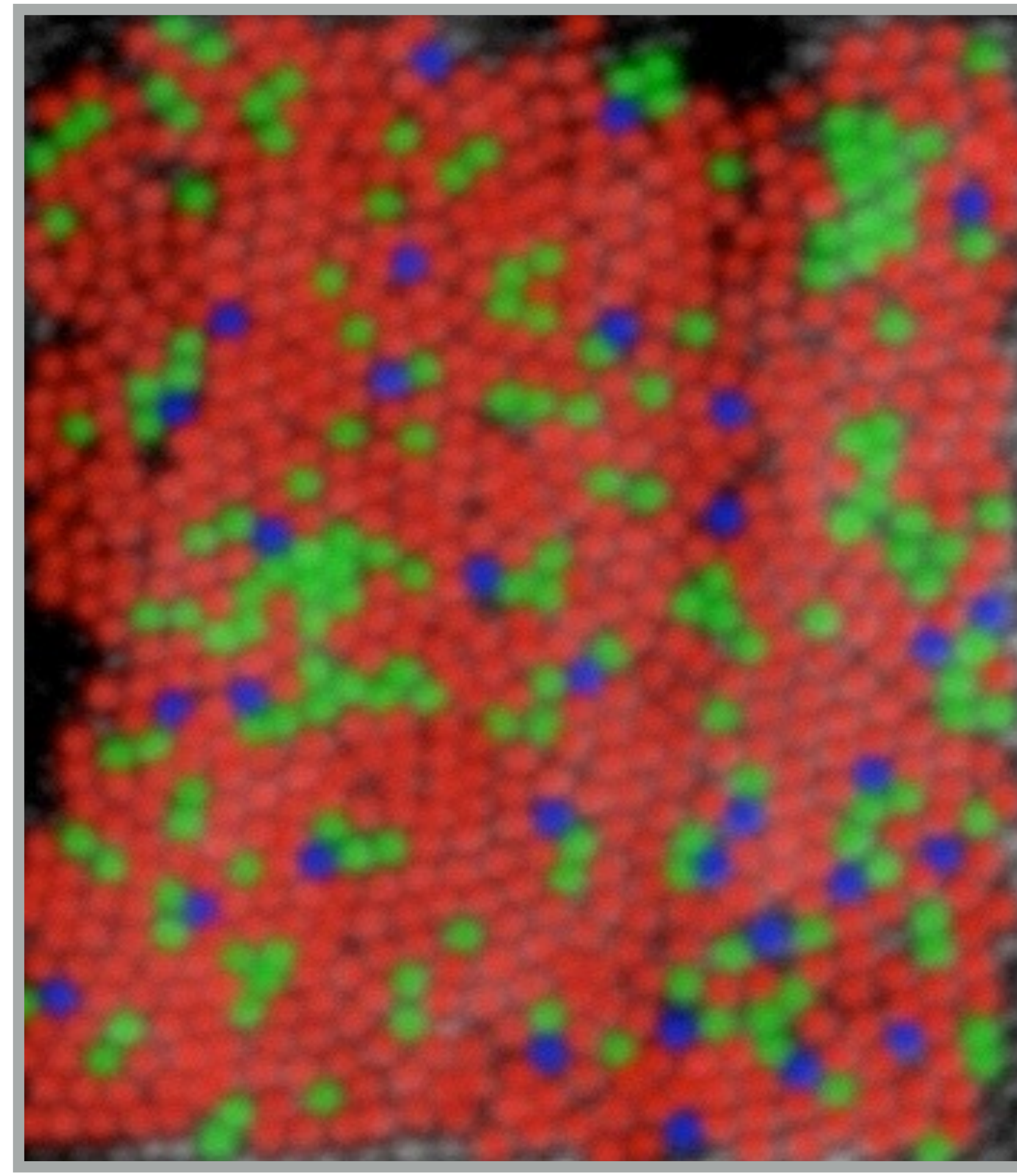
- -what’s so special about the plane?
- -animation
- -color

the eye


lens
vitreous humor
iris
retina
pupil
central fovea
optical nerve
cornea
aqueous humor
ciliary muscles
sclera

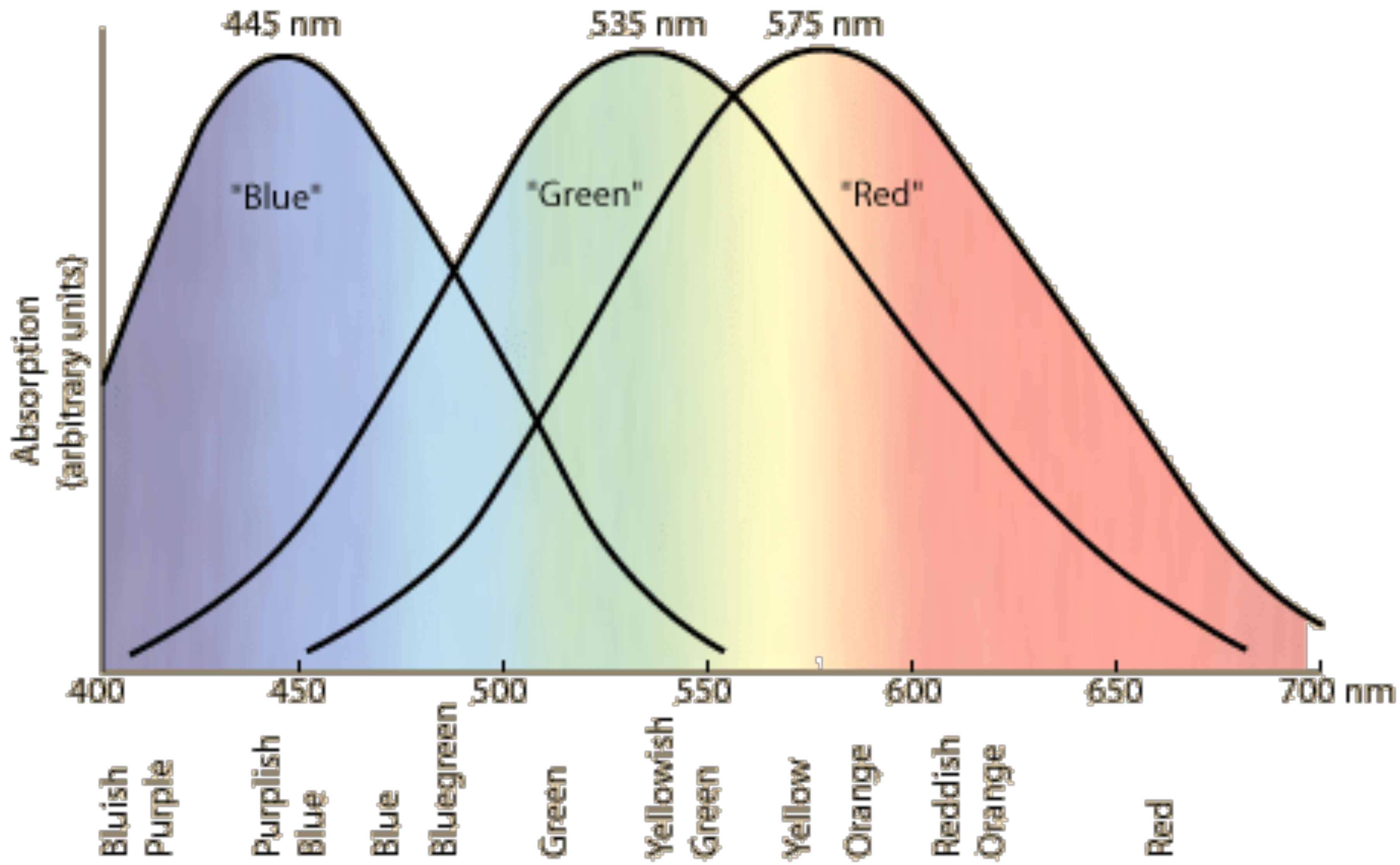


120 million rods

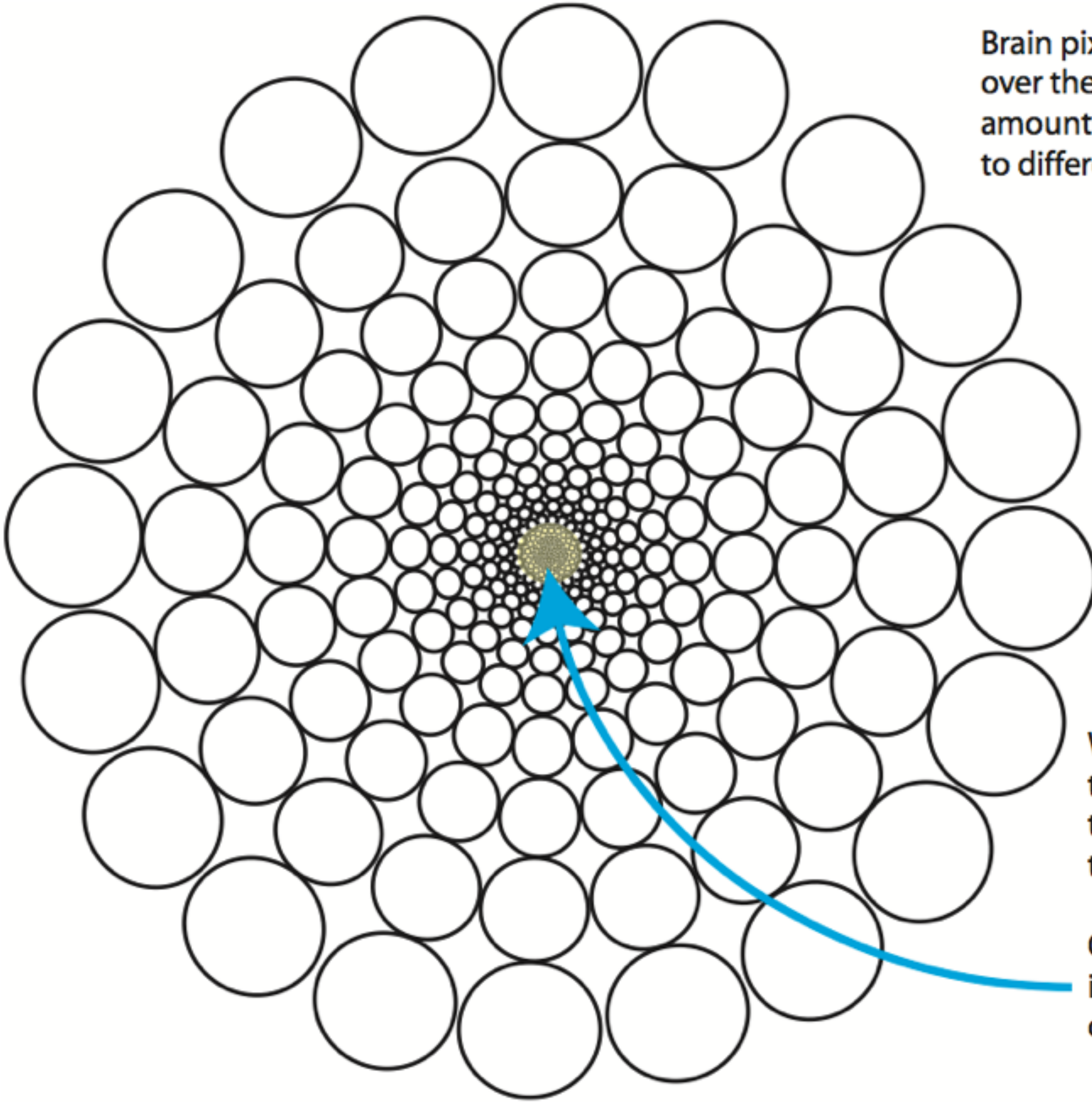


5-6 million cones

Wandell, "Foundations of Vision" (left)
David R. Williams, Univ. of Rochester (right)



HyperPhysics, Georgia State University



Brain pixels vary enormously in size over the visual field. This reflects differing amounts of neural processing power devoted to different regions of visual space.

At the edge of the visual field we can only barely see something the size of a fist at arm's length.

We can resolve about 100 points on the head of a pin held at arm's length in the very center of the visual field called the fovea.

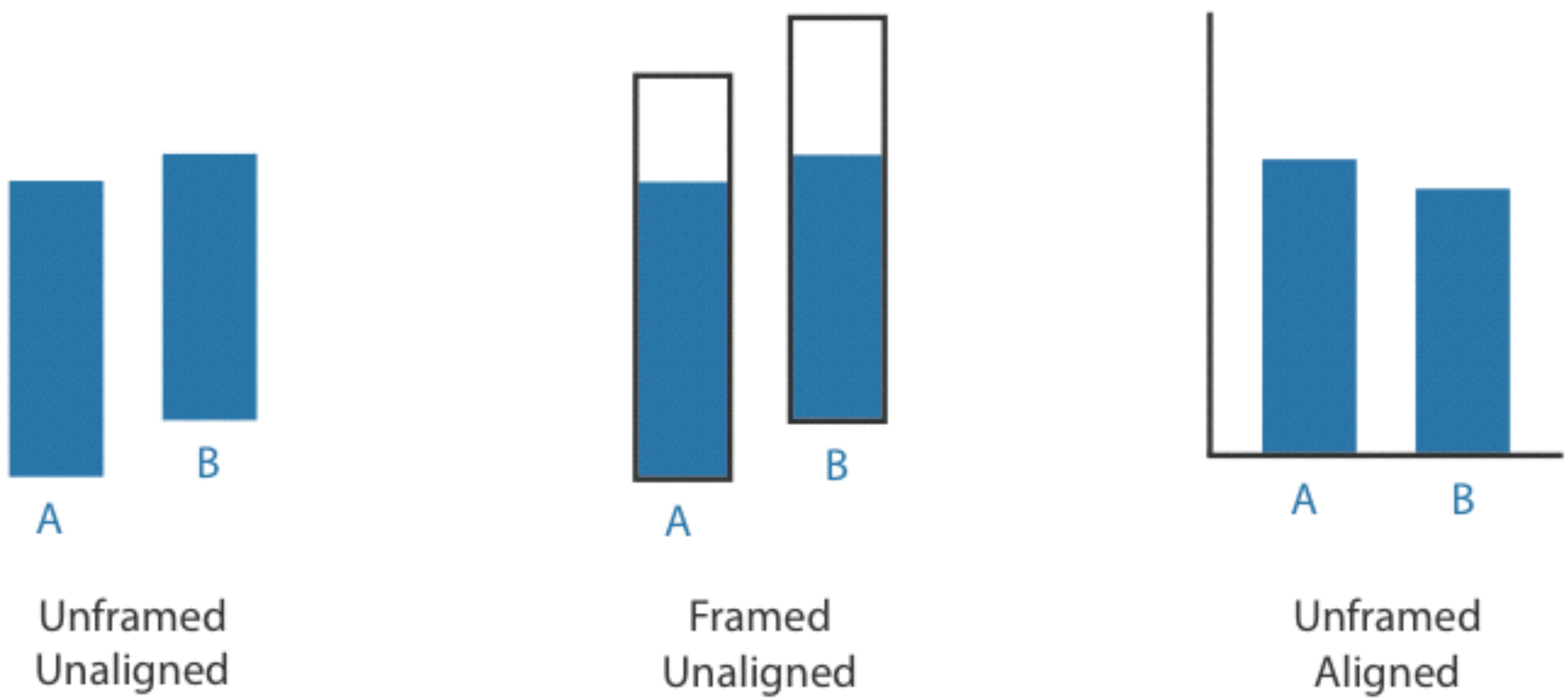
Over half of our visual processing power is concentrated in a slightly larger area called the parafovea.

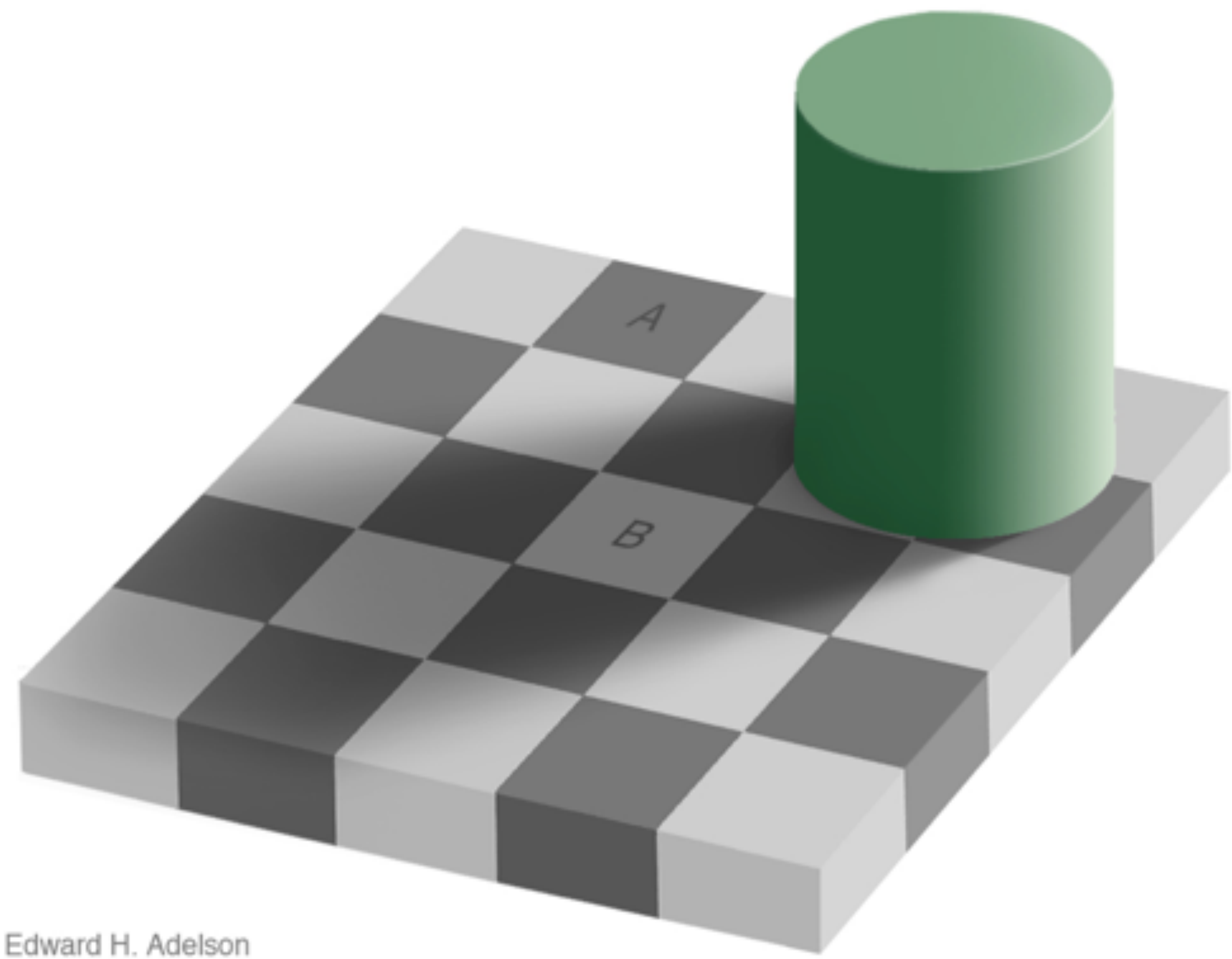
Ware 2010

Weber’s law

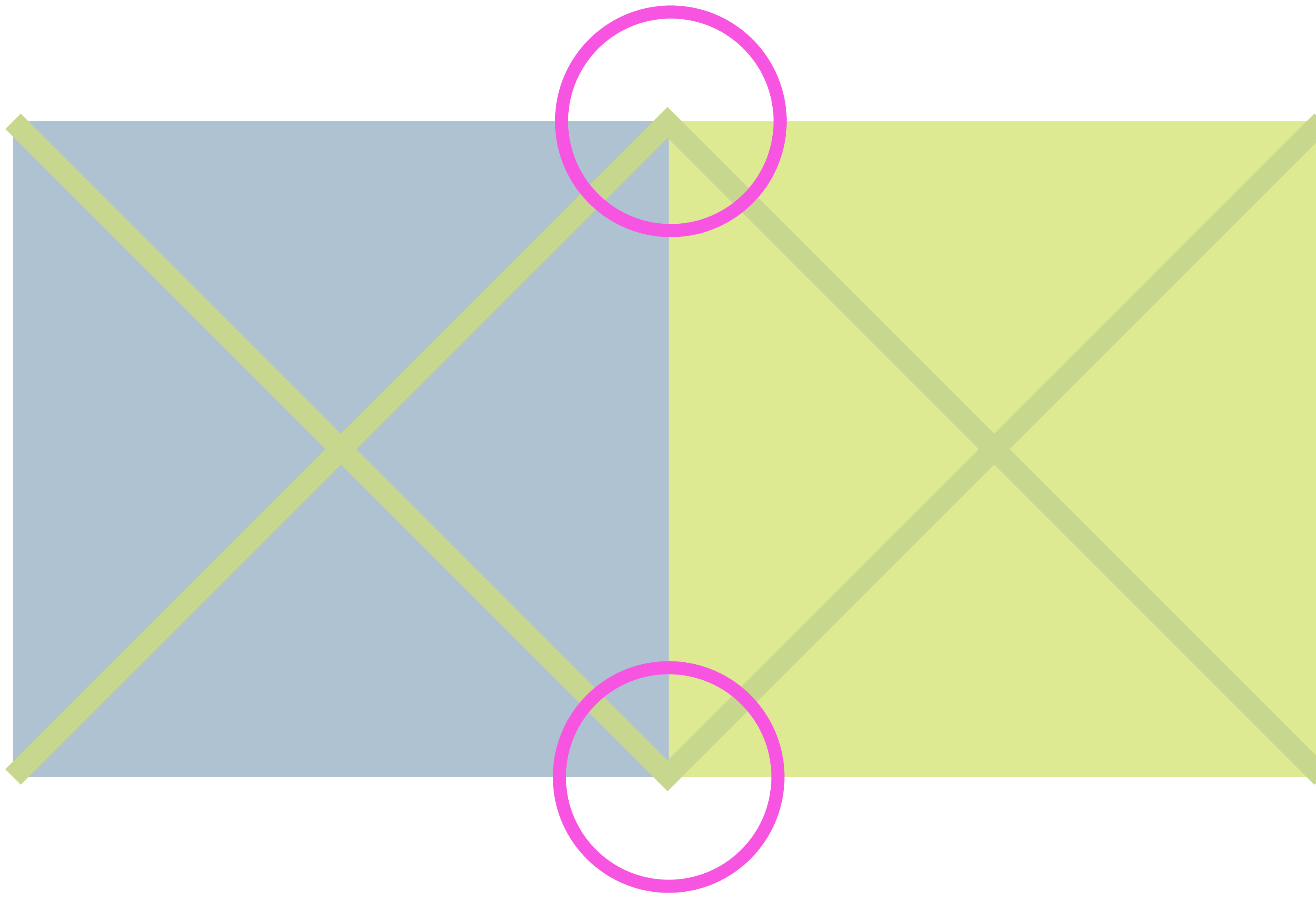
WEBER'S LAW

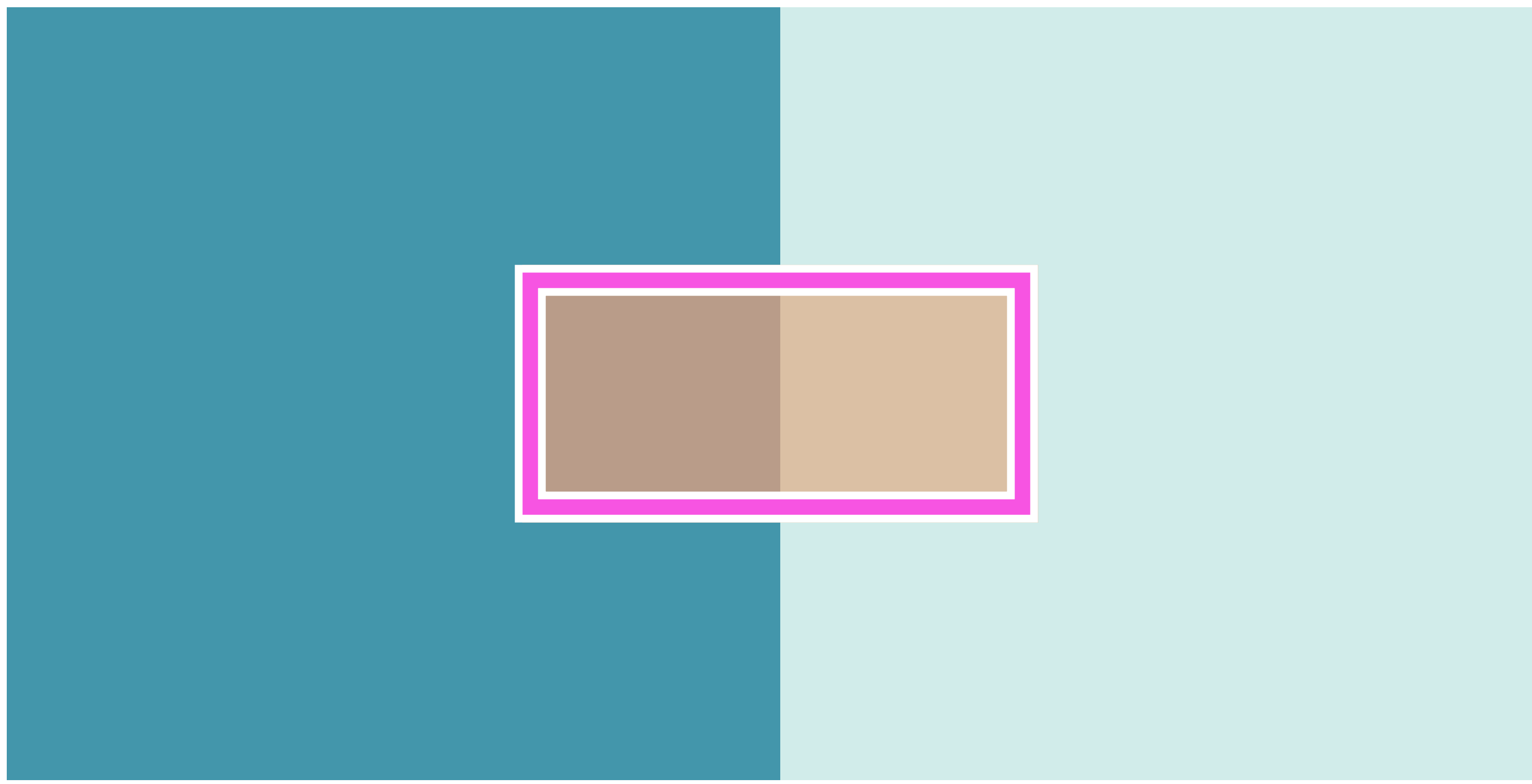
we judge based on relative, not absolute, differences

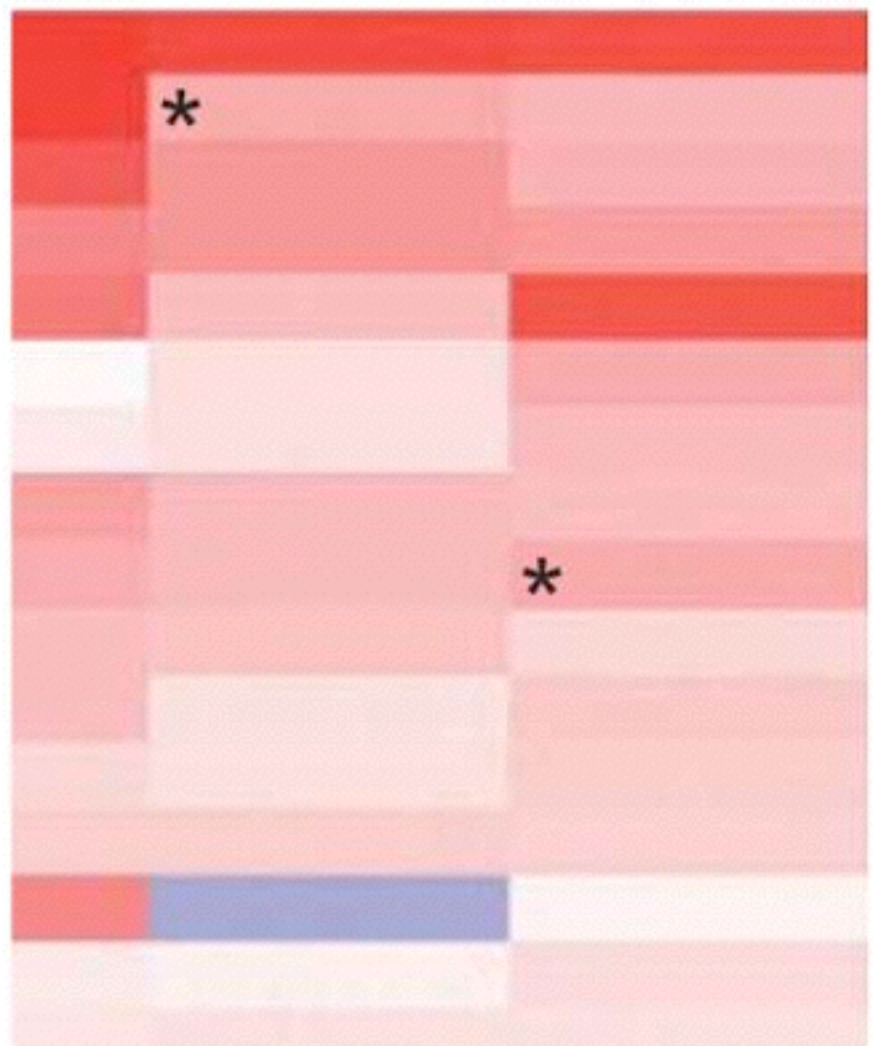




http://persci.mit.edu/_media/gallery/checkershadow_double_full.jpg



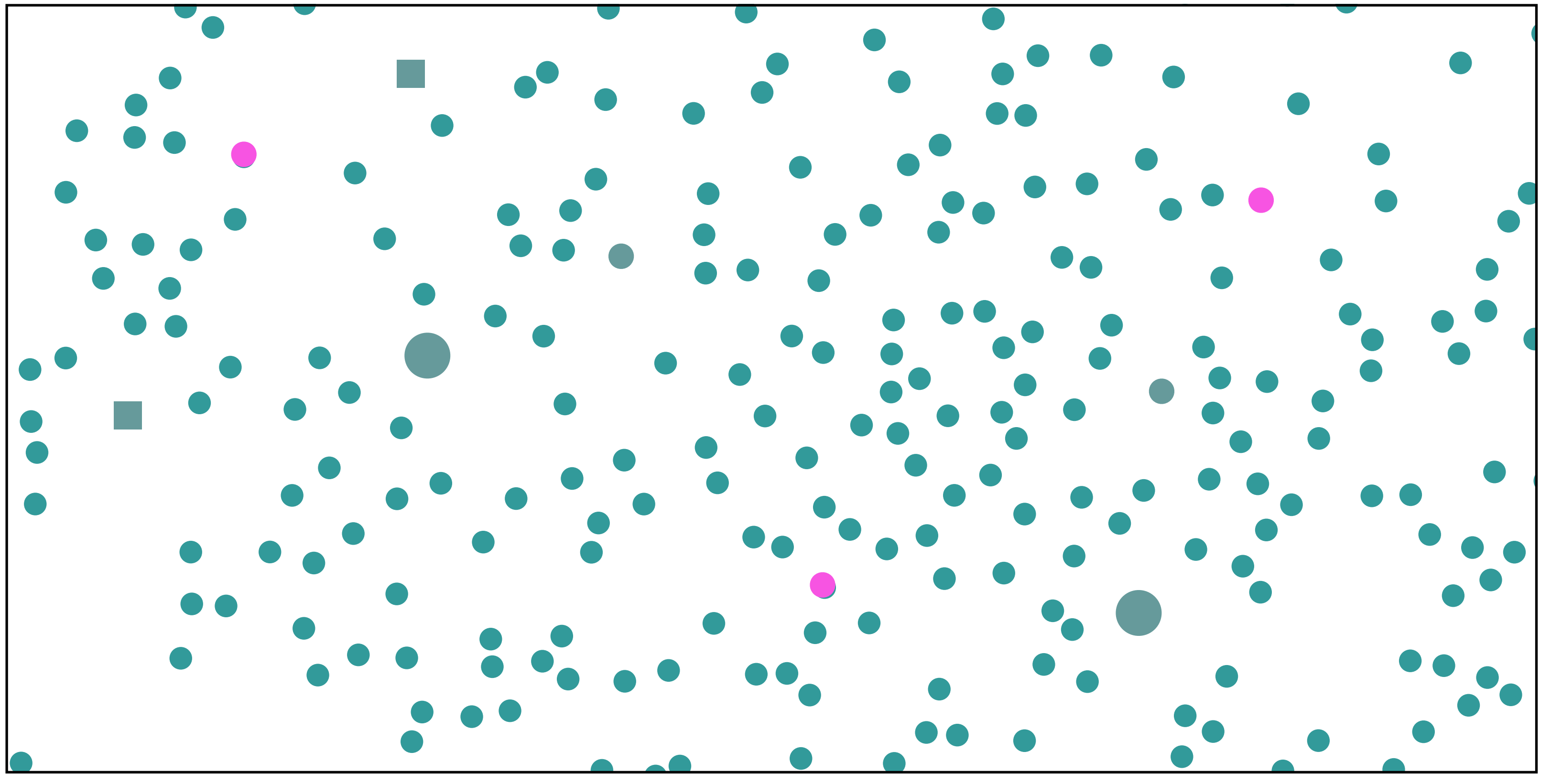


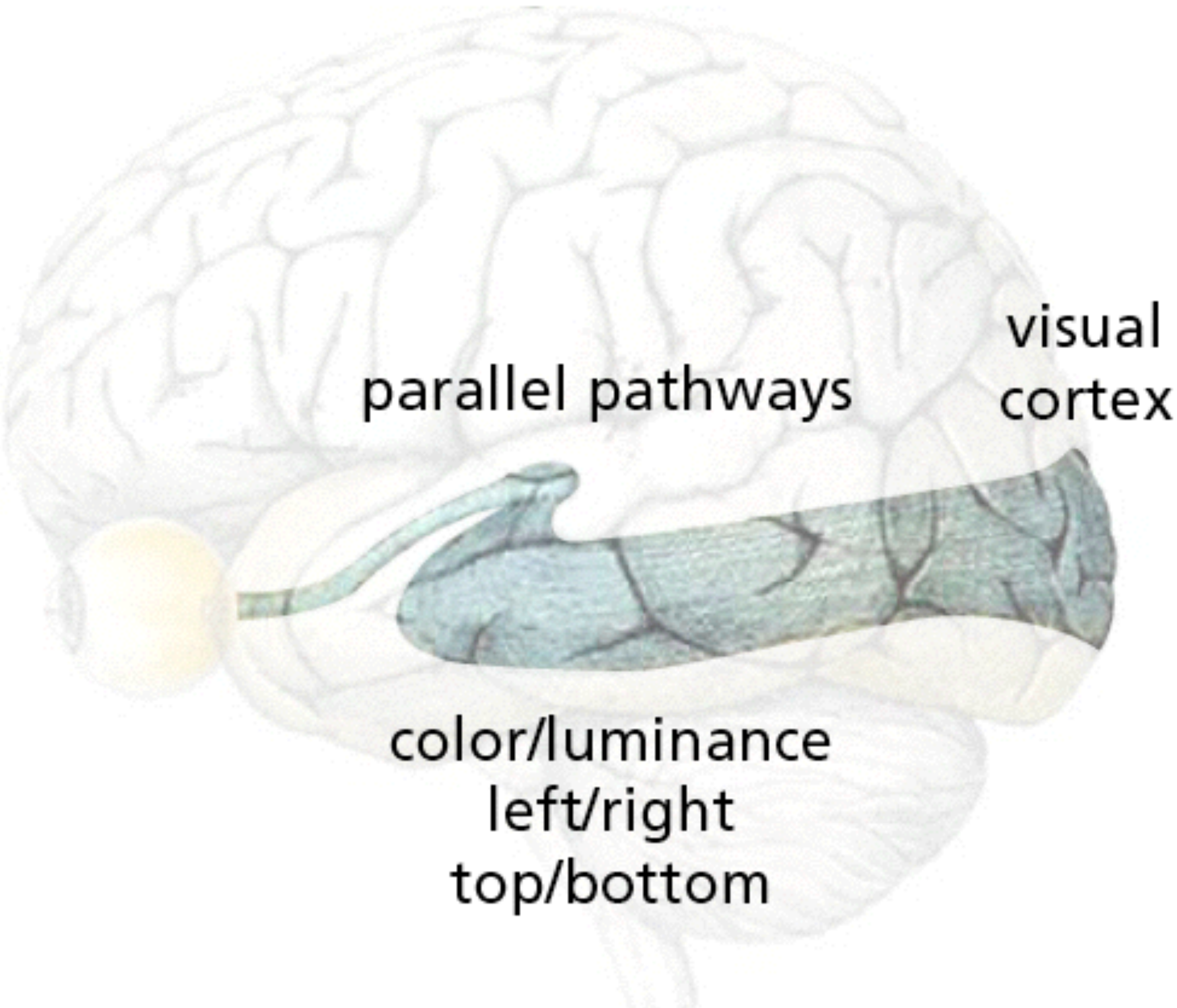


Wong 2010

pre-attentive processing

POPOUT





Based on slide from Mazur

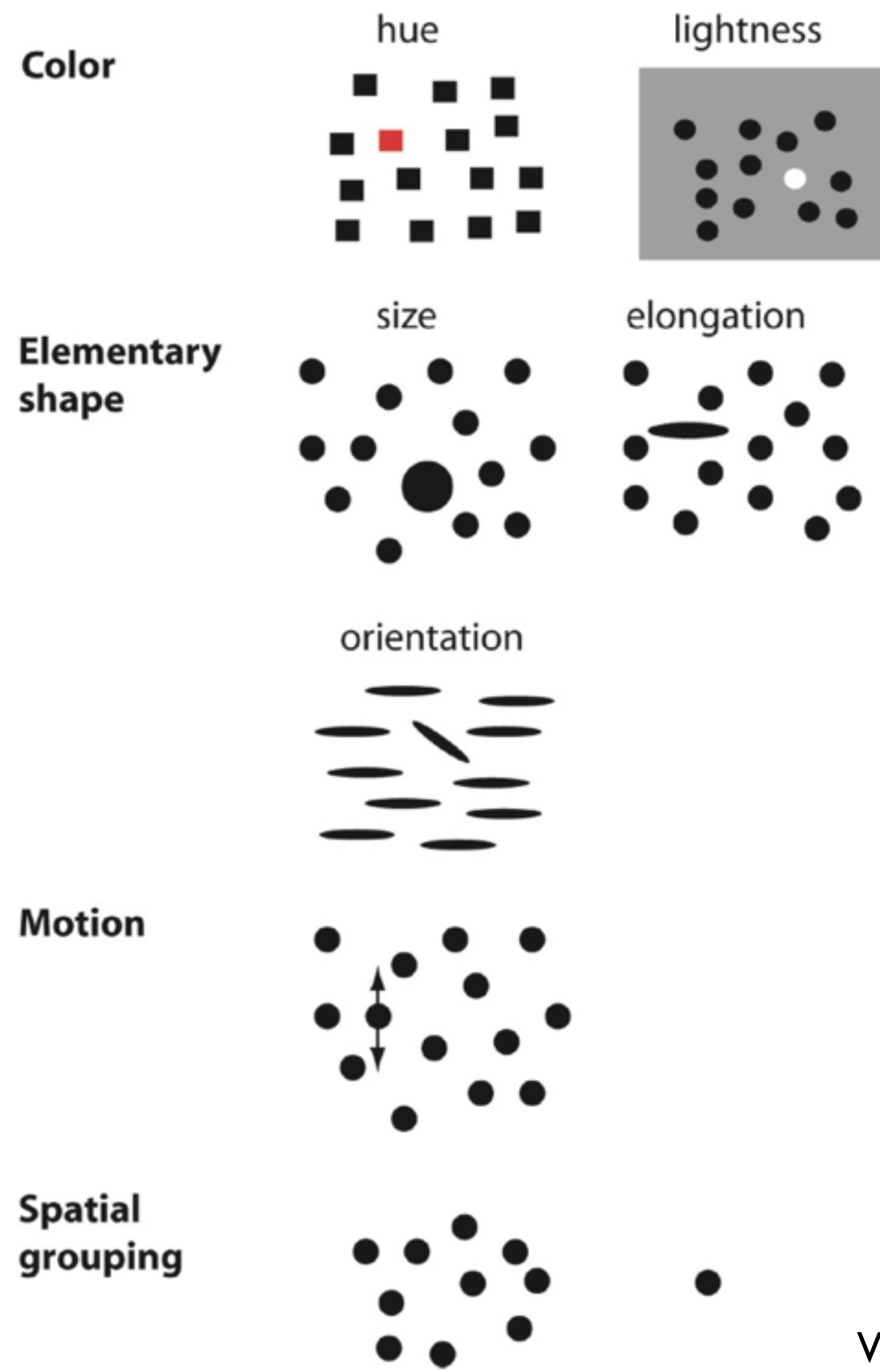
pre-attentive processing

-requires attention, despite name

-very fast: <200 ms

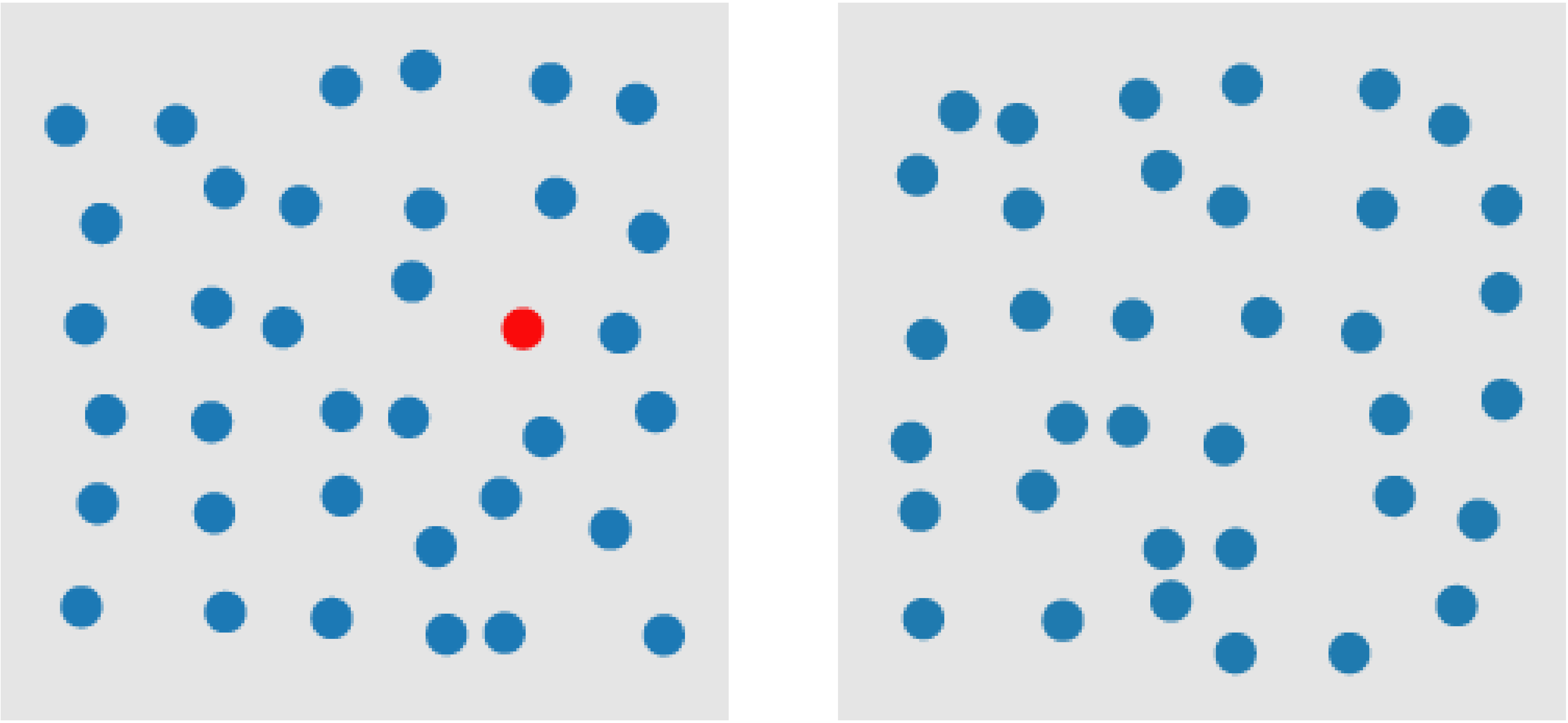
-what matters most is contrast between features

BASIC POPOUT CHANNELS

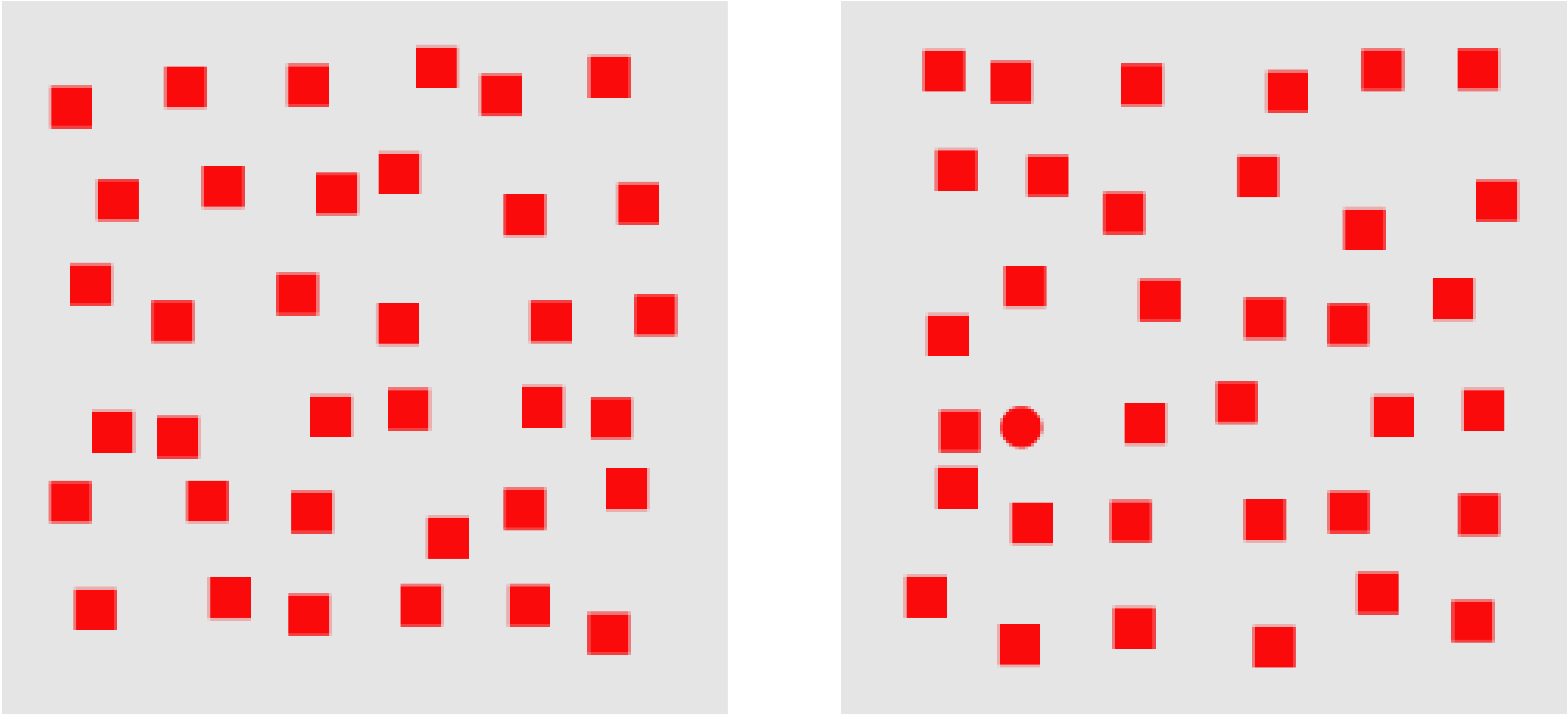


Ware 2008

which side has the outlier?

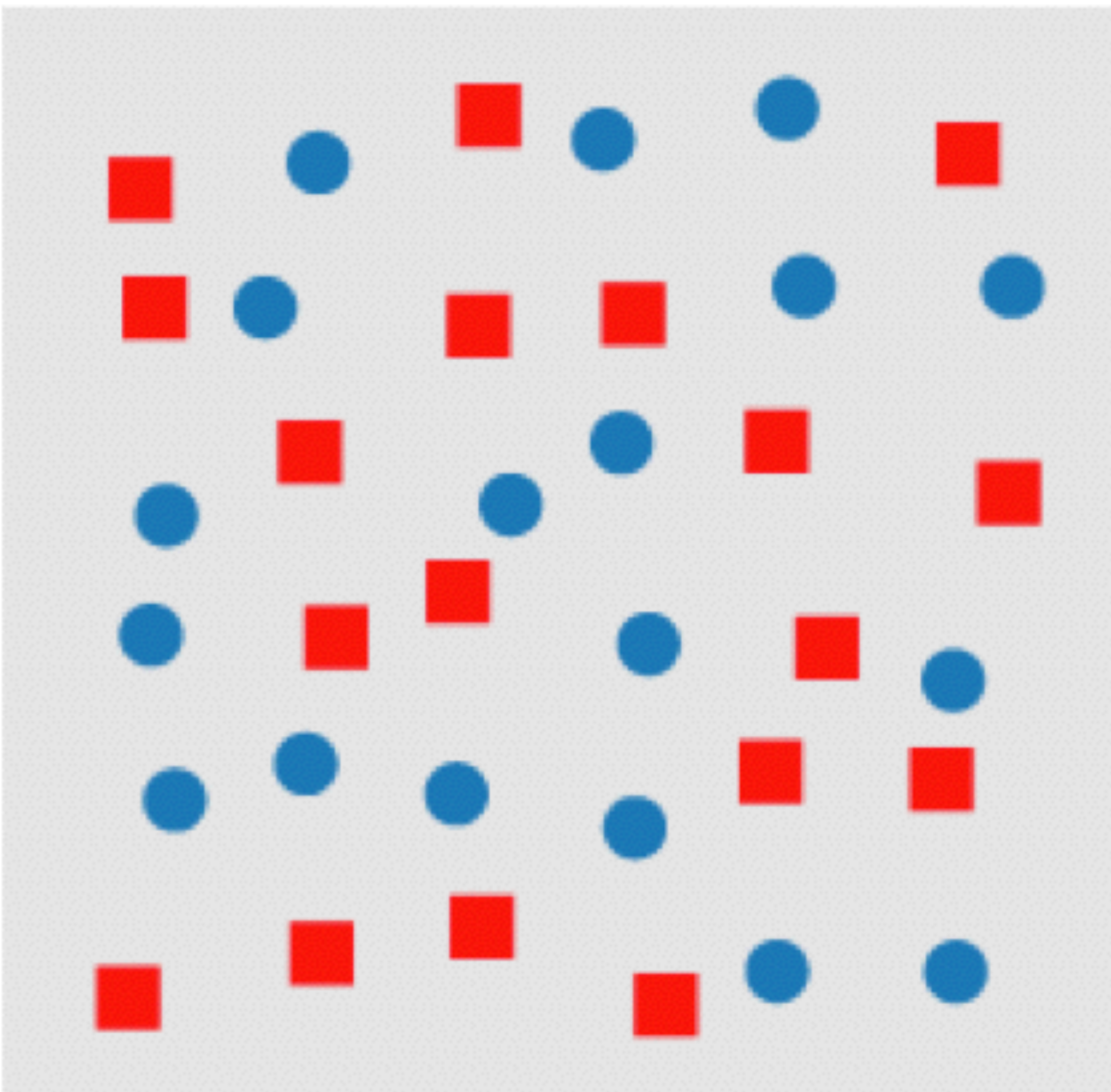


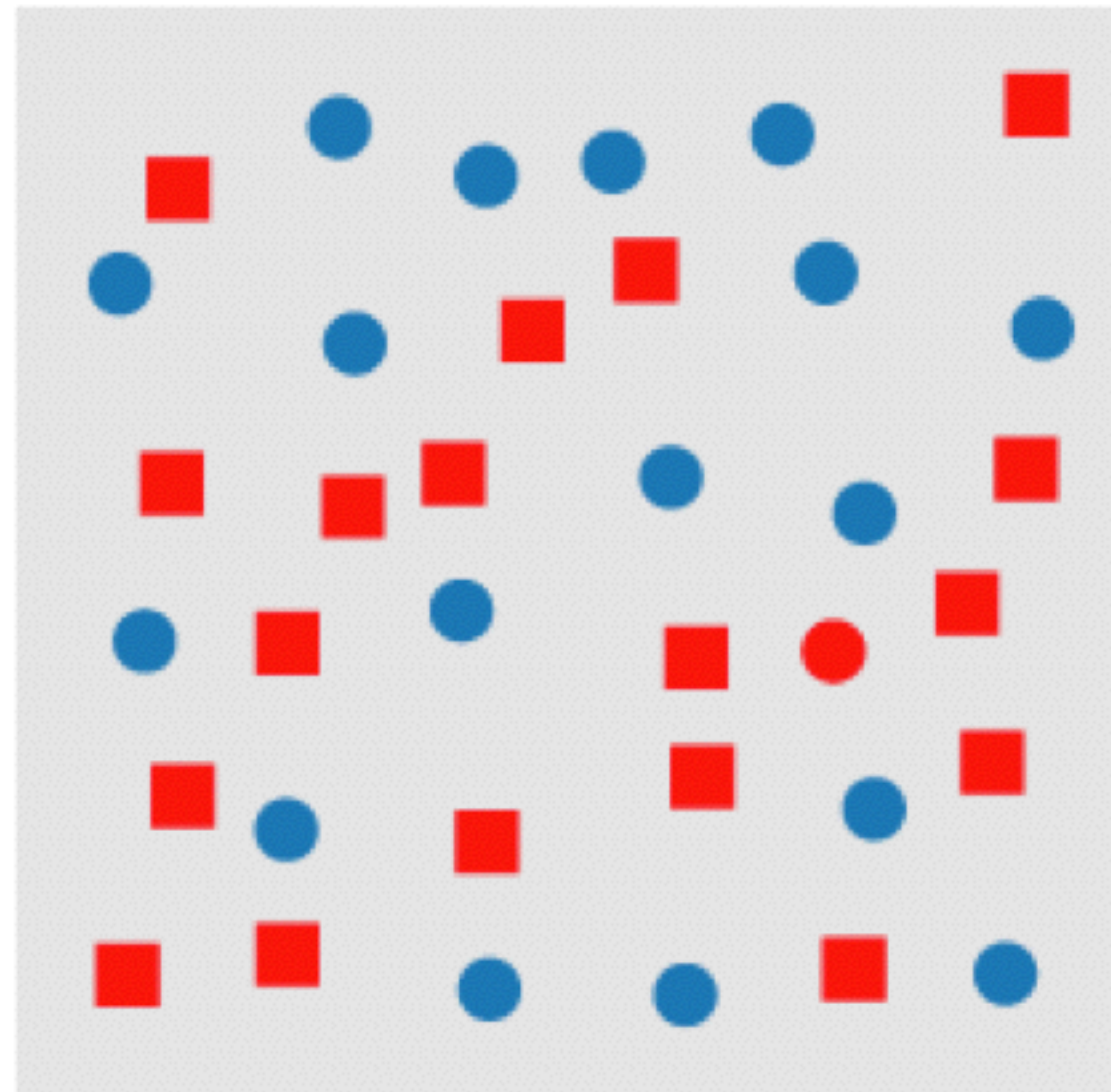
Healy 2007



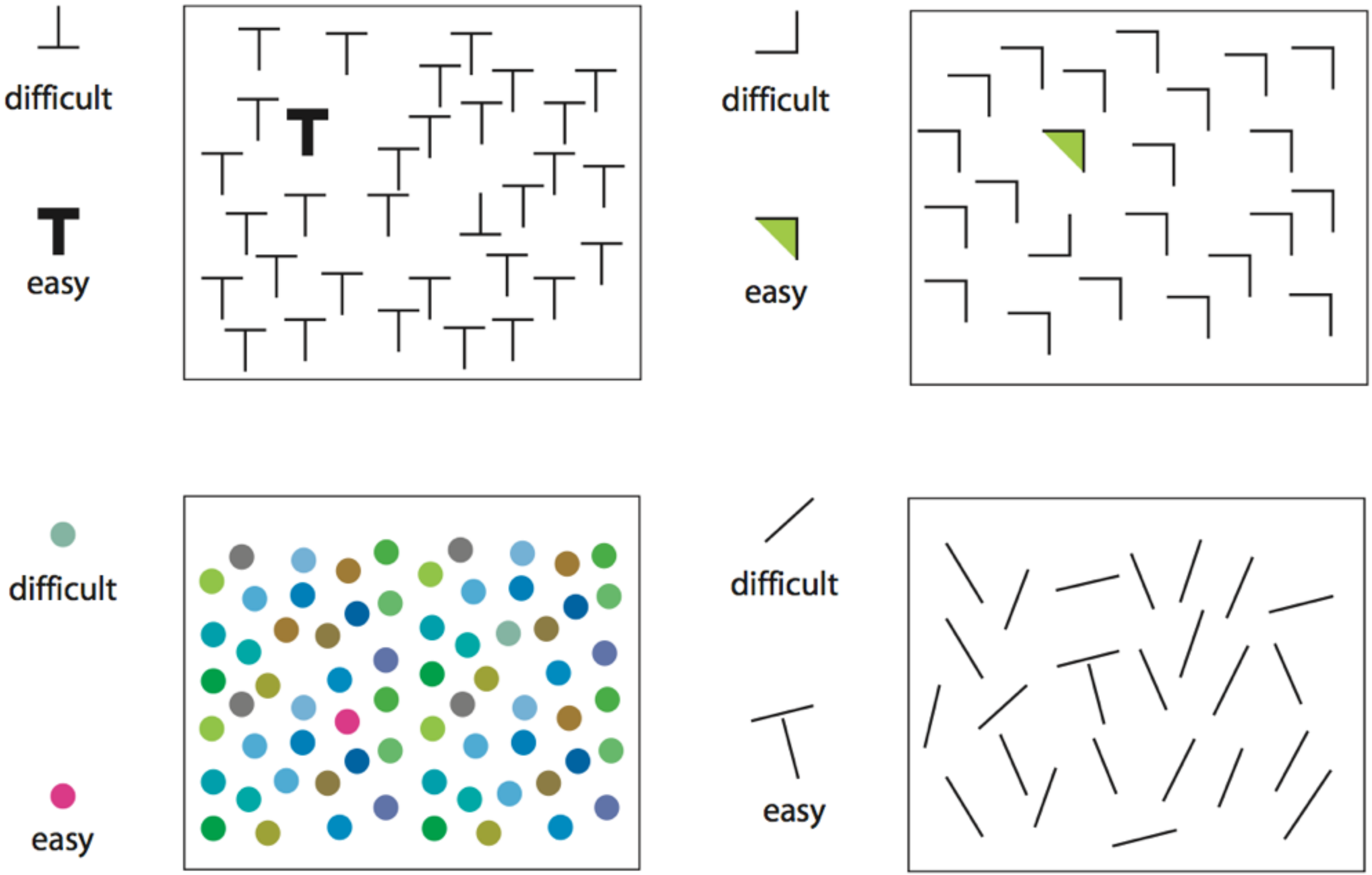
Healy 2007

CONJUNCTION
or, why to use a single channel at a time





Healey 2007


difficult
easy
difficult
easy
difficult
easy
difficult
easy

encoding channels

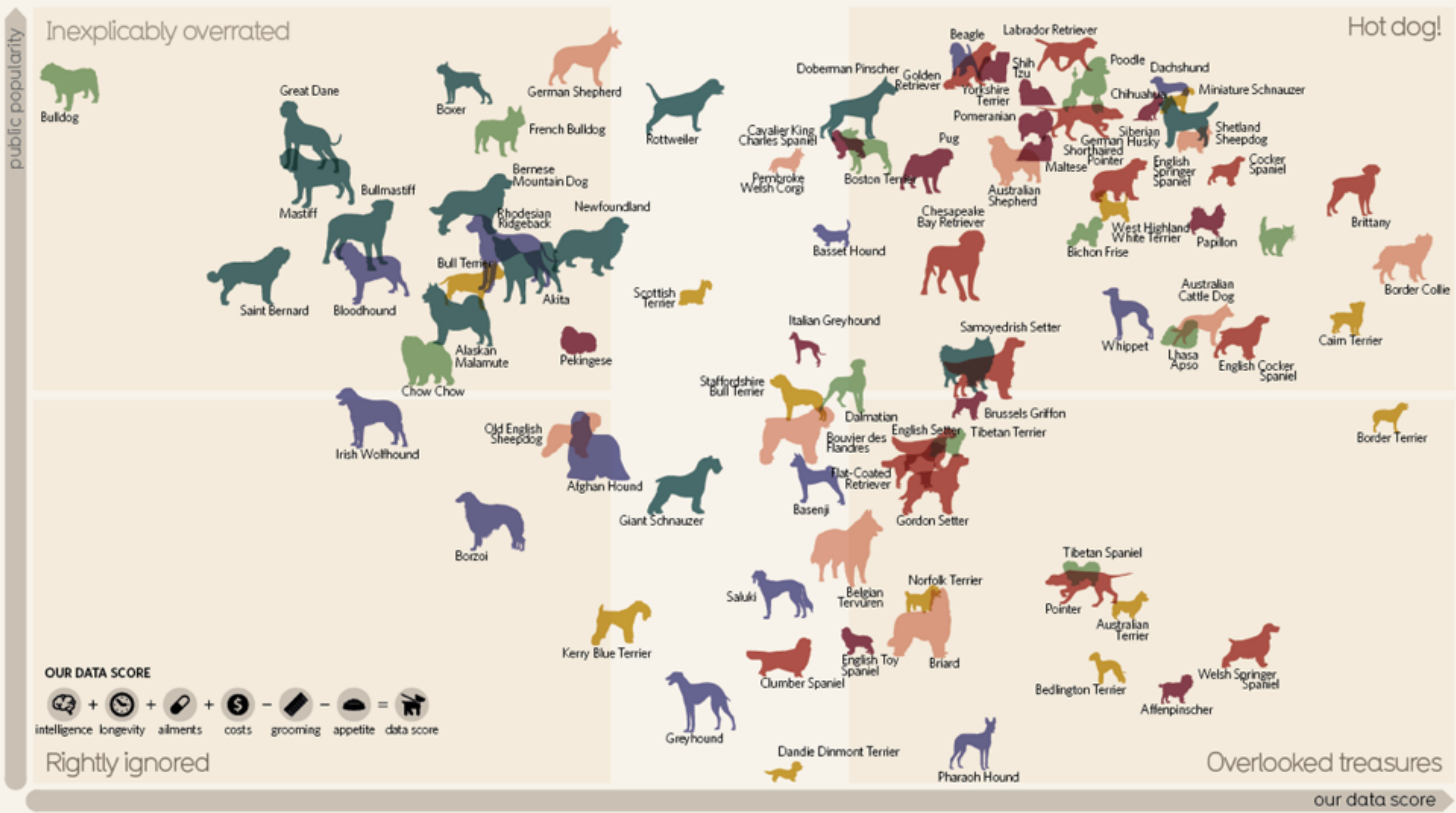
HOW MUCH? magnitude

WHAT? category

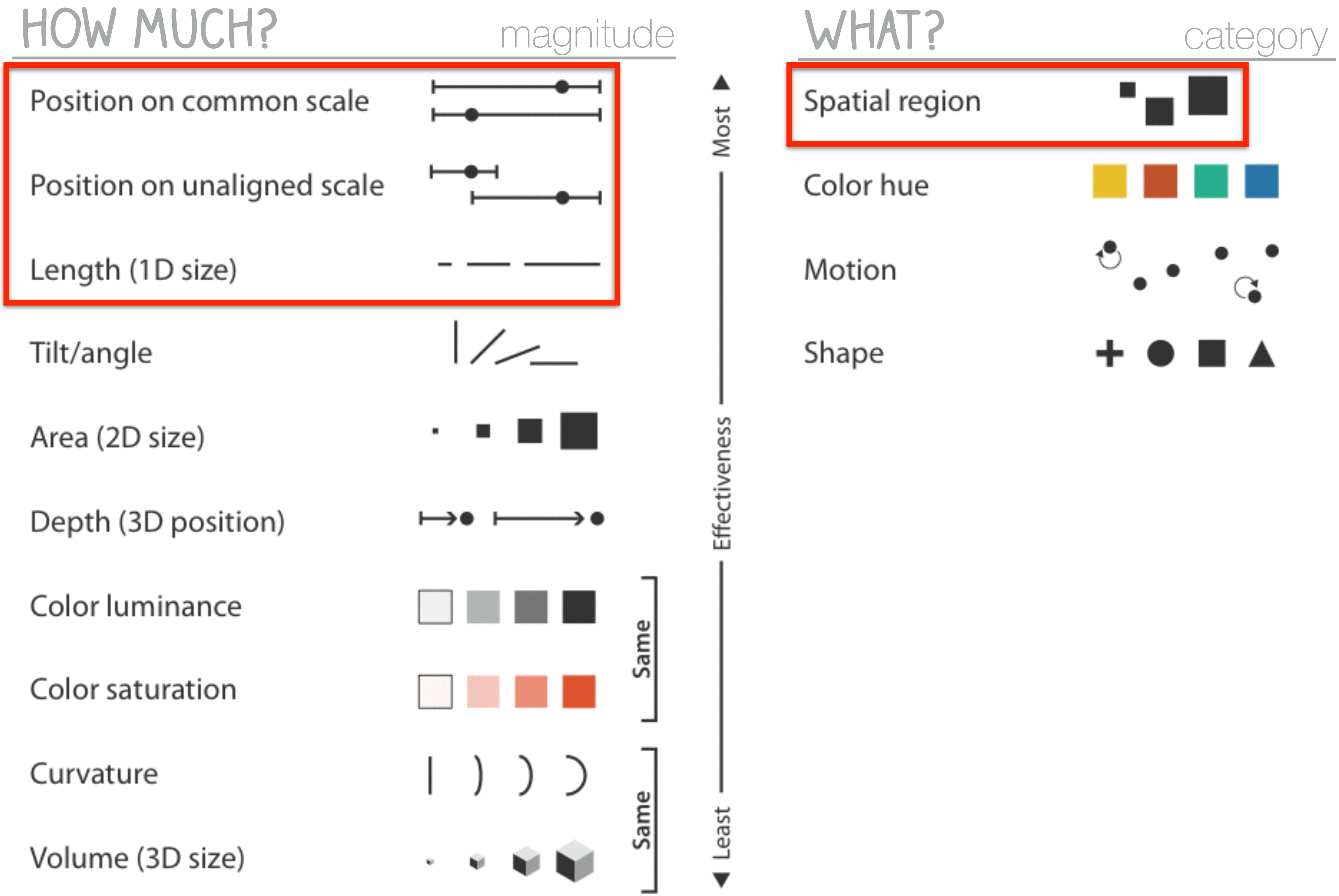
name that channel . . .

Best in Show

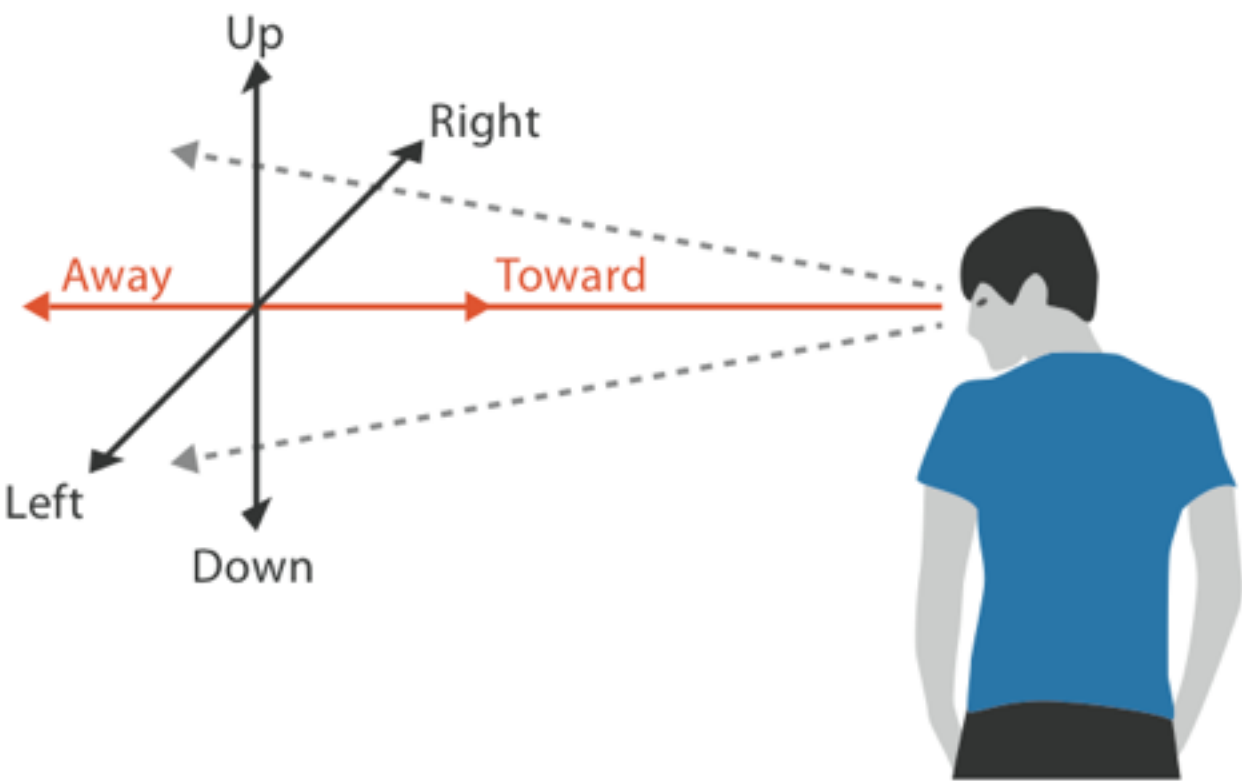
The ultimate data-dog

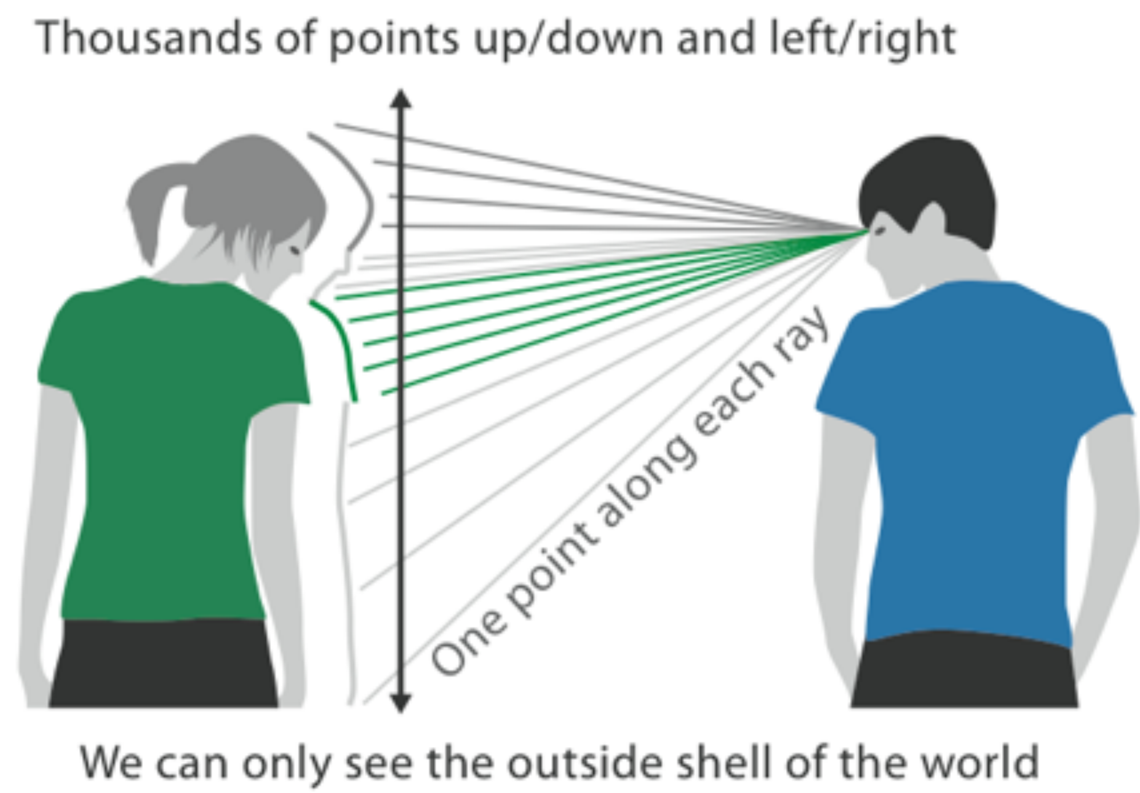


what's so special about the plane?

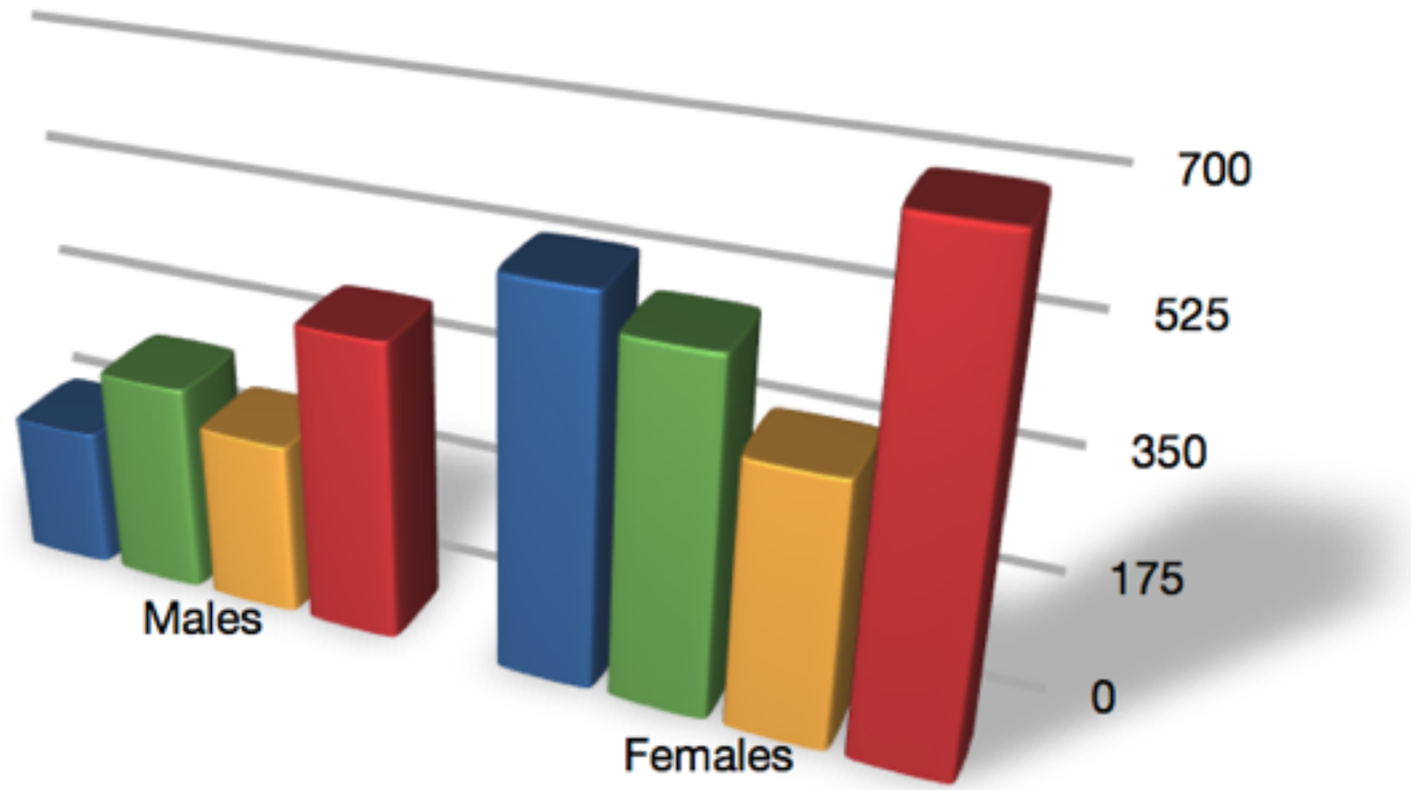

HOW MUCH?
magnitude
Position on common scale
Position on unaligned scale
Length (1D size)
Tilt/angle
Area (2D size)
Depth (3D position)
Color luminance
Color saturation
Curvature
Volume (3D size)
Same
Same
Most
Effectiveness
Least
WHAT?
category
Spatial region
Color hue
Motion
Shape

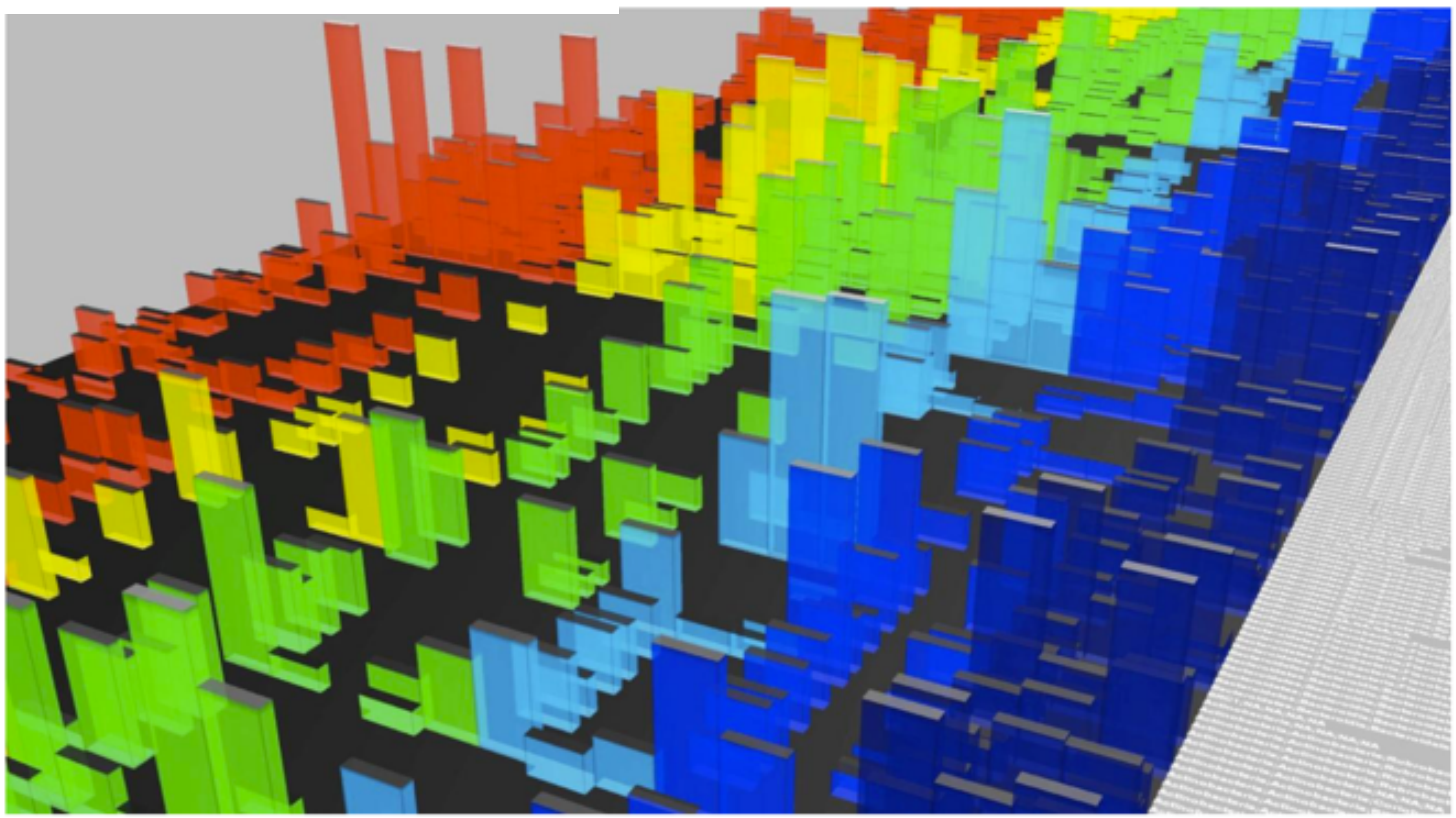
we see the world as a ~~2.5D~~ 2.05D space



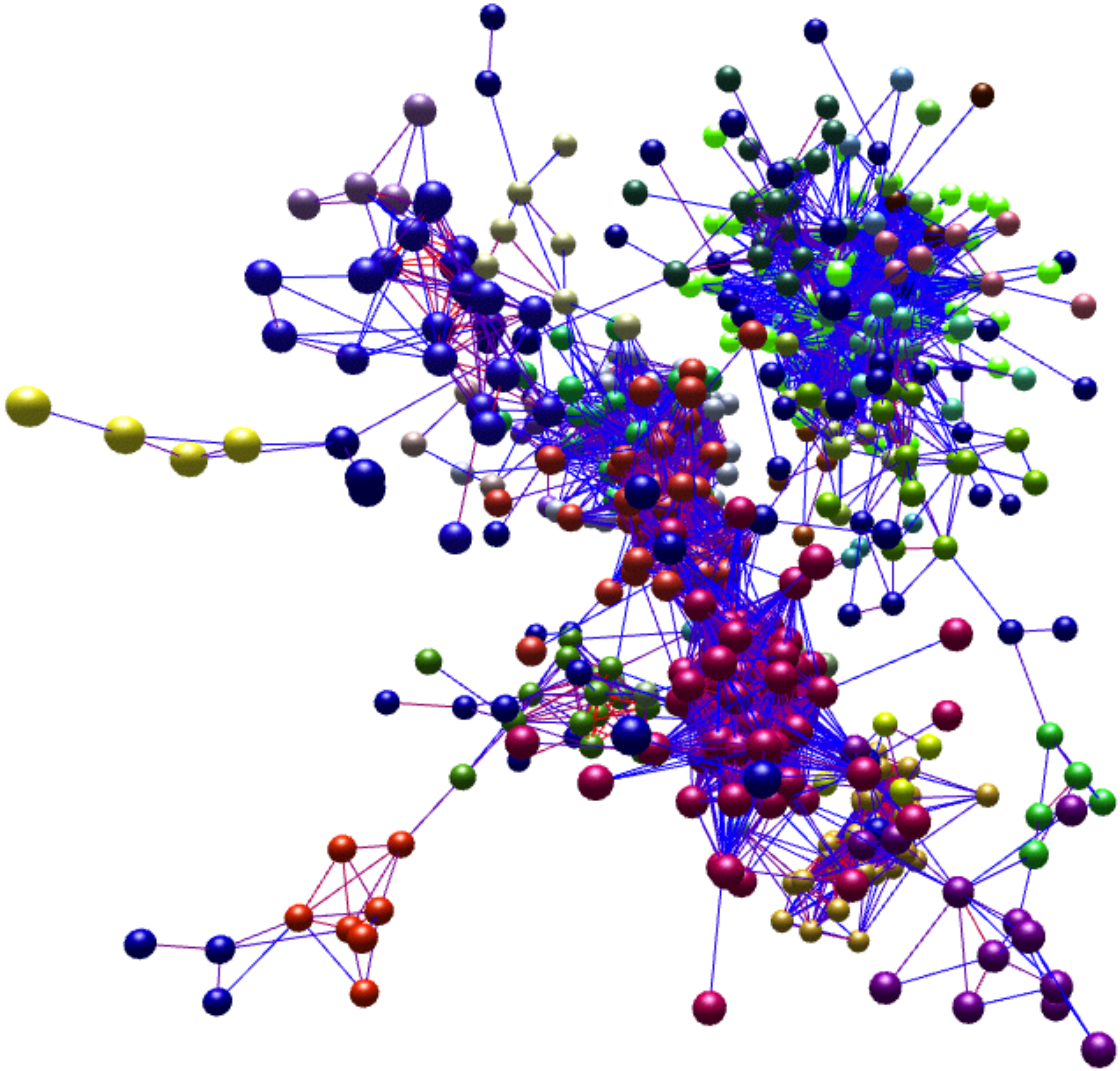


- **power does not extend to 3D**
  - perspective cues
    - *interfere with color and size channels*
  - occlusion of data
  - text legibility



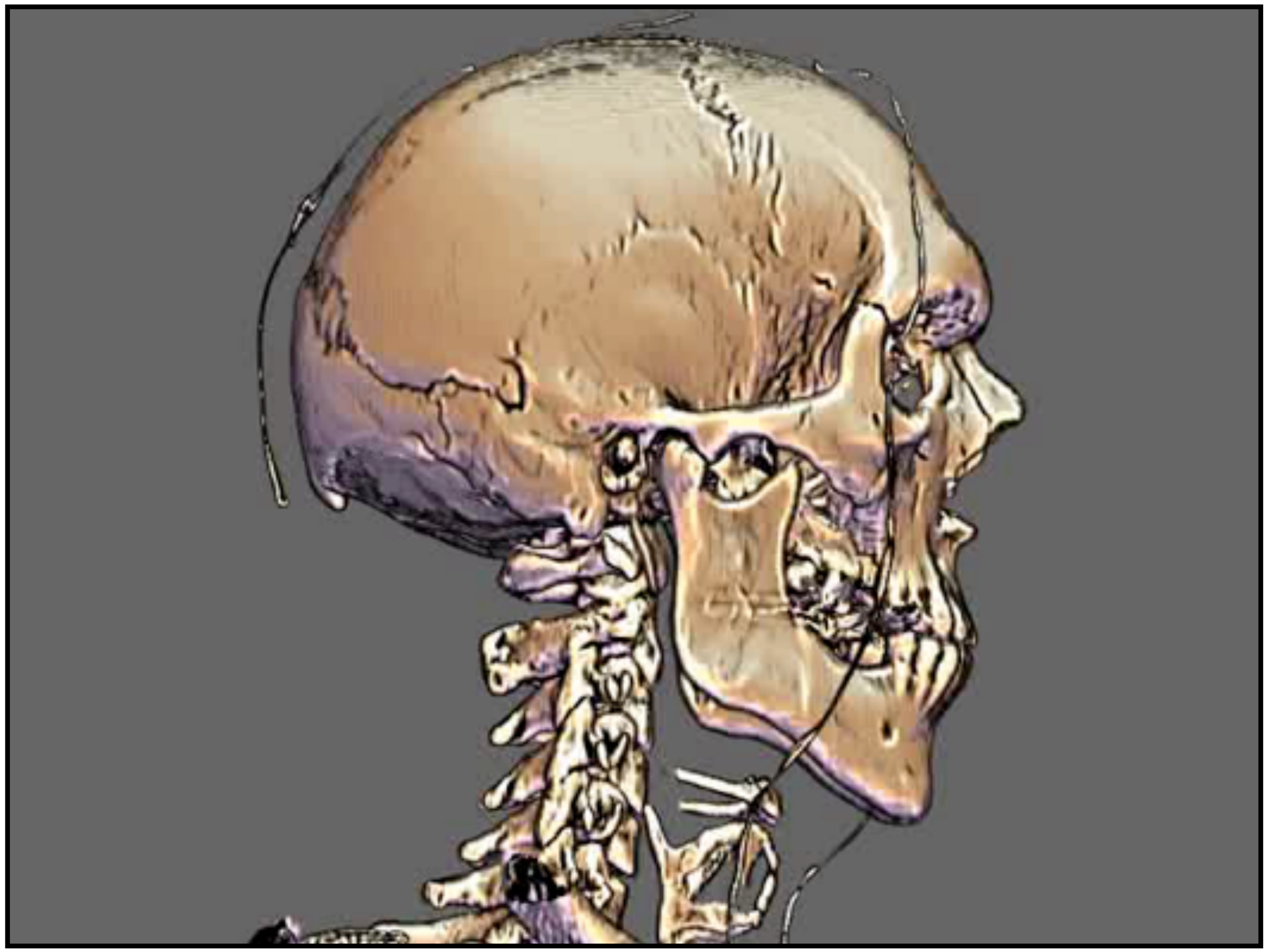


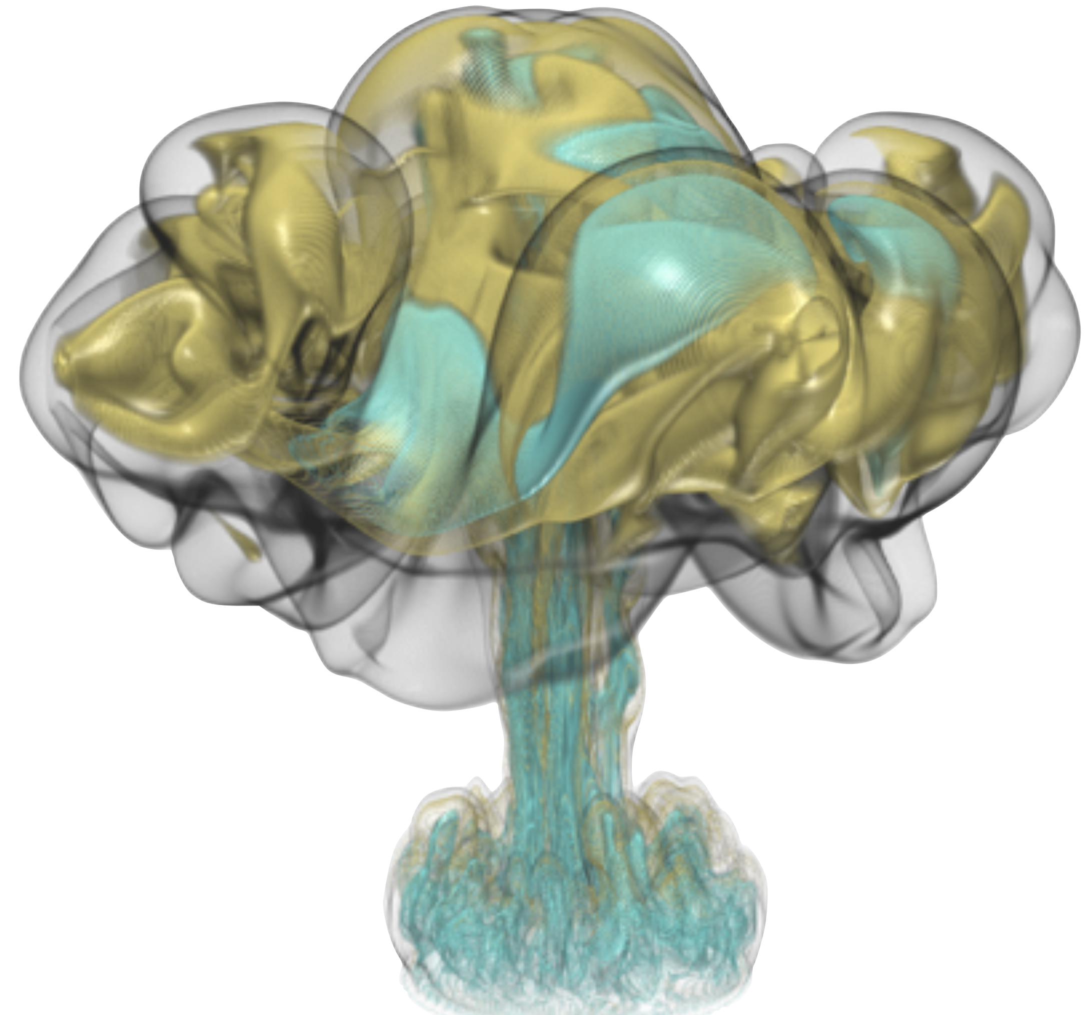
Moore 2011



http://www.biolayout.org/

exception...

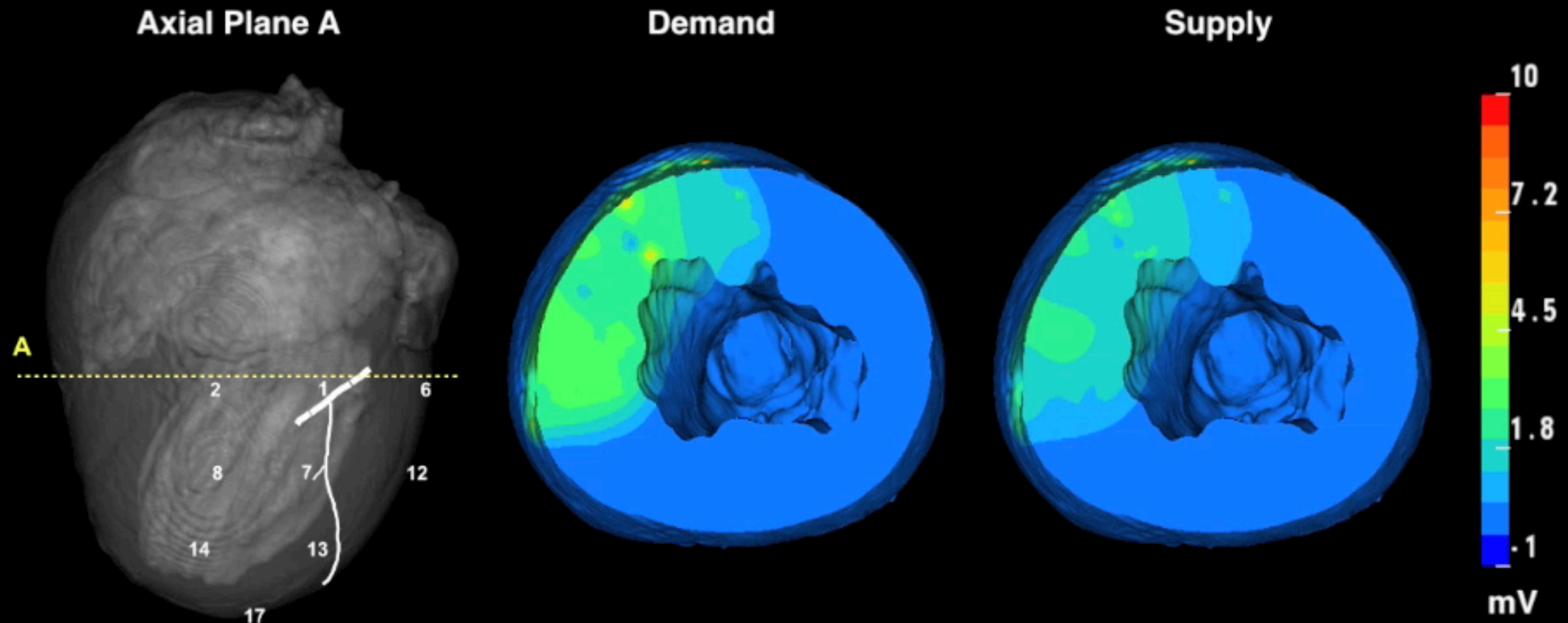




animation

RSM-09-11-03 Canine In Situ Model

Progression of ST Elevated Regions (ST 40)



Flow Rate: 35ml **Pacing Rate: 400ms** **Occlusion Cycle: 15**

ComParrot
by Bonnie J. Malcolm

Can you spot 12 differences between these pictures?

ComParrot
by Bonnie J. Malcolm

Can you spot 12 differences between these pictures?

ComParrot

by Bonnie J. Malcolm

Can you spot 12 differences between these pictures?

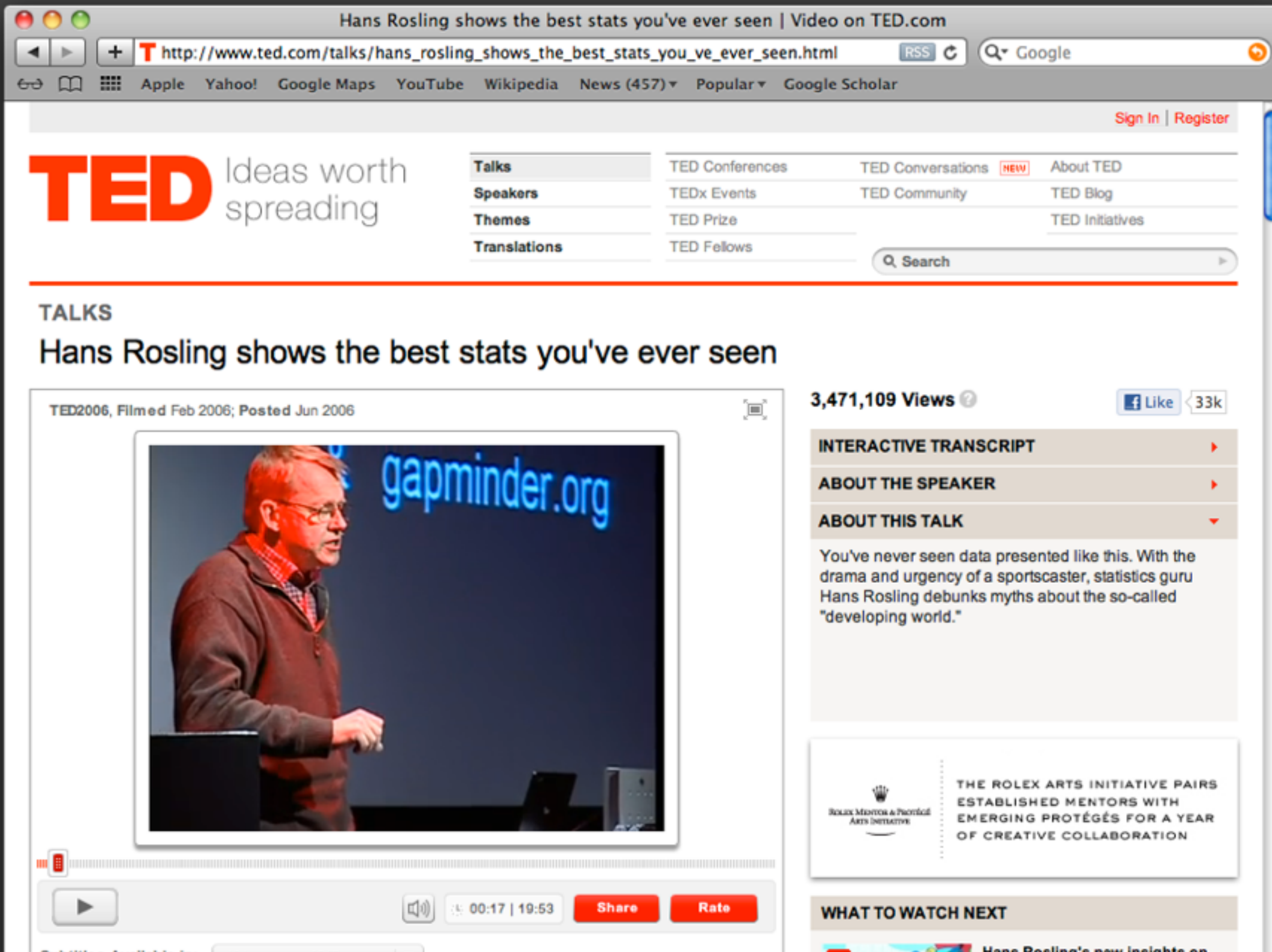
Solution: 1. Top tree leaf removed. 2. Nose line on left giraffe removed. 3. Shadow on lower left coconut removed. 4. Leaf vein below gecko removed. 5. Ear line on left giraffe removed. 6. Bottom spot on right giraffe colored in. 7. Small leaf at right of tree colored in. 8. Horn on right giraffe moved. 9. Spot on left giraffe moved. 10. Branch on left side shorter. 11. Gecko tail longer. 12. Gecko eye missing.

visualization

uses pictures to enhance working memory.

WHEN TO USE ANIMATION?

GOOD: STORYTELLING



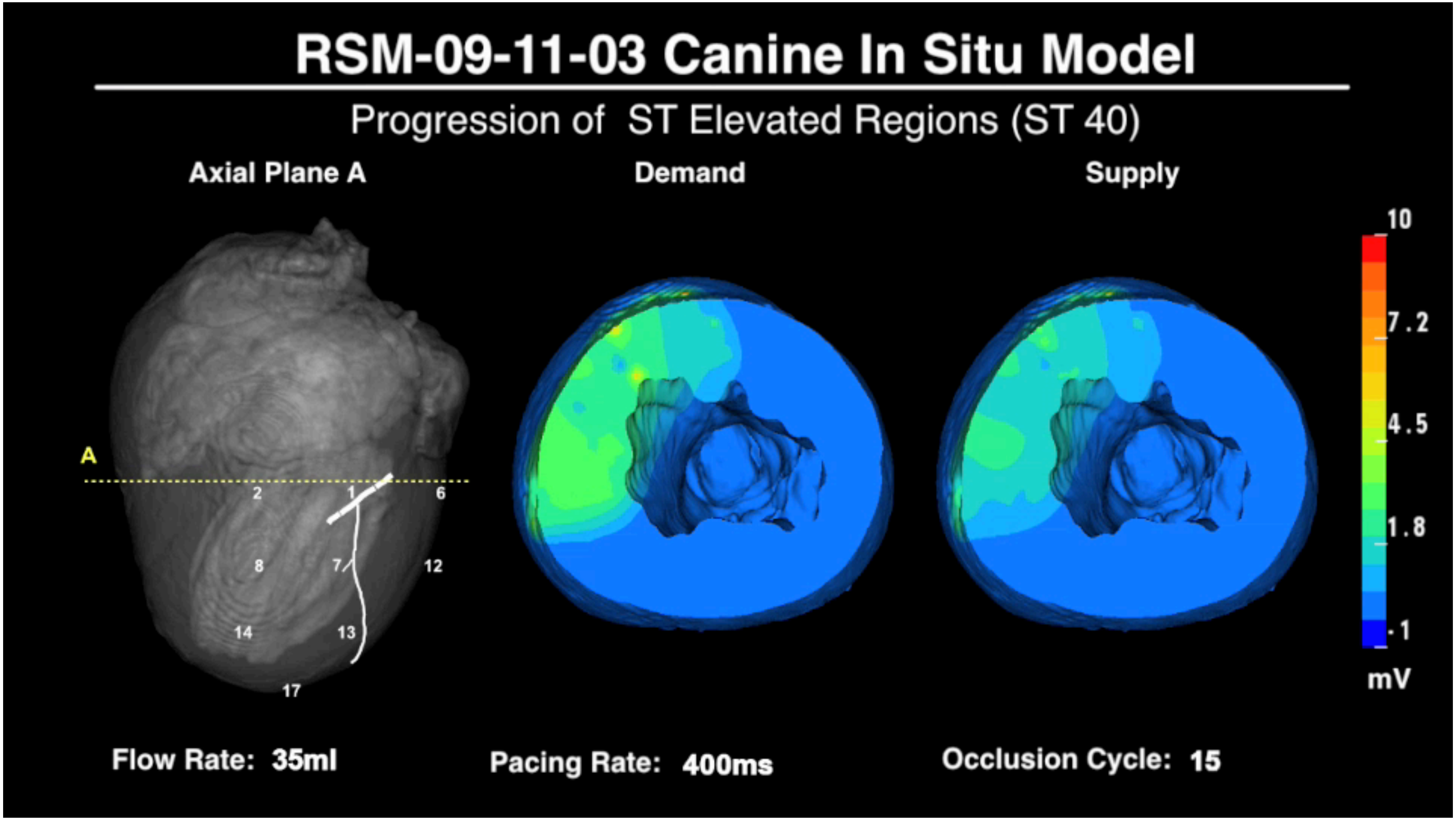
GOOD: TRANSITIONS

Animated Transitions in Statistical Data Graphics

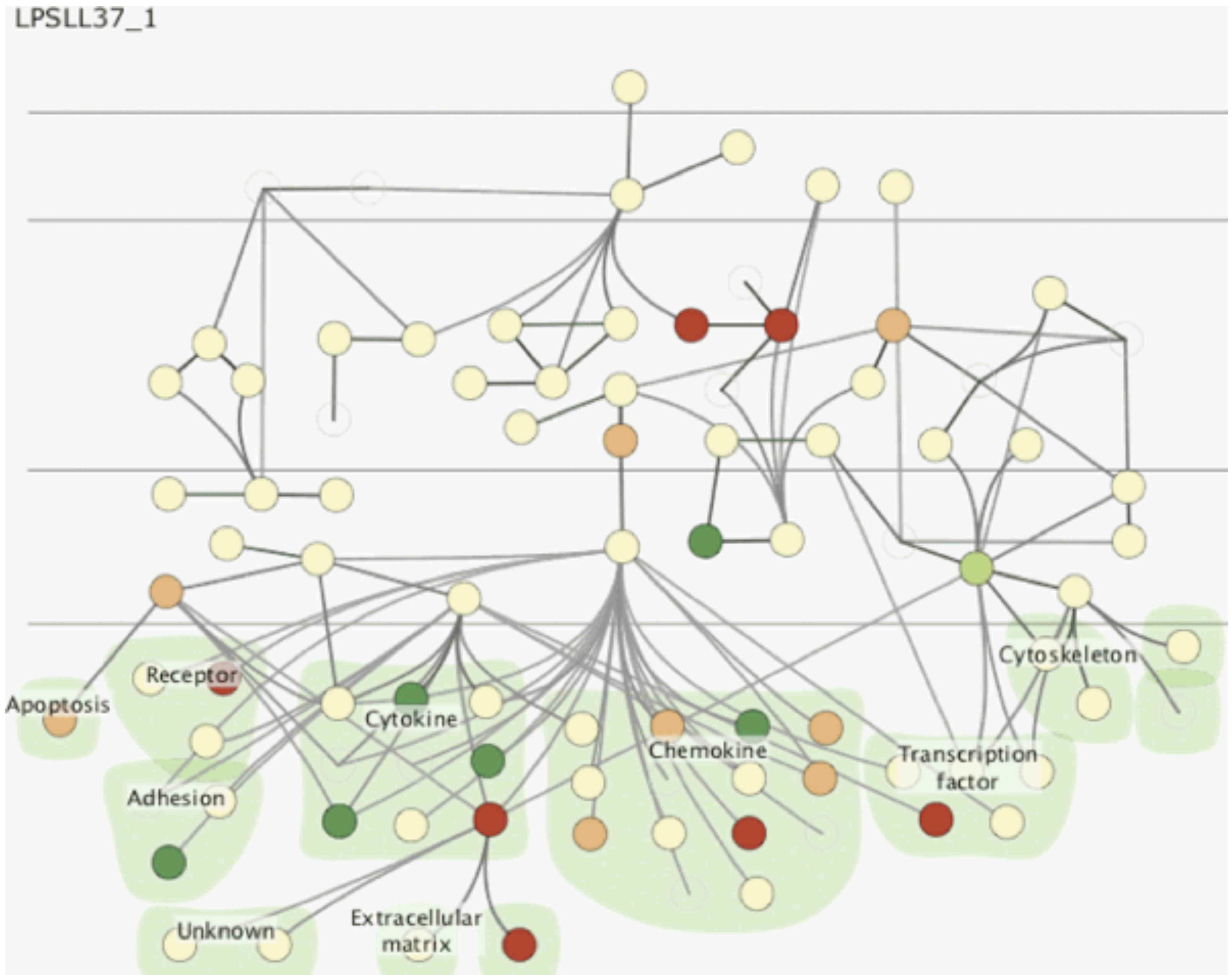
Jeffrey Heer
George G. Robertson

Microsoft Research

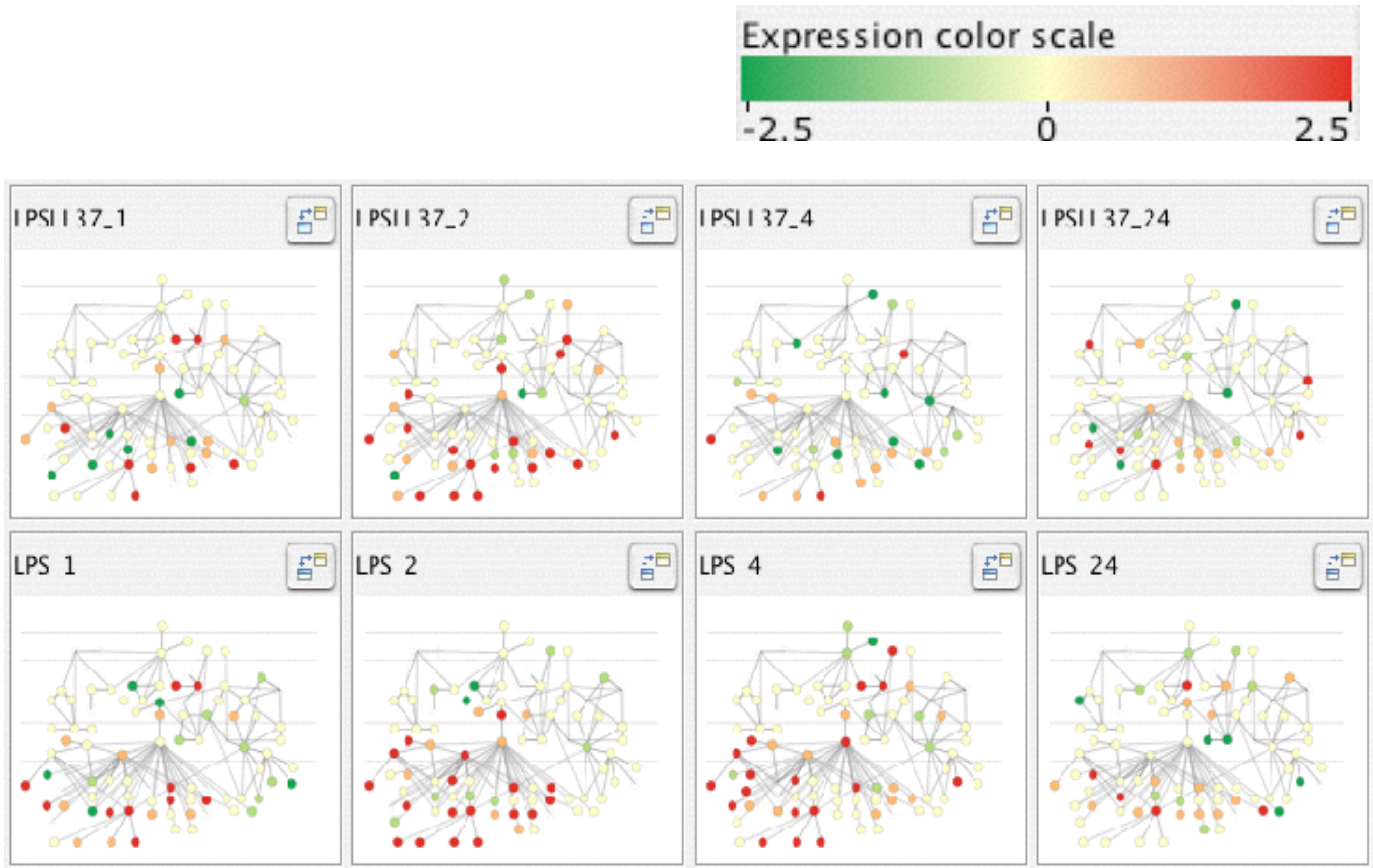
BAD: COMPARING COMPLEX STATE CHANGES OVER TIME



BAD: MULTIPLE STATES WITH MULTIPLE CHANGES



BAD: MULTIPLE STATES WITH MULTIPLE CHANGES
alternative: small multiples



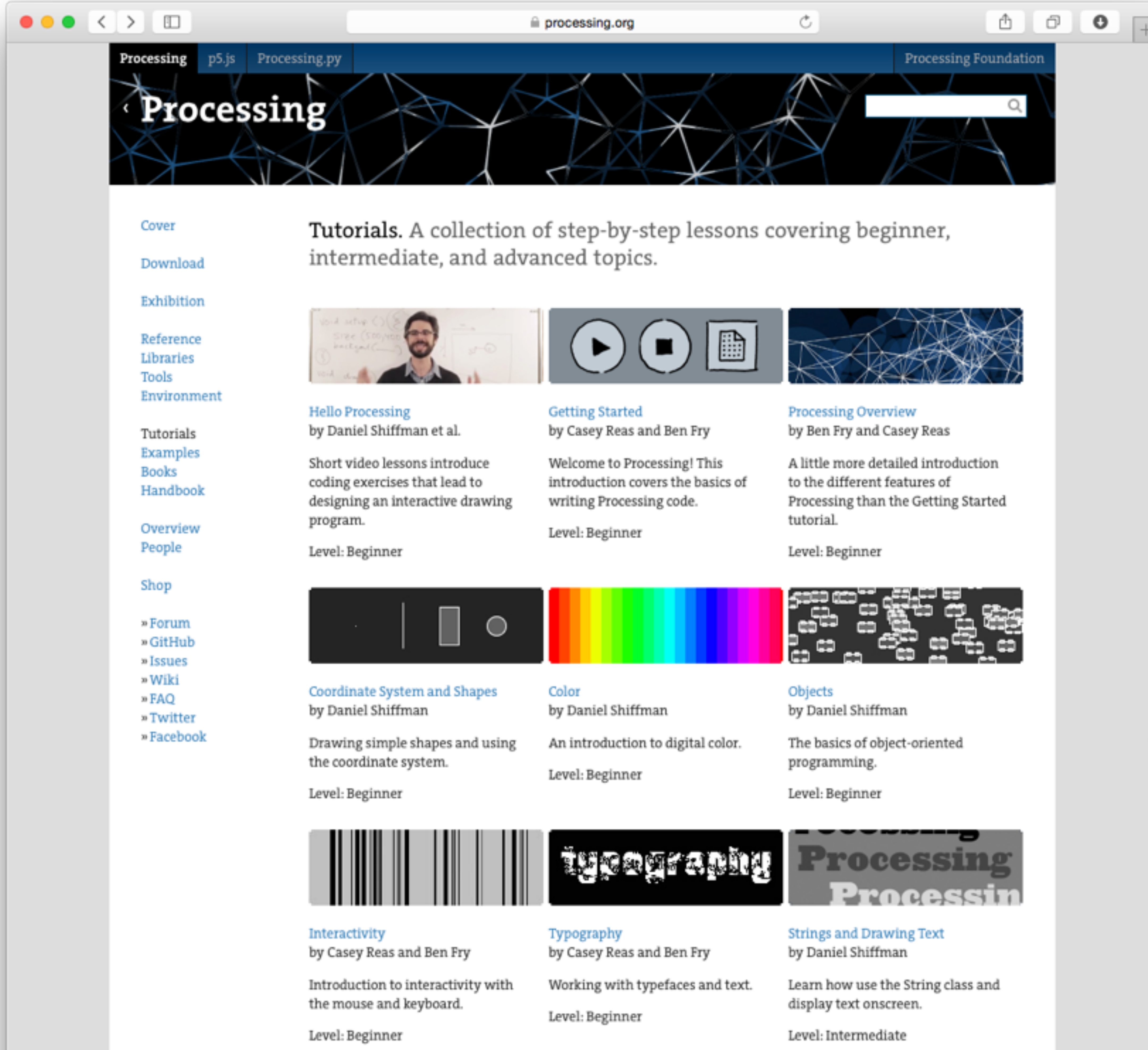
Barsky 2008

color

Get it right in black and white.

Maureen Stone

next time…


processing.org
Processing
p5.js
Processing.py
Processing Foundation
Processing
Cover
Download
Exhibition
Reference
Libraries
Tools
Environment
Tutorials
Examples
Books
Handbook
Overview
People
Shop
» Forum
» GitHub
» Issues
» Wiki
» FAQ
» Twitter
» Facebook
Tutorials. A collection of step-by-step lessons covering beginner, intermediate, and advanced topics.
Hello Processing
by Daniel Shiffman et al.
Short video lessons introduce coding exercises that lead to designing an interactive drawing program.
Level: Beginner
Getting Started
by Casey Reas and Ben Fry
Welcome to Processing! This introduction covers the basics of writing Processing code.
Level: Beginner
Processing Overview
by Ben Fry and Casey Reas
A little more detailed introduction to the different features of Processing than the Getting Started tutorial.
Level: Beginner
Coordinate System and Shapes
by Daniel Shiffman
Drawing simple shapes and using the coordinate system.
Level: Beginner
Color
by Daniel Shiffman
An introduction to digital color.
Level: Beginner
Objects
by Daniel Shiffman
The basics of object-oriented programming.
Level: Beginner
typography
Processing
Interactivity
by Casey Reas and Ben Fry
Introduction to interactivity with the mouse and keyboard.
Level: Beginner
Typography
by Casey Reas and Ben Fry
Working with typefaces and text.
Level: Beginner
Strings and Drawing Text
by Daniel Shiffman
Learn how use the String class and display text onscreen.
Level: Intermediate

-homework

  -assignment 12 due tonight