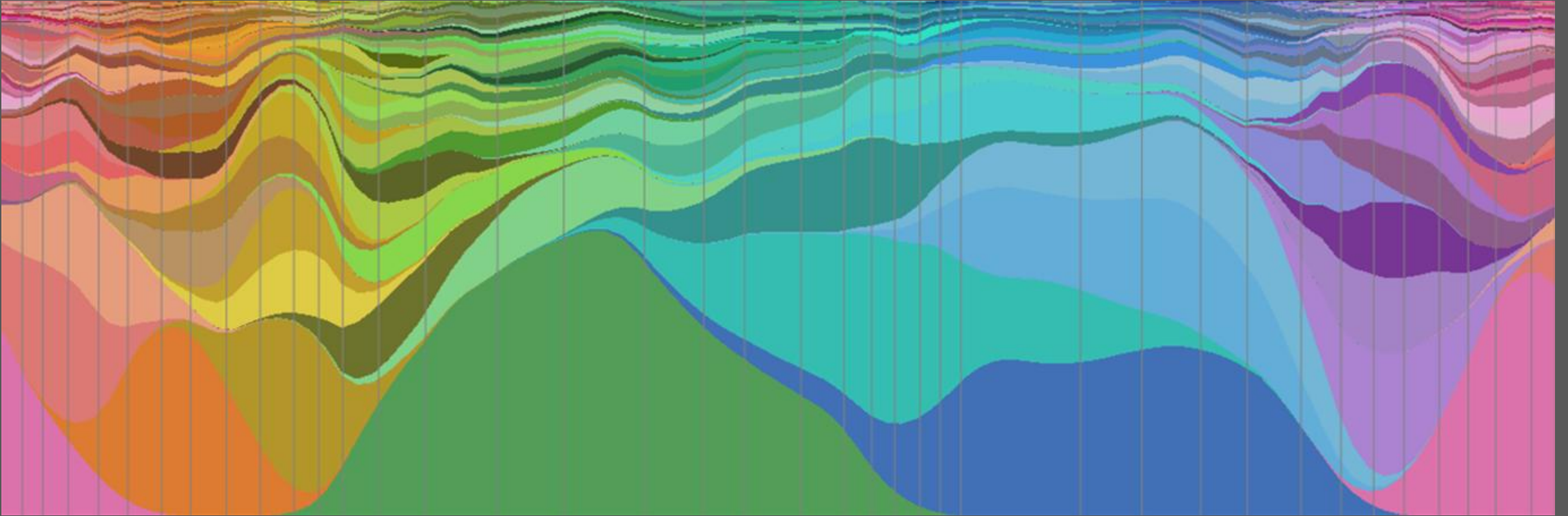


# LDSCI5209 - Information Presentation and Visualisation

## Week 2: Visual Communication

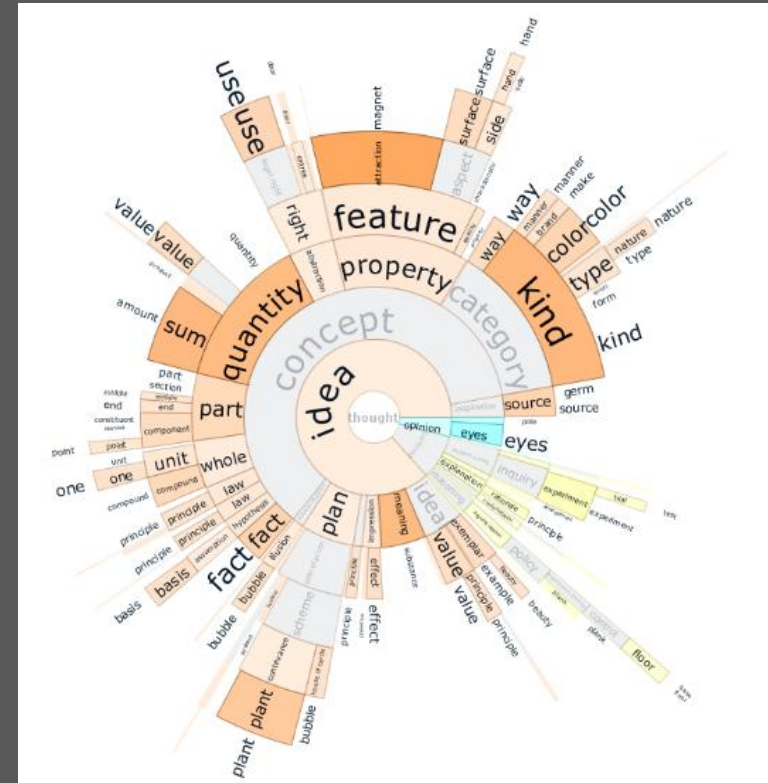


Dimitris Mylonas

Northeastern University London

# Recap: Why visualise data?

- Help cognition
- Expand memory
- Find patterns
- Generate and answer questions
- Make decisions
- Communicate
- Inspire



## DocuBurst (Collins, 2007)

# Plan for today

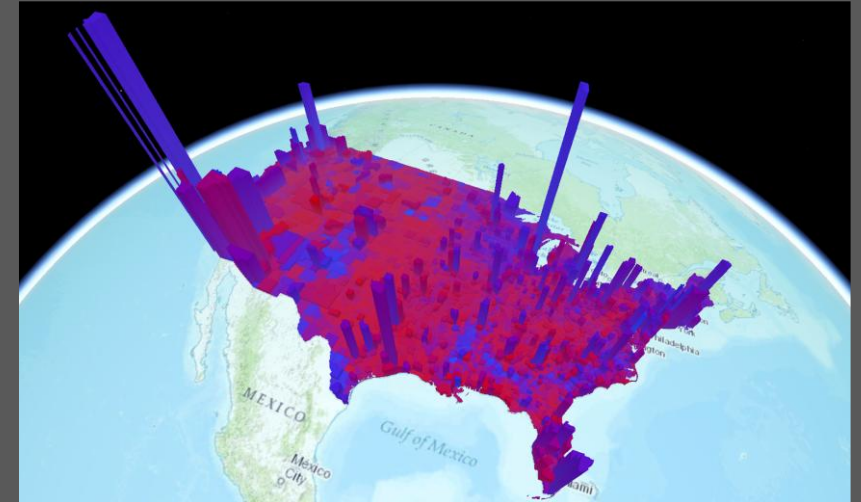
- Design principles
- Measurement scales
- Marks and Channels

# Design principles

Criteria, Graphical Integrity, Rules of Thumb

# Visualisation Critique

- DESCRIBE: What do you see?
- ANALYSE: How is the work organised?  
What are the visual encodings?
- TASK: What is the purpose of the visualisation?
- DECIDE: Is this a successful (effective) visualisation?

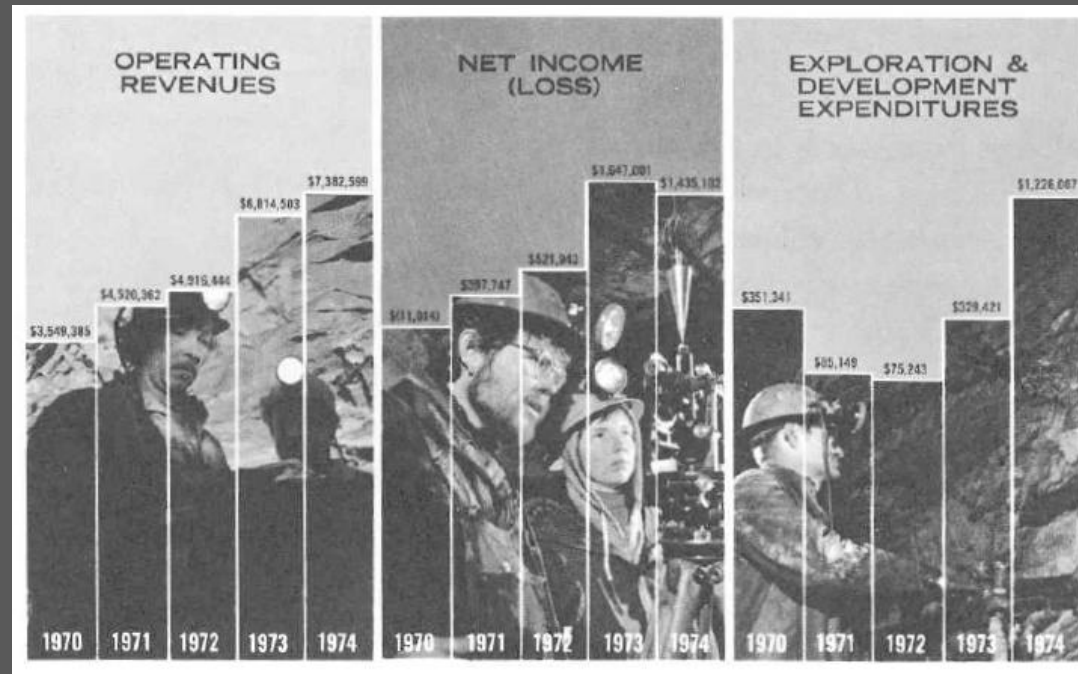


# Design Criteria

**Expressiveness:** A set of facts is expressible in a visual language if the sentences (i.e. the visualisations) in the language express all the facts in the set of data, and only the facts in the data.

**Effectiveness:** A visualisation is more effective than another visualisation if the information conveyed by one visualisation is more readily perceived than the information in the other visualisation.

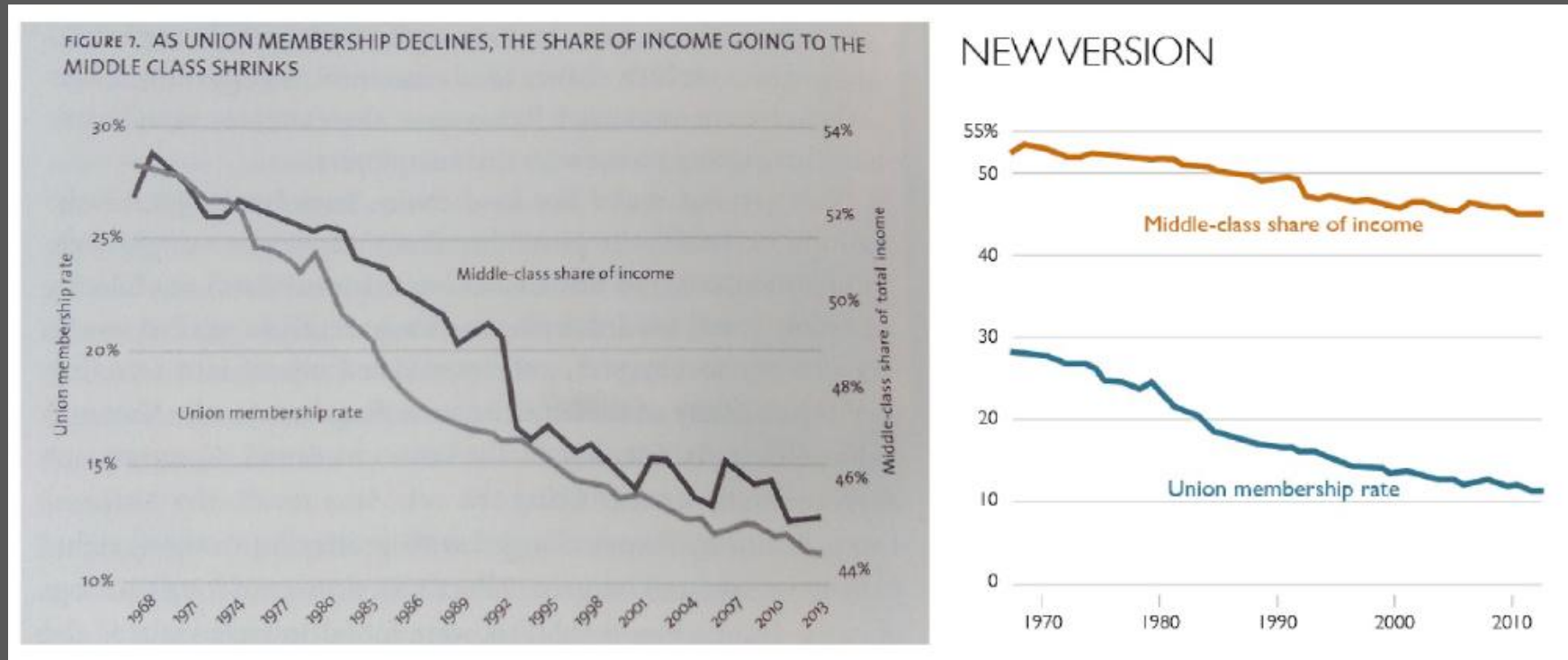
# Graphical integrity



“Clear, detailed, and thorough labeling should be used to defeat graphical distortion and ambiguity. Write out explanations of the data on the graphic itself. Label important events in the data.”

Tufte (1983)

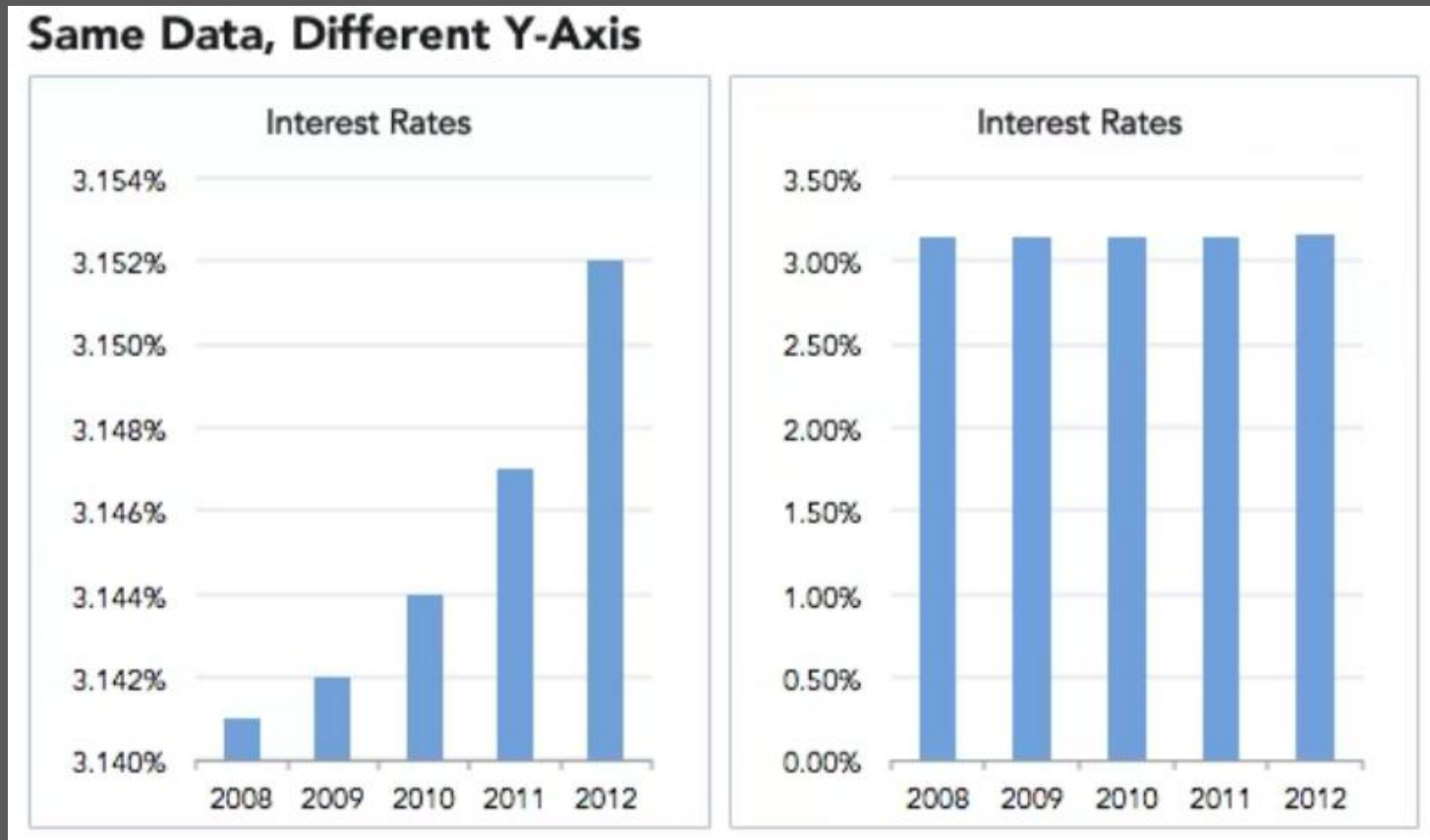
# *Double the axes, double the mischief*



Tufte (1983)

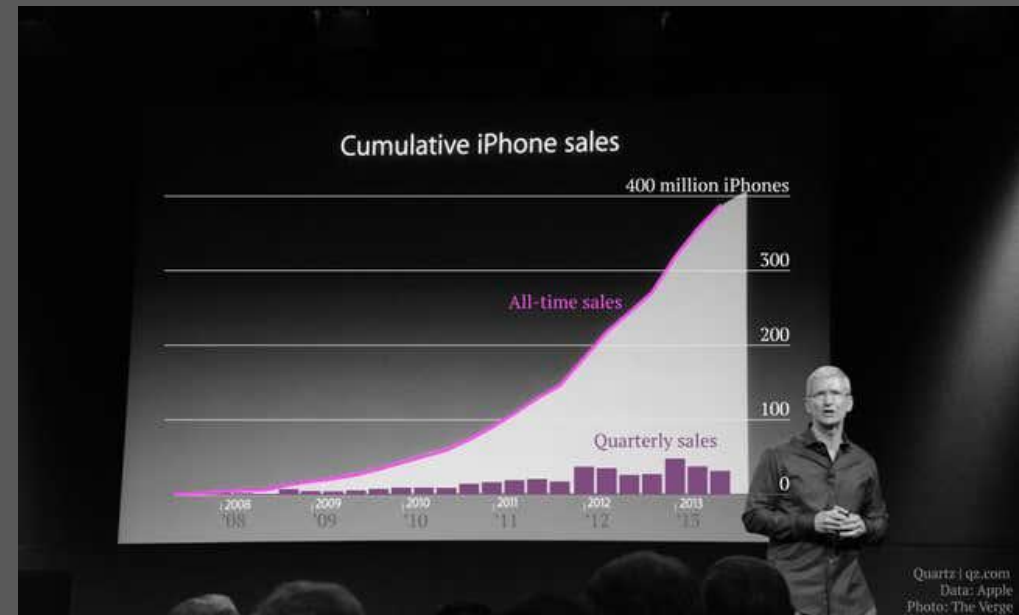


# How to lie with data visualisation



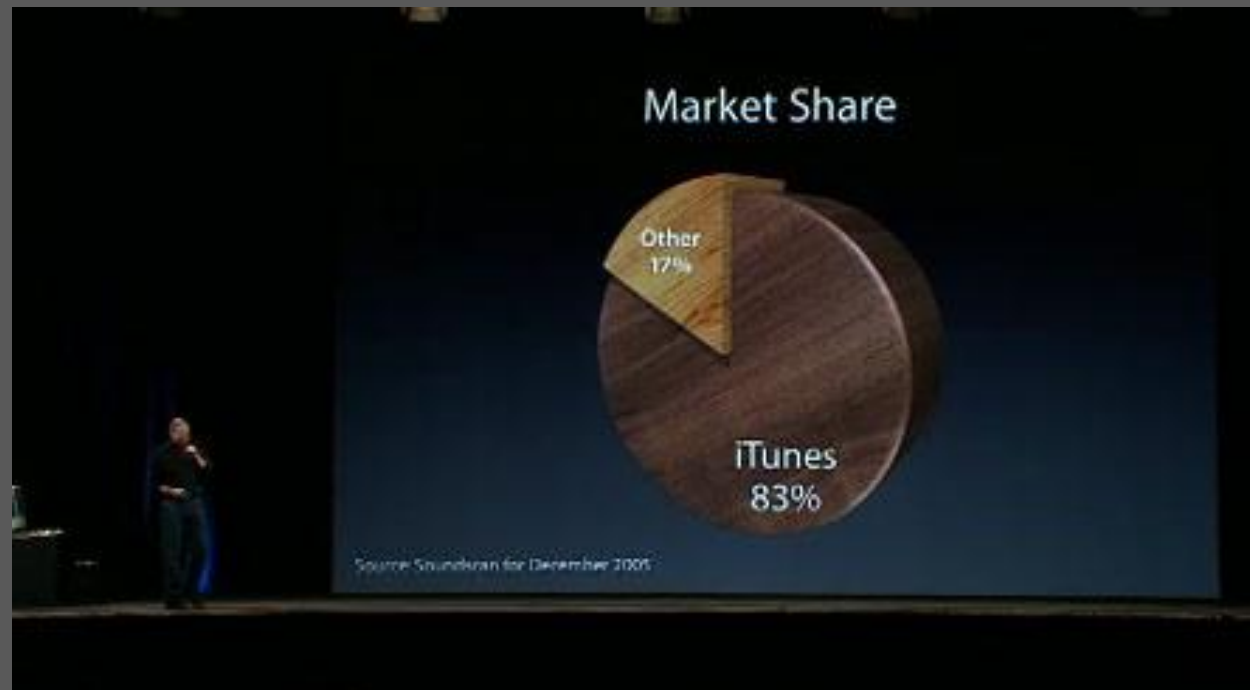
<https://www.heap.io/blog/how-to-lie-with-data-visualization>

# How many iPhones were sold?



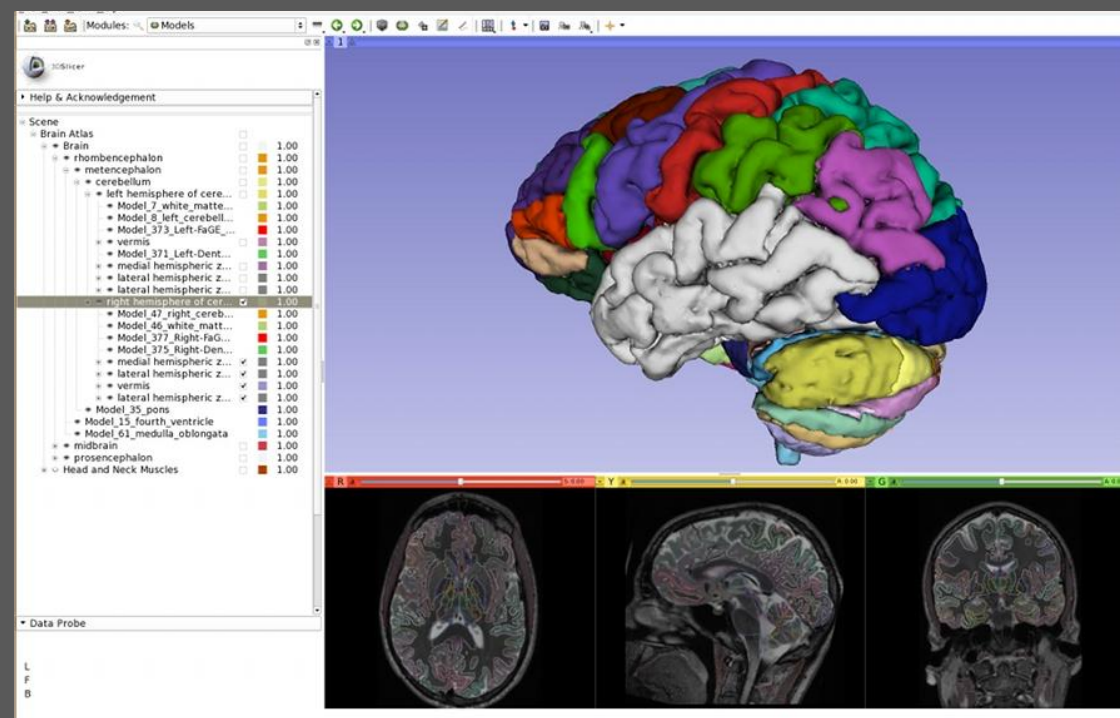
<https://qz.com/122921/the-chart-tim-cook-doesnt-want-you-to-see>

# Unjustified 3D effect



Steve Jobs used 3D pie charts to (mis)represent the market share of products.

# Justified 3D effect

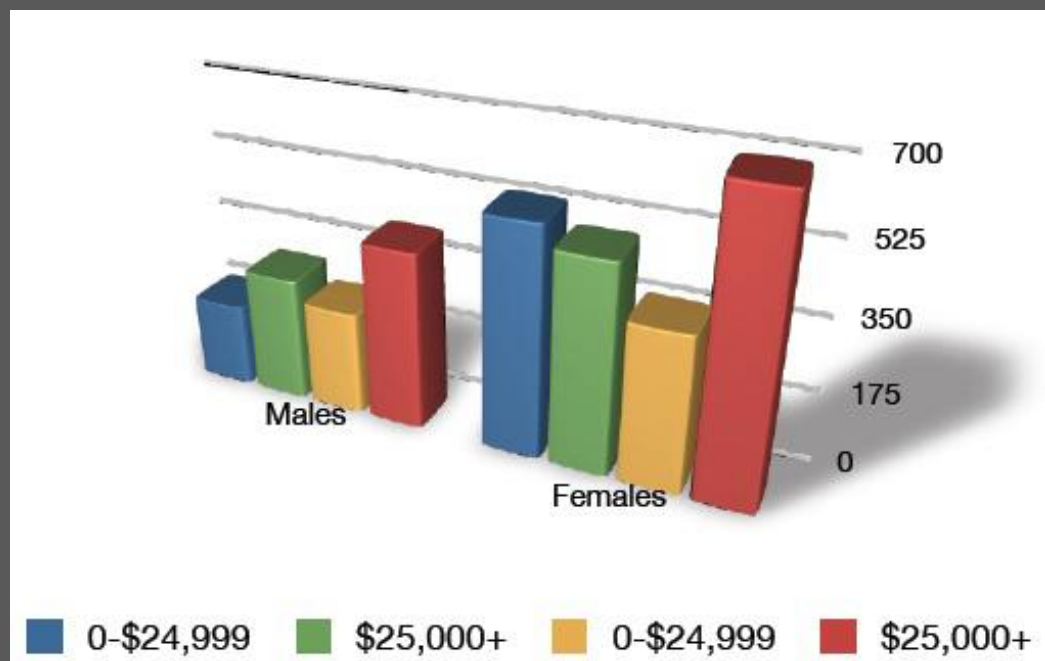


“The number of information-carrying (variable) dimensions depicted should not exceed the number of dimensions in the data.”

Tufte (1983)

# Data ink ratio

Data Ink Ratio = data-ink / total ink in graphic



Tufte (1983)

# Design Rules of Thumb

- **CLEAR VISION:** Make clear visualisations and ensure that the data stands out.
- **CLEAR UNDERSTANDING:** Ensure that main points and conclusions are graphically clear and represented.
- **SCALES:** Pick appropriate axes and tick-mark scales, and ensure all the data is represented.
- **GENERAL STRATEGY:** Ensure all the data is represented. Design your visualizations carefully and allow time to proofread.

# Measurement scales

Nominal, Ordinal, Quantitative

# Mapping data to visual variables

Assign **data fields** (e.g., with *Nominal*, *Ordinal*, *Quantitative* types) to **visual channels** (x, y, colour, shape, size, ...) for a chosen **graphical mark** type (point, bar, line, ...).

Additional concerns include choosing appropriate **encoding parameters** (log scale, sorting, ...) and **data transformations** (bin, group, aggregate, ...).

These options define a large combinatorial space, containing both useful and questionable charts



# Data attribute types

→ Categorical



e.g.,  
fruit (apple, pear, grape),  
colleges(CAMD, Khoury, COE)

→ Ordered

→ *Ordinal*



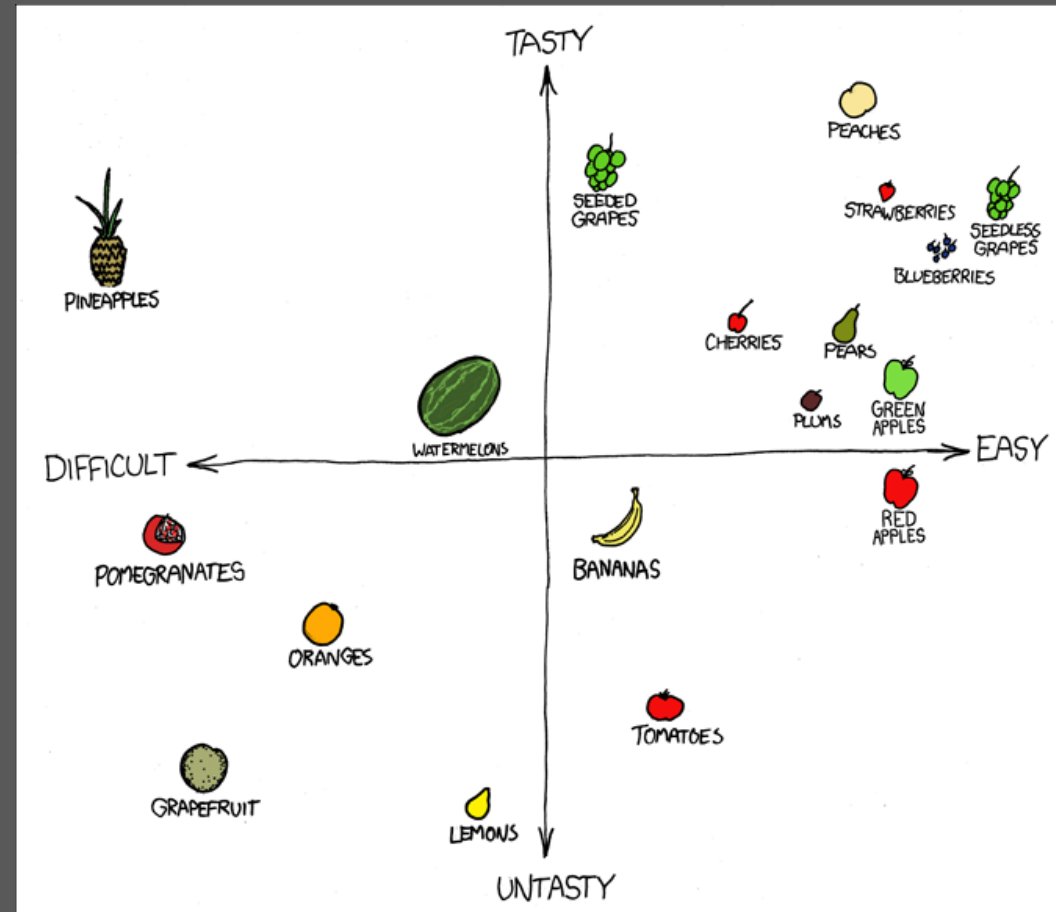
e.g.,  
sizes (xs, s, m, l, xl),  
months(J, F, M)

→ *Quantitative*



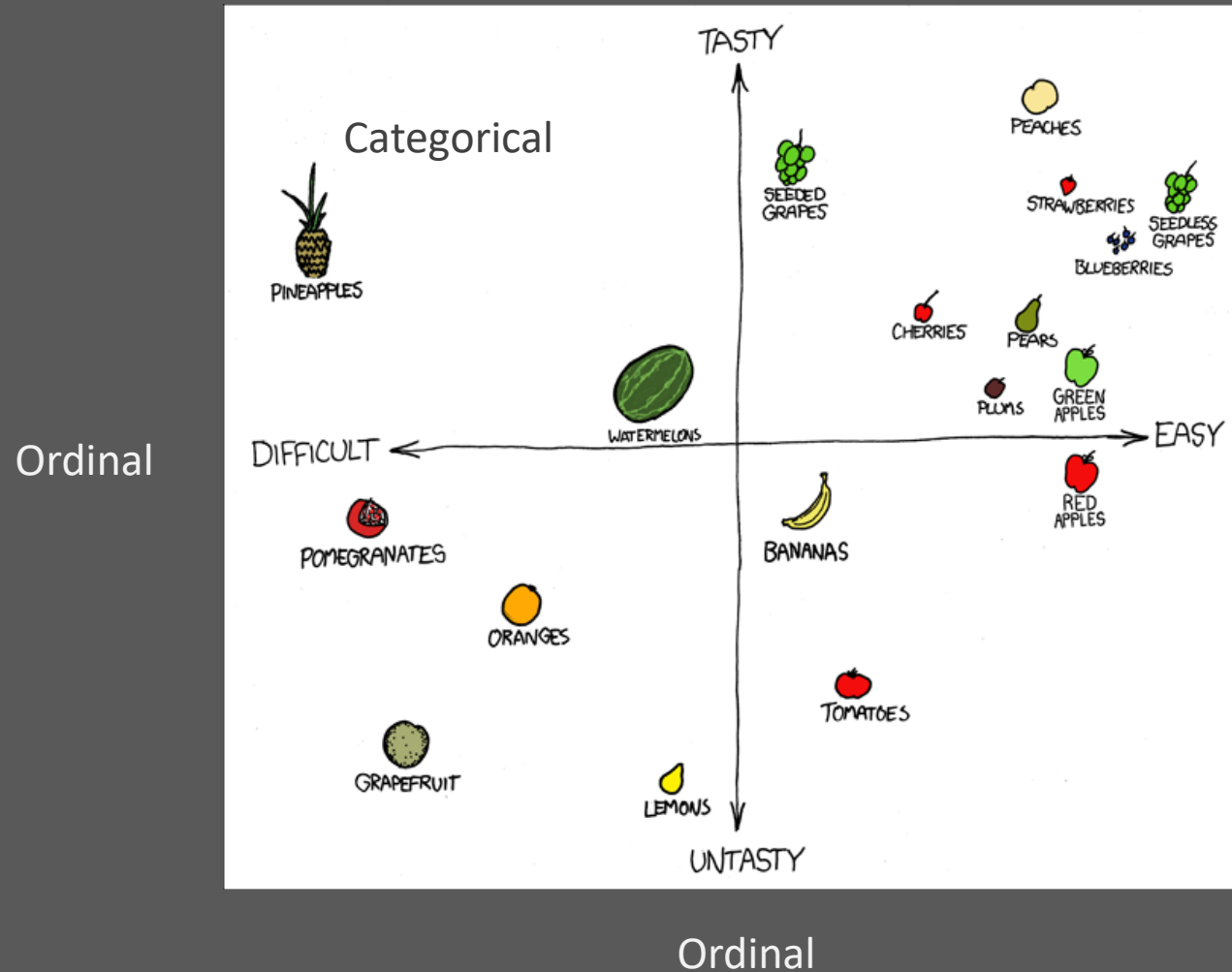
e.g.,  
lengths(1', 2.5', 5'),  
population

# Effort and tastiness of grapefruits



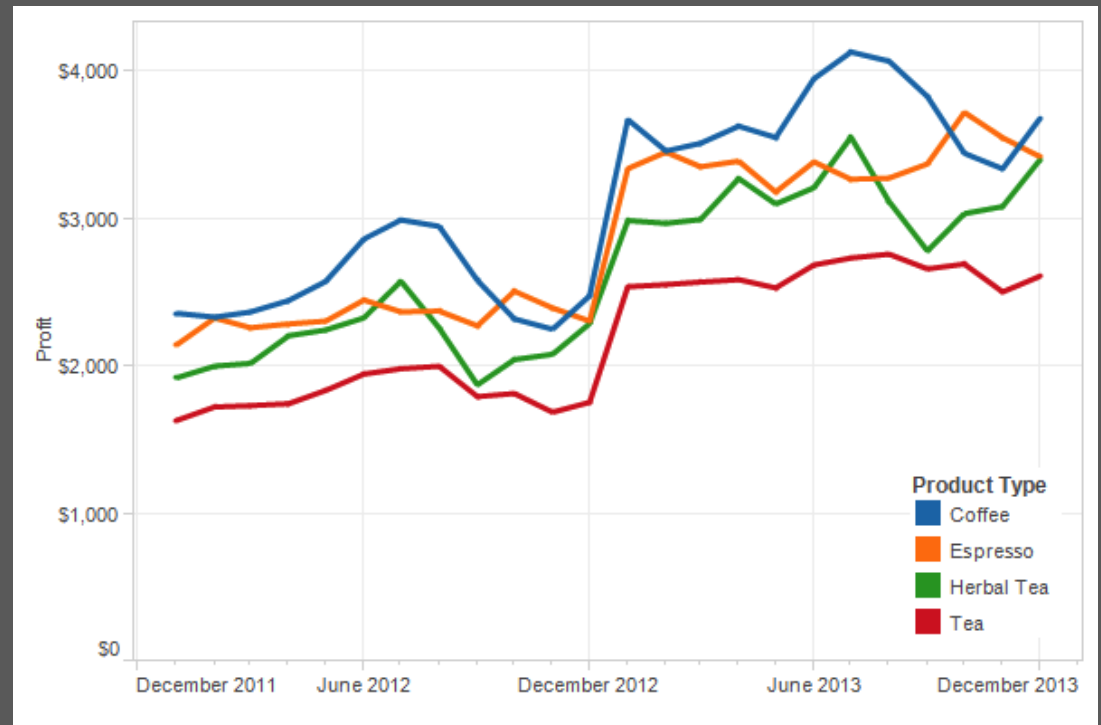
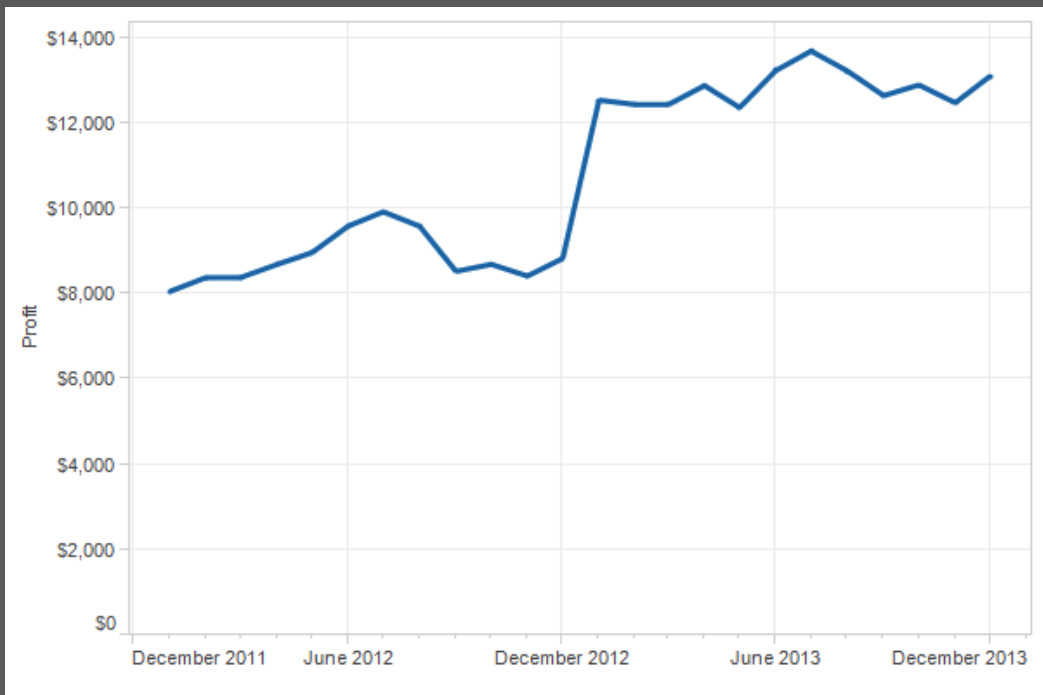
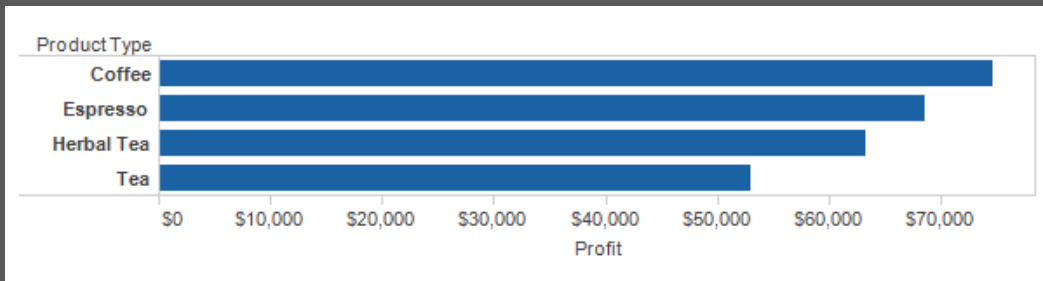
<https://xkcd.com/388/>

# Categorical vs. Ordinal



<https://xkcd.com/388/>

# Categorical vs. Quantitative



<https://eagereyes.org/blog/2013/data-continuous-vs-categorical>

# Marks and Channels

Visual encoding and basic graphical primitives of visualisation

# Constructing visualisations

**MARK** = basic graphical element in an image

## Marks as Items/Nodes

➞ Points



➞ Lines



➞ Areas



## Marks as Links

➞ Containment



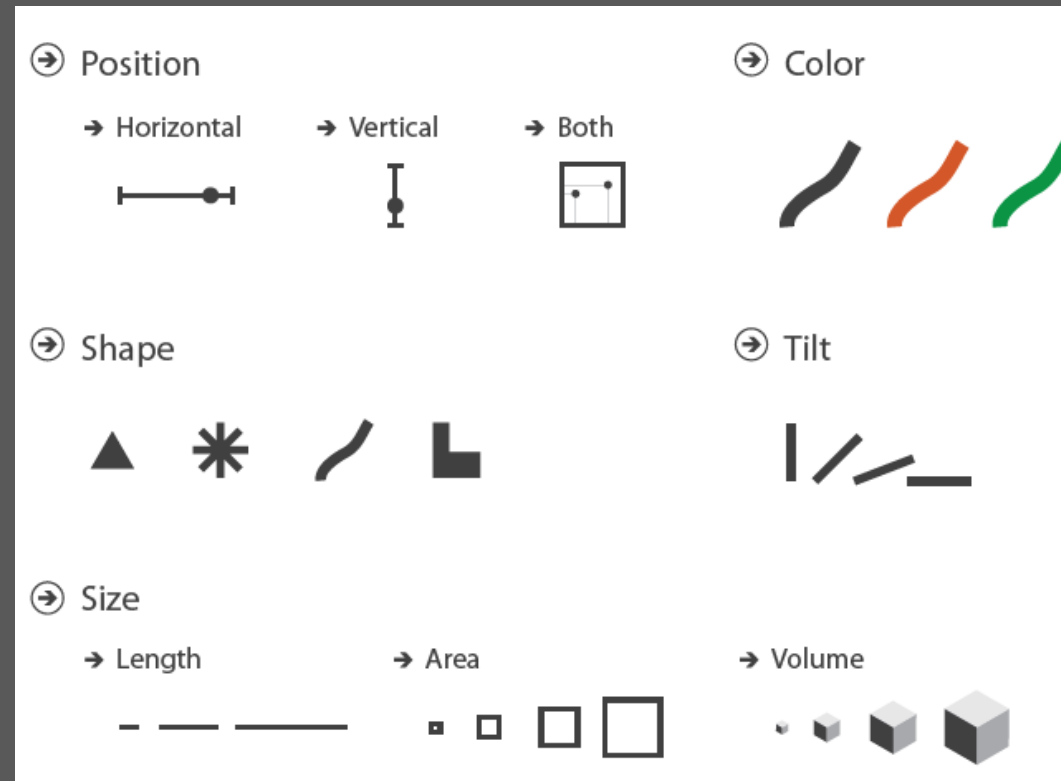
➞ Connection



*Munzner, "Visualization Analysis and Design" (2014)*

# Constructing visualisations

**CHANNEL** = way to control the appearance of marks



*Munzner, "Visualization Analysis and Design" (2014)*

# Visual encodings

Position (x 2)

Size

Value

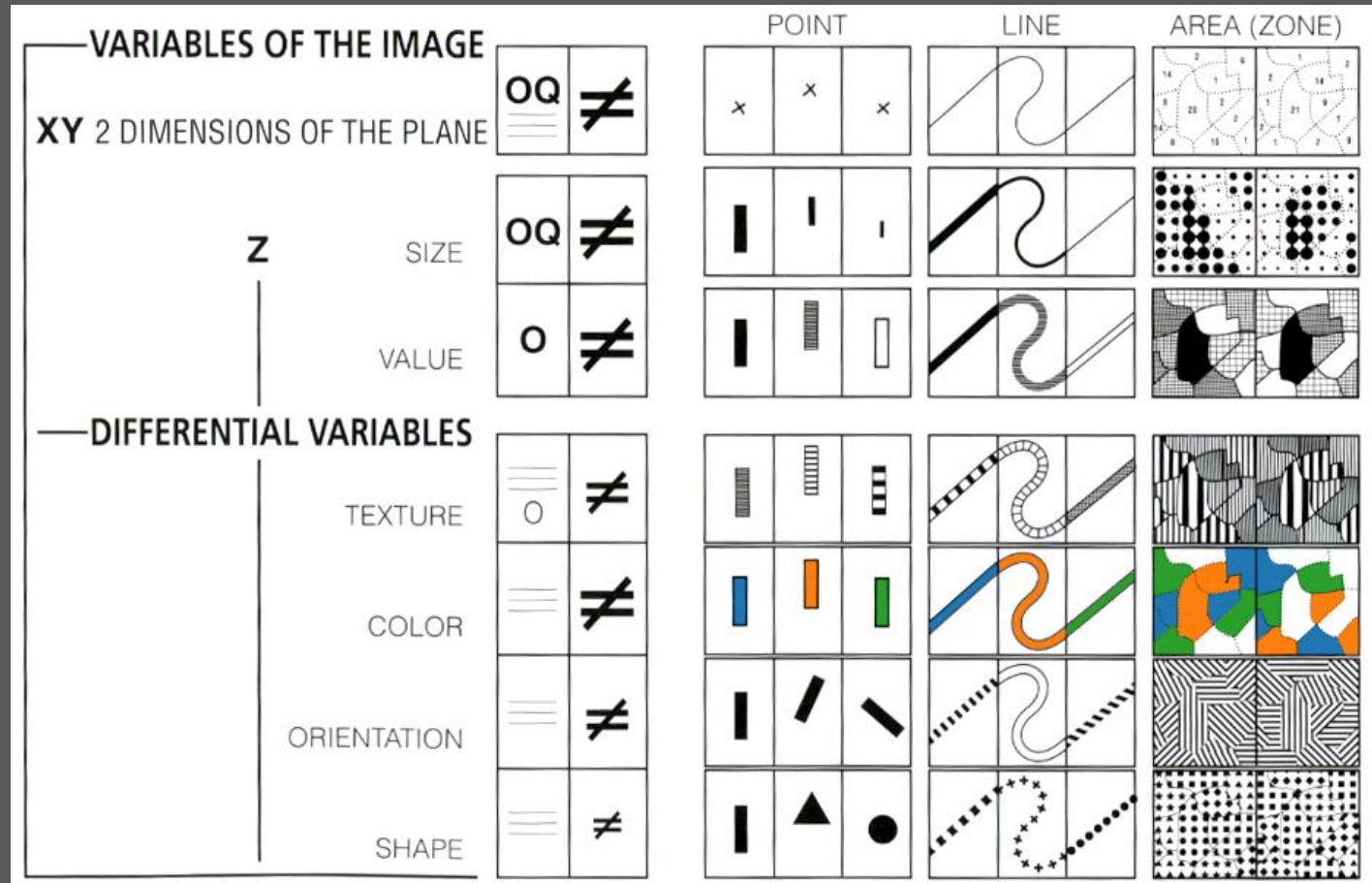
Texture

Colour

Orientation

Shape

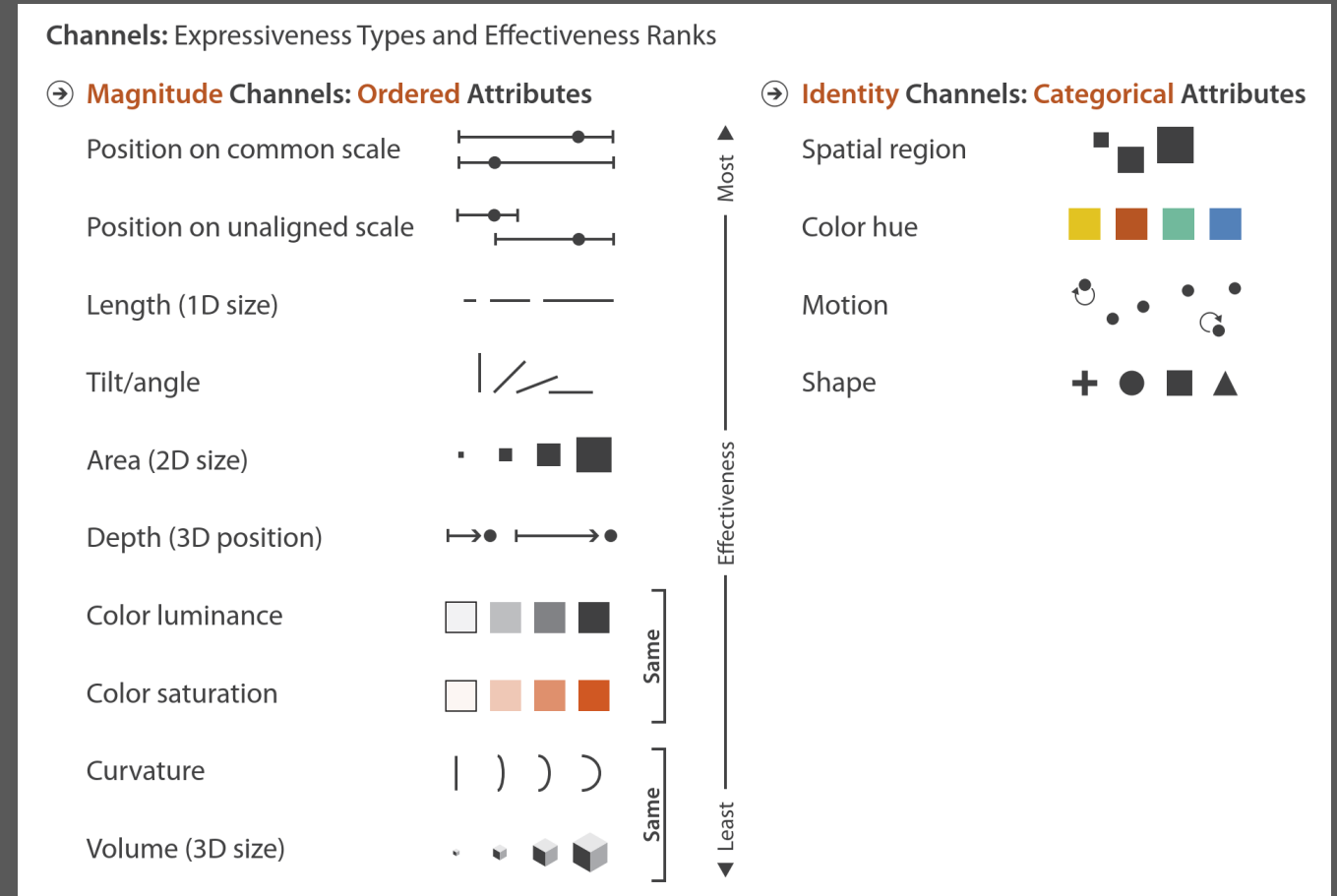
???



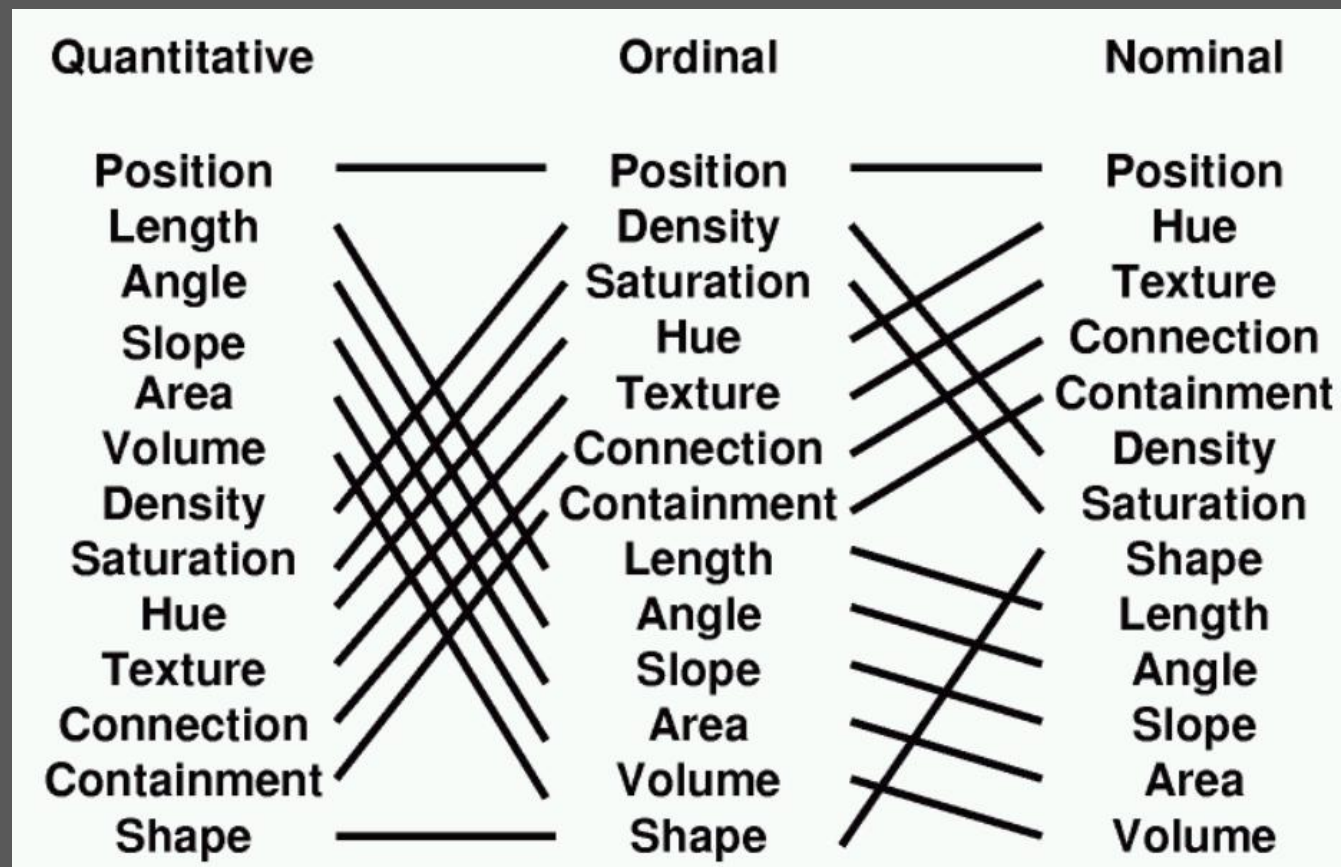
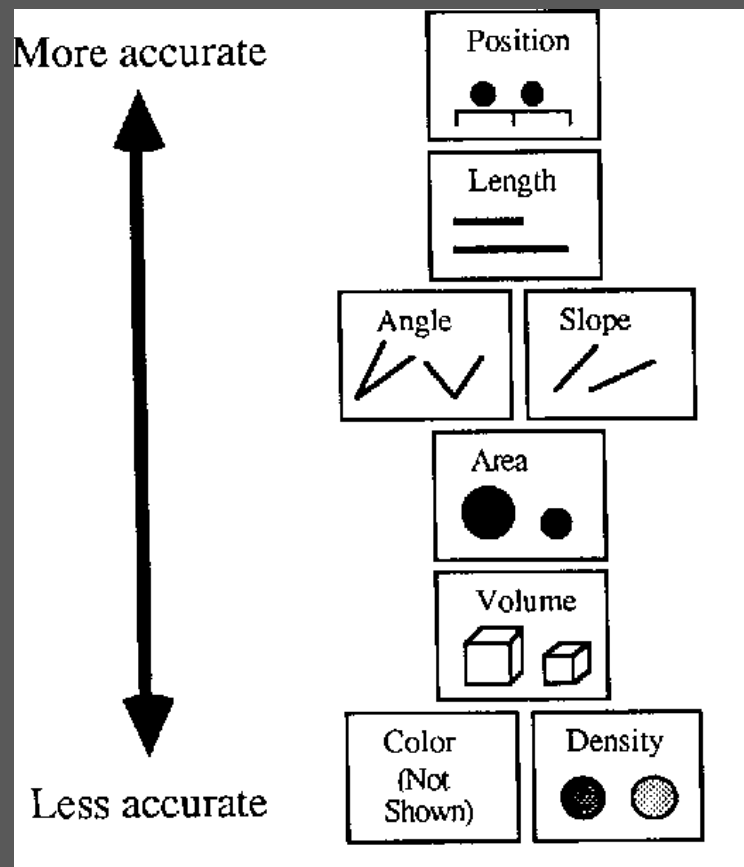


# Channels: Matching Types

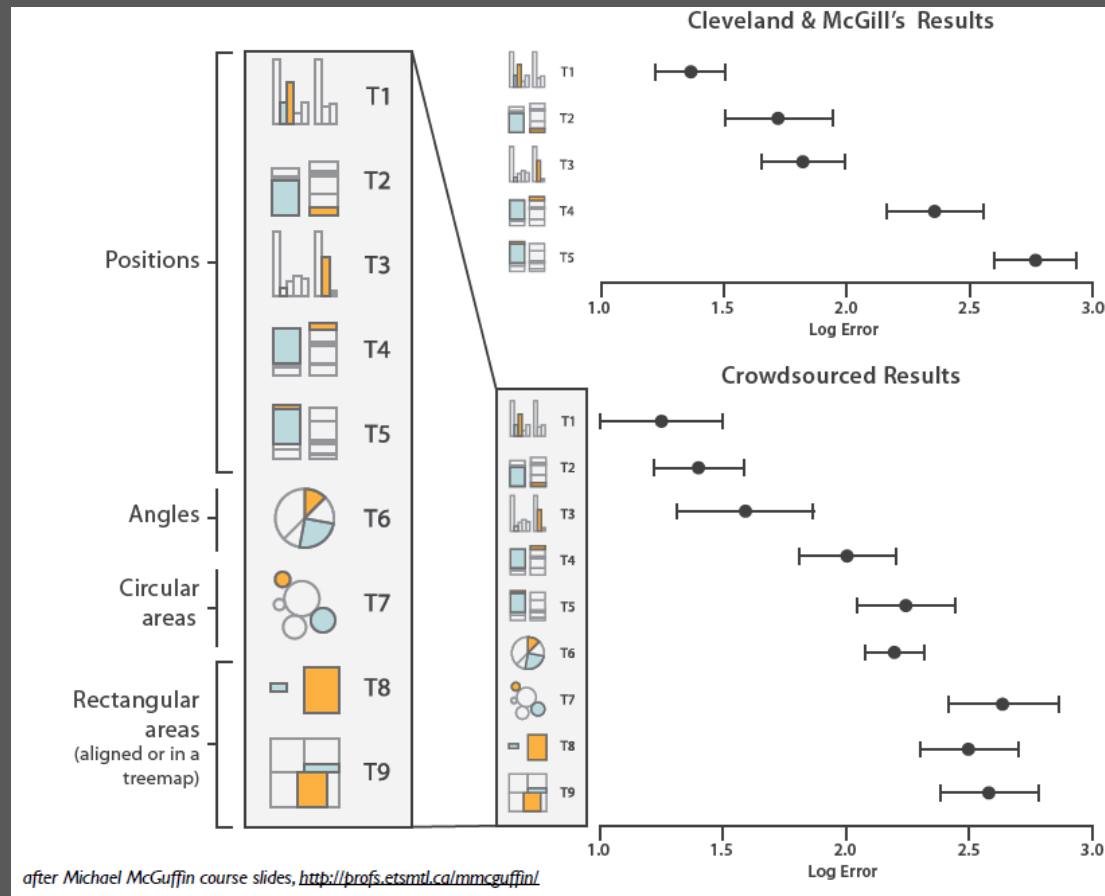
- expressiveness principle
  - match channel and data characteristics
  - **Magnitude** for **ordered**
  - how much? which rank?
  - **Identity** for **categorical**
  - what?
- effectiveness principle
  - encode most important attributes with highest ranked channels?



# Ranks of effectiveness of visual encodings



# Visual encodings accuracy

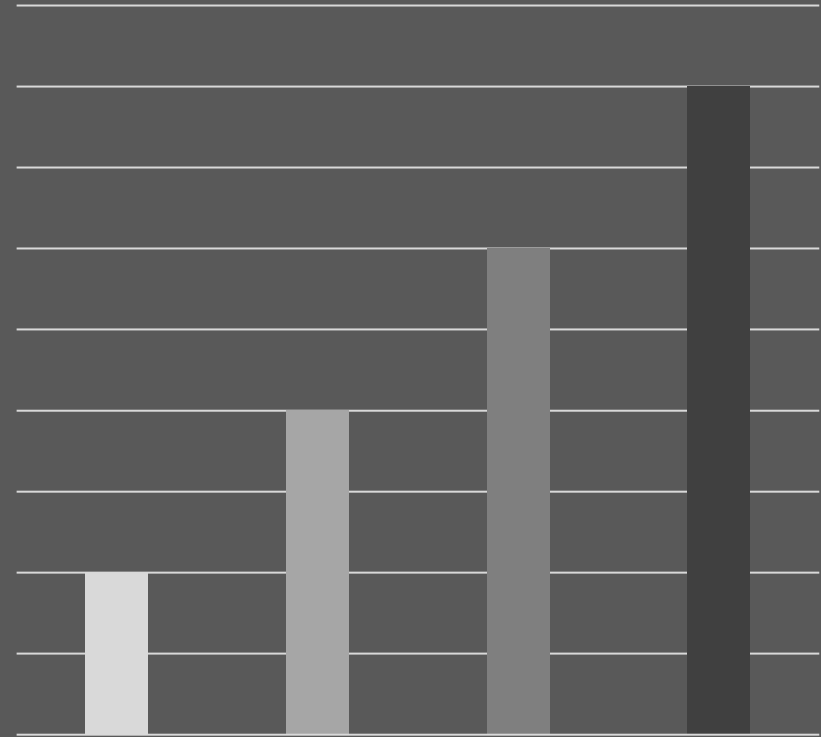


Crowdsourcing Graphical Perception: Using Mechanical Turk to Assess Visualization Design. Heer and Bostock. *CHI 2010*

# Redundant encoding

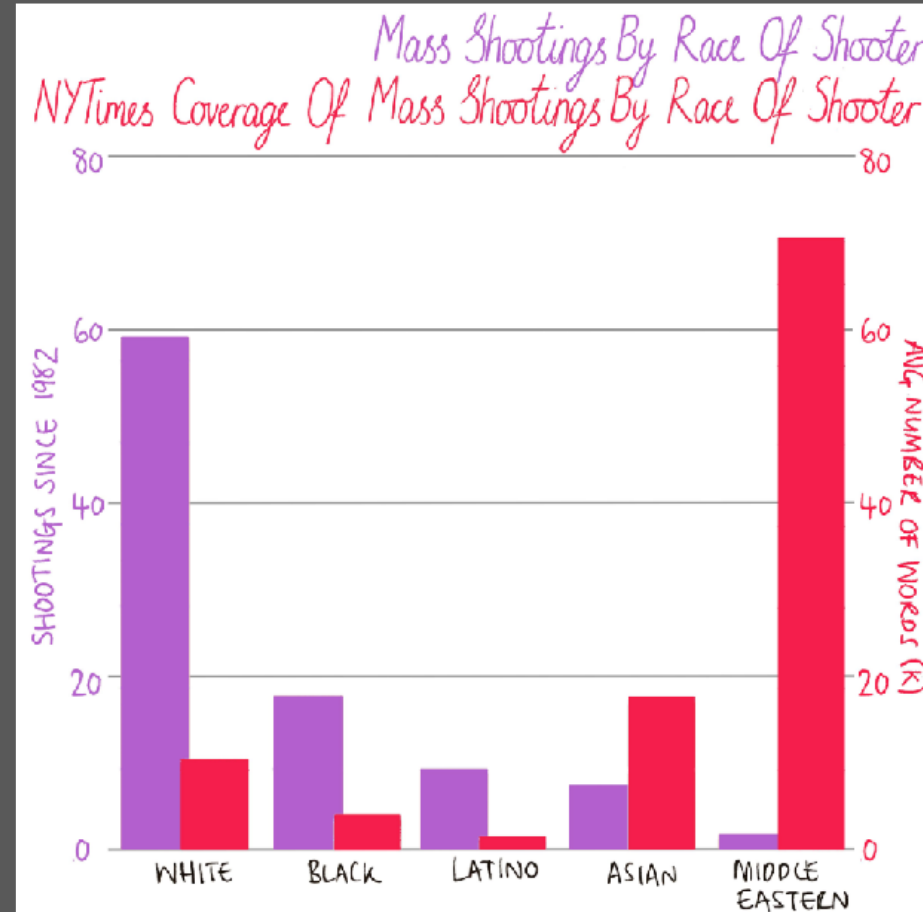
Length, Position, and Value

- sends stronger message
- but uses up channels



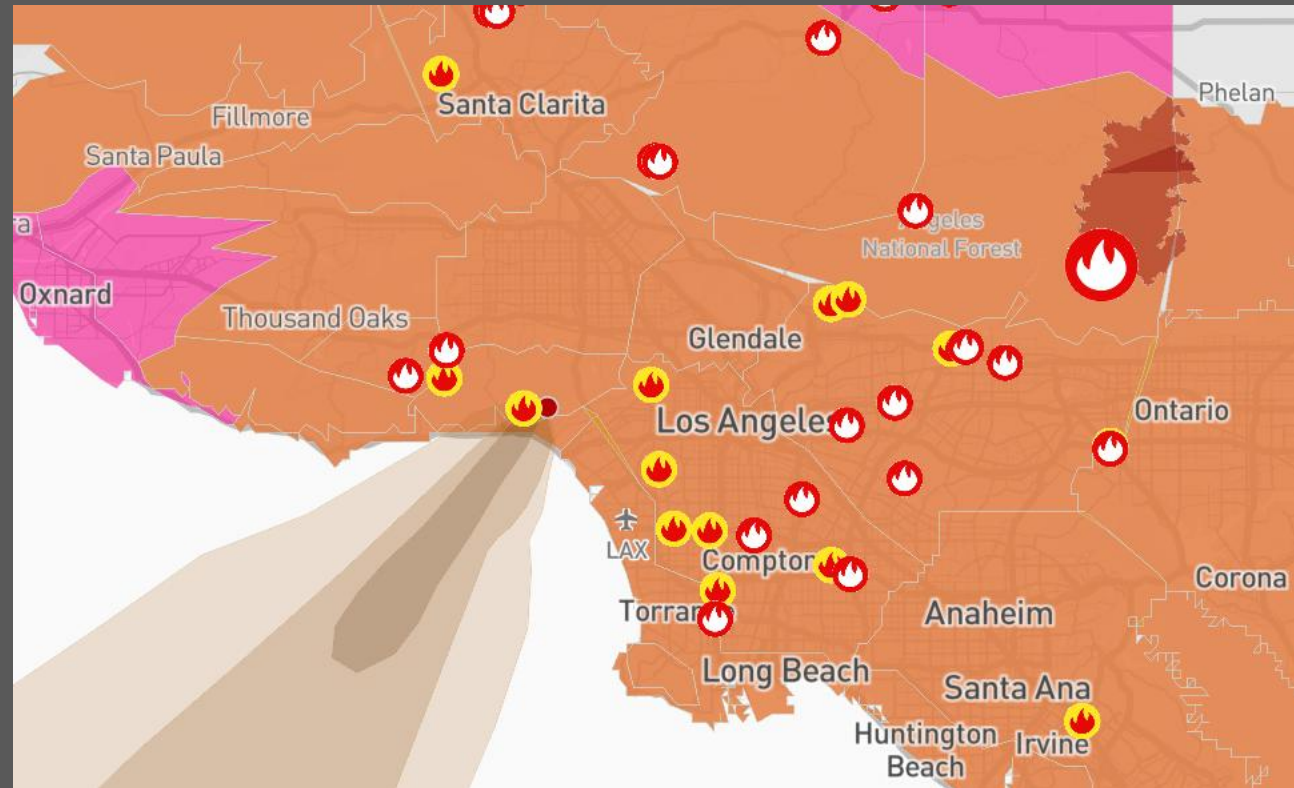
# Name that mark and those channels

- What mark?
- Which channels?



# Name that mark and those channels

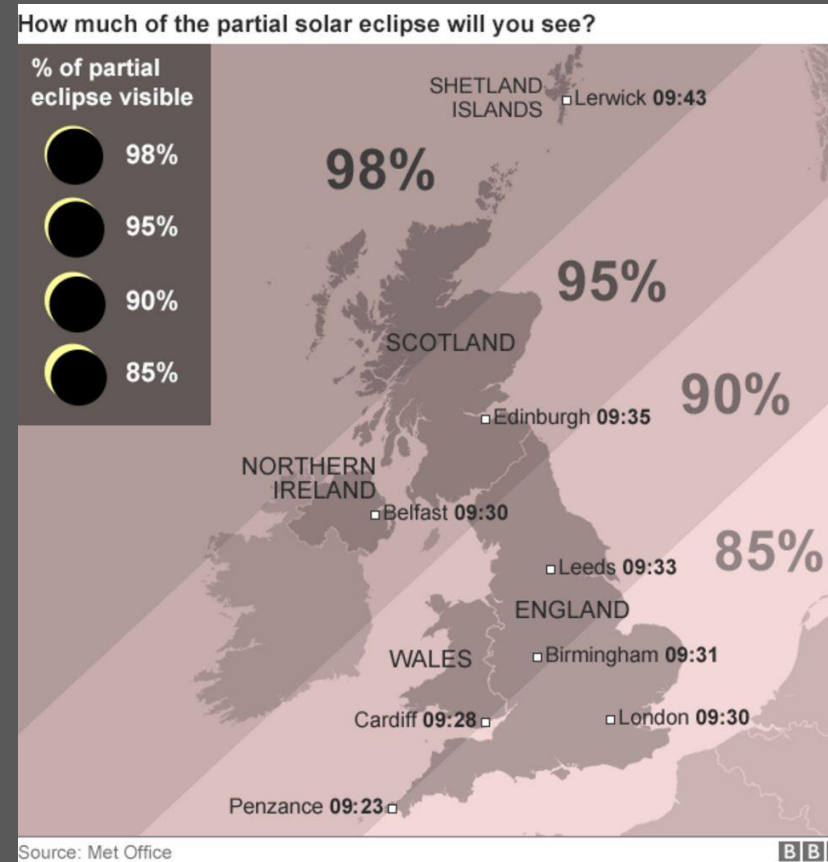
- What mark?
- Which channels?



<https://www.aol.com/another-blaze-eaton-fire-hits-041145374.html>

# Name that mark and those channels

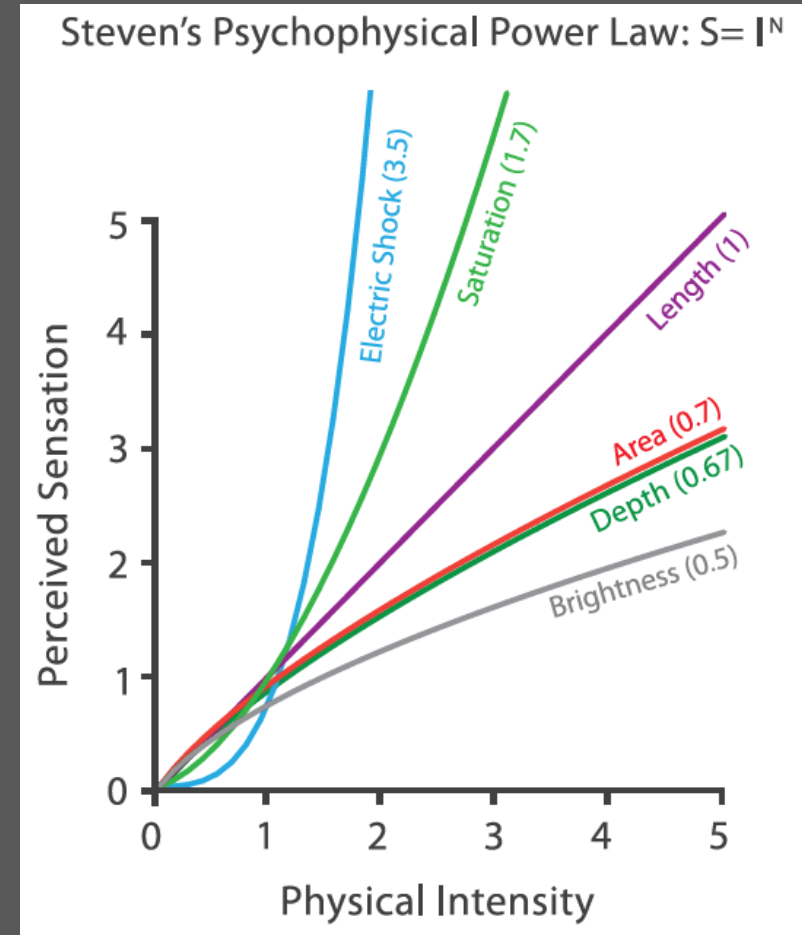
- What mark?
- Which channels?



<https://www.bbc.co.uk/news/science-environment-31965456>

# Channel effectiveness

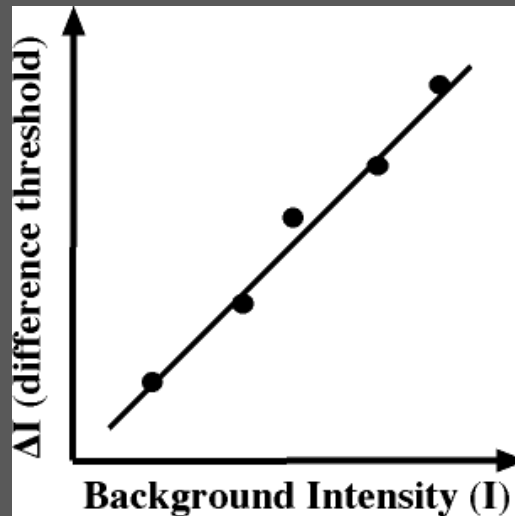
- **Accuracy:** how precisely can we tell the difference between encoded items?
- **Discriminability:** how many unique steps can we perceive?
- **Separability:** is our ability to use this channel affected by another one?
- **Popout:** can things jump out using this channel?



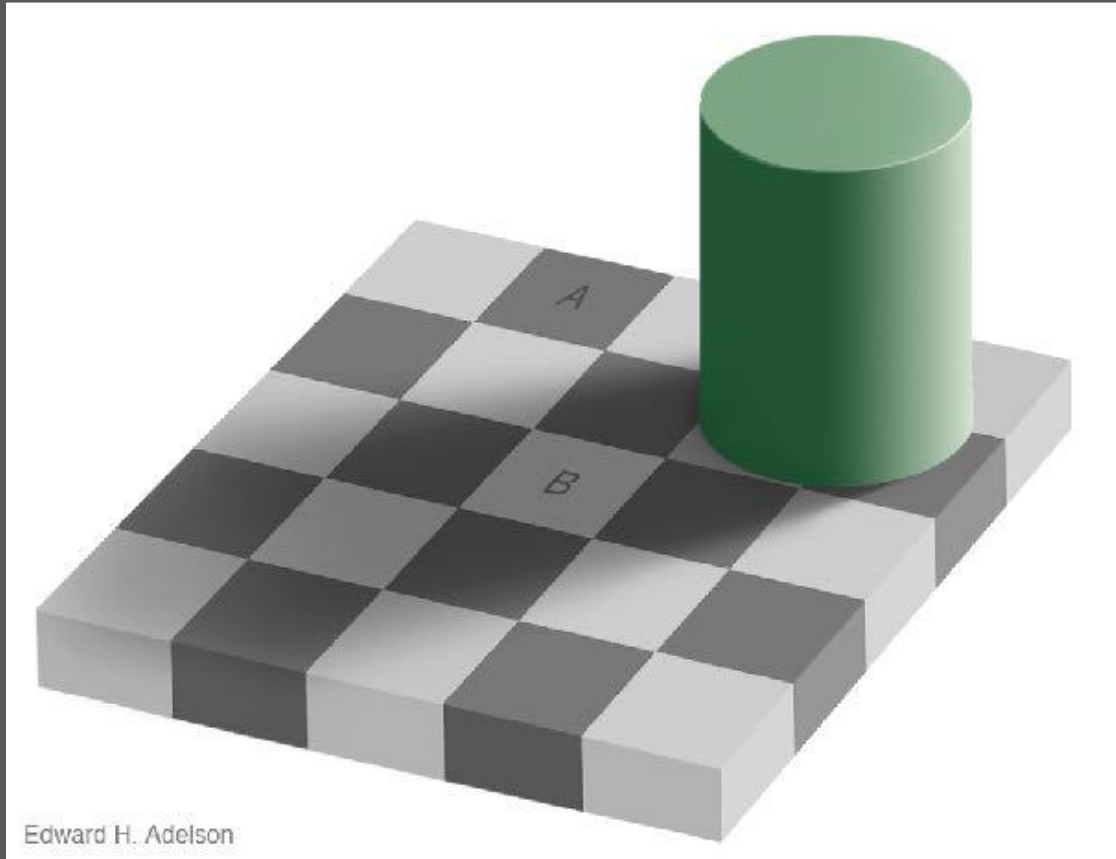


# Relative vs. absolute judgements

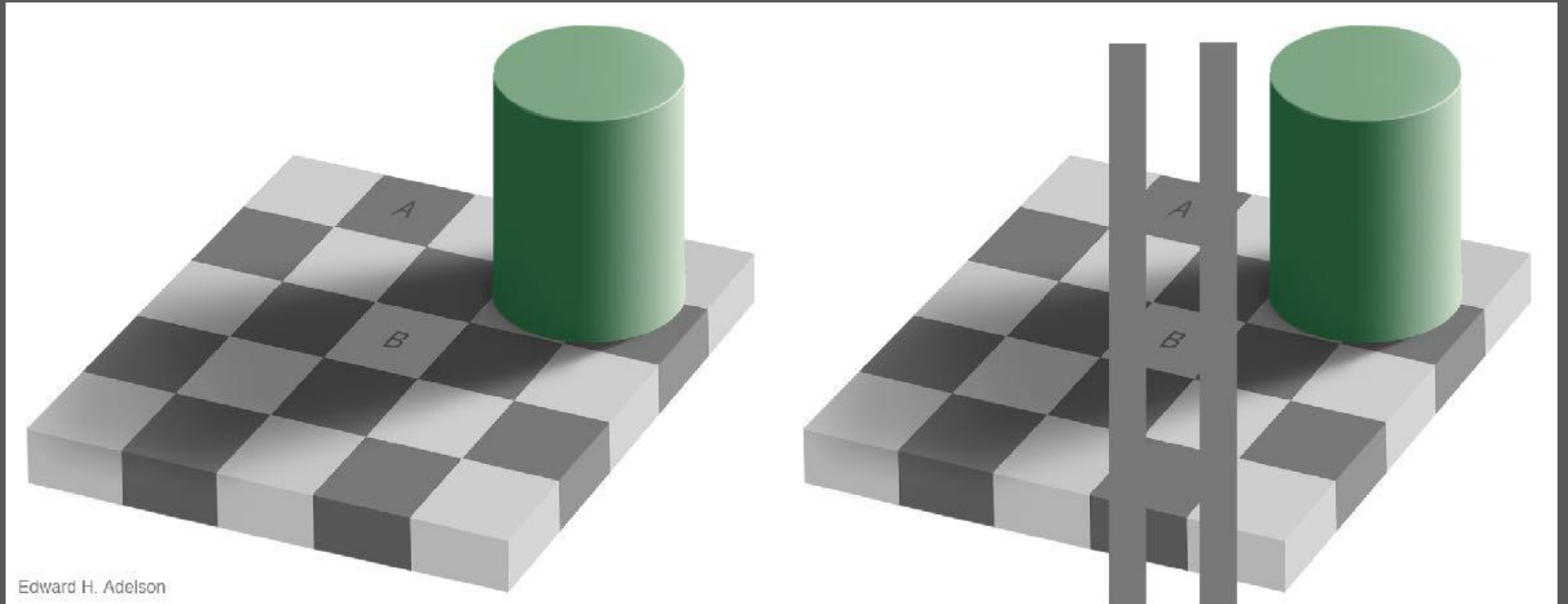
We perceive the world mostly through relative judgements, not absolute ones. Weber's Law: ratio of increment to background is constant .



# Relative luminance judgements



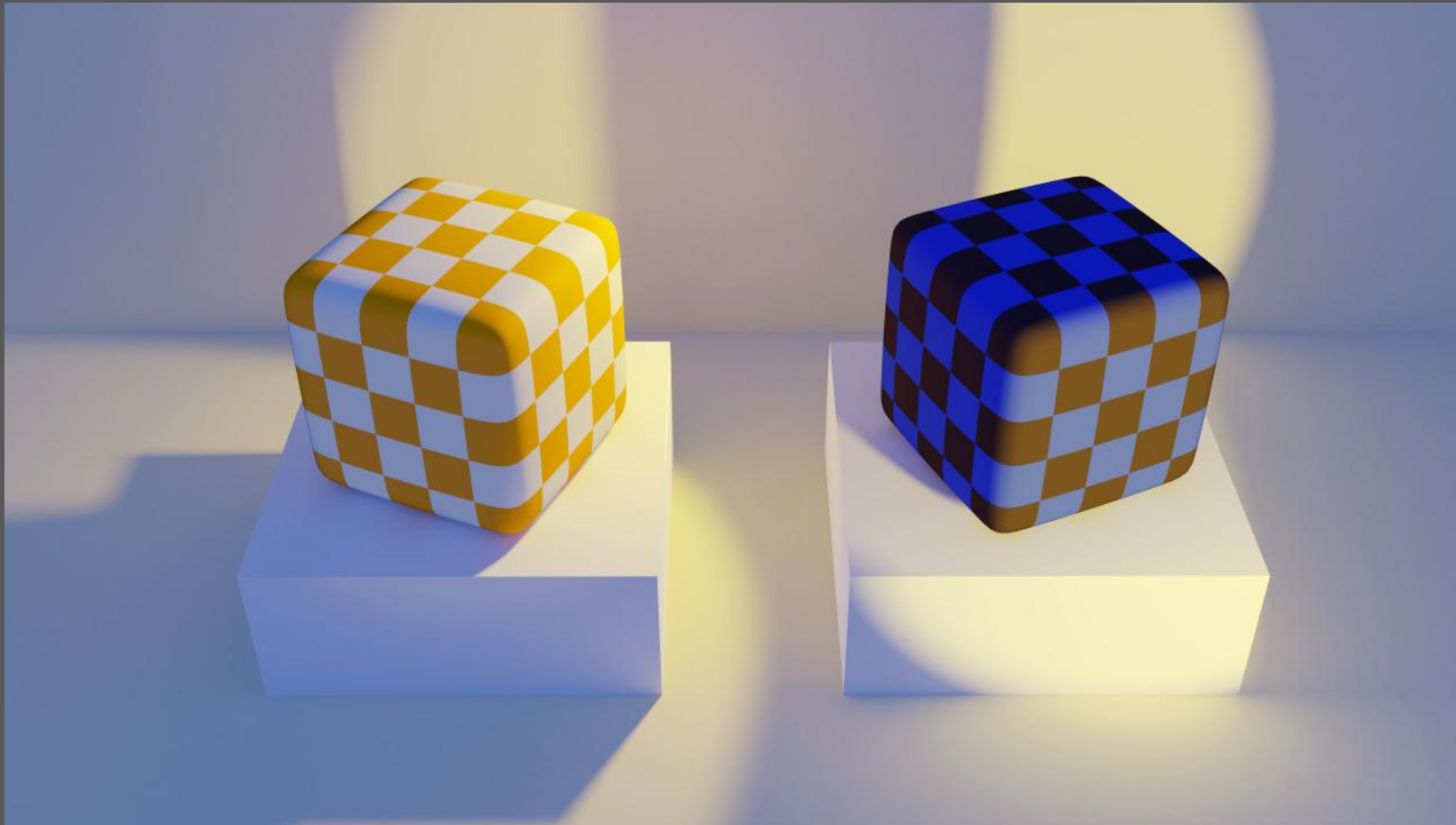
# Relative luminance judgements



# Relative colour judgements #thedress

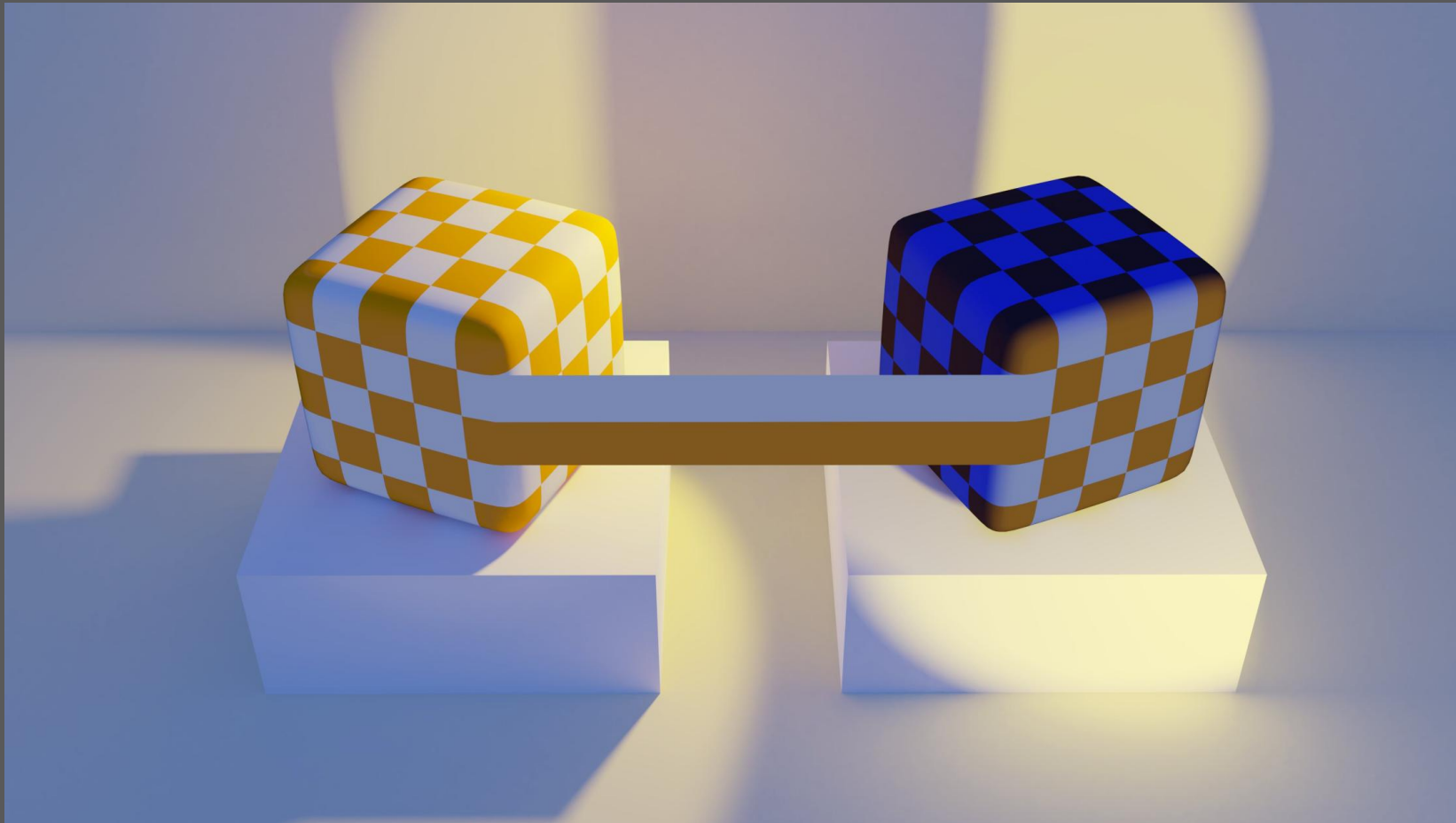


# Relative colour judgements



Cubes illusion, Vladusich (2021)

# Relative colour judgements



Cubes illusion, Vladusich (2021)

Questions?