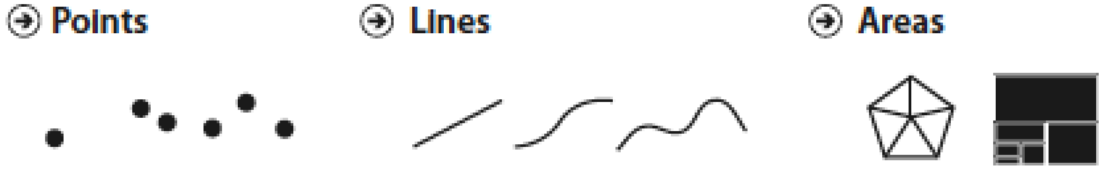
Marks and Channels

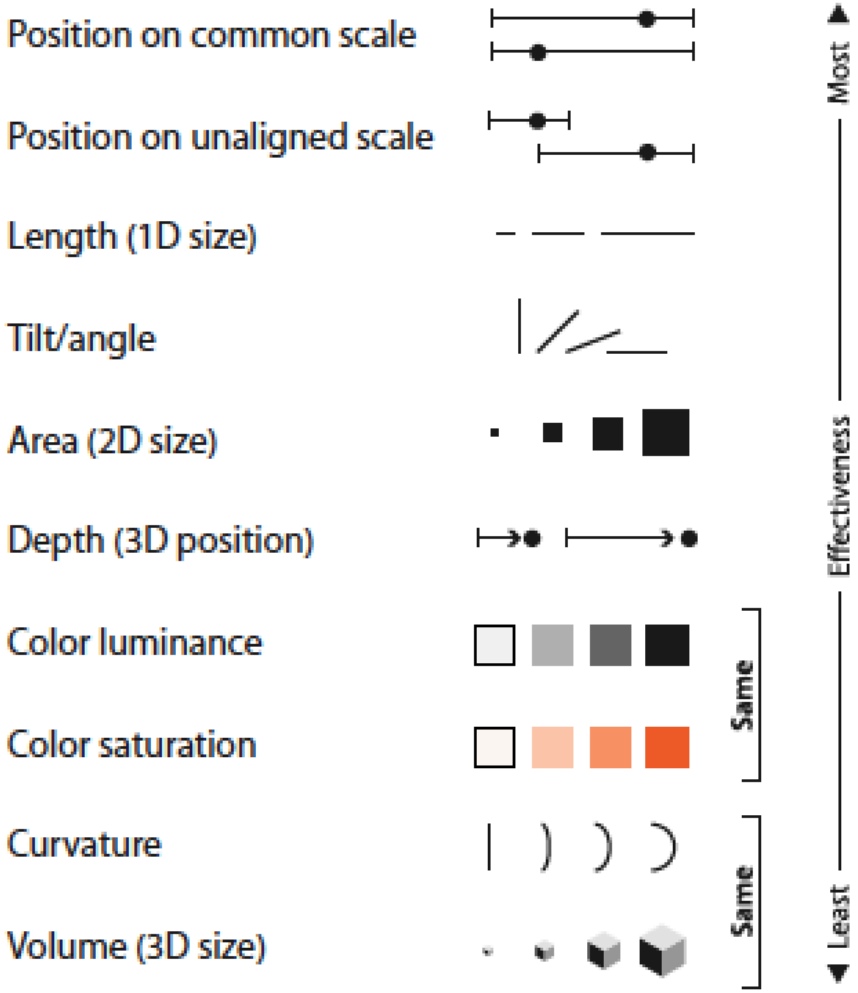
The Big Picture

- Marks: basic geometric elements that depict items and links

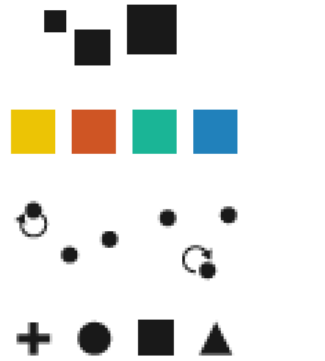


- Channels: control the marks' appearance
  - Magnitude for ordered data
  - Indentify for categorical data
- Marks and channels are building blocks for visual encoding

Magnitude Channels: Ordered Attributes

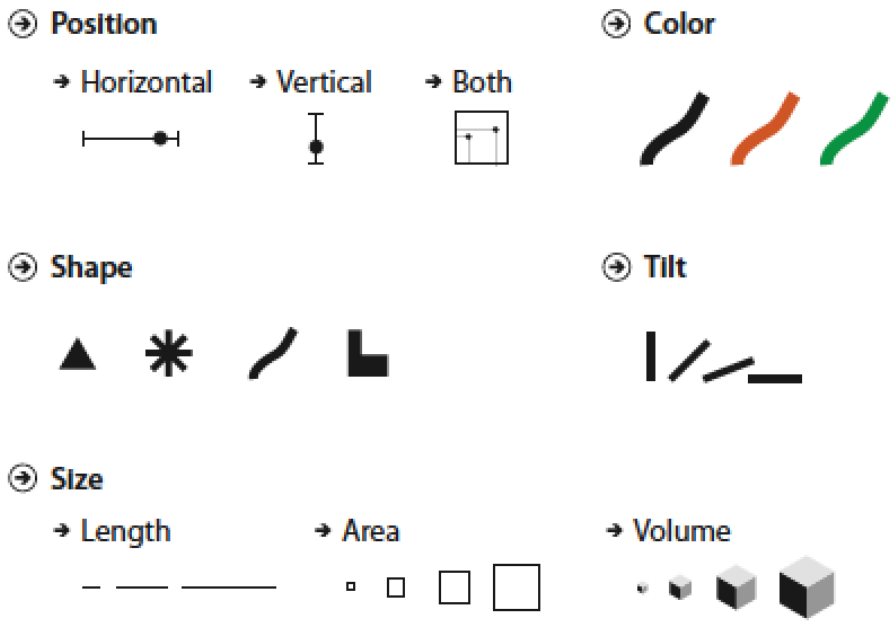


Identity Channels: Categorical Attributes



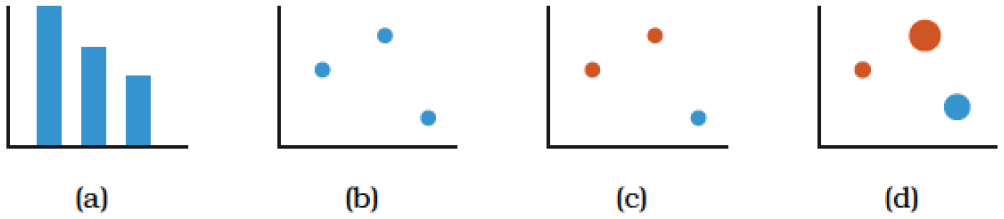
Marks and Channels

- Marks can be classified according to their spatial dimensions
  - 0 D: points; 1D: lines; 2D: areas, etc.
- Channels encode properties of a mark



Marks and Channels

- Bar charts:
  - Marks: Lines
  - Channels: Vertical lengths and horizontal positions
- Scatterplots:
  - Marks: Points
  - Channels: Vertical and Horizontal positions + colors (optional)



Channel and Mark Types

- Channel Types:
  - Identify channels: what something is and where it is (circle, triangle, cross, etc.)
  - Magnitude channels: how much something there is (length, luminance, etc.)
- Mark Types:
  - Item marks
  - Link marks: show relationship between items
    - Connection marks: show pair wise relationship
    - Containment marks: show hierarchical relationship

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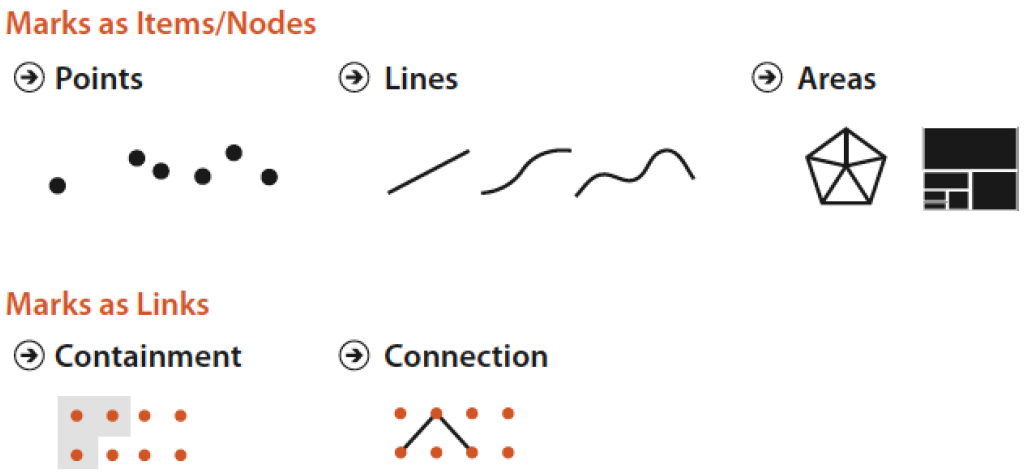
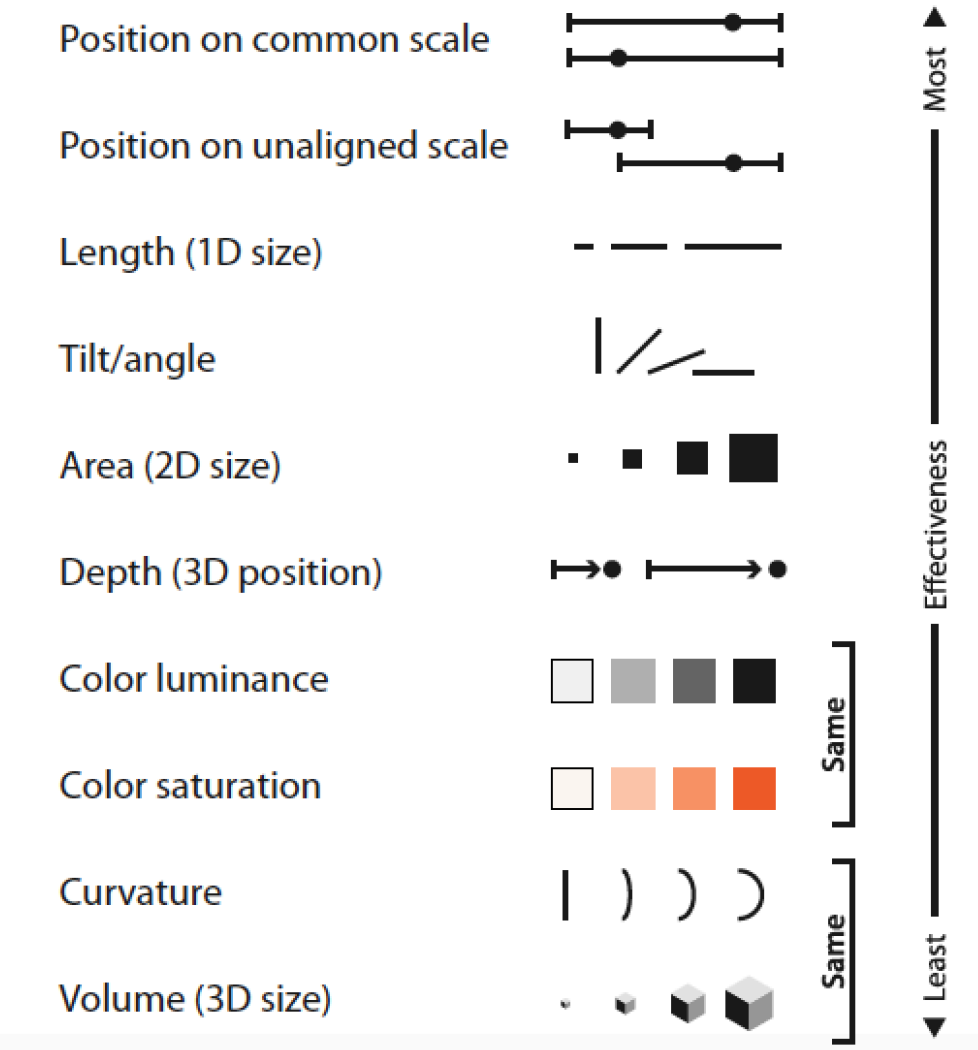


Choice of Marks and Channels

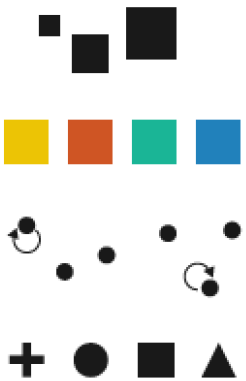
- Expressiveness
  - The visual encoding should express all of the information in the data set
    - For example, ordered data are seen as orders (and vice versa)
- Effectiveness
  - The importance of the attribute should match the salience of the channel
    - For example, important items are made the most noticeable

Channel Ranking

Magnitude Channels: Ordered Attributes



Identity Channels: Categorical Attributes



Channel Effectiveness

- How do we determine the ranking above?
  - Accuracy
  - Discriminability
  - Separability
  - Popout
  - Grouping

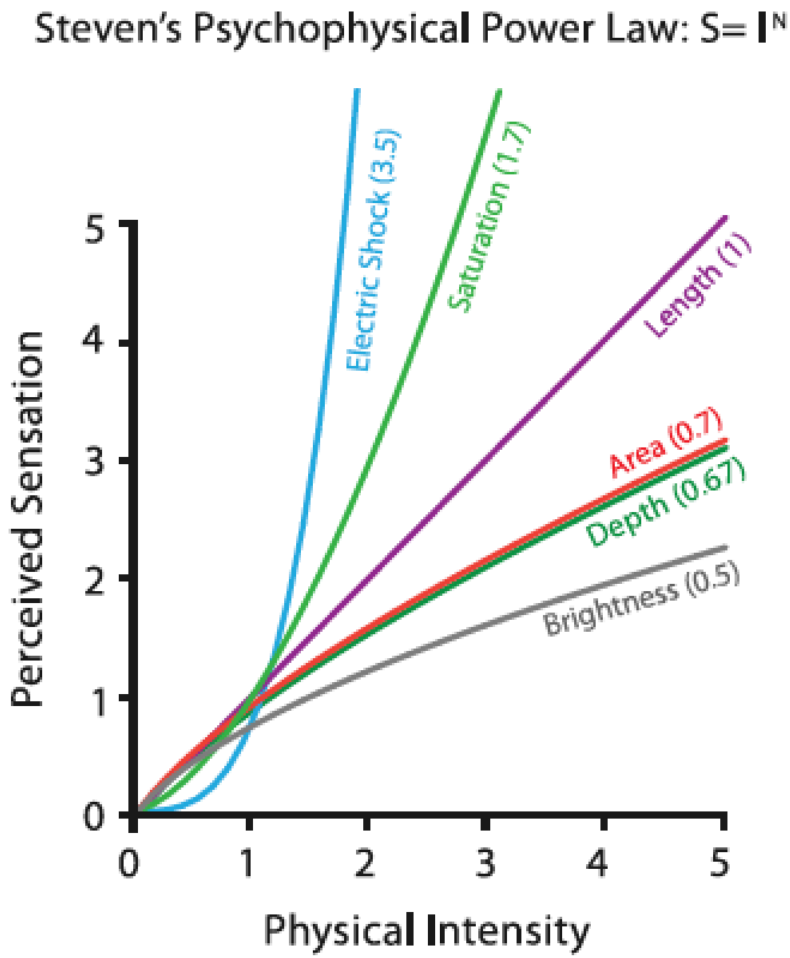
Channel Accuracy

- How close is human perceptual judgment to some objective measurement of the stimulus?
- Our responses to the sensory experience of magnitude follow power laws

$$S = I^n$$

  - S: perceived sensation
  - I: physical intensity

Steven's Pyschophysical Law

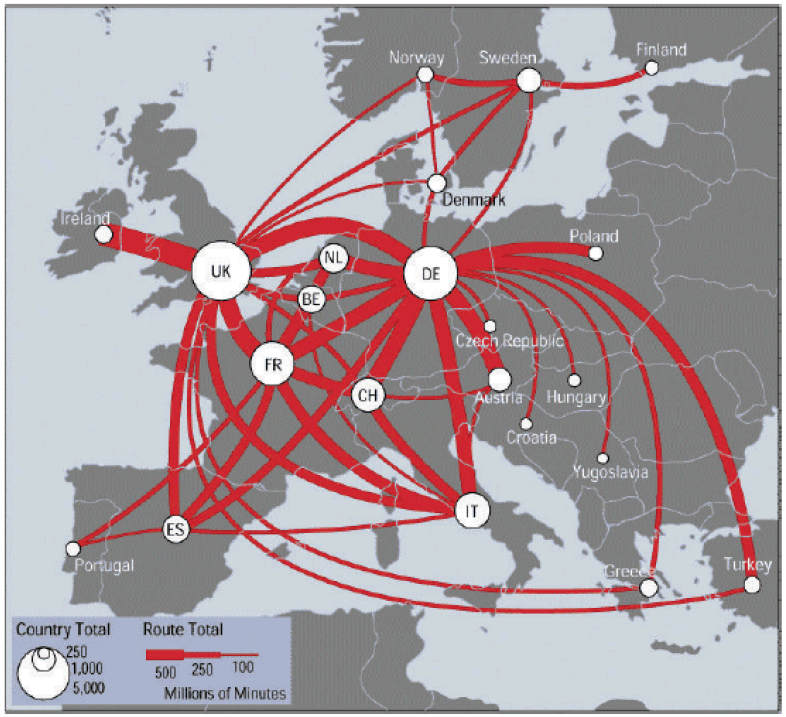


Channel Accuracy

- Cleveland and McGill's experiment on magnitude channel
- Aligned position > unaligned position > length > angle > area > volume > curvature > luminance > hue

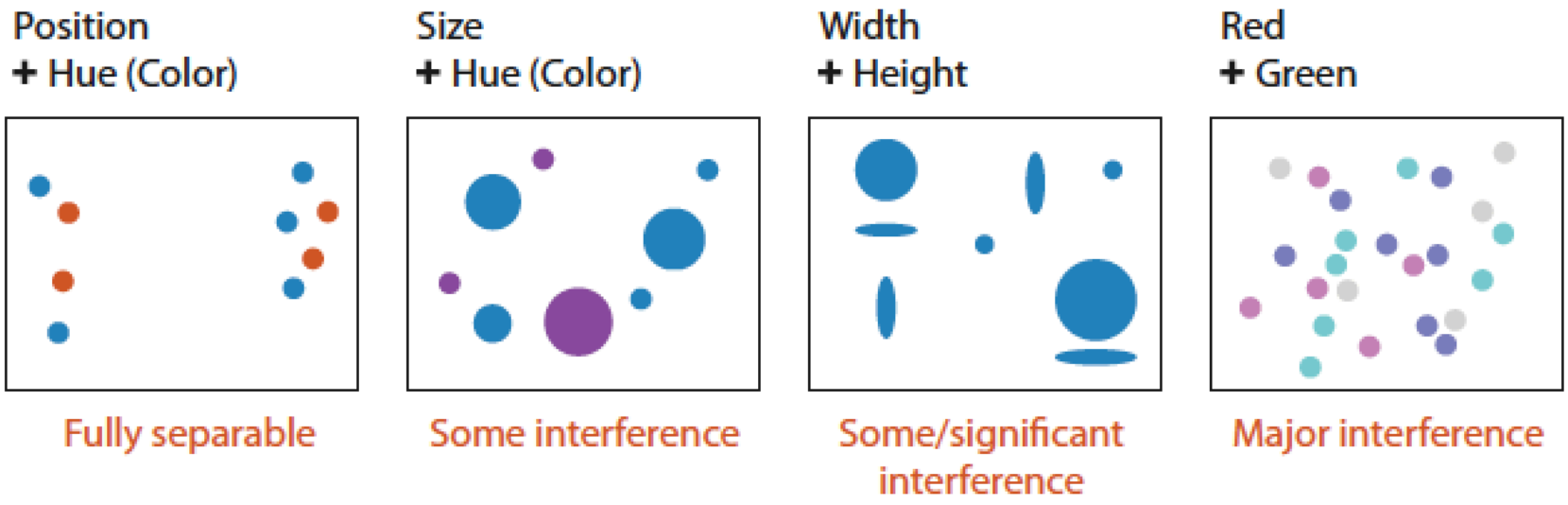
Discriminability

- How many distinguishable levels (bins) in the channel?
  - Linewidth works well for 3 or 4 levels



Separability

- Not all channels are independent



Popout

- Distinct items stand out

Harder

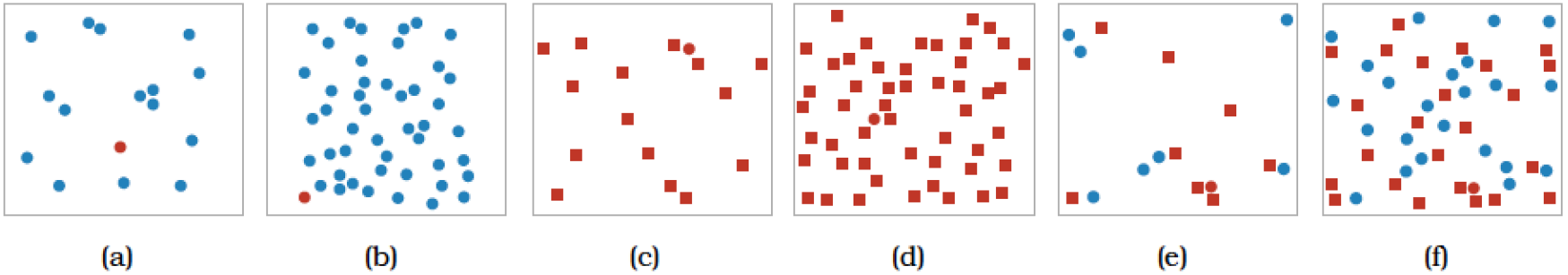
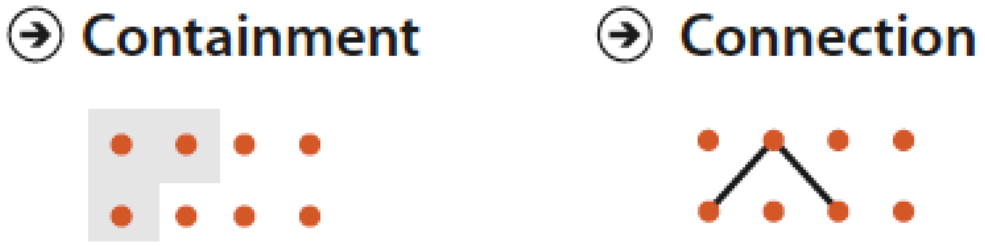


Figure 5.11. Visual popout. (a) The red circle pops out from a small set of blue circles. (b) The red circle pops out from a large set of blue circles just as quickly. (c) The red circle also pops out from a small set of square shapes, although a bit slower than with color. (d) The red circle also pops out of a large set of red squares. (e) The red circle does not take long to find from a small set of mixed shapes and colors. (f) The red circle does not pop out from a large set of red squares and blue circles, and it can only be found by searching one by one through all the objects. After http://www.csc.ncsu.edu/faculty/healey/PP by Christopher G. Healey.

More difficult to pop out with multiple channels combined together

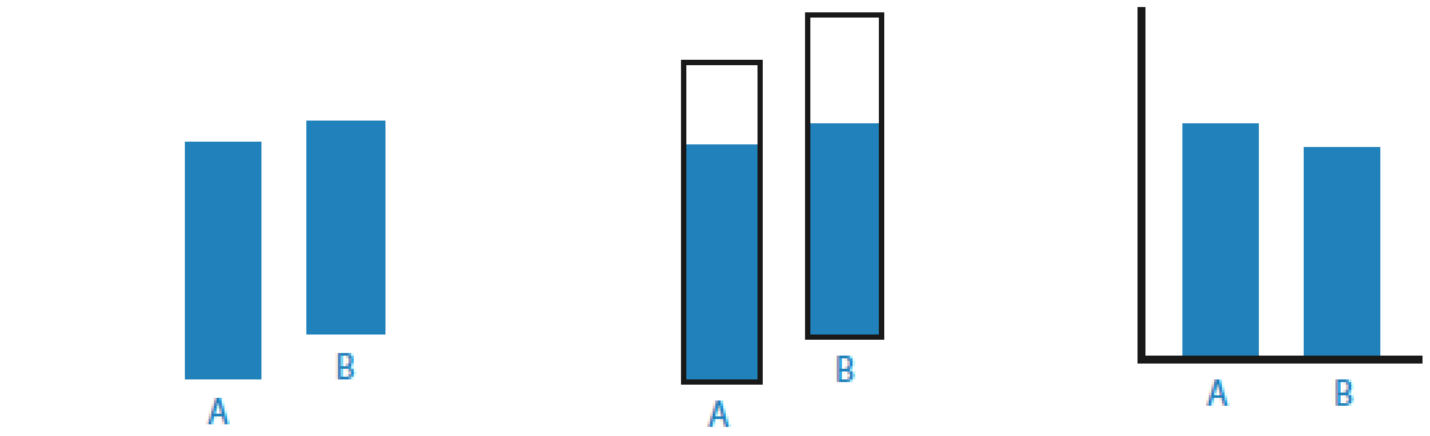
Grouping

- Select proper channels that allow visual grouping or visual clustering
  - Use link marks with area of containment
  - Use identify channel to encode categorical data
  - Proximity: placing similar items nearby
  - Similarity: hue, motion, etc



Relative vs. Absolute Judgment

- Human perception is based on relative judgment, not absolute - Weber's law



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Do square A and B have the same luminance?