Visual Perception

CMSC 205

Winter 2017

What makes a good visualization?

Tufte's graphical excellence

- ...is the well designed presentation of interesting data - a matter of substance, of statistics and of design.
- ...consists of complex data communicated with clarity, precision and efficiency.
- ...is that which gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space.
- ...is nearly always multivariate.
- ...requires telling the truth about the data.

Ross Ihaka's three principles

- If the "story" is simple, keep it simple.
- If the "story" is complex, make it look simple.
- Tell the truth.

Graphical perception

Graphical perception

The ability of viewers to interpret visual (graphical) encodings of information and thereby decode information in graphs.

Which best encodes quantities?

Position

Length

Area

Volume

Value (Brightness)

Color

Hue

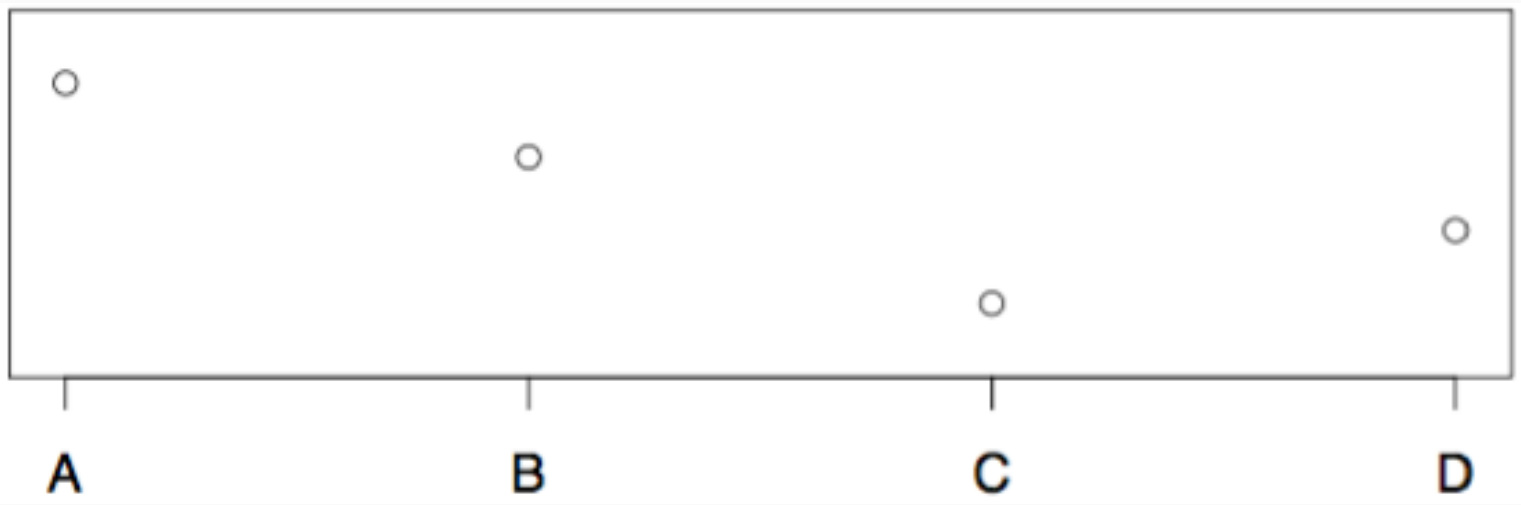
Orientation (Angle)

Shape

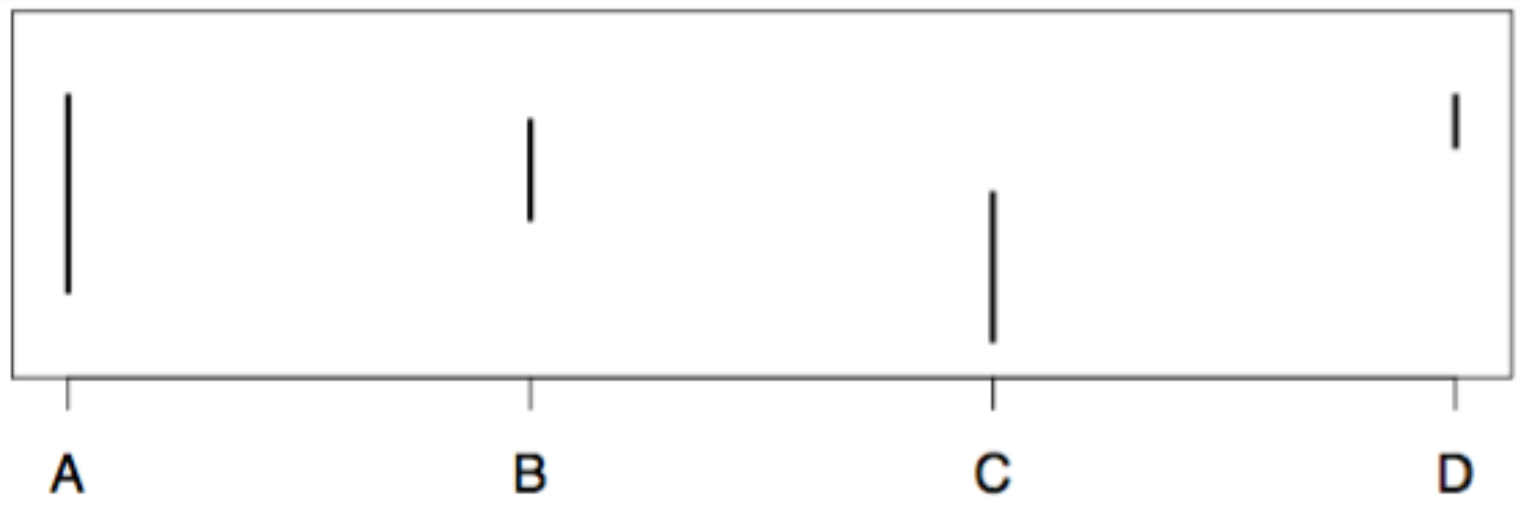
Quick experiment

	A	B	C	D
Positions	1	?	?	?
Lengths	1	?	?	?
Angles	1	?	?	?
Areas	1	?	?	?

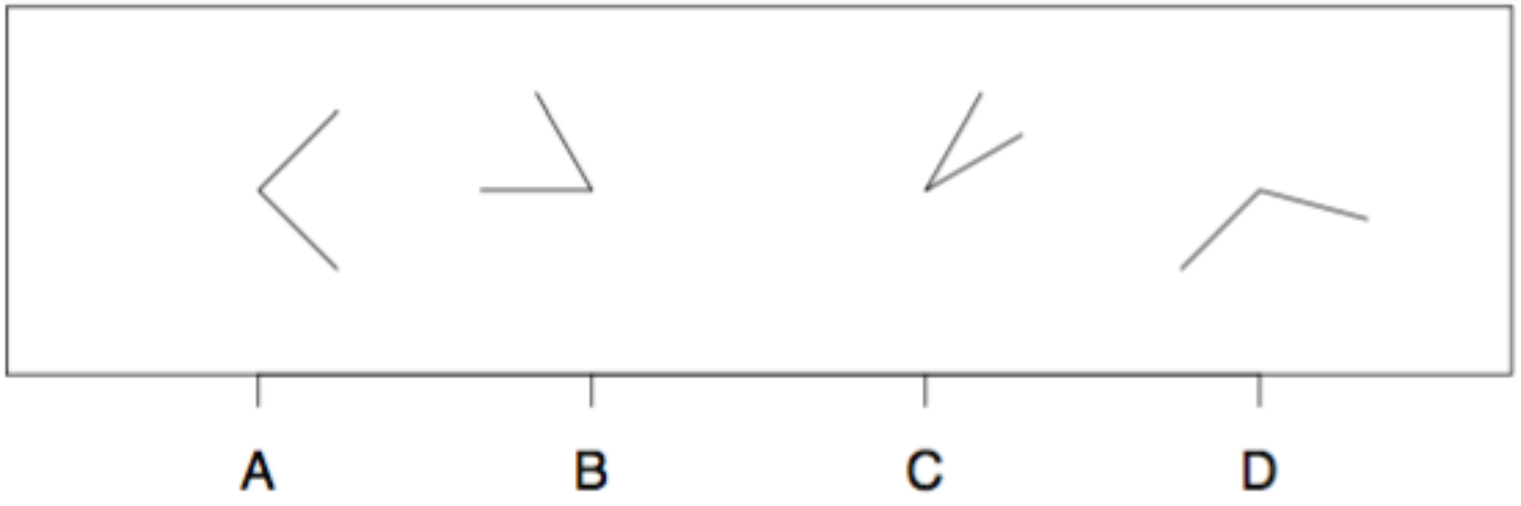
Perceptual task: position, aligned



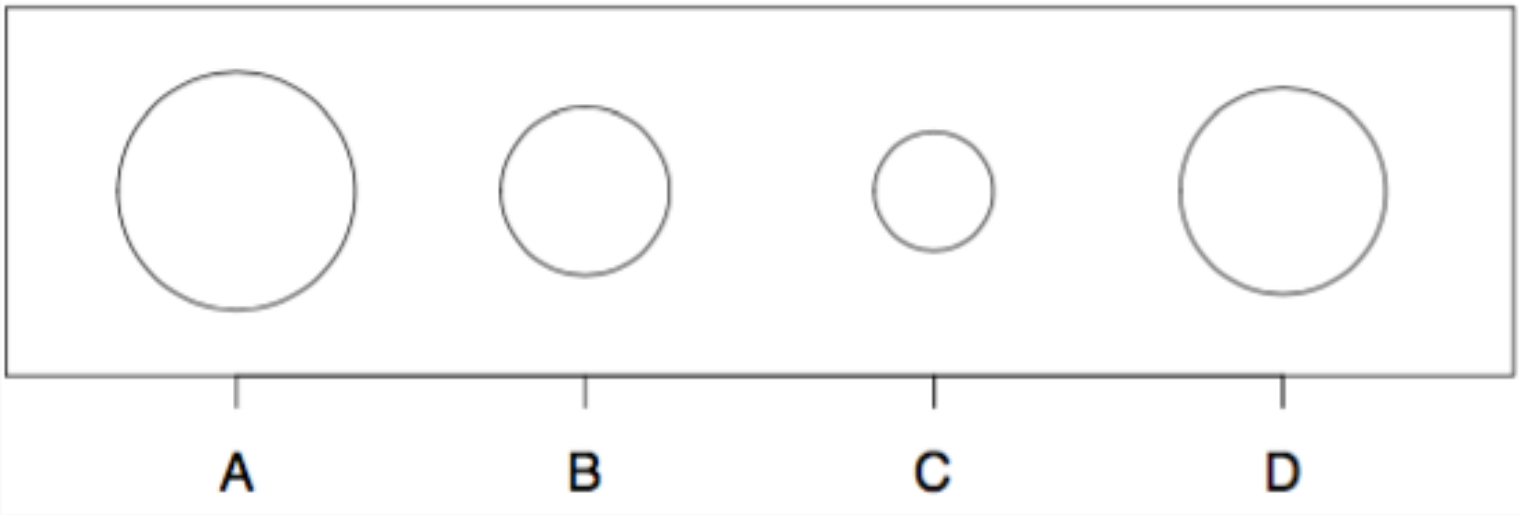
Perceptual task: length



Perceptual task: angle



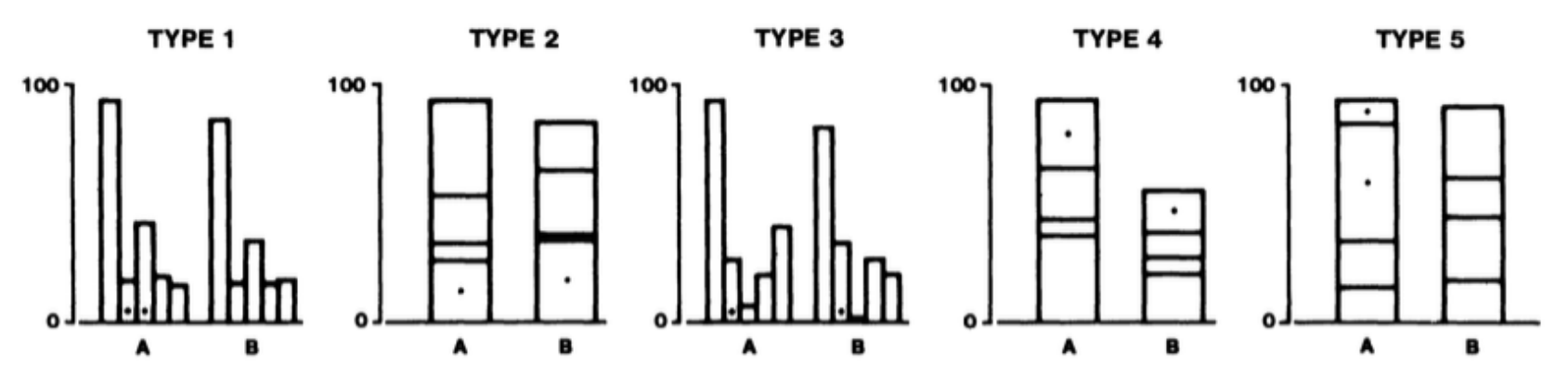
Perceptual task: area



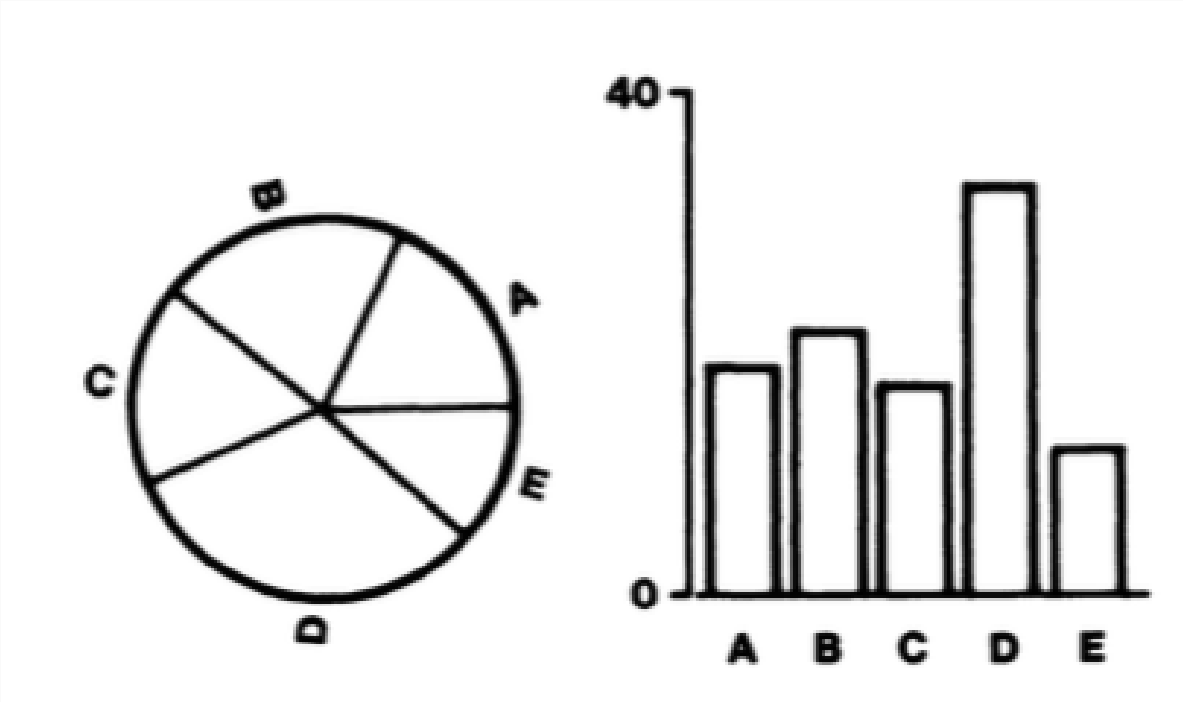
Quick experiment

	A	B	C	D
Positions	1	3/4	1/4	2/4
Lengths	1	2/4	3/4	1/4
Angles	1	2/3	1/3	4/3
Areas	1	2/4	1/4	3/4

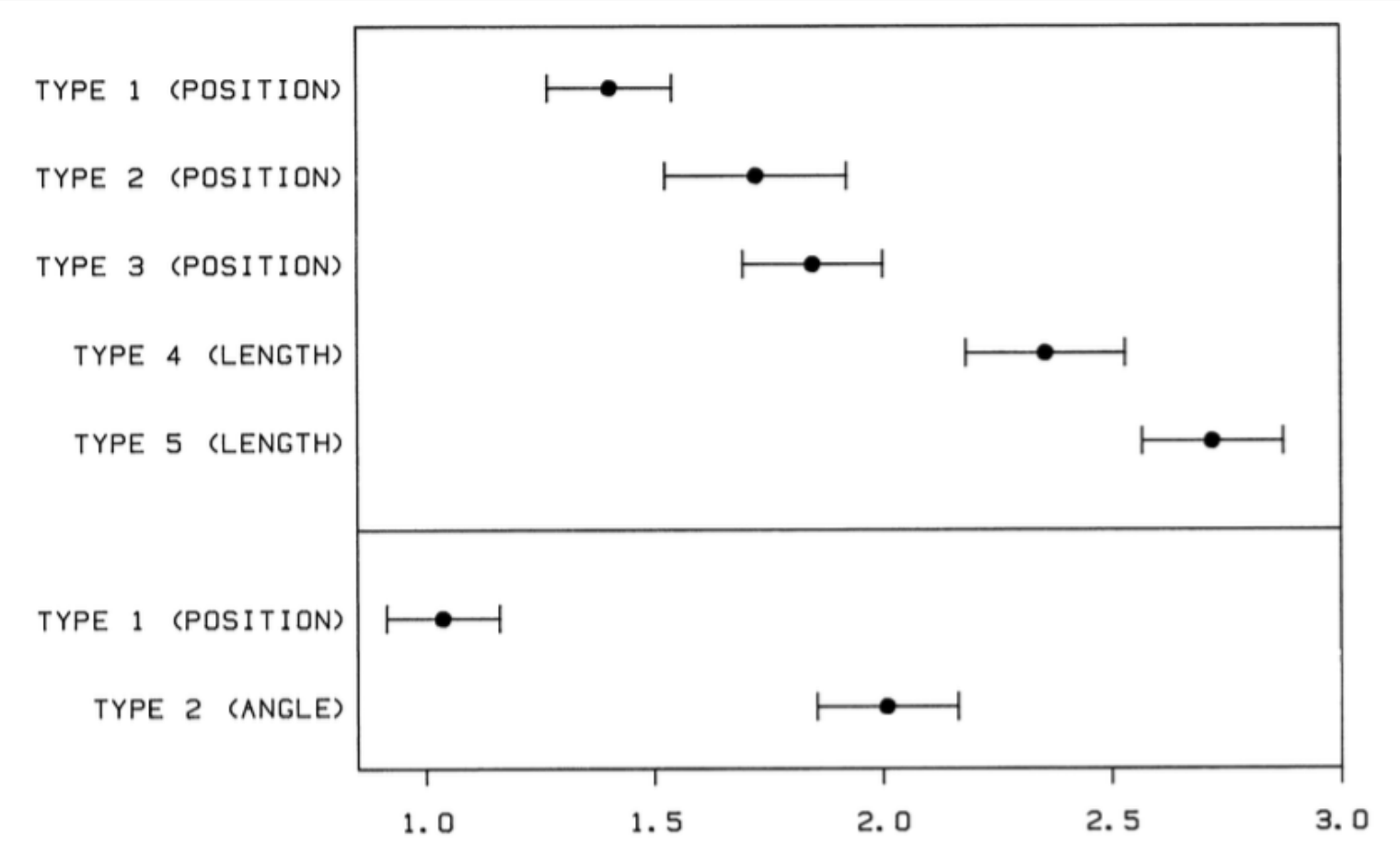
Cleveland & McGill, 1984



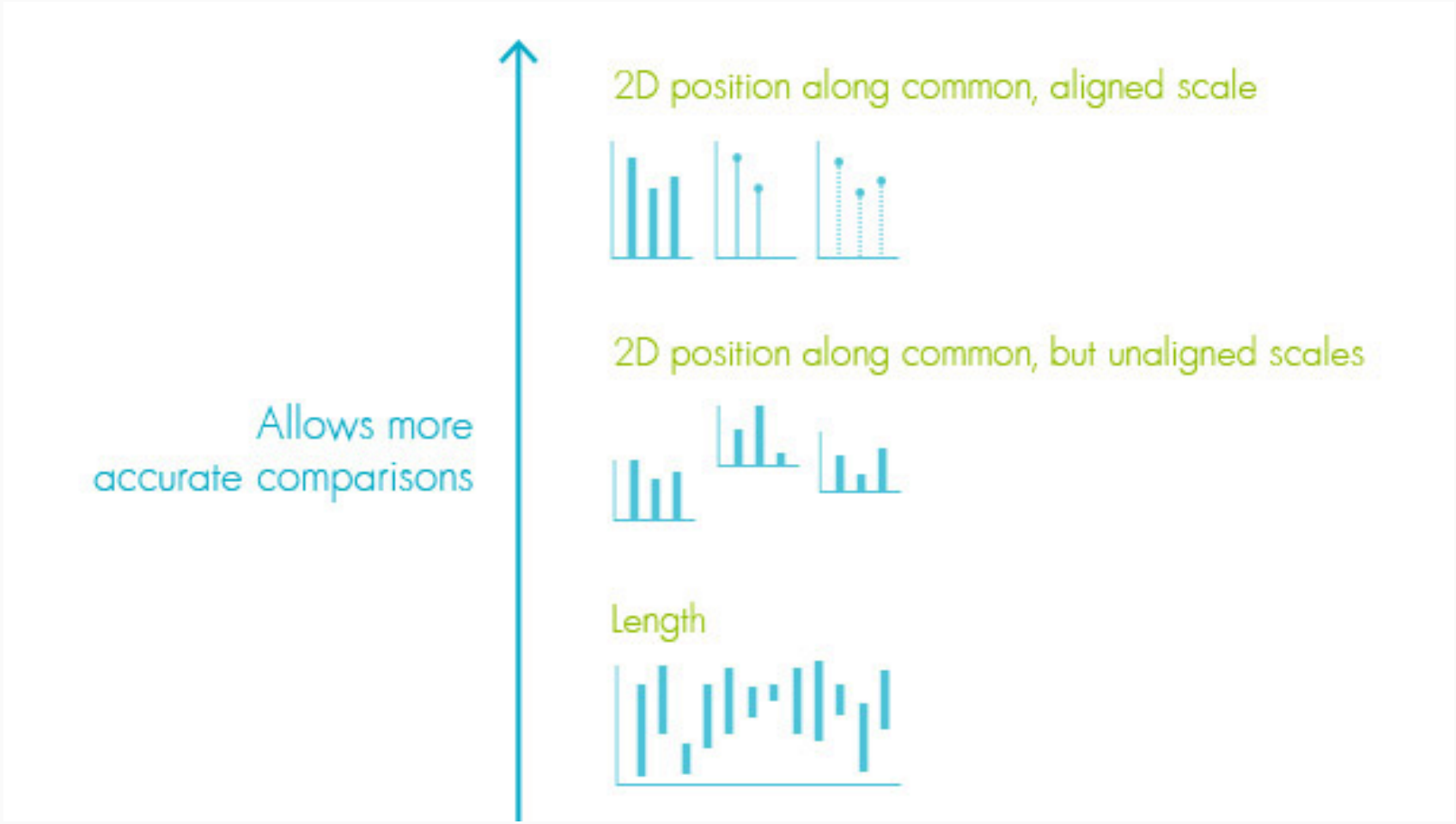
Cleveland & McGill, 1984



Cleveland & McGill, 1984



Relative magnitude estimation (Cleveland & McGill, 1984)



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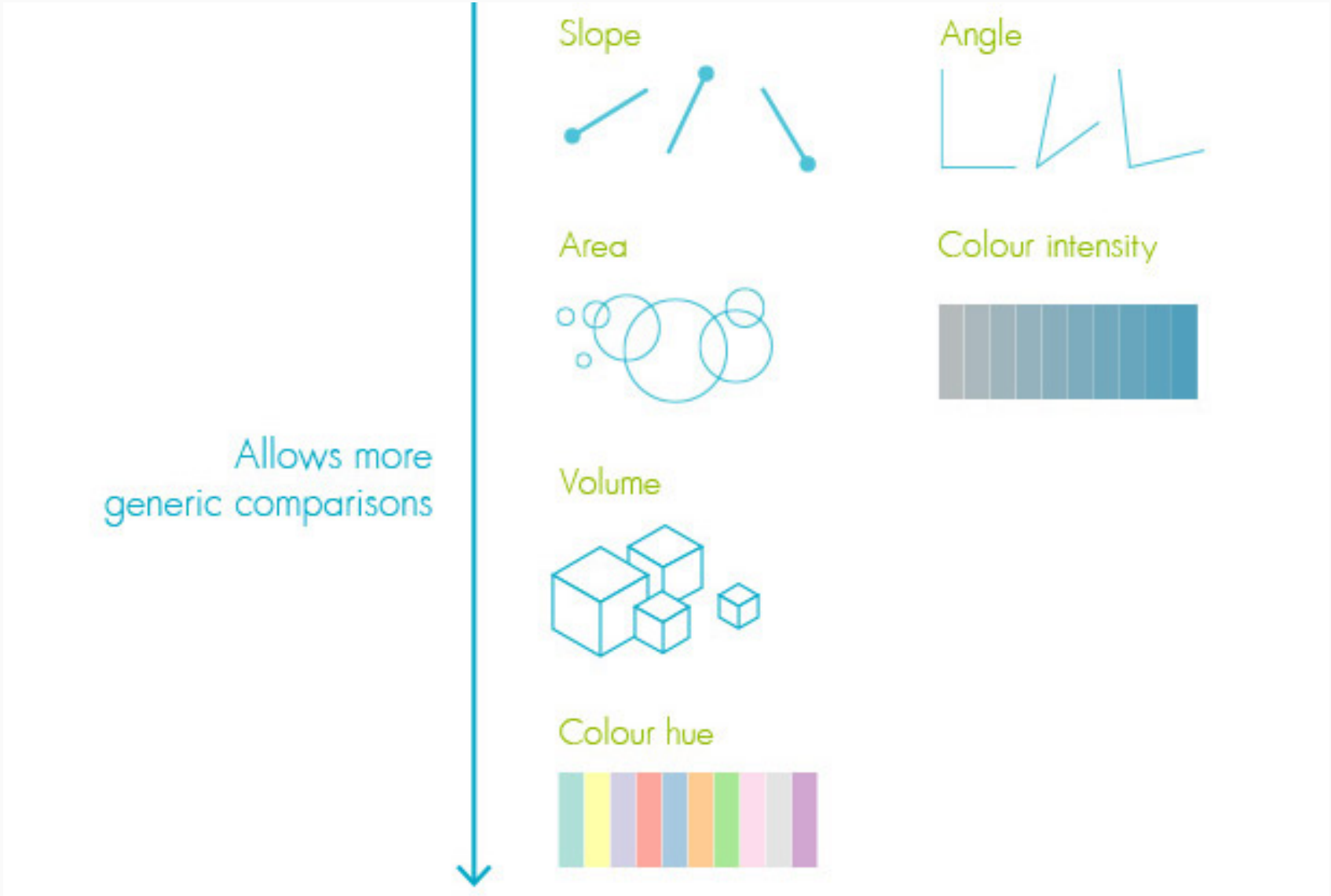


Mackinlay's ranking of encodings

Quantitative	Ordinal	Nominal
Position	Position	Position
Length	Density (Val)	Color Hue
Angle	Color Sat	Texture
Slope	Color Hue	Connection
Area (Size)	Texture	Containment
Volume	Connection	Density (Val)
Density (Val)	Containment	Color Sat
Color Sat	Length	Shape
Color Hue	Angle	Length
Texture	Slope	Angle
Connection	Area (Size)	Slope
Containment	Volume	Area (Size)
Shape	Shape	Volume

Advice

- Show quantitative variables with position or length
- Bars encode length, start them at 0 — switch to dotplots to zoom in
- Avoid stacked bars (not aligned) — use dots/lines (aligned baselines) instead
- Avoid pie charts, area, and volume
- Choose and order hues sensibly (Color Brewer does this)
- Place things you want to compare close to each other

Preattentive processing

Tasks that can be performed on large multi-element displays in less than 200 to 250 milliseconds (msec) are considered preattentive.

How many 6s

0	5	0	8	2	4	9	3	2	0	6	9	0	0	3	0	4	6	2	7
9	0	1	1	7	9	9	7	9	3	4	6	4	4	9	7	4	8	0	7
3	7	6	5	2	7	5	9	5	5	9	2	7	3	1	0	0	3	6	8
4	4	5	5	4	6	7	2	7	3	2	4	3	8	5	0	3	6	2	7
4	7	4	1	5	5	1	8	1	3	7	9	9	1	1	2	2	1	5	2

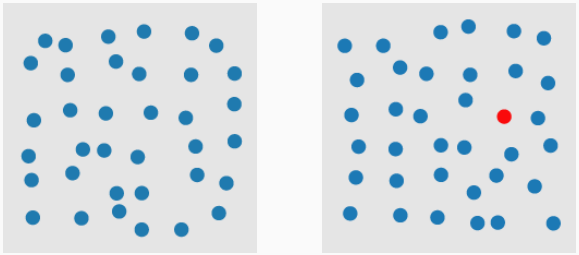
How many 6s

0	5	0	8	2	4	9	3	2	0	6	9	0	0	3	0	4	6	2	7
9	0	1	1	7	9	9	7	9	3	4	6	4	4	9	7	4	8	0	7
3	7	6	5	2	7	5	9	5	5	9	2	7	3	1	0	0	3	6	8
4	4	5	5	4	6	7	2	7	3	2	4	3	8	5	0	3	6	2	7
4	7	4	1	5	5	1	8	1	3	7	9	9	1	1	2	2	1	5	2

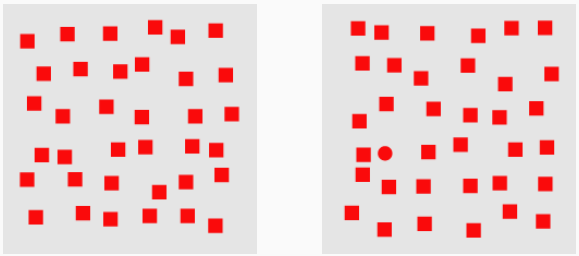
Preattentive processing

https://www.csc2.ncsu.edu/faculty/healey/PP/

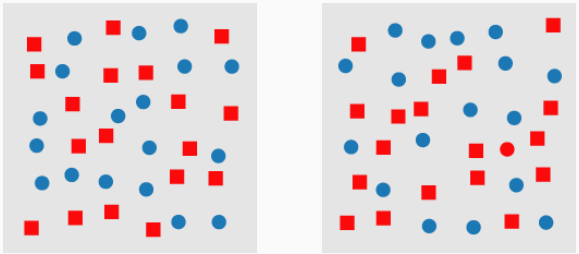
Pop-out: Color



Pop-out: Shape

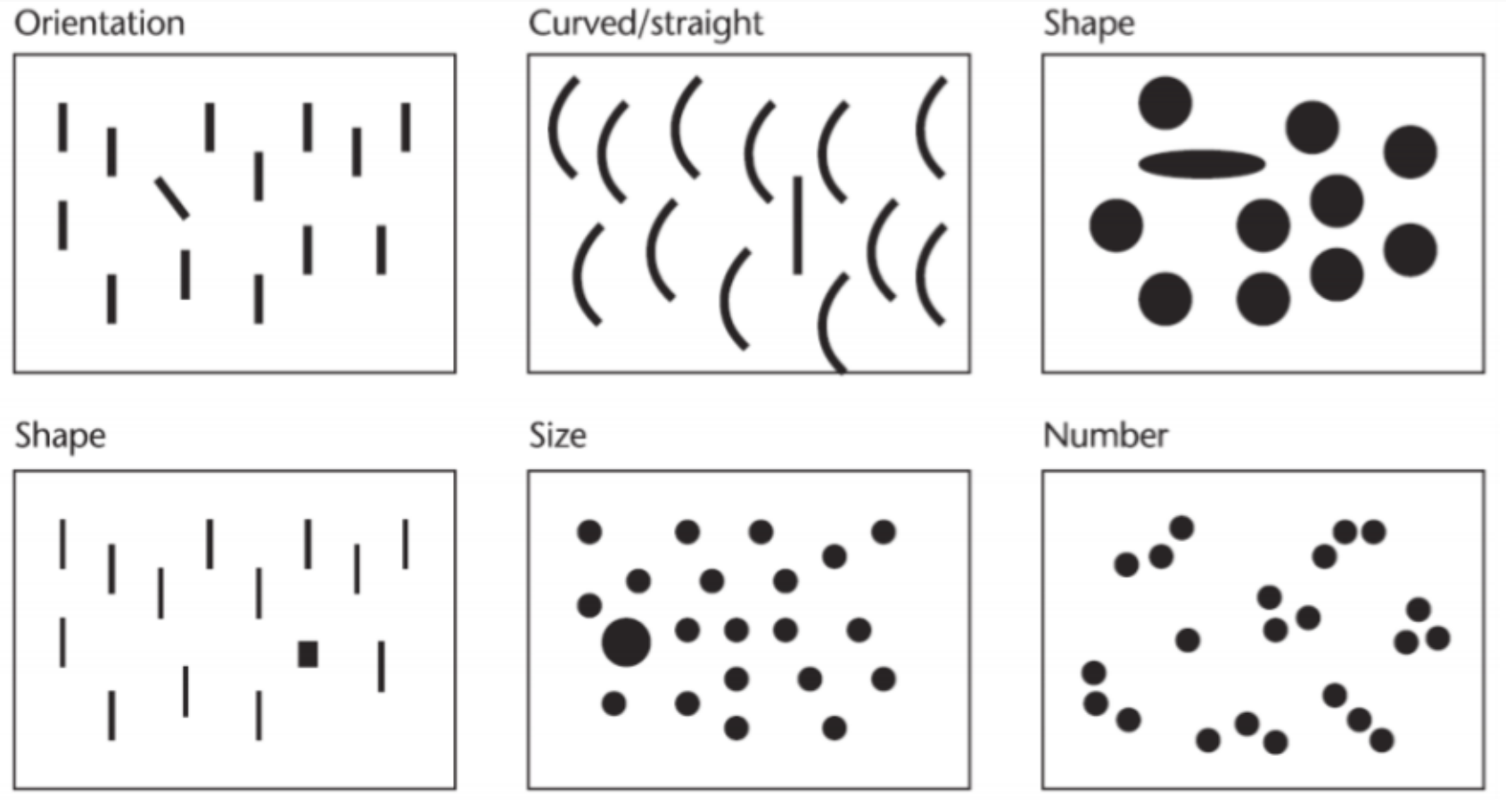


Conjunction search

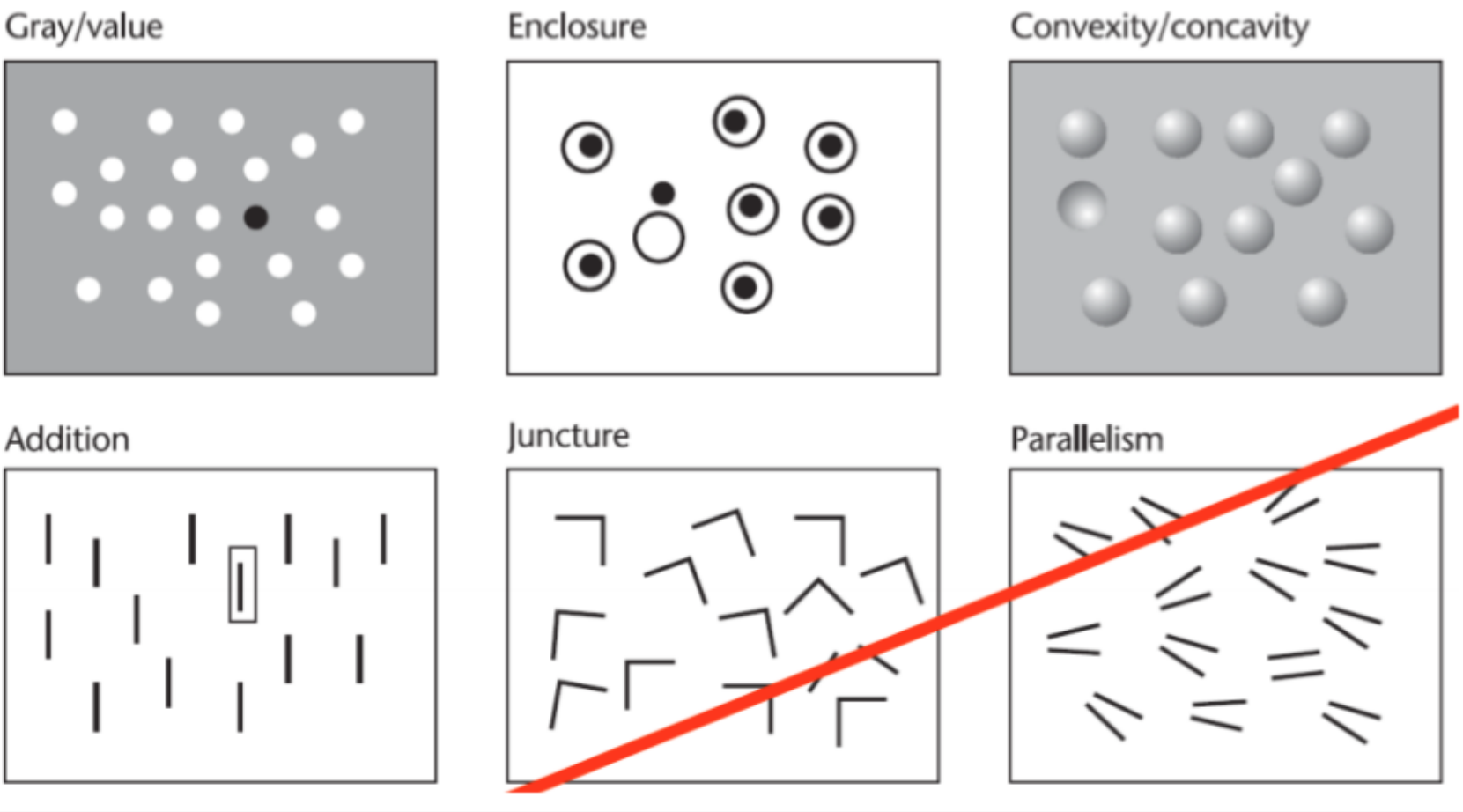


Preattentive features

From *Information Visualization*, Ware



Preattentive features

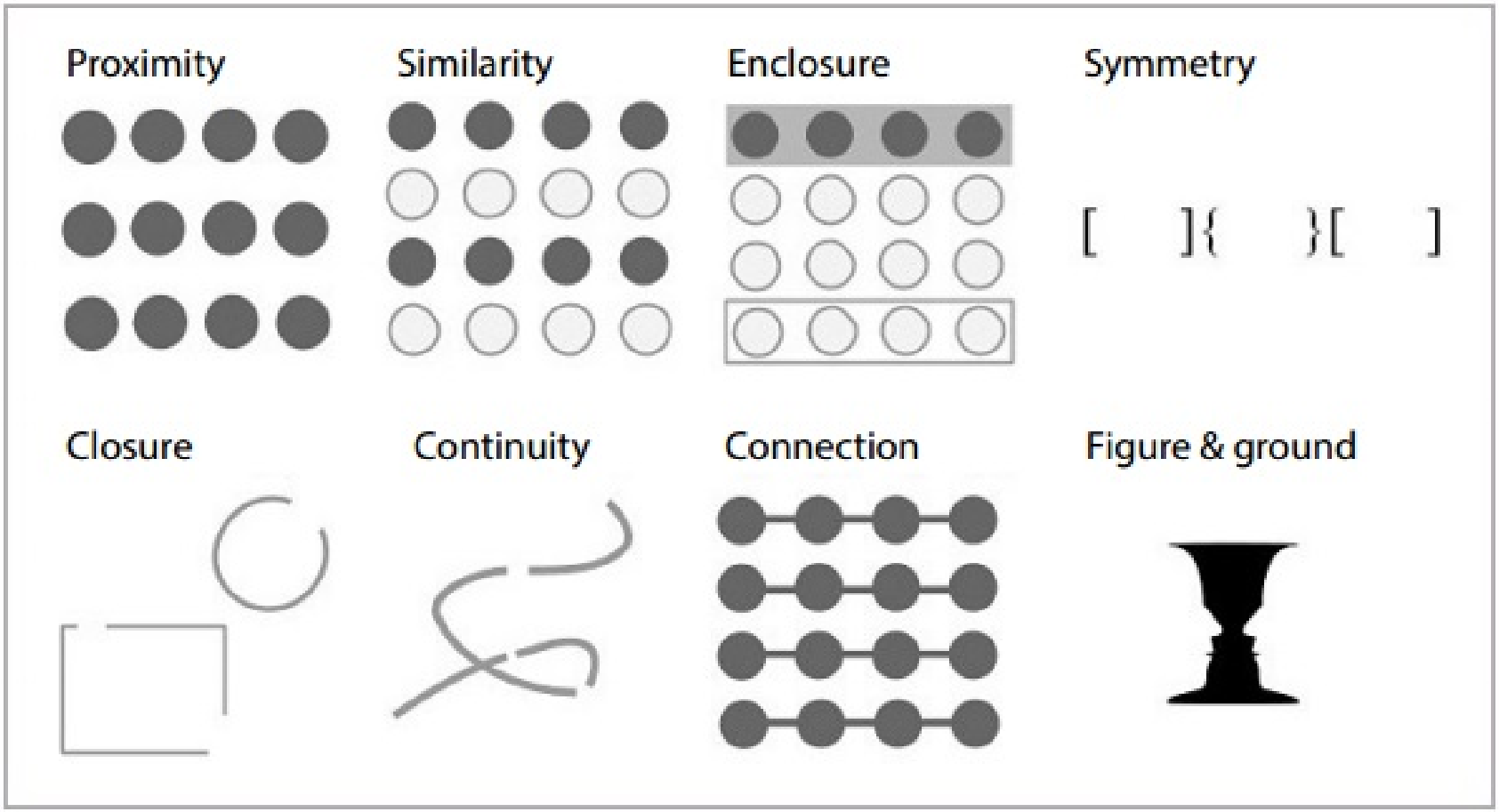


Advice

- Distinguish categorical groups by features like hue and shape
- Don't try to show too many groups on one plot; use small multiples to show more sub-groups
- If highlighting one group, use a preattentive attribute

Gestalt

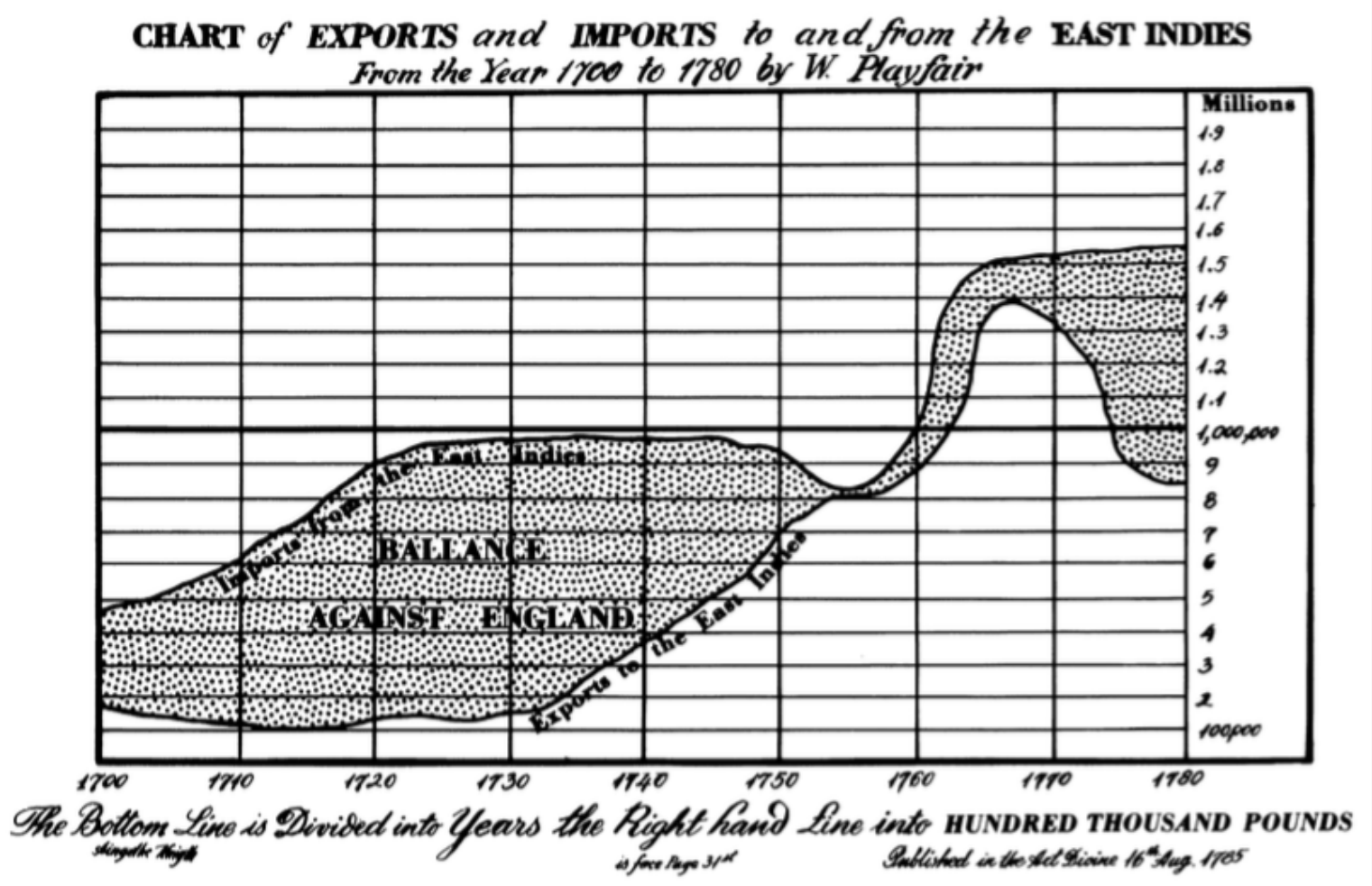
- Gestalt = "pattern" in German
- How do we identify structure/pattern from individual elements?



Advice

- Distinguish categorical groups by similarity, proximity, or enclosure
- Use proximity to structure your layout (arrange small multiples)
- Use connection to show groups on line chart, parallel coordinates chart, network graph, etc.
- To highlight one group, use gestalt principles such as enclosure or similarity

Plot what you want to show



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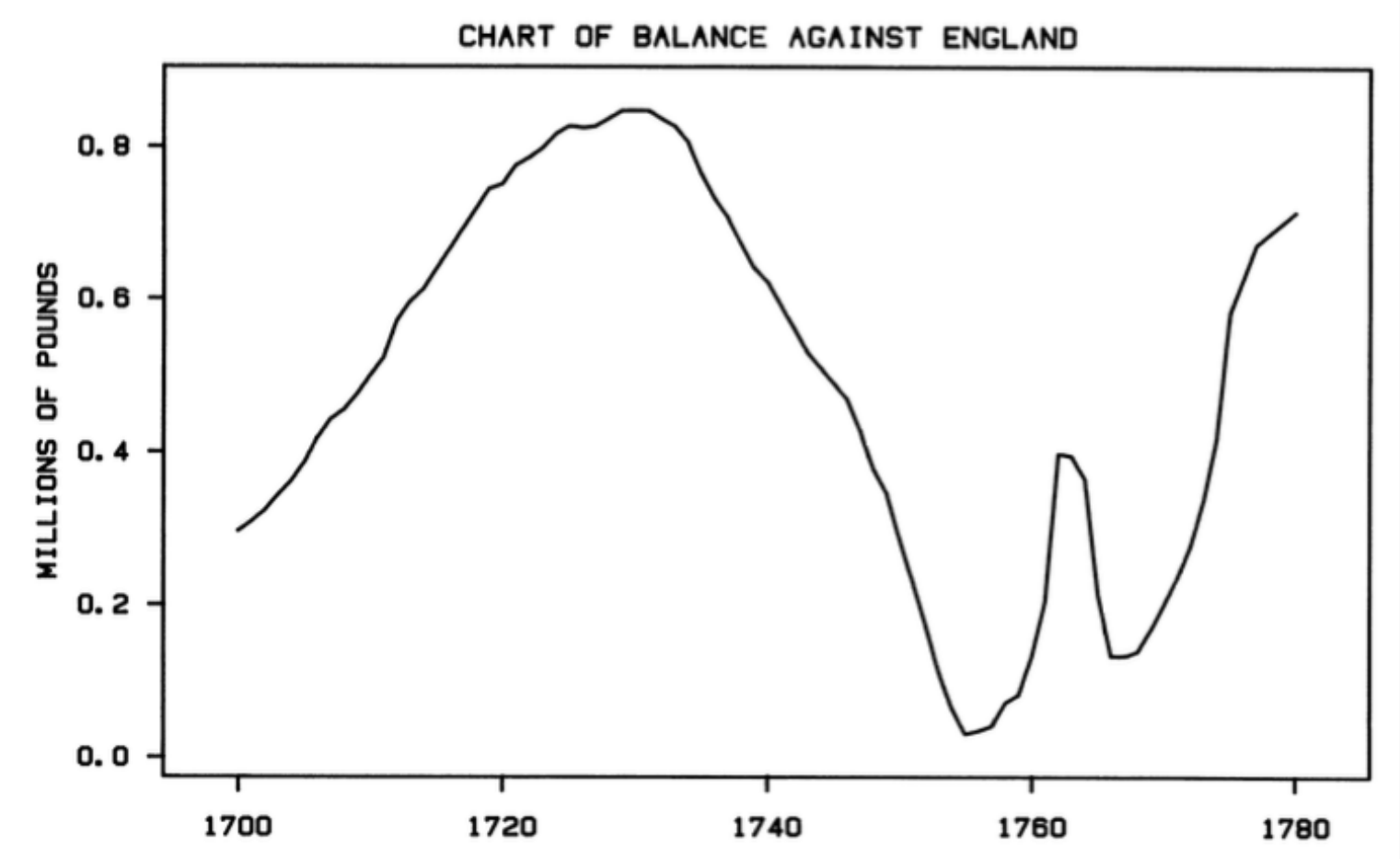
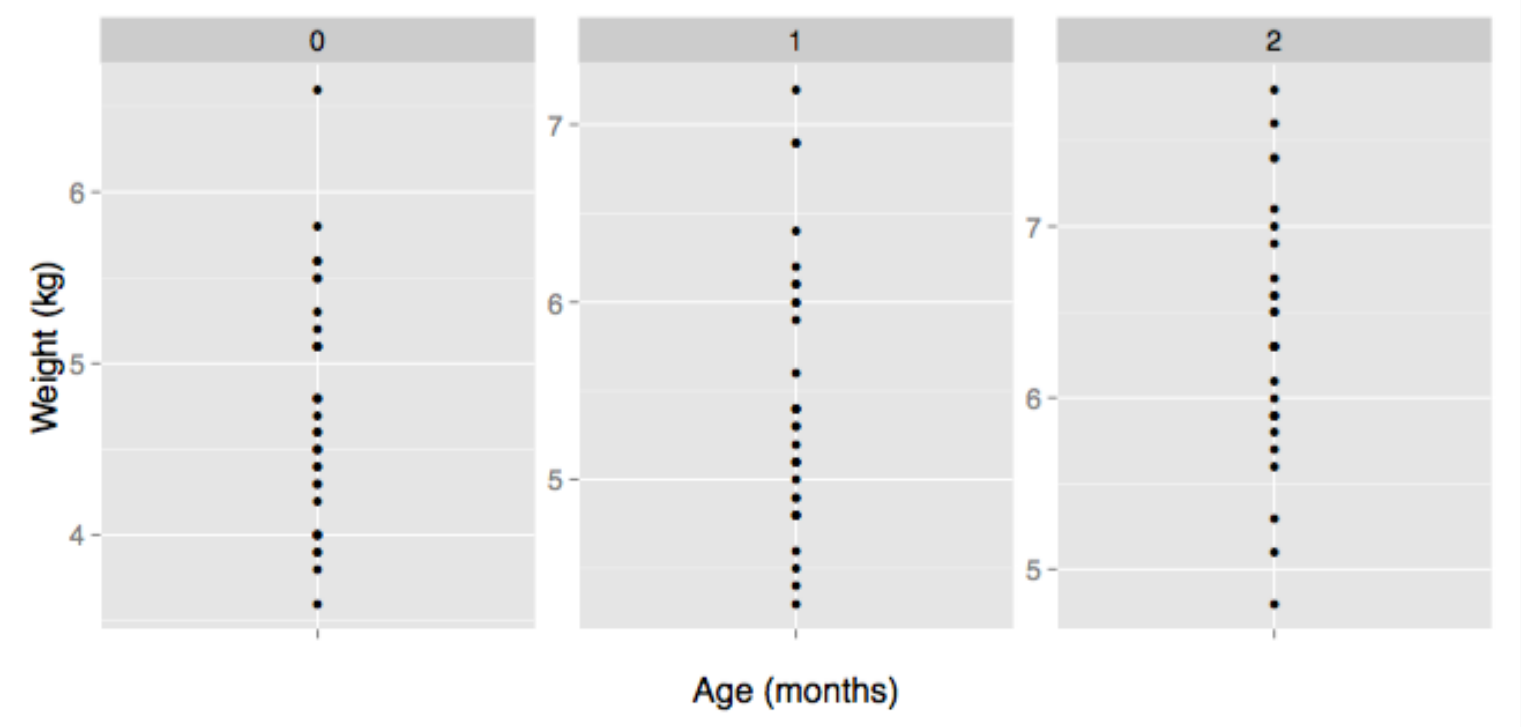


Be consistent



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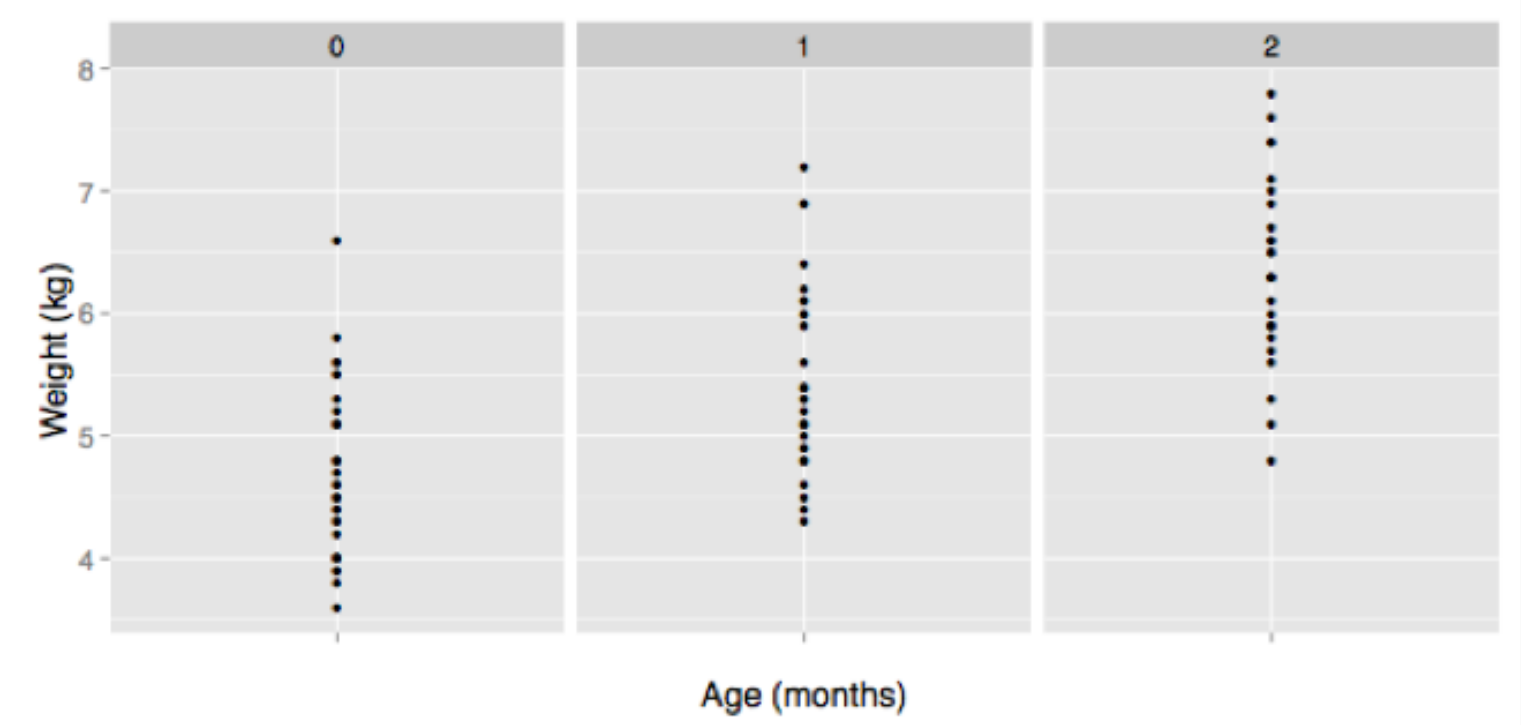

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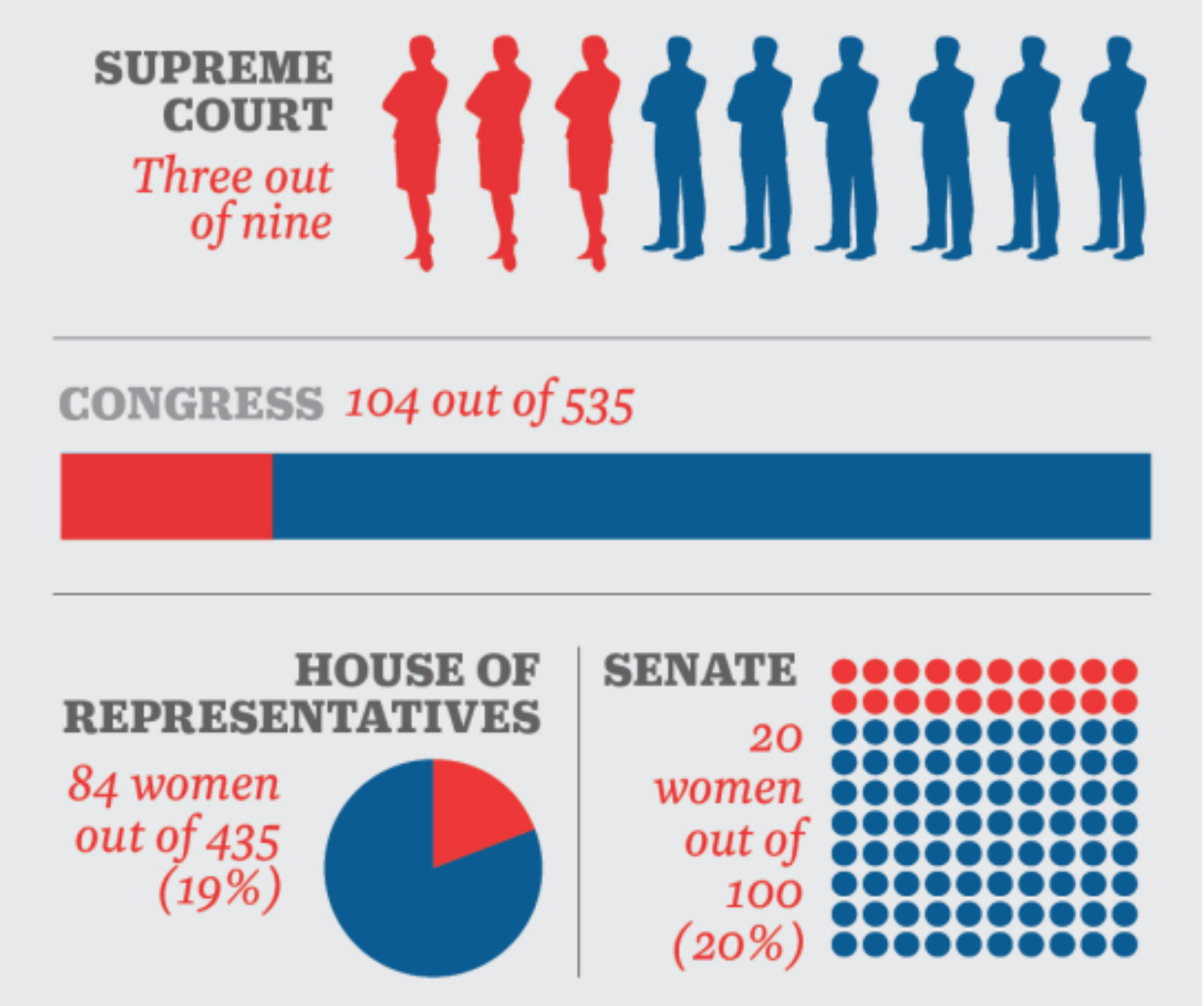

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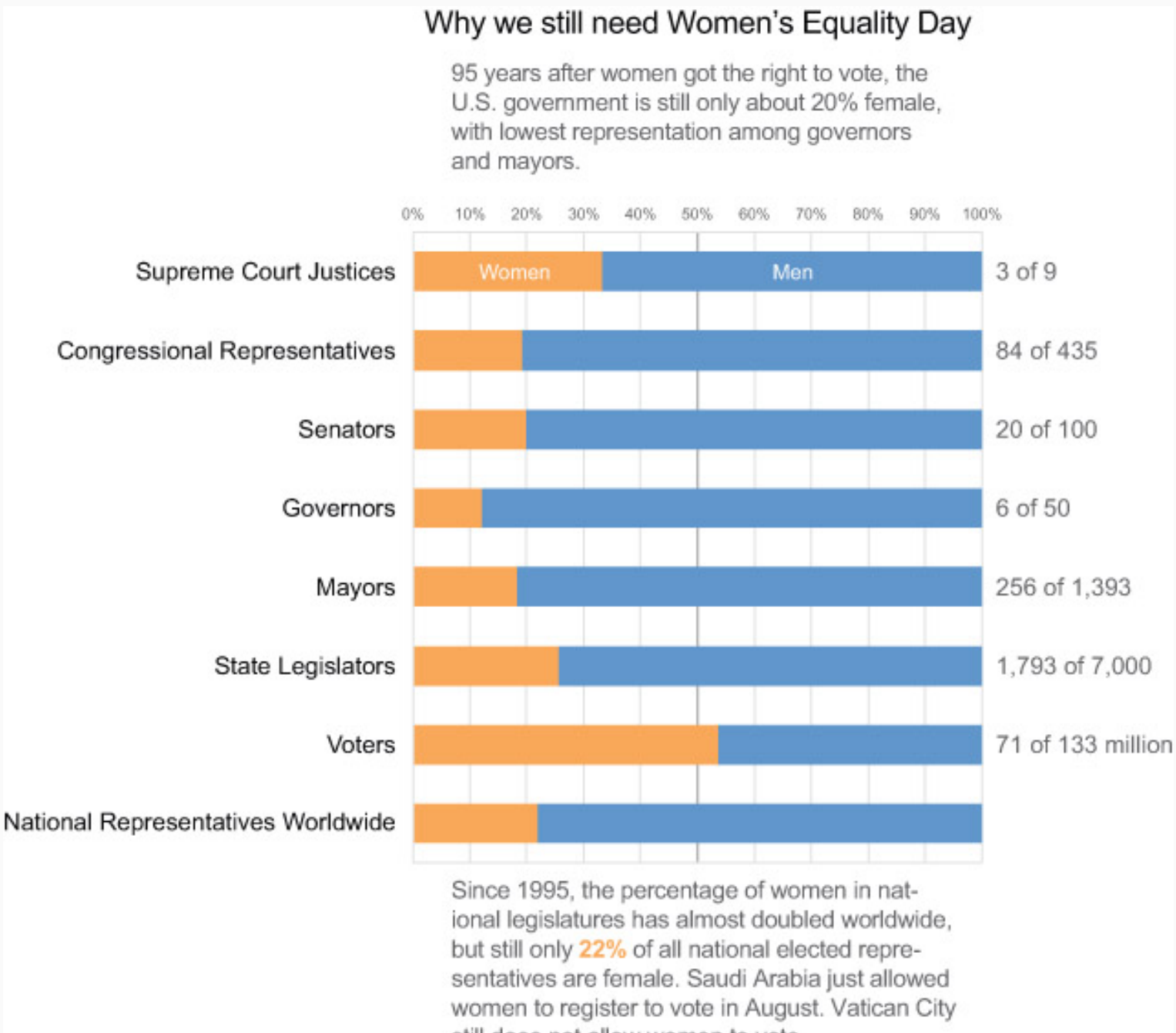

Acknowledgements

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