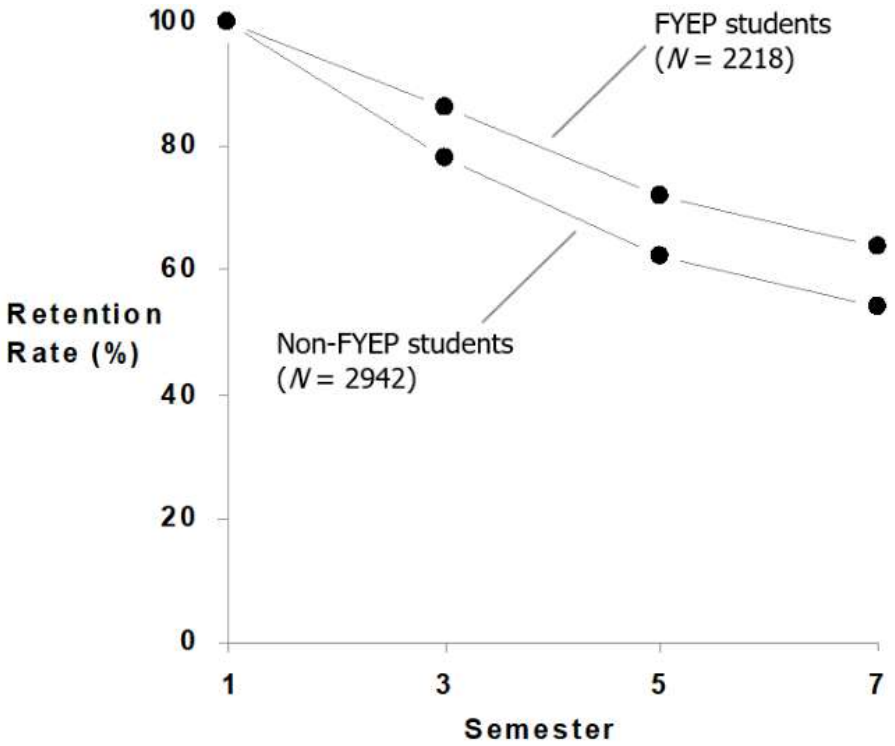
Designing effective displays

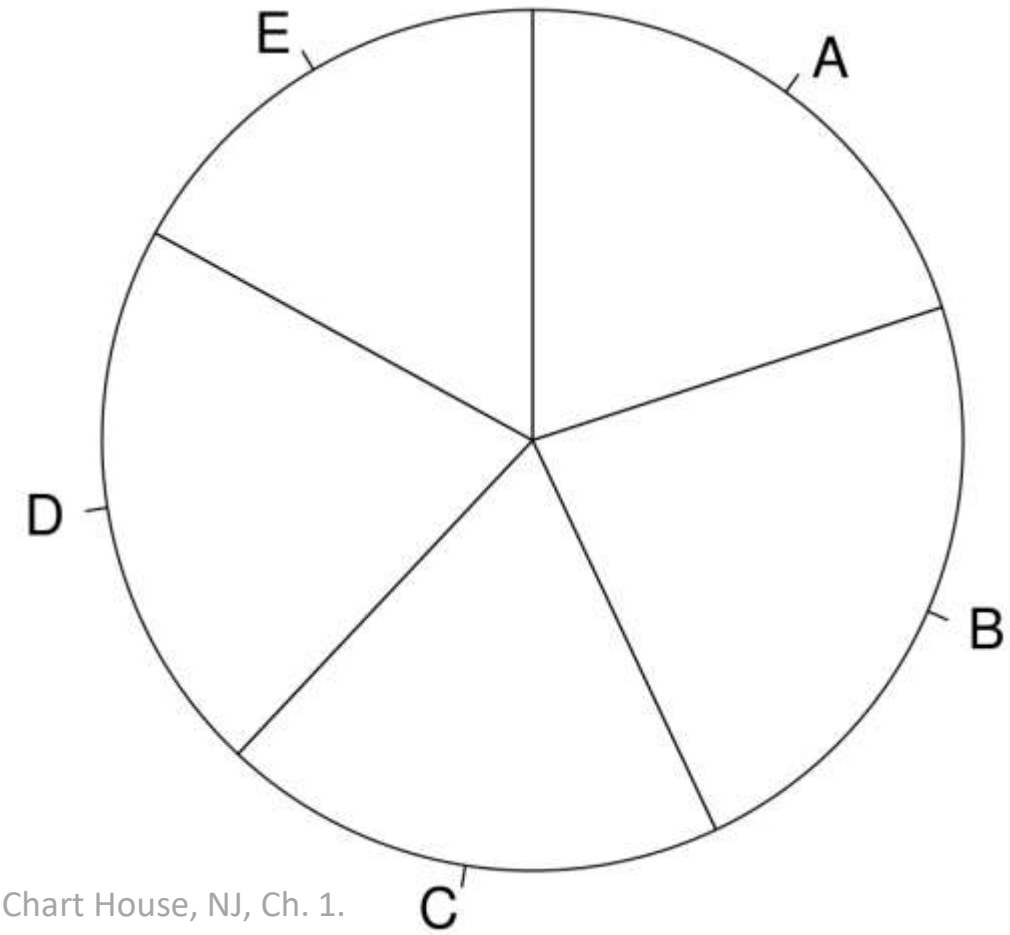
Richard Layton
Matthew Ohland

Workshop: Engaging with MIDFIELD Data
ASEE Annual Conference
2021-07-26



Pie charts support visual tasks of low-accuracy.

Poll: Which slice is largest?

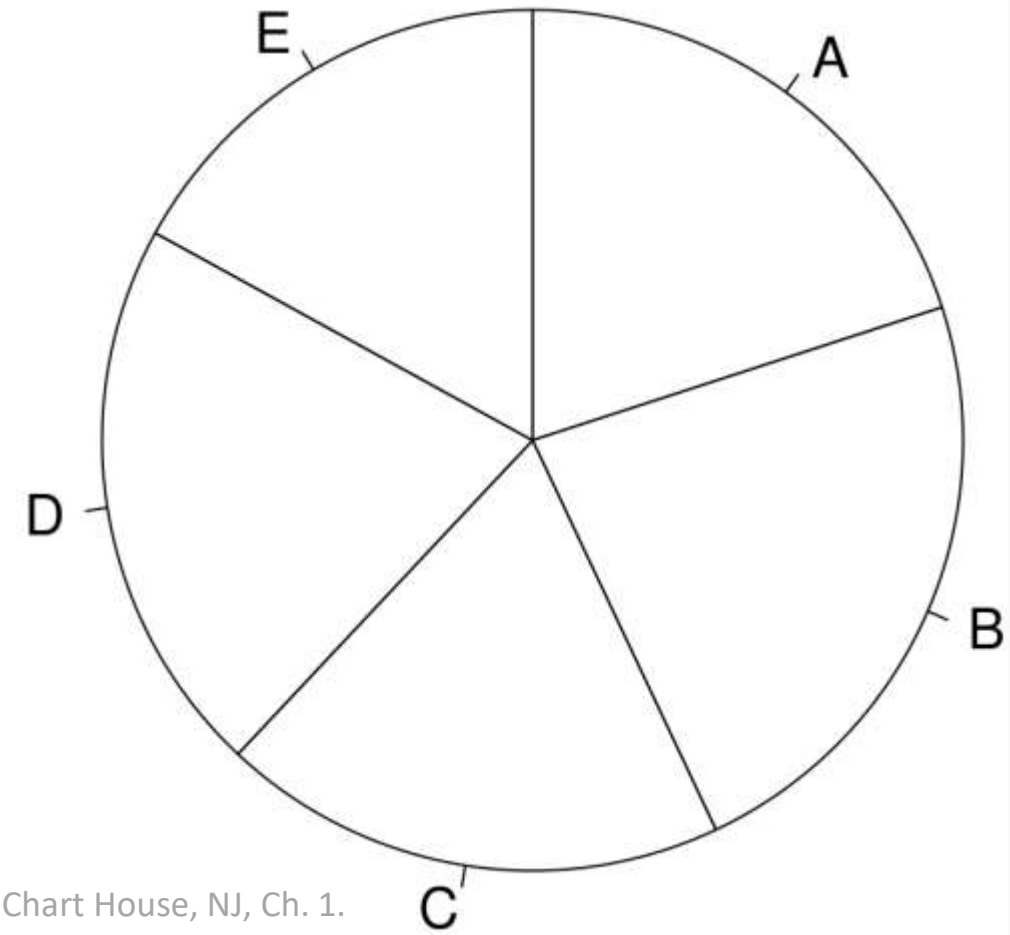


Naomi Robbins (2013) *Creating More Effective Graphs*, Chart House, NJ, Ch. 1.

Pie charts support visual tasks of low-accuracy.

Poll: Which slice is largest?

Poll: Which slice is smallest?



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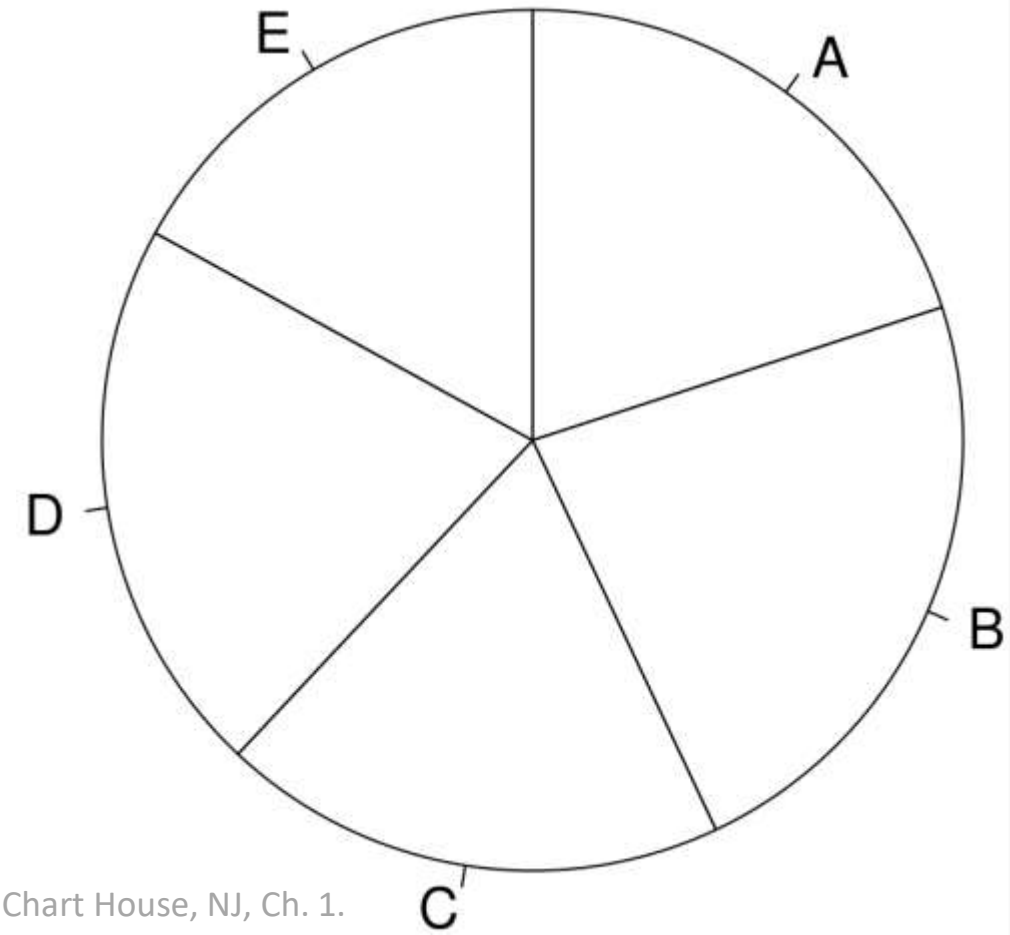
Pie charts support visual tasks of low-accuracy.

Poll: Which slice is largest?

Poll: Which slice is smallest?

Answer:

B (largest)
D
A
C
E (smallest)



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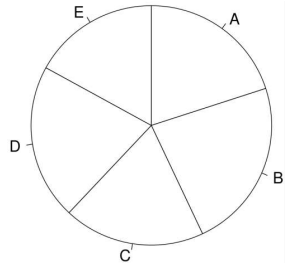
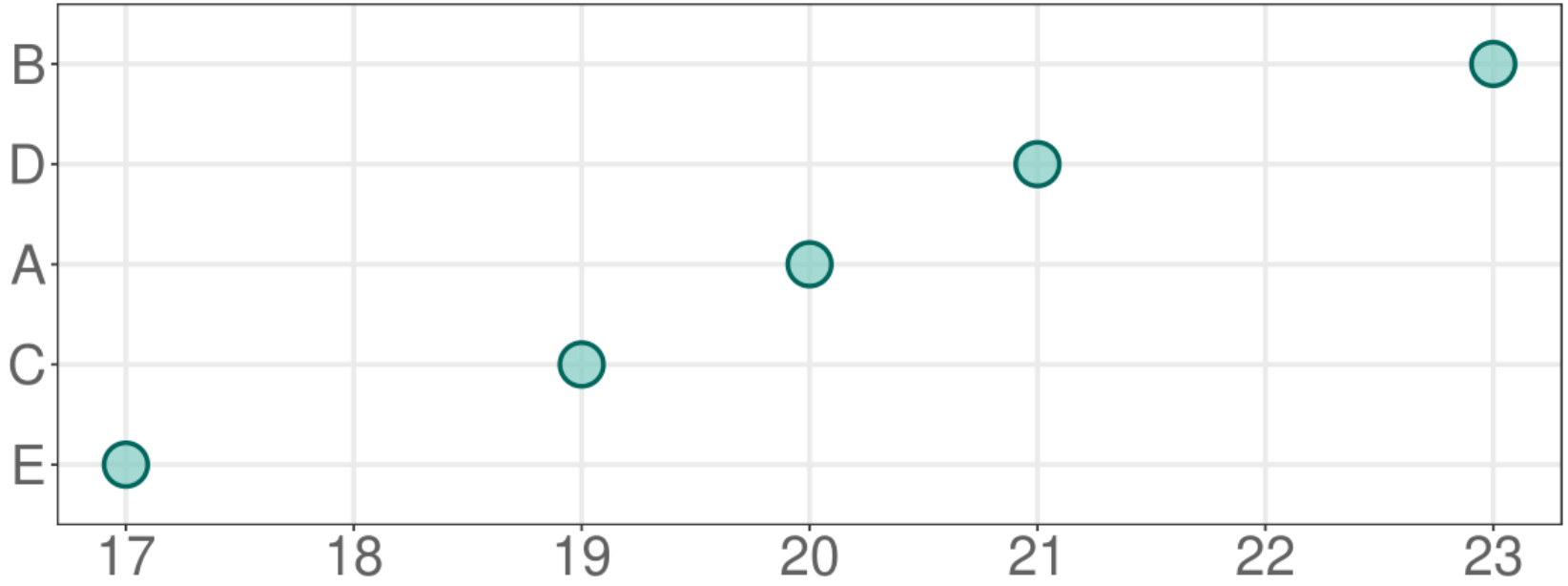
Judging position along a common horizontal scale is a visual task of high-accuracy.

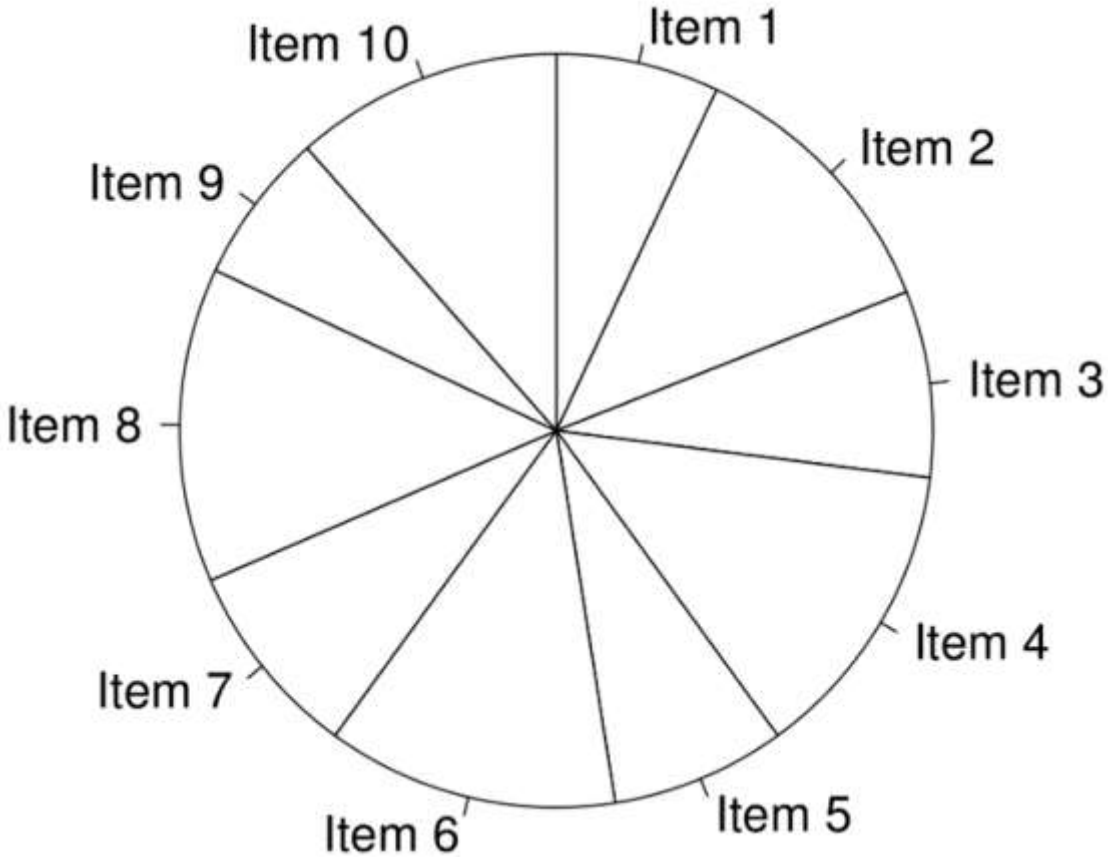


The same data plotted along a common horizontal scale.



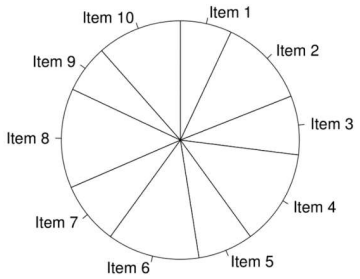
Pie charts support visual tasks of low-accuracy.

What patterns do you see?

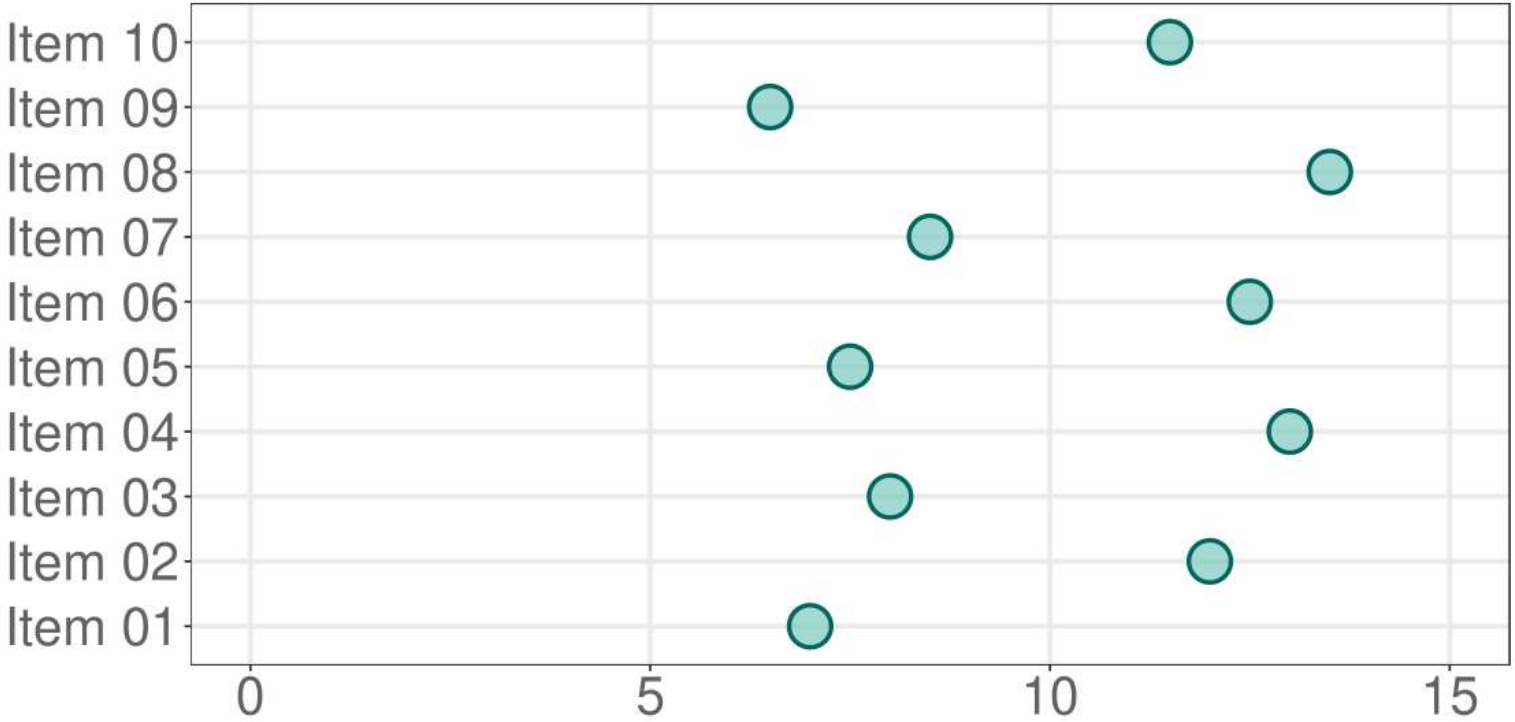


Naomi Robbins (2013) *Creating More Effective Graphs*, Chart House, NJ, Ch. 2.

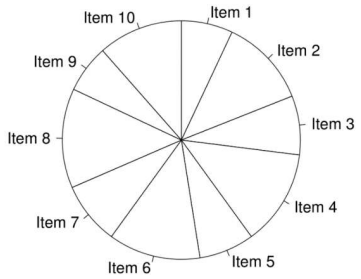
We position the data along a common horizontal scale.



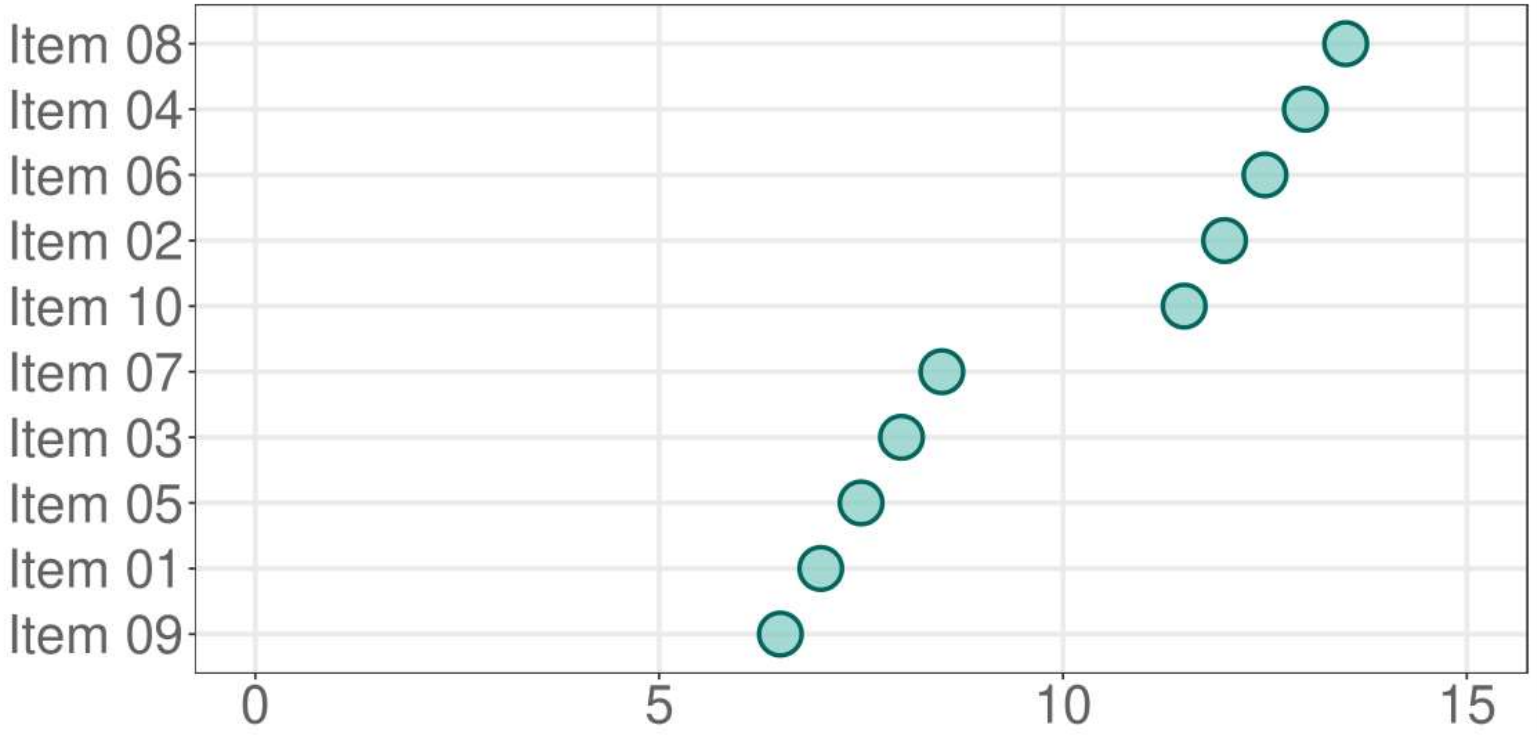
Any new observations?



We reorder the rows by the data values.

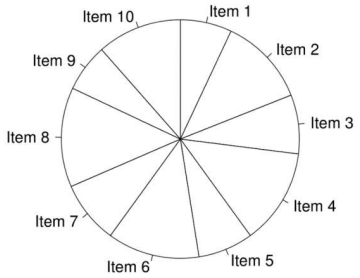


Any new observations?



The item numbers are also data.

Suppose we label the symbols.



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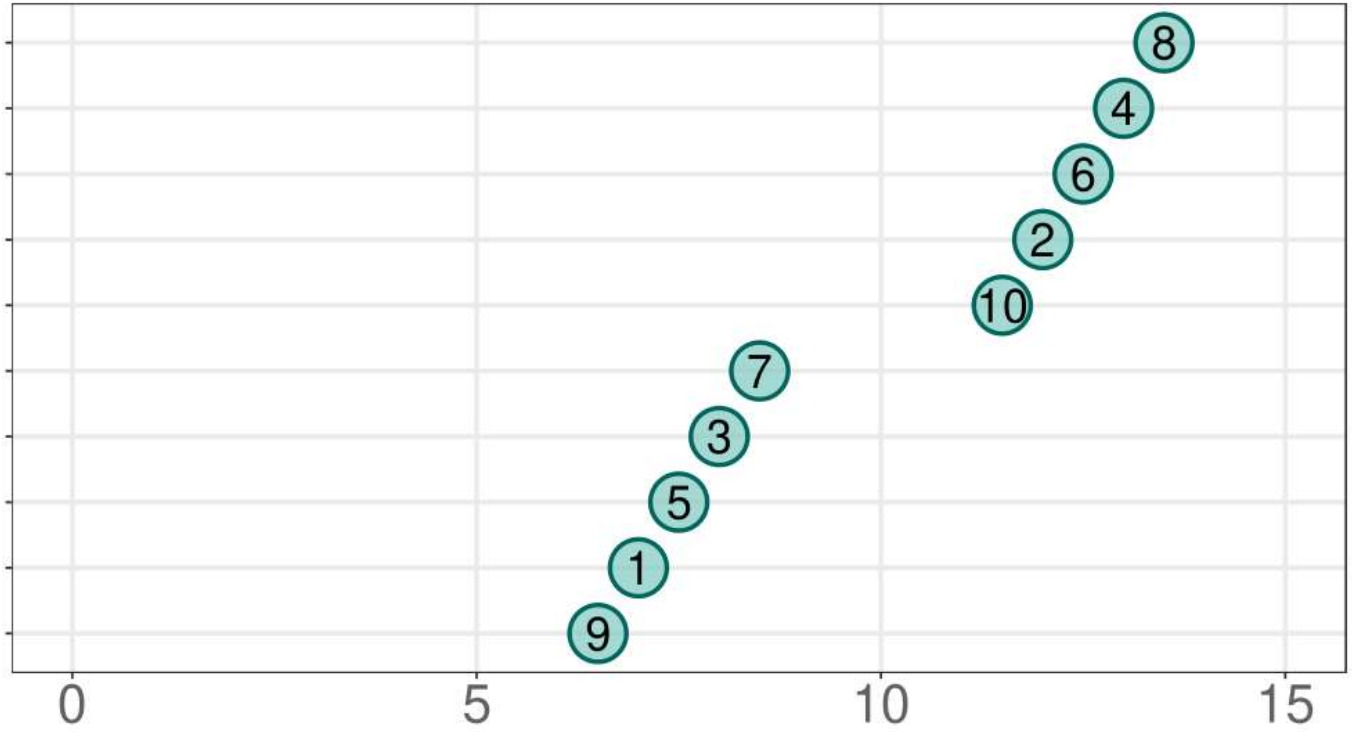
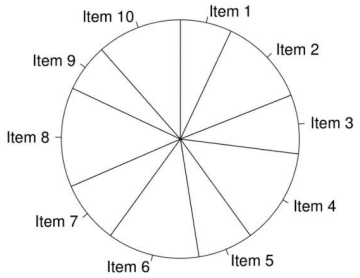
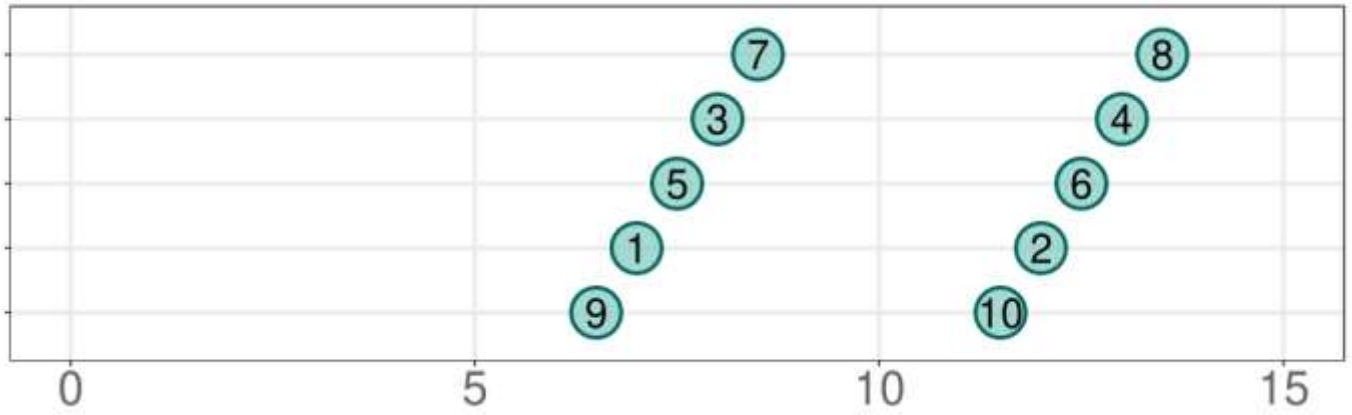


The evenly-spaced odd-even pairs are now obvious.



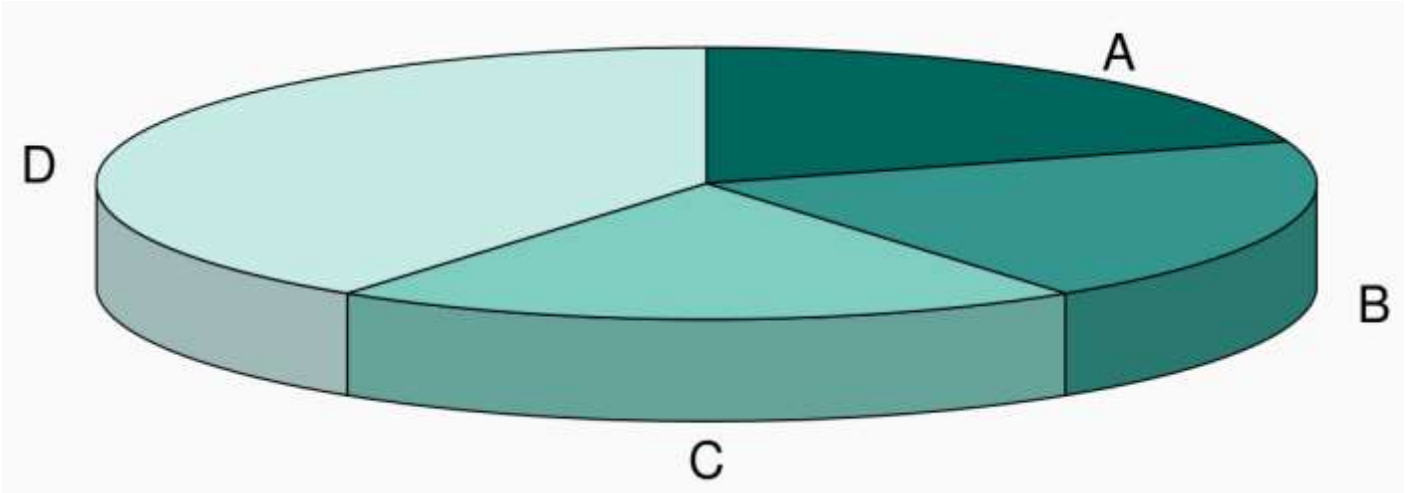


The greatest value of data visualization is when
it forces us to notice what we never expected to see.

— John Tukey (1915–2000)

3D effects distort our judgement.

Poll: Slice D is what percentage of the whole?



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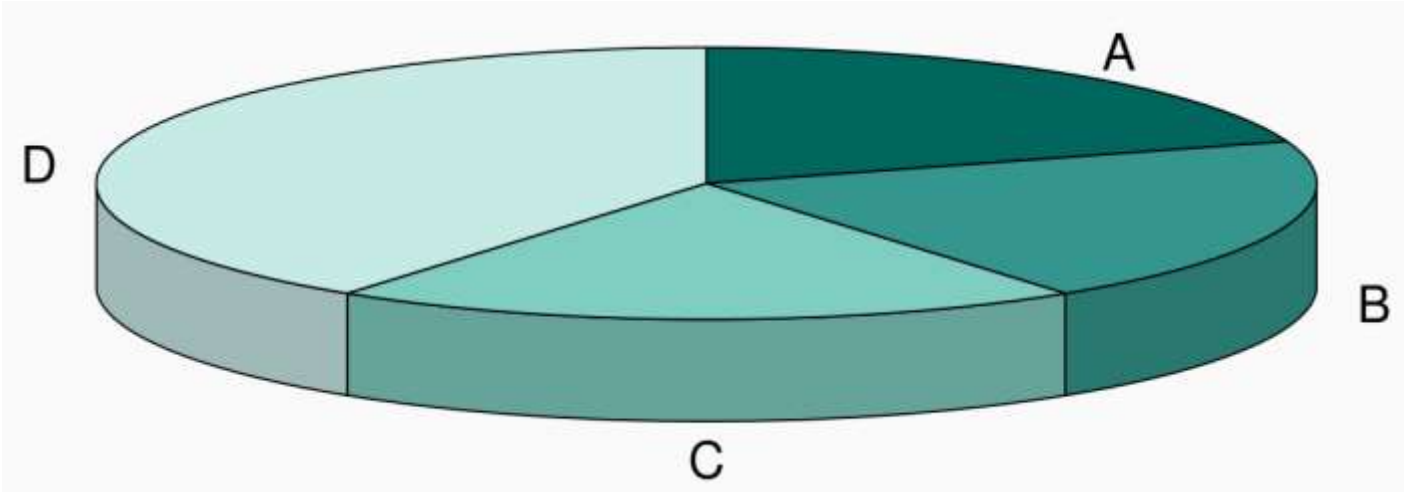

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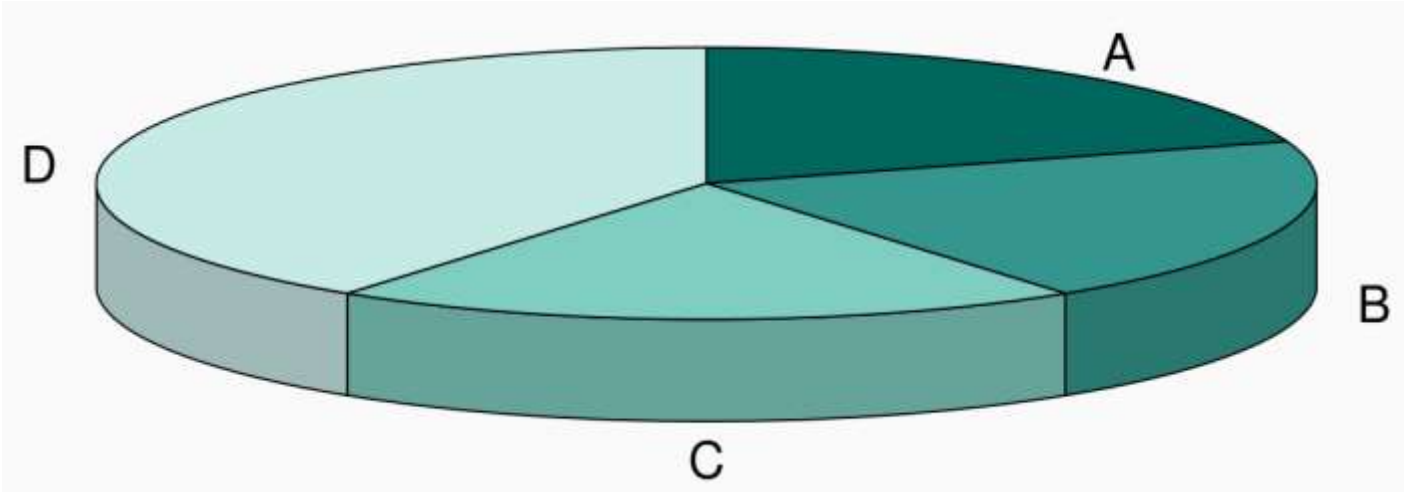
3D effects distort our judgement.

Poll: Slice D is what percentage of the whole?

Poll: Slice B is what percentage of the whole?

Answer:

A 40%
B 20%
C 20%
D 20%



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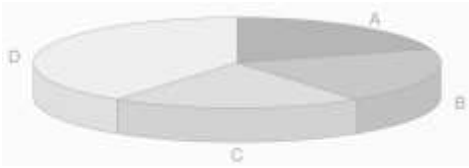

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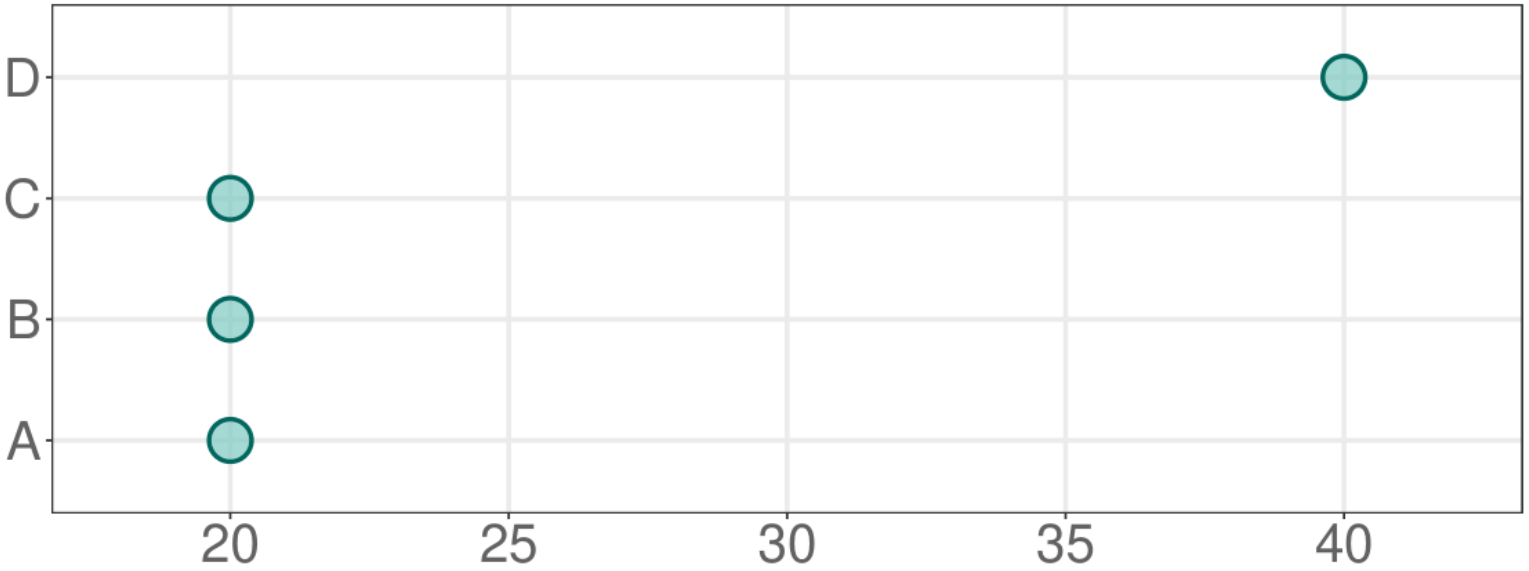
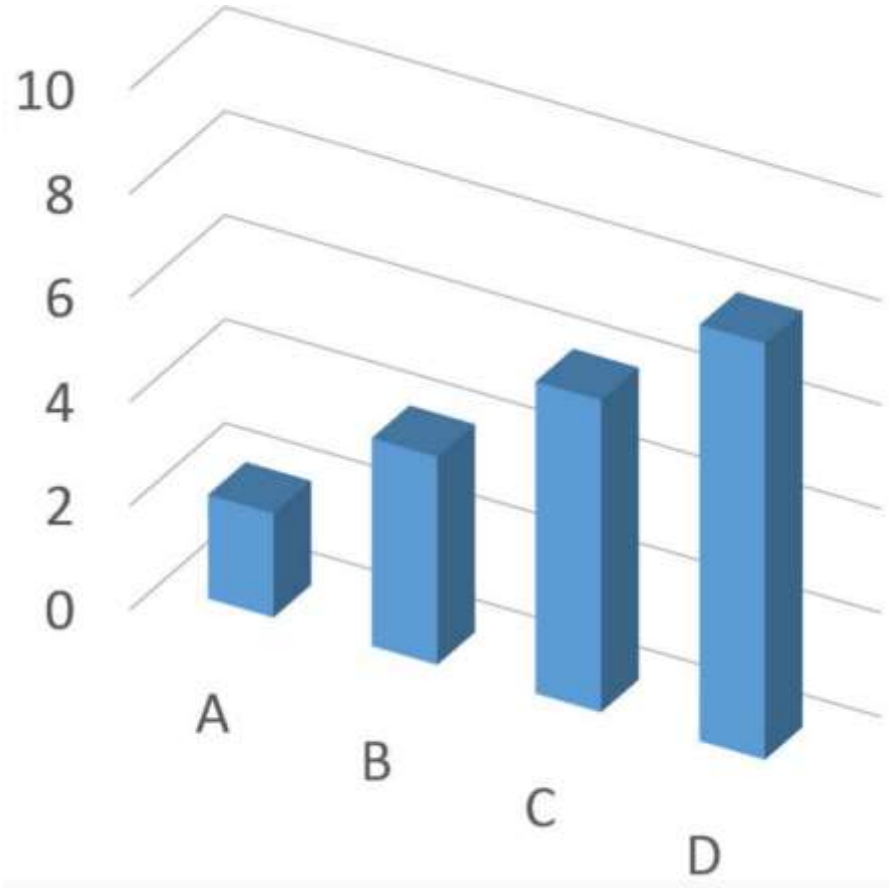


Write down the heights of the four bars.

This is a visual inspection only.
(No rulers.)



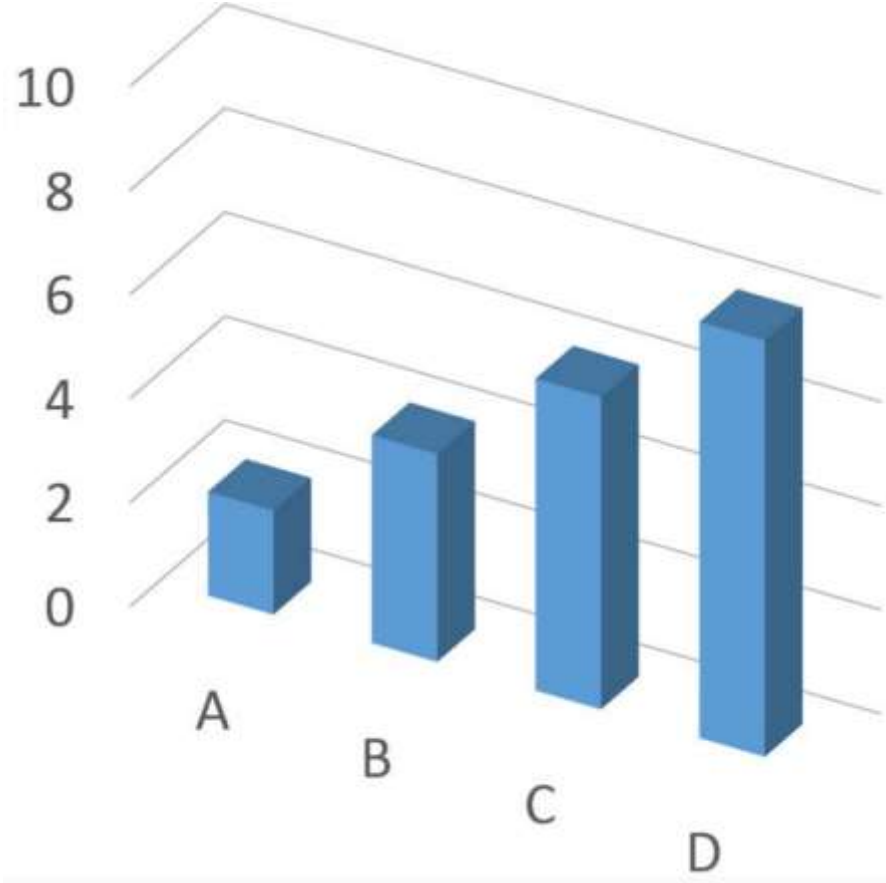
Naomi Robbins (2013) *Creating More Effective Graphs*, Chart House, NJ, Ch. 2.

Again, 3D effects distort our judgment.

This is a visual inspection only.
(No rulers.)

Answer:

A 2
B 4
C 6
D 8



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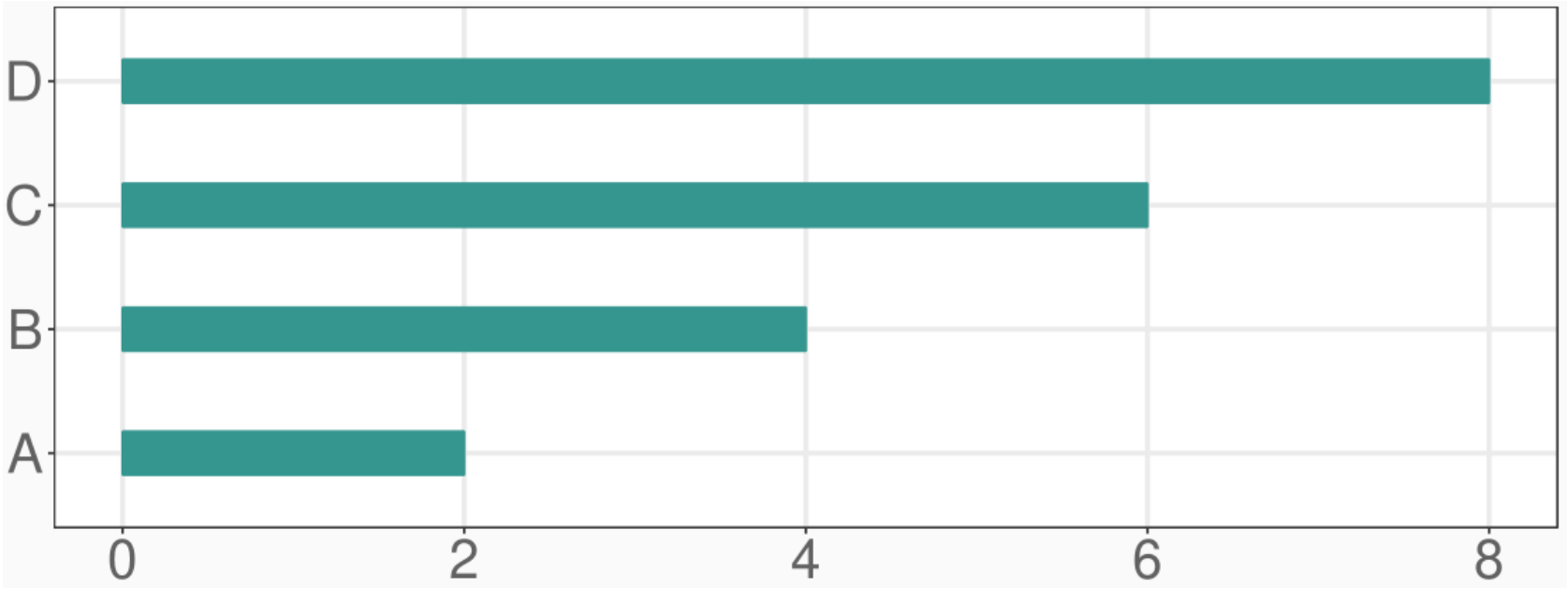
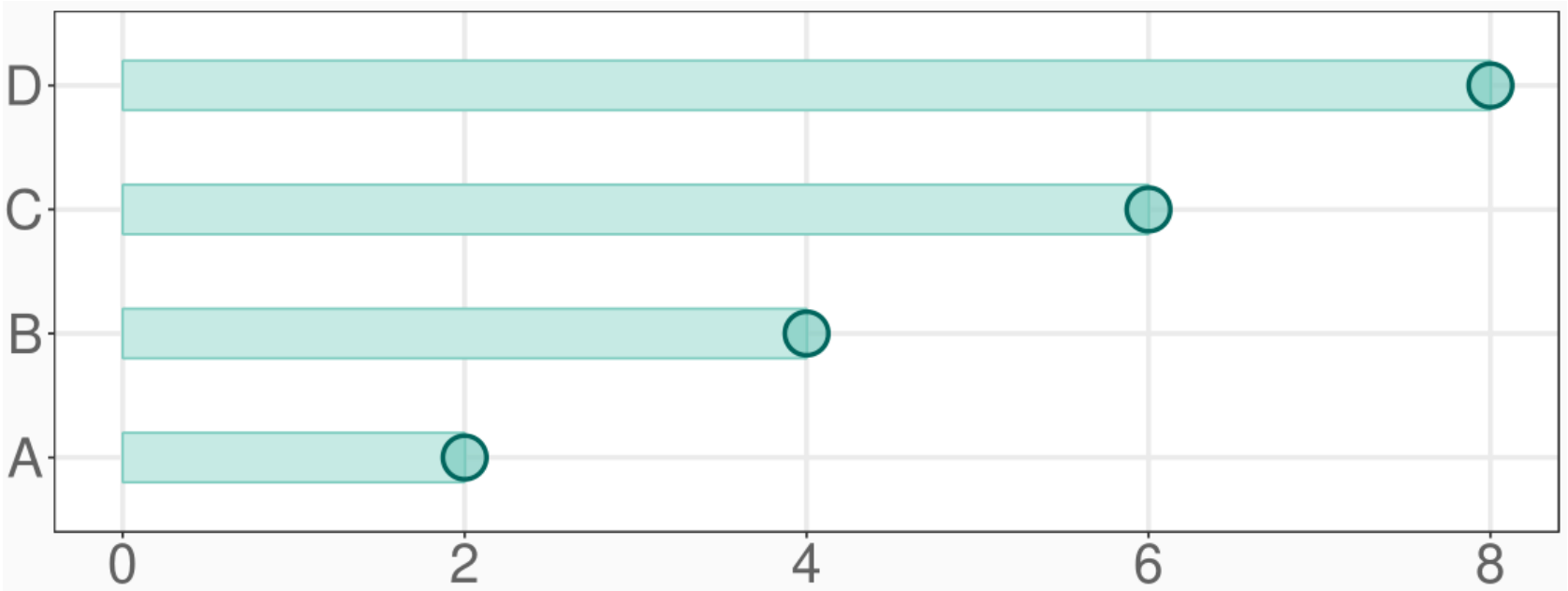
Bars align along a common horizontal scale, but the scales with bars must include zero.



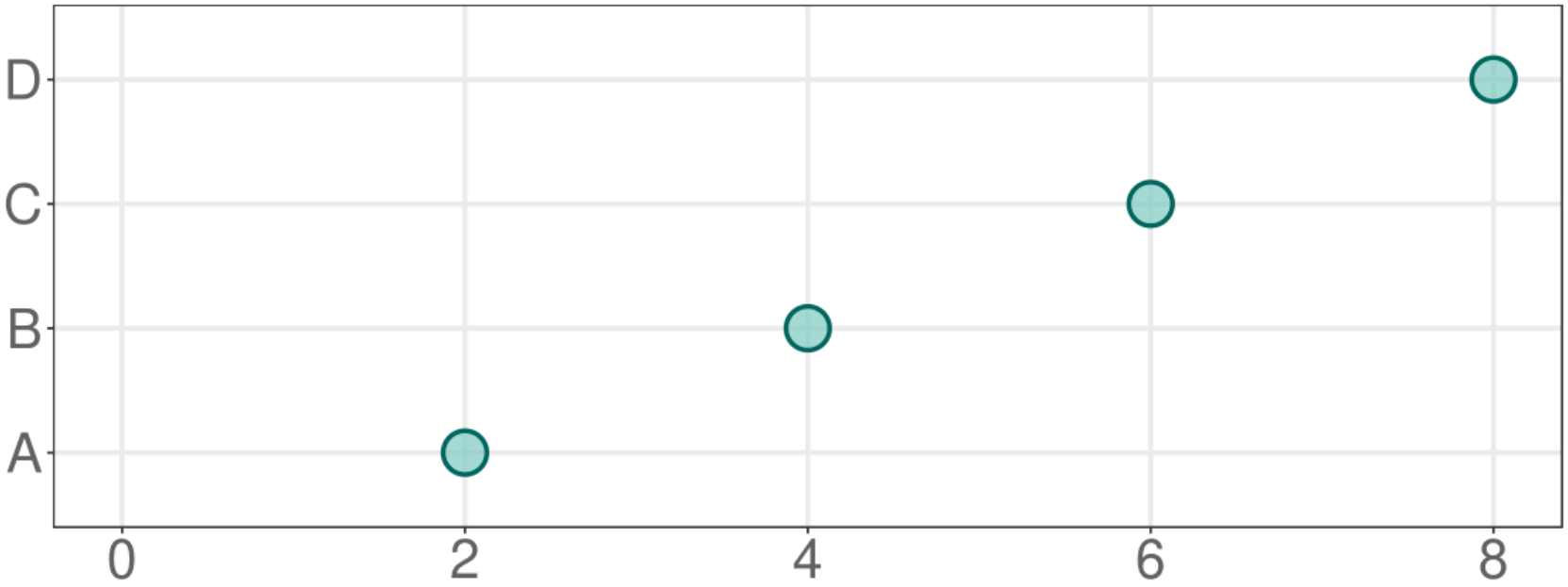
Omitting the scale zero on a bar chart is one of the most common graphical lies.

If you mark the endpoints, you can omit the bar.



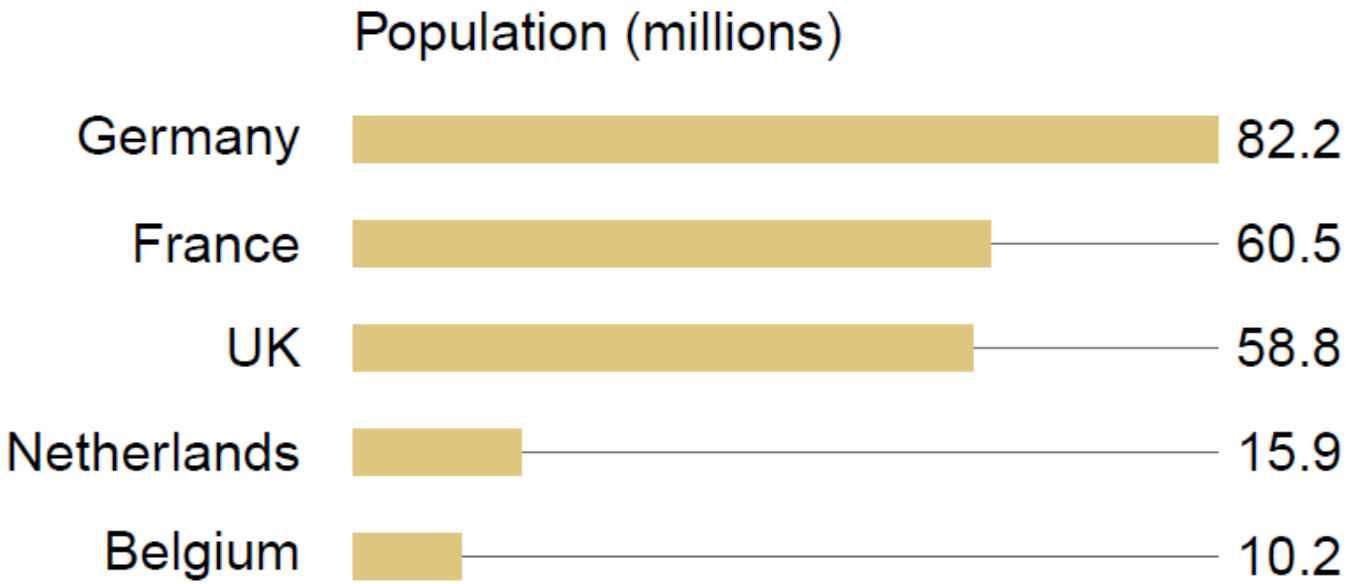
The endpoints are the only data here.

Producing a dot plot with rows ordered per the data



The scale zero can be omitted without distorting the visual comparisons.

Not all bars are bad. This design employs both visual and textual information.



Jean-luc Doumont (2009) *Trees, maps, and theorems*, Principiae, pp.135

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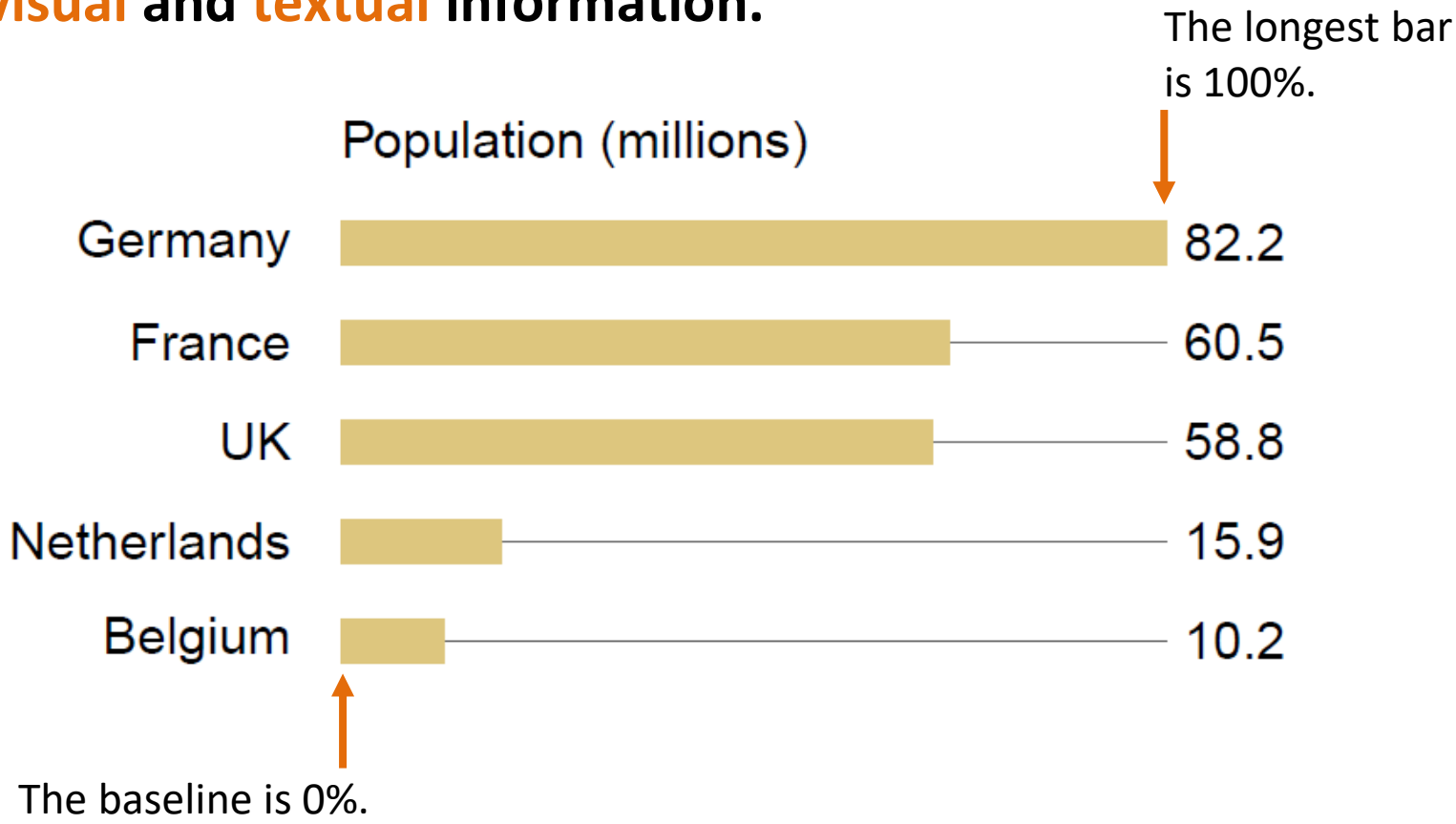

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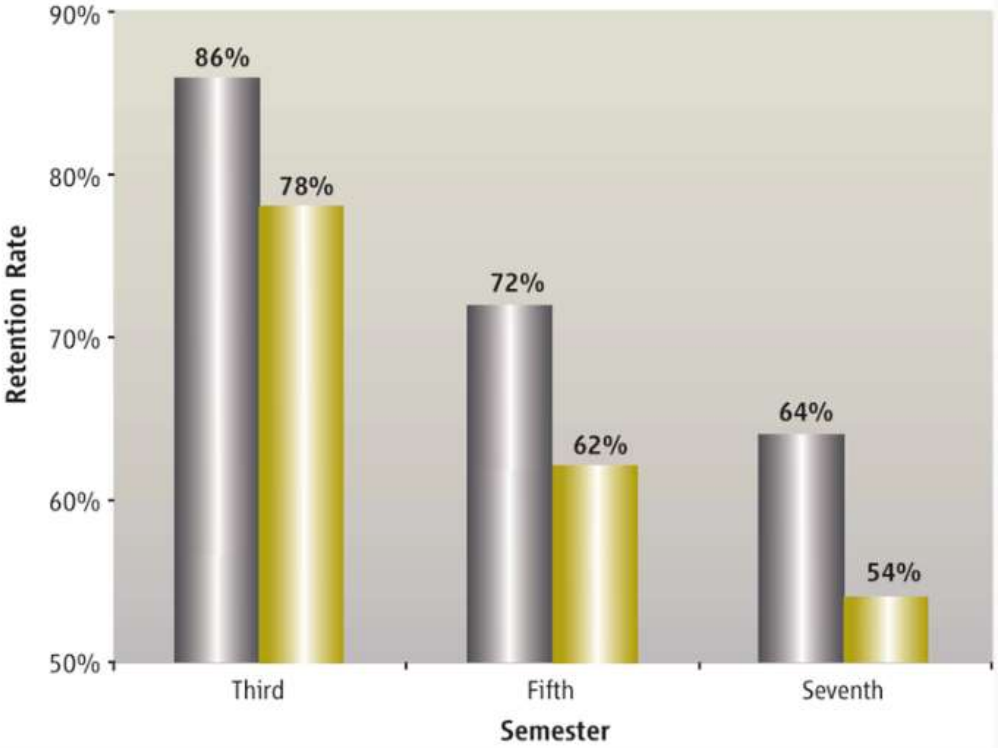
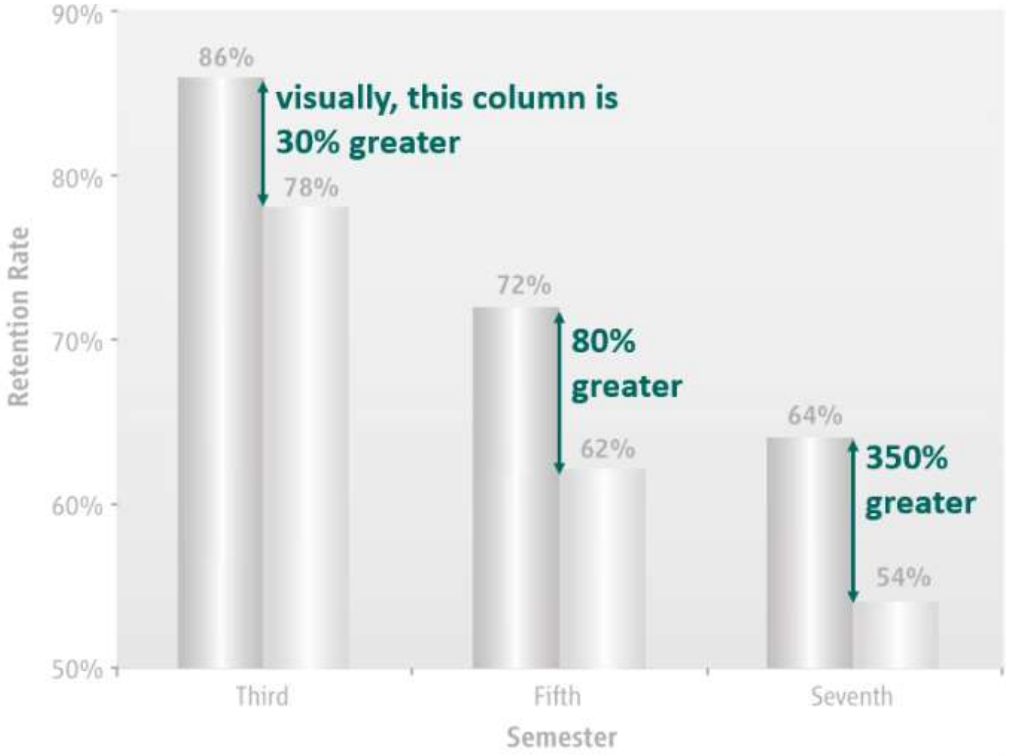
The trouble with bars.
What's wrong with this graph?



Gains in retention. The FYEP course improved retention of engineering students into the third, fifth, and seventh semester. There were 2128 students who took the FYEP course (gray) and 2942 students who did not (gold). All retention gains over expected retention rates shown are significant ($P < 0.05$).

Norman L. Fortenberry, Jacquelyn F. Sullivan, Peter N. Jordan, and Daniel W. Knight (2007)
Engineering education research aids instruction, *Science*, **31**:1175–1176.

The visual story is the increasing significance of the gap over time.



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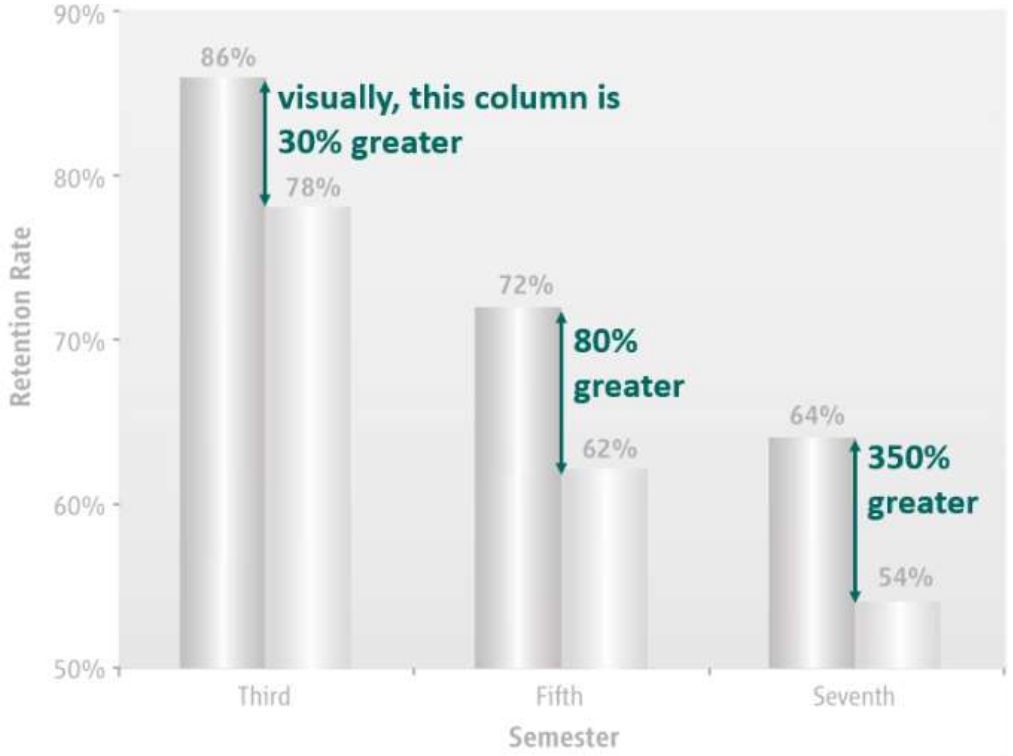
A more subtle flaw:
Can you identify what information is missing?



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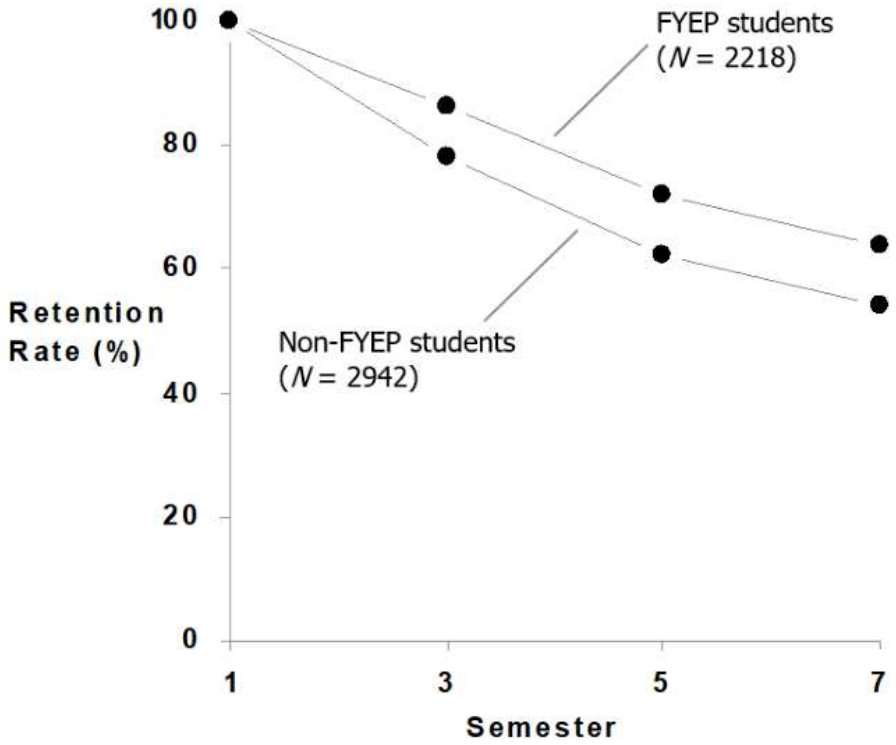
Redesigned, with full scales, a different story emerges.

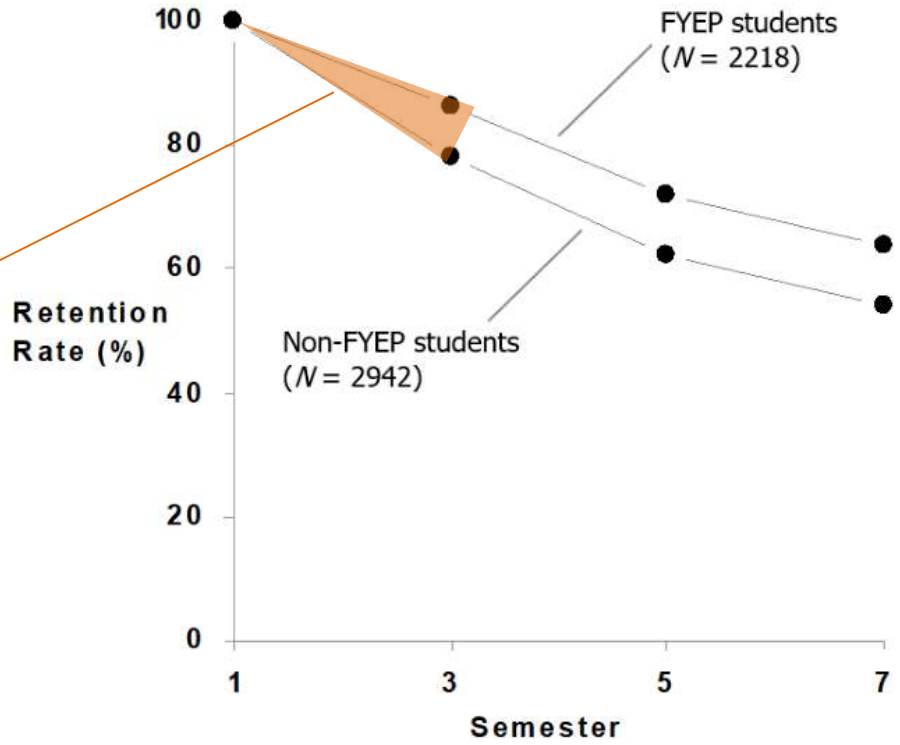
Semester 1 was missing.



First-year gains in retention. The primary impact of the first-year engineering projects (FYEP) course is in the higher retention rate in the third semester. Subsequently, both groups lose students at about the same rate with a persistent 10% difference between FYEP and non-FYEP students.

Redesigned, with full scales, a different story emerges.

FYEP impact is in the first year.



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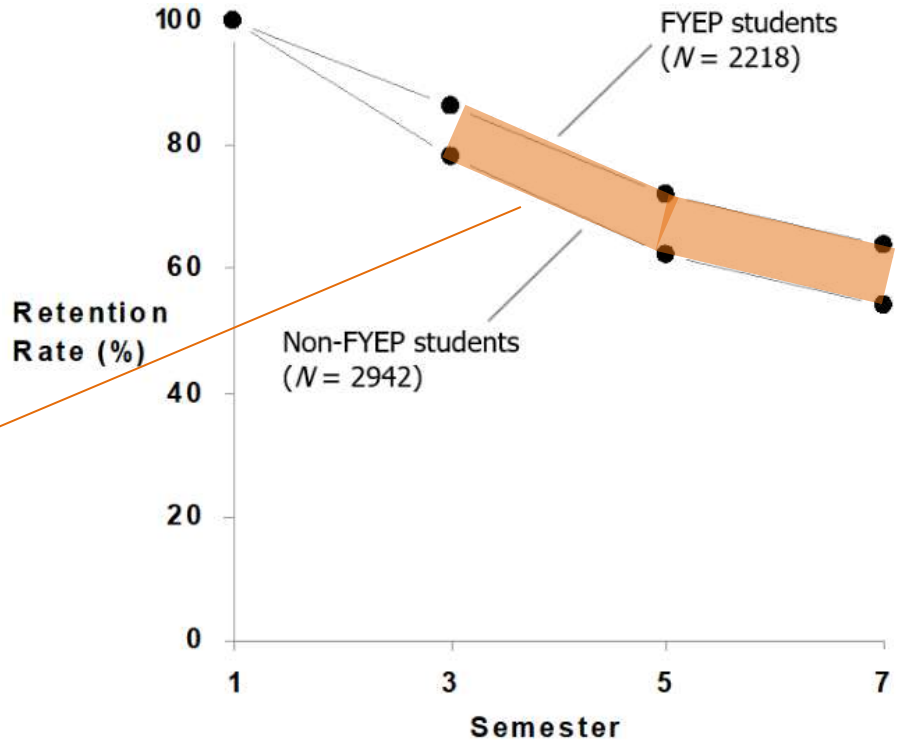
Attrition rate afterwards is about the same for both groups.



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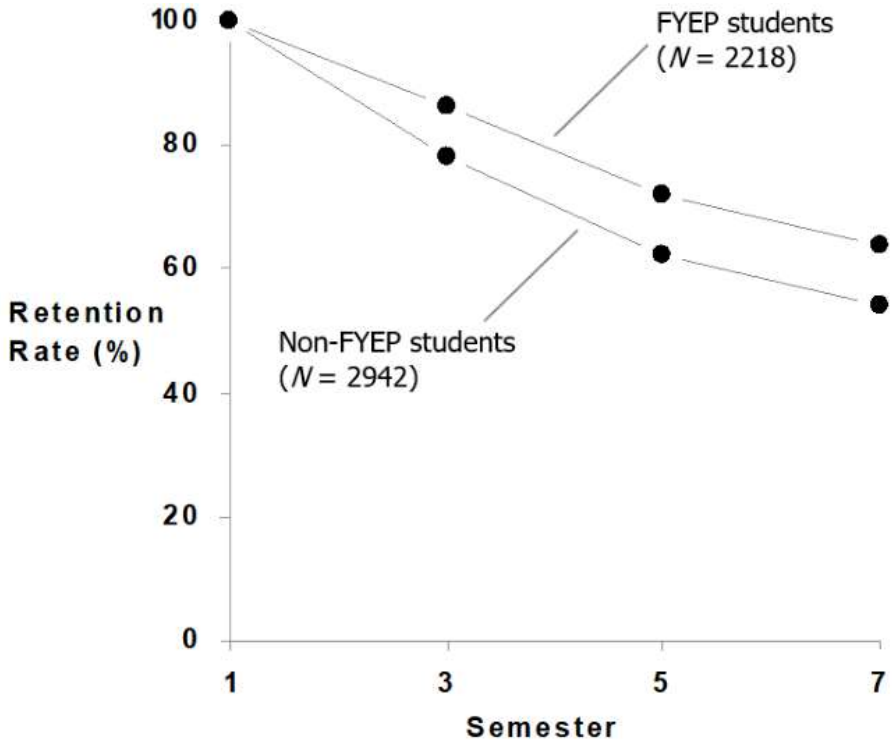

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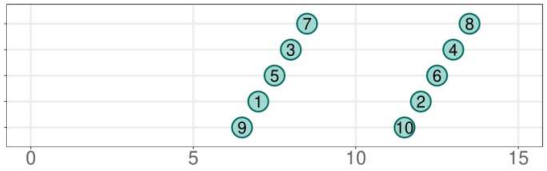
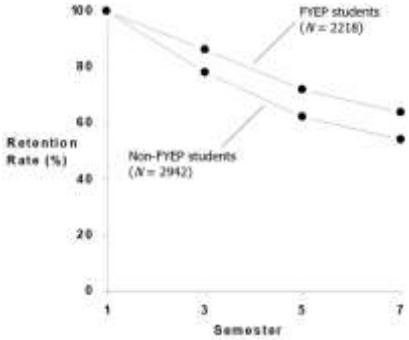
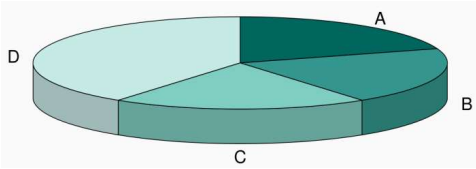
Implications for the designer



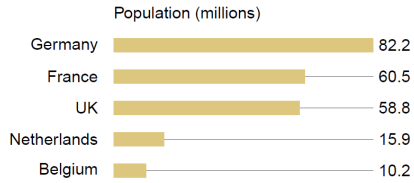
Visually explore the stories in the data.
Revise until the story is clear.



Explore context and causality; reveal complexity.
Consider what information might be missing.



Avoid 3D effects and other distortions.



Commingle visual and textual elements.