Seneca | SDDS

Business Analytics

Introduction to Data Visualization

BAN140 - Section NBB /NCC

Mufleh Al-Shatnawi, Ph.D., P.Eng.,

Week 6

Week Topics

Previous Week

- Finding the Most Important Thing

Current Week

- Cognitive load & Visual Perception

clutter is your enemy!

Chapter three: From Storytelling with Data: A Data Visualization Guide for Business Professionals, Wiley, 2017

Available online through Seneca Libraries: https://senecacollege-primo.hosted.exlibrisgroup.com/permalink/f/t3376v/01SENC_ALMA51463742800003226

Cognitive load

- **Defined as the mental effort that's required to learn new information**.
- *Perceived* cognitive load:
  - How hard the audience believes they are going to have to work to get the information out of your communication
  - Humans' brains have a finite amount of mental processing power.
- Goal: To lower cognitive load, to make it easier for audience

Clutter

- **Visual elements that take up space but don't increase understanding**
- *A Clutter can make something feel more complicated than it is.*
- The more clutter, the higher the cognitive load: the longer it takes to answer questions about the visual you are looking at.

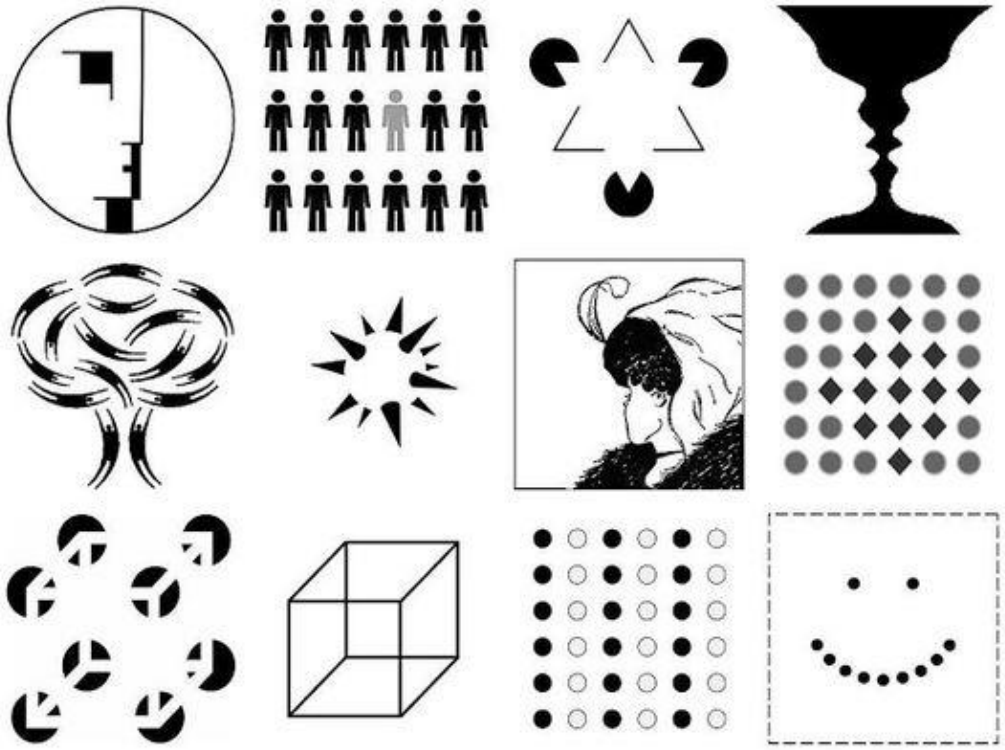
Data-to-ink ratio

- $\text{Data-to-ink ratio} = \dfrac{\text{Ink used to describe the data}}{\text{Ink used to describe everything else}}$

  - similar to "**signal-to-noise**" ratio
  - If a high value, means low "clutter"

Gestalt Principles of Visual Perception

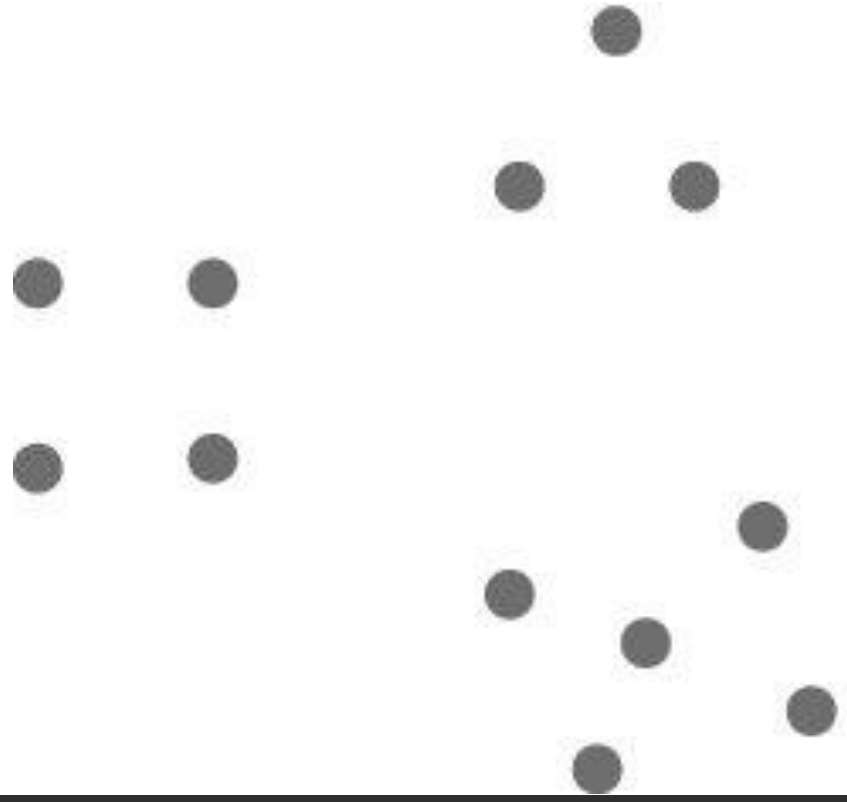
- Gestalt school of psychology
- Set out in the early 1900s to understand **how individuals perceive order in the world around them**
- Cues the visual system uses to group lower level sensory stimuli into perceived “objects”.
- Six principles here: **proximity**, **similarity**, **enclosure**, **closure**, **continuity**, and **connection**.



https://upload.wikimedia.org/wikipedia/commons/thumb/a/a7/Gestalt_Principles_Composition.jpg/560px-Gestalt_Principles_Composition.jpg

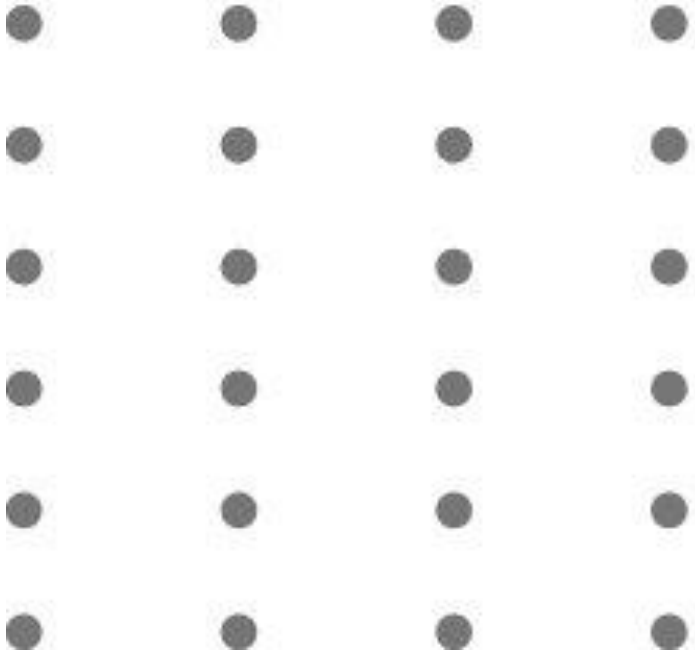
1- Gestalt principle of proximity

- Objects close together are perceived as belonging to the same group.



Proximity - application

- Seeing columns or rows; table design



You see columns and rows, simply due to dot spacing

2- Gestalt principle of similarity

- Objects of similar **color**, **shape**, **size**, **or orientation** are perceived as belonging to the same group.

Similarity- application

- Seeing rows due to similarity of color; no need for borders

You see rows due to similarity of color

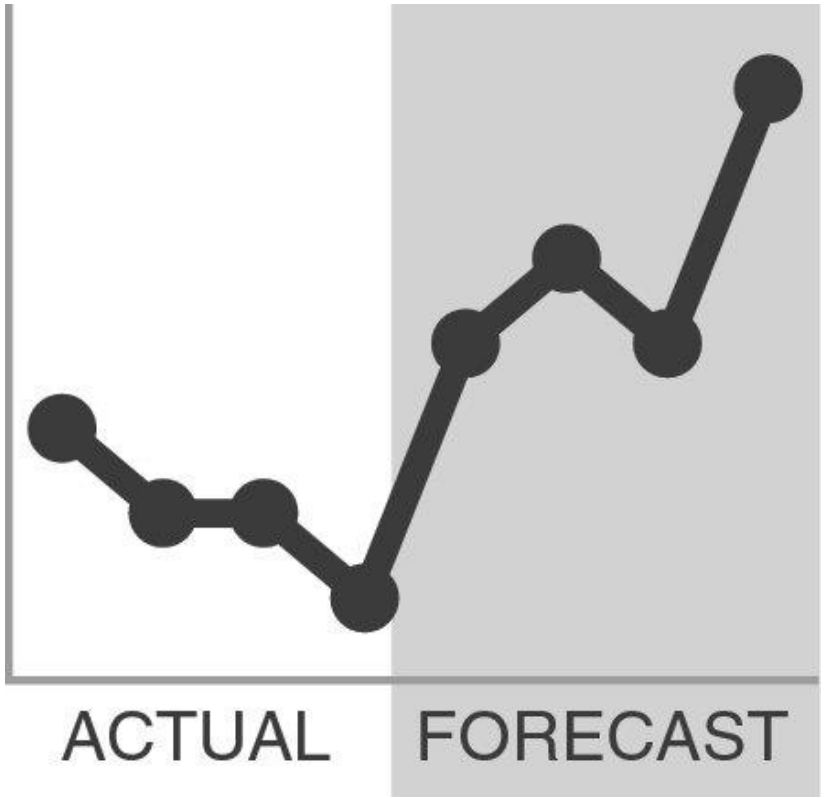
3- Gestalt principle of enclosure

- Objects enclosed together are perceived as belonging to the same group.
- A light background shading is often enough.

Visual hierarchy: some gestalts take precedence over others

Enclosure- application

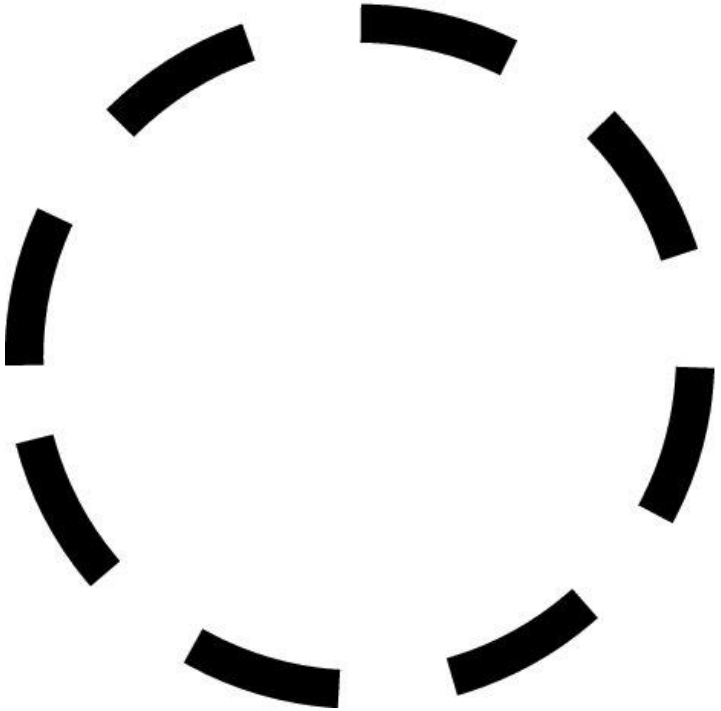
- Drawing a visual distinction within our data



The shaded area separates the forecast from actual data

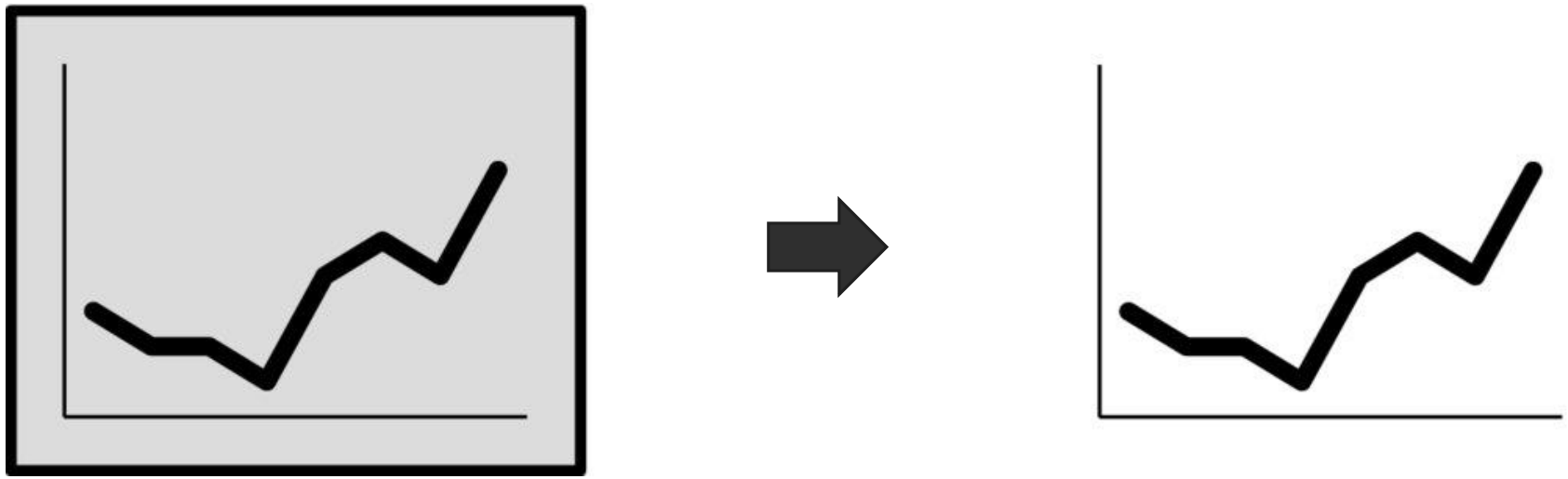
4- Gestalt principle of closure

- A set of individual elements are perceived as a single, closed, recognizable shape.
- Seeking the simplest explanation
- Seen as a circle first



Closure- application

- No need for chart borders and background shading
- It still appears as a cohesive entity

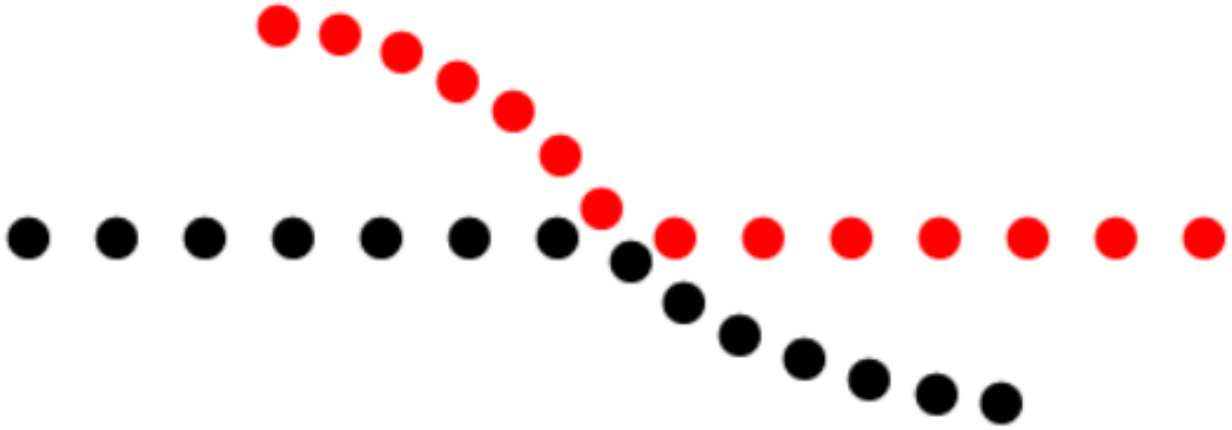


The graph still appears complete without the border and background shading

5- Gestalt principle of continuity

- Seeking the smoothest path, naturally perceiving continuity
- Objects arranged in either a straight line or a smooth curve tend to be seen as a unit.

Human eye naturally follows a line or a curve, making **continuation** a stronger signal of relatedness than the similarity of color



https://www.usertesting.com/blog/gestalt-principles#continuity

Continuity- application

- The bars are seen as lined up; No need for y-axis in this figure:

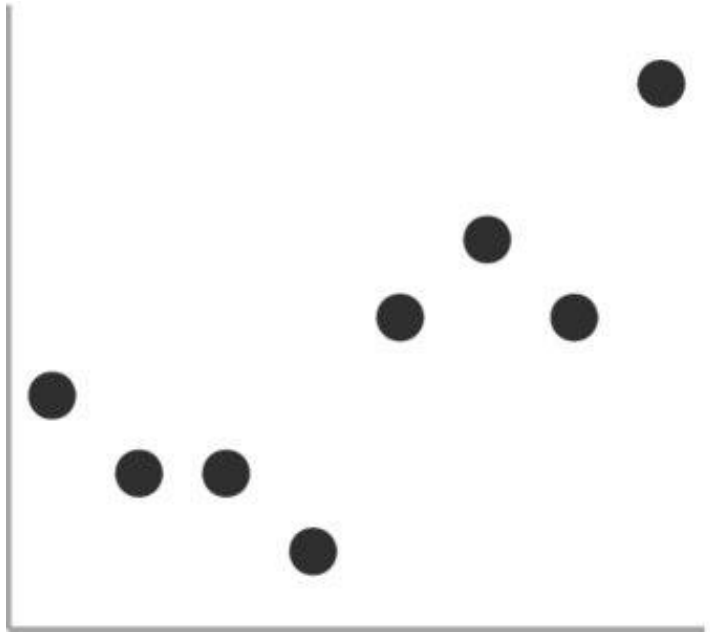
Graph with *y*-axis line removed

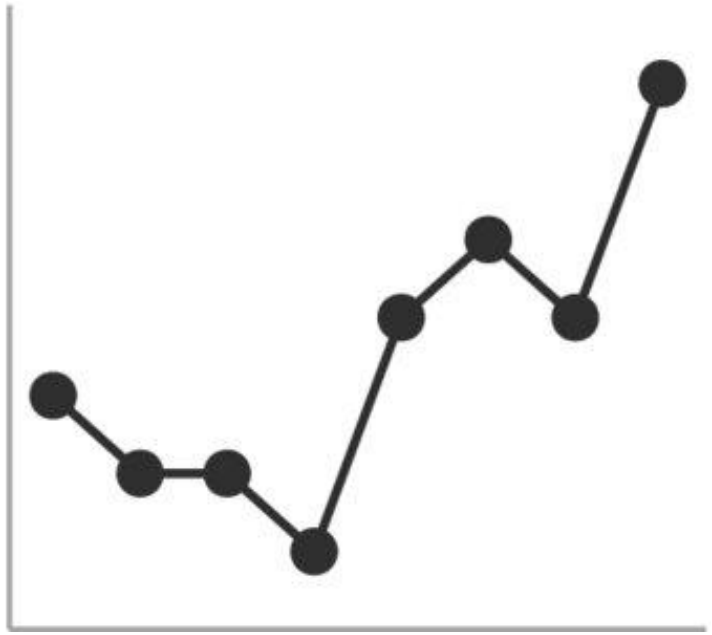
6- Gestalt principle of connection

- **Objects that are physically connected are perceived as belonging to the same group.**
  - ***Objects* that are connected by uniform visual properties are perceived as being more related than elements that are <u>not connected</u>**
- Stronger cue than similarity
- Not typically as strong as enclosure

Connection- application

- Line graphs





Lines connect the dots

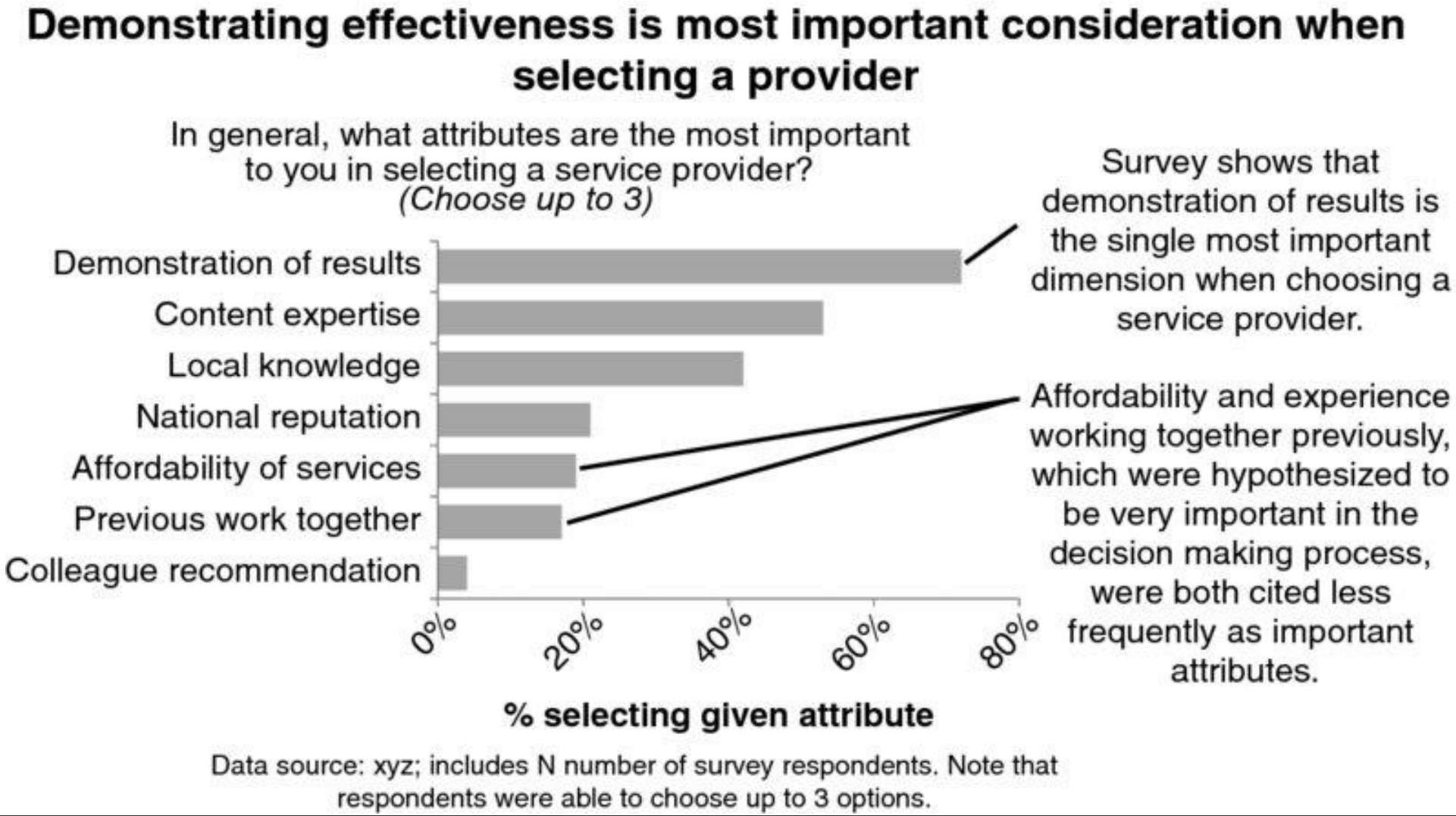
How We Can Use Gestalt Principles

- Understand how people see visual communications.
- Identify unnecessary visual elements and remove them

Other types of visual clutter

- Lack of visual order
  - Lacking Alignment
  - Not leveraging reading order (“z”s)
  - Using diagonal components
  - Lacking White space
- Nonstrategic use of contrast

Lack of visual order



Added visual order

Demonstrating effectiveness is most important consideration when selecting a provider

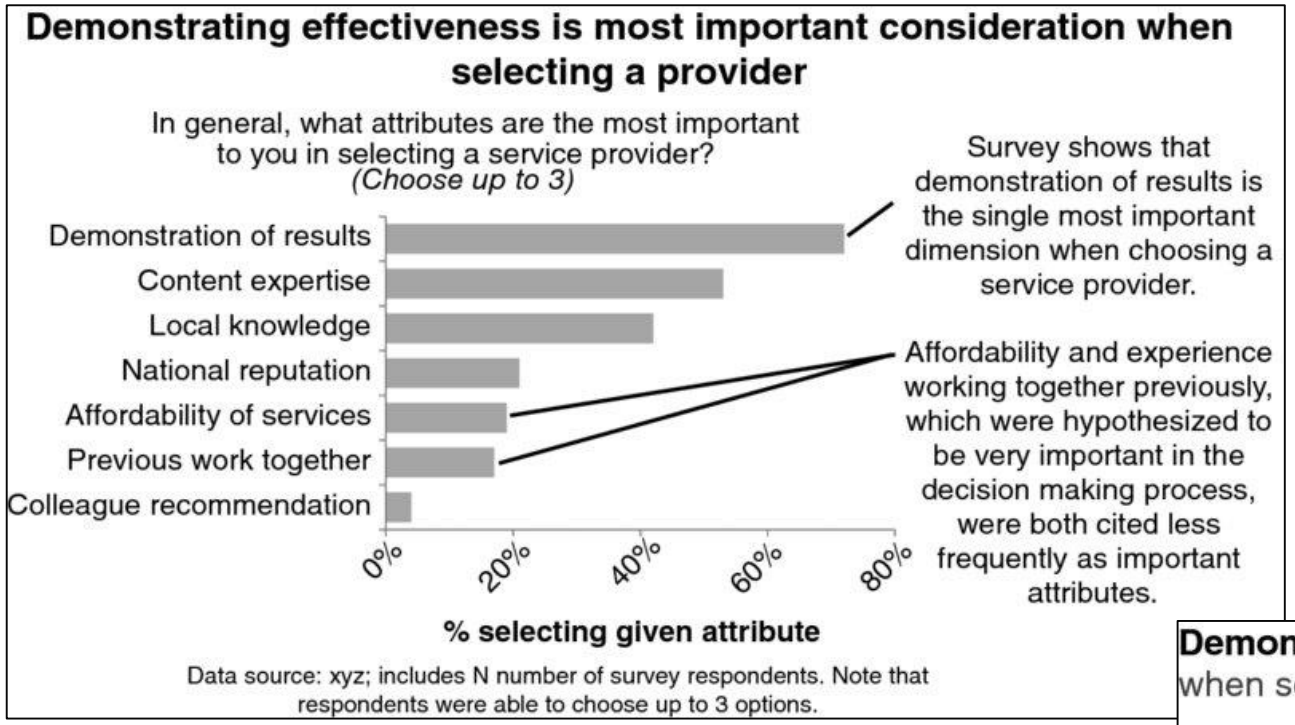
In general, **what attributes are the most important** to you in selecting a service provider?

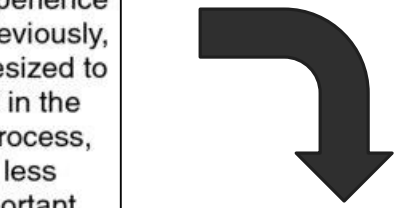
(Choose up to 3)

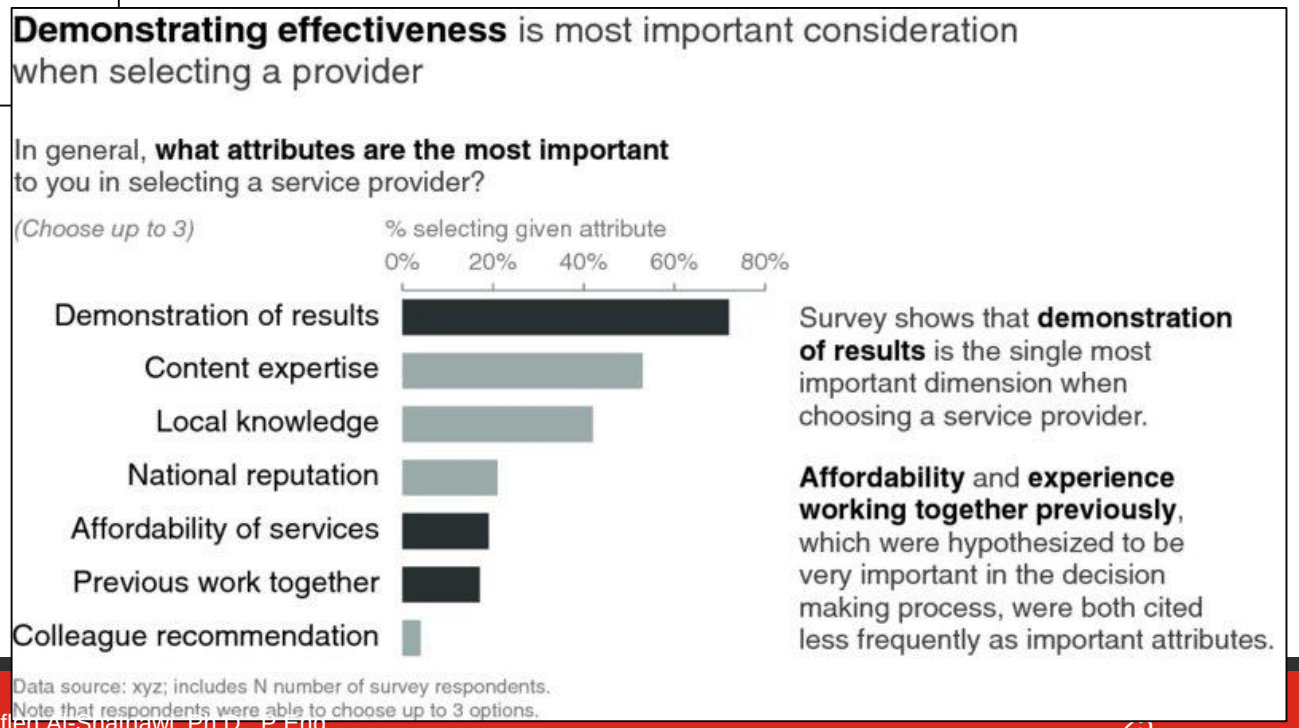
Survey shows that **demonstration of results** is the single most important dimension when choosing a service provider.

Affordability and **experience working together previously**, which were hypothesized to be very important in the decision making process, were both cited less frequently as important attributes.

Data source: xyz; includes N number of survey respondents.
Note that respondents were able to choose up to 3 options.


Demonstrating effectiveness is most important consideration when selecting a provider
In general, what attributes are the most important to you in selecting a service provider?
(Choose up to 3)
Demonstration of results
Content expertise
Local knowledge
National reputation
Affordability of services
Previous work together
Colleague recommendation
0%
20%
40%
60%
80%
% selecting given attribute
Survey shows that demonstration of results is the single most important dimension when choosing a service provider.
Affordability and experience working together previously, which were hypothesized to be very important in the decision making process, were both cited less frequently as important attributes.
Data source: xyz; includes N number of survey respondents. Note that respondents were able to choose up to 3 options.



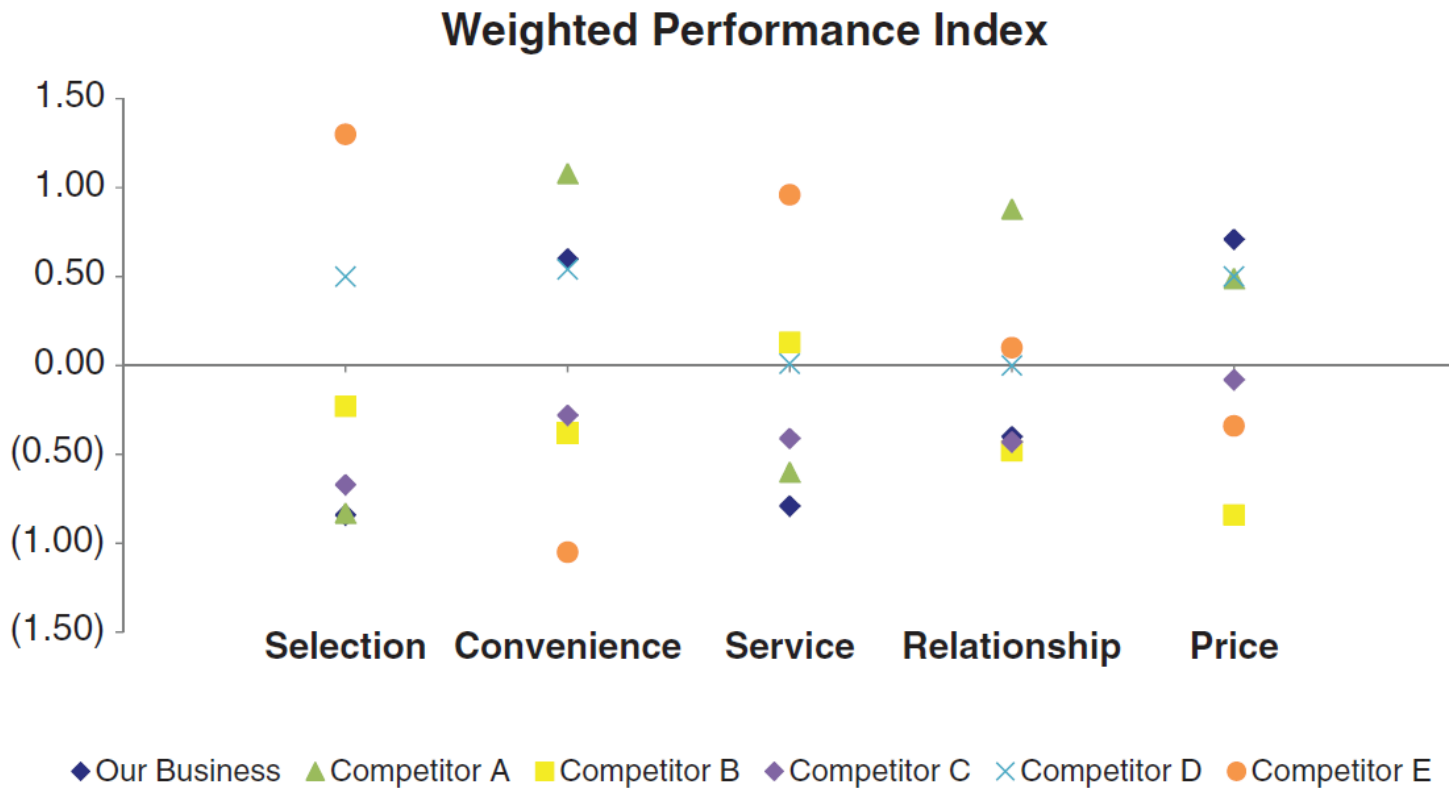

Demonstrating effectiveness is most important consideration when selecting a provider
In general, what attributes are the most important to you in selecting a service provider?
(Choose up to 3)
% selecting given attribute
0%
20%
40%
60%
80%
Demonstration of results
Content expertise
Local knowledge
National reputation
Affordability of services
Previous work together
Colleague recommendation
Survey shows that demonstration of results is the single most important dimension when choosing a service provider.
Affordability and experience working together previously, which were hypothesized to be very important in the decision making process, were both cited less frequently as important attributes.
Data source: xyz; includes N number of survey respondents. Note that respondents were able to choose up to 3 options.

Minor changes

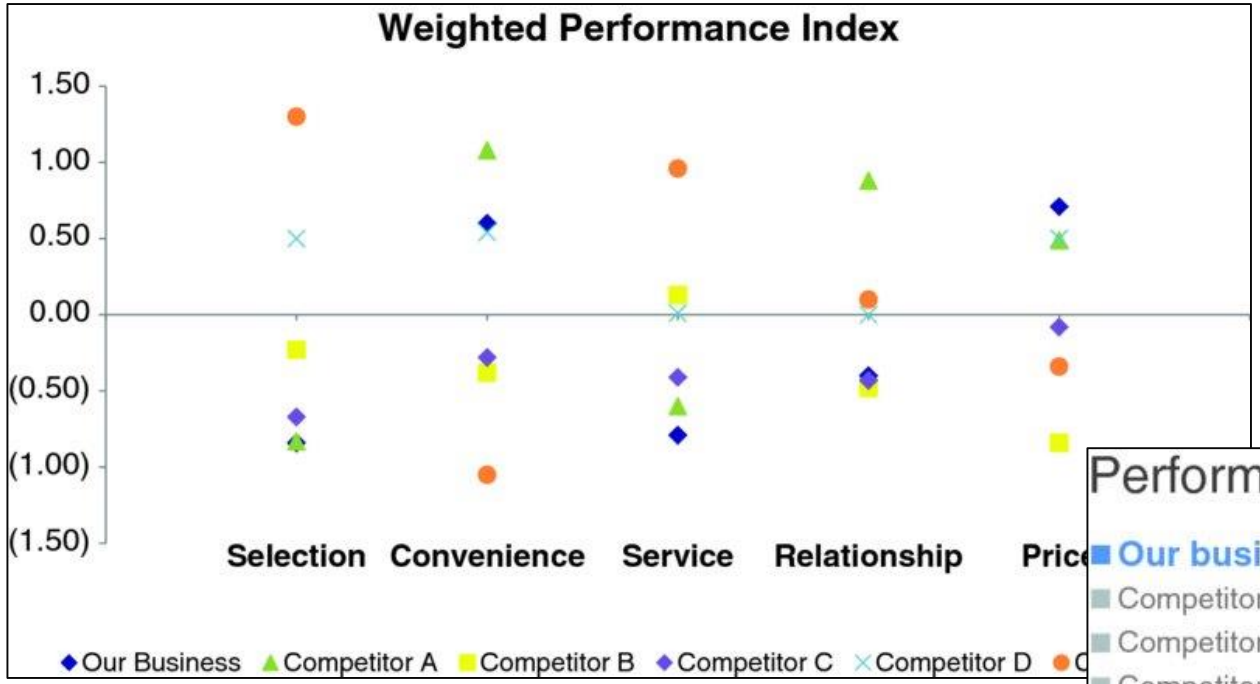
- Left-justified text
  - Title, axis titles, legend
- Supporting common reading order “z”
- No diagonal components (lines or text)
  - Reading of text rotated 45 degrees in either direction was shown to be, on average, 52% slower than reading normally oriented text
  - Reading of text rotated 90 degrees in either direction was shown to be, on average, 205% slower than reading normally oriented text
- Use of white space

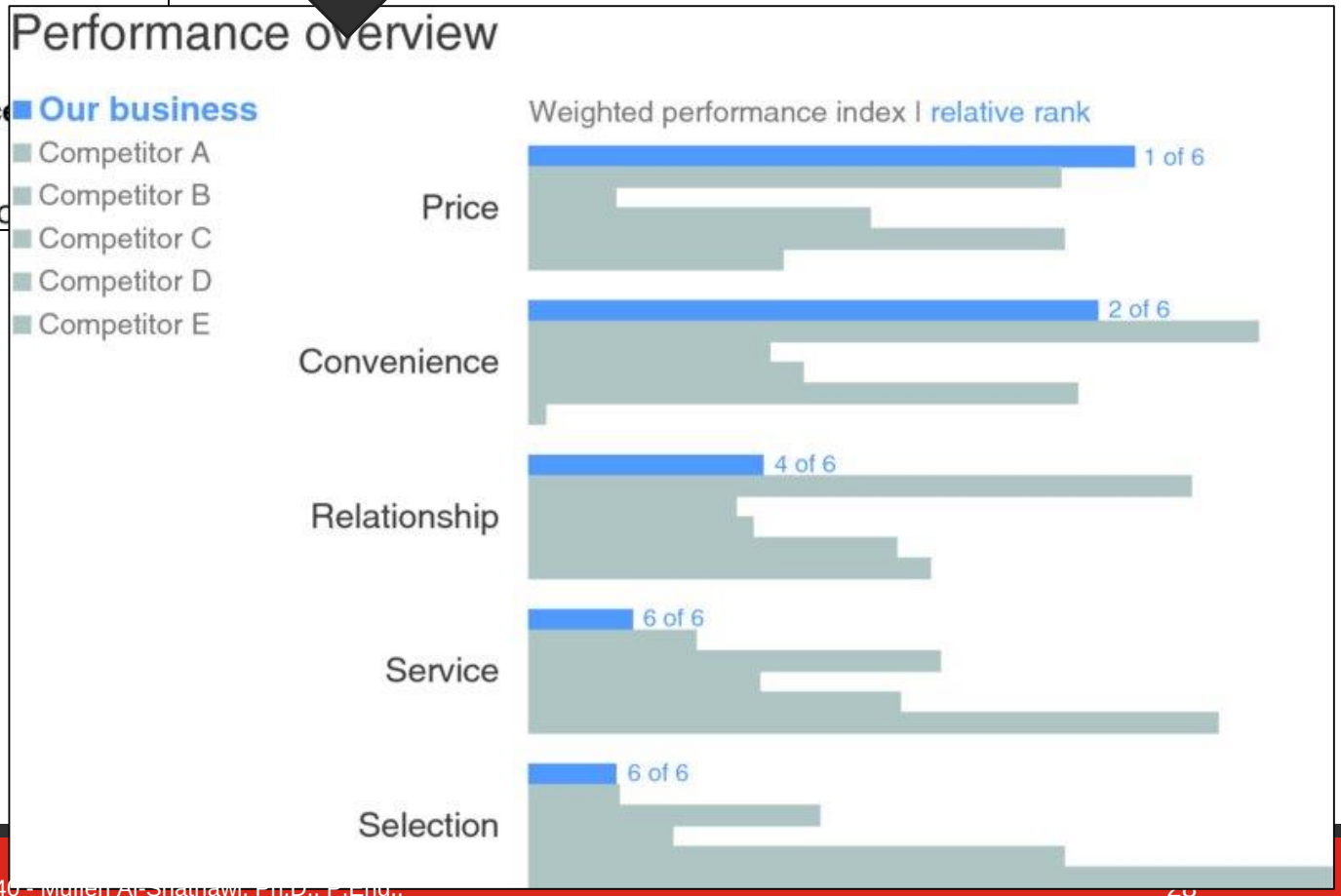
Non-strategic use of contrast

- Not a clear contrast
- Too much going on



if there is something important, we want our audience to know or see, we should make that ***the one thing that is very different from the rest***


Weighted Performance Index
1.50
1.00
0.50
0.00
(0.50)
(1.00)
(1.50)
Selection
Convenience
Service
Relationship
Price
Our Business
Competitor A
Competitor B
Competitor C
Competitor D

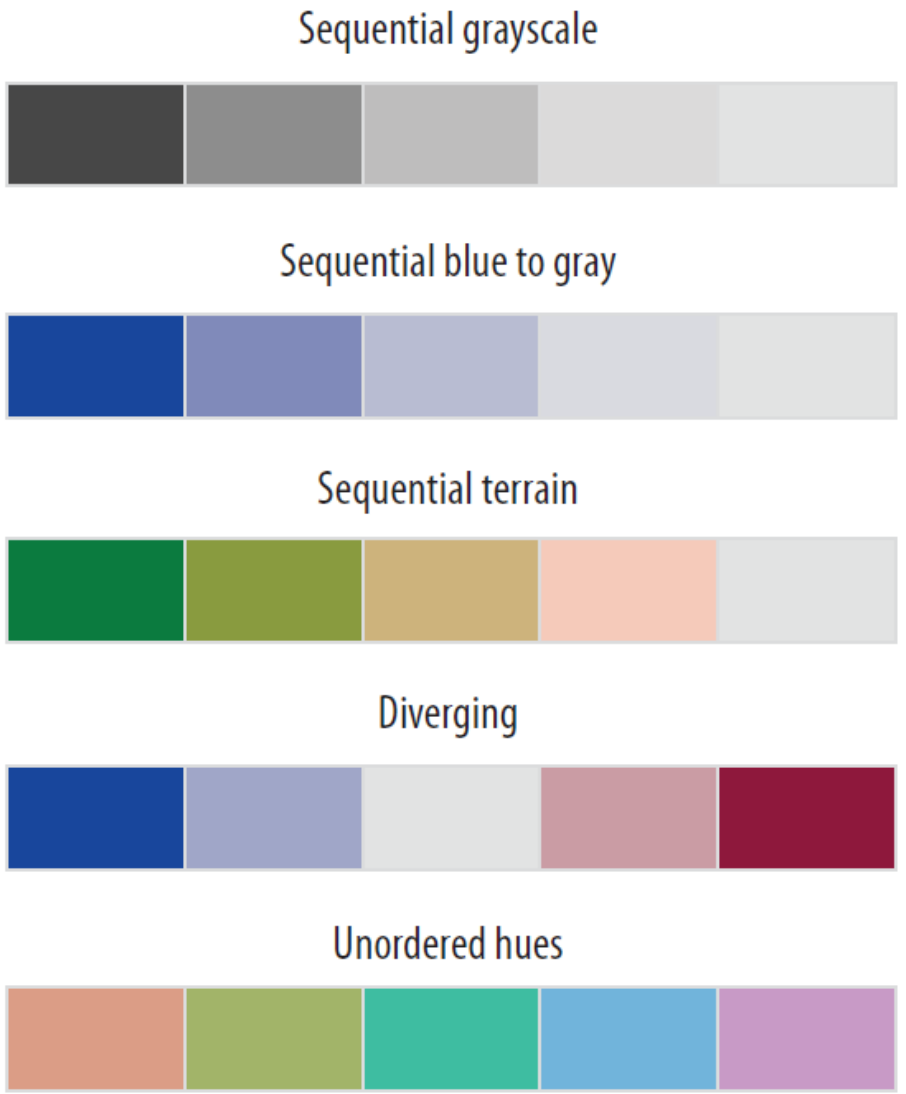

Performance overview
Our business
Competitor A
Competitor B
Competitor C
Competitor D
Competitor E
Weighted performance index I relative rank
Price
1 of 6
Convenience
2 of 6
Relationship
4 of 6
Service
6 of 6
Selection
6 of 6

Changes

- Choice of horizontal bar chart for categorical information
- Rescaled numbers to positive
- Categories along the vertical y-axis
  - More room to write the category names
- Not showing the x-axis deliberately
  - The relative difference is important here
- Reading order; categories ranked top to bottom; “Our business” on top and colored
- Note: This design doesn’t allow for identification of the competitors.

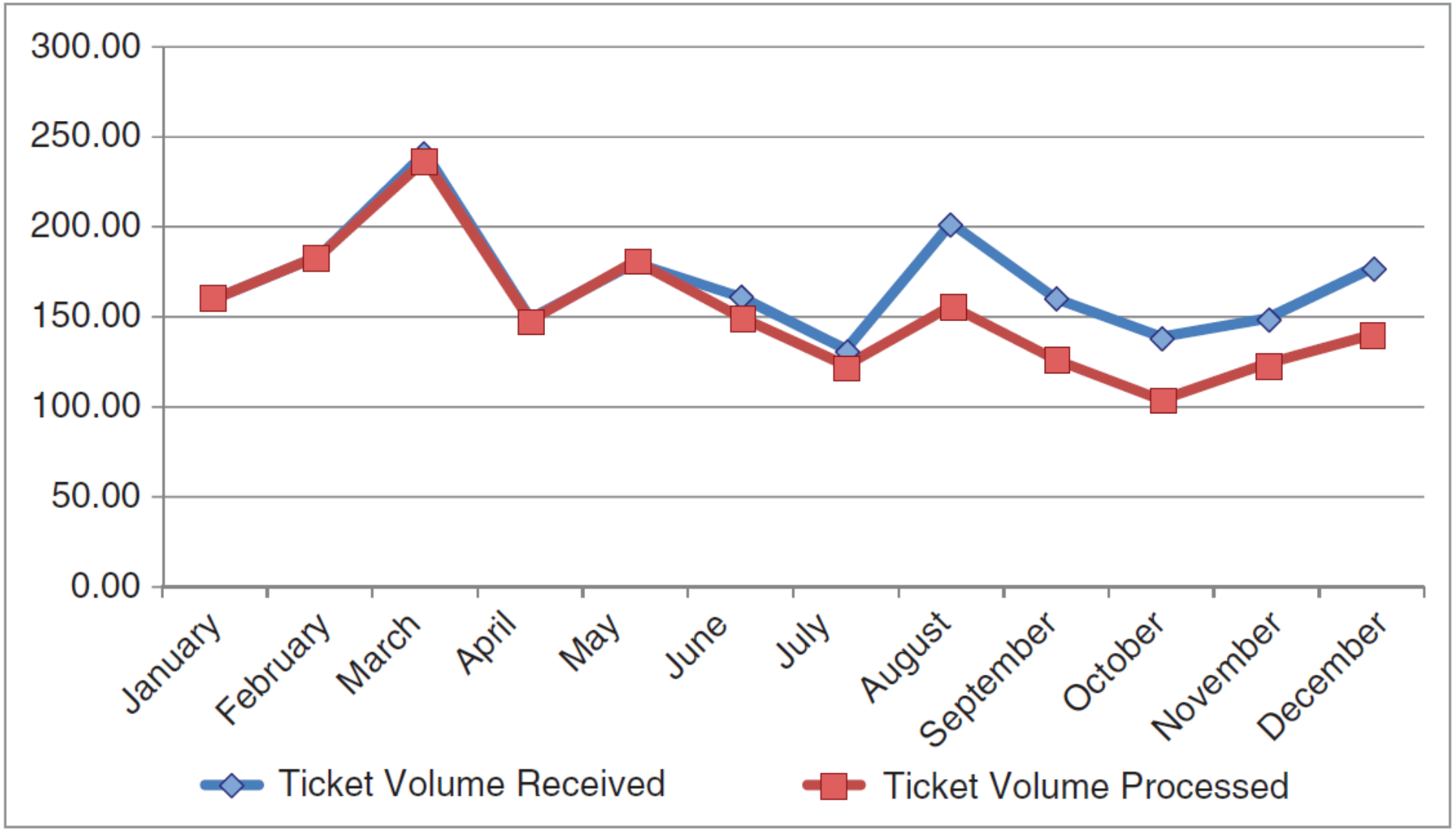
Choosing color palettes

- When choosing color schemes, we want mapping from data to color that are not just *numerically*, but also *perceptually* uniform.
- **Sequential**
  - Suitable for all positive or all negative quantitative values
- **Diverging**
  - Suitable for quantitative values with a neutral midpoint; diverging from a zero or mean
- **Unordered**
  - Suitable for categorical or qualitative values



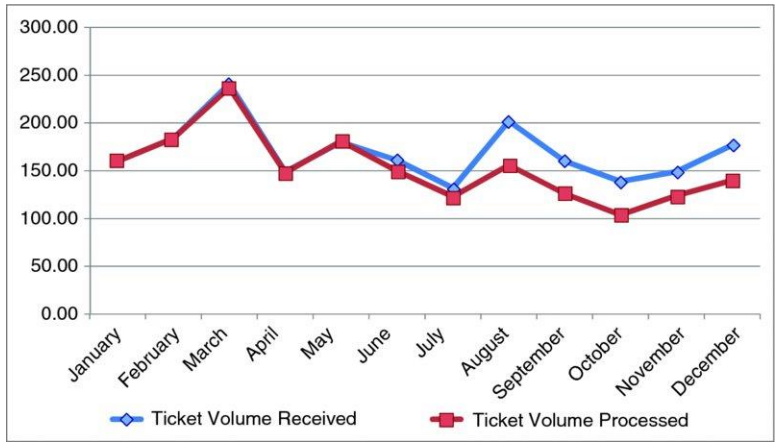
De-cluttering example

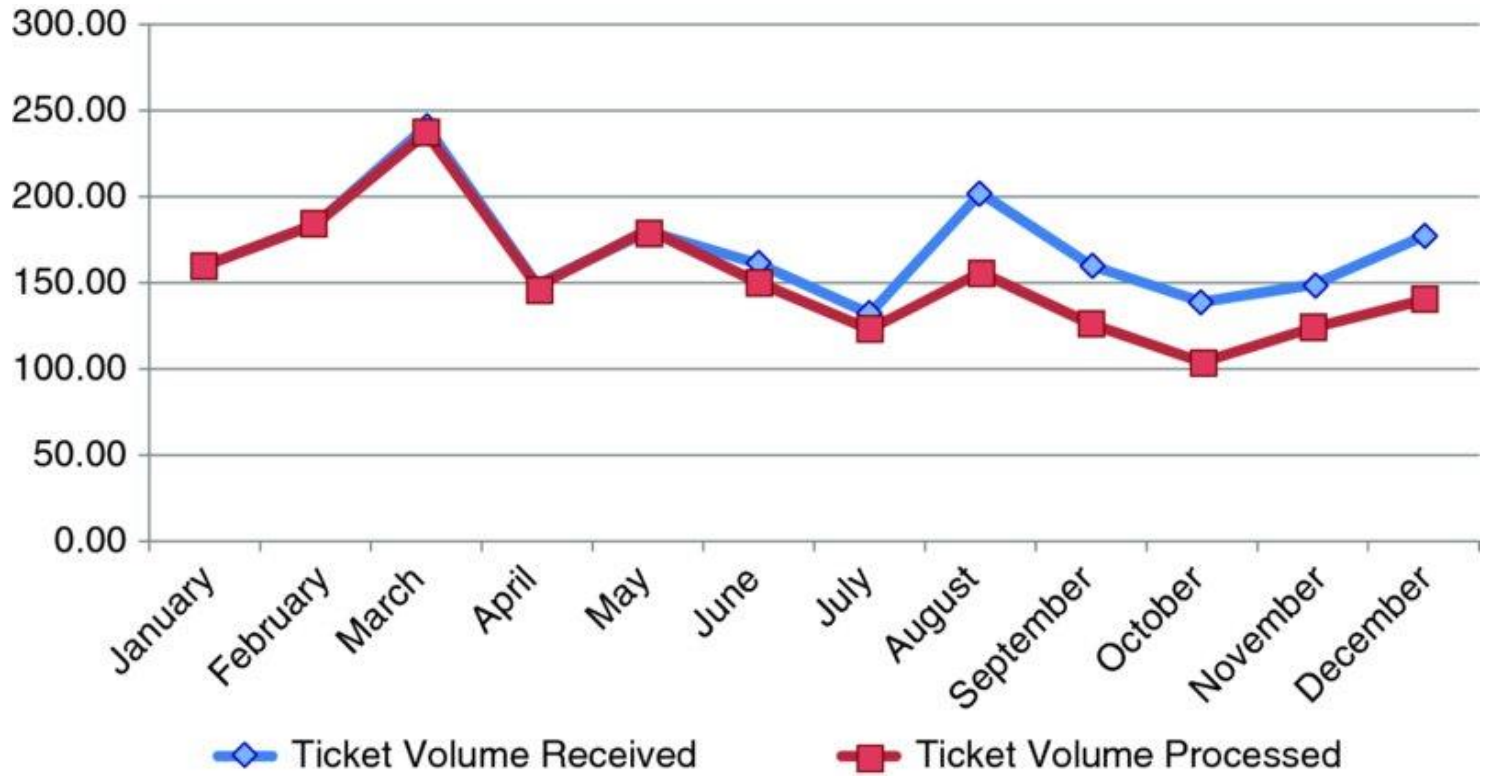
Decluttering: step-by-step



1- Remove chart border

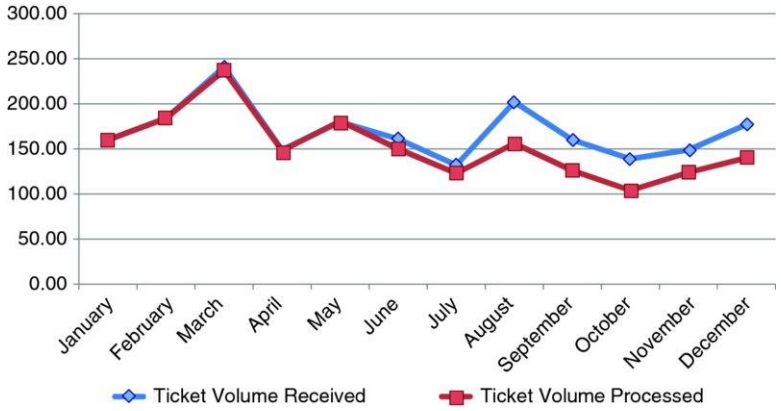
- Based on Gestalt principle of closure

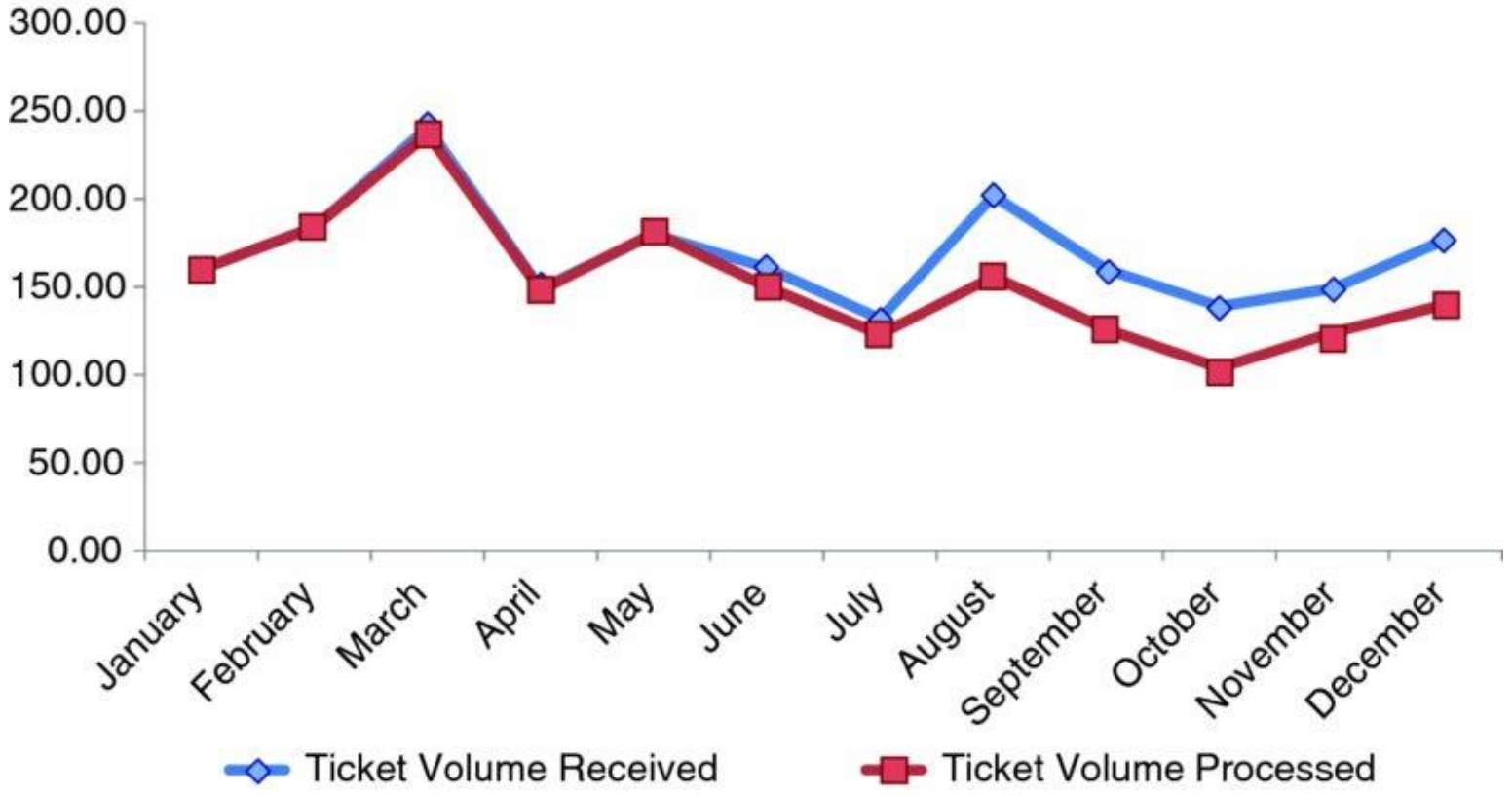




2- Remove gridlines

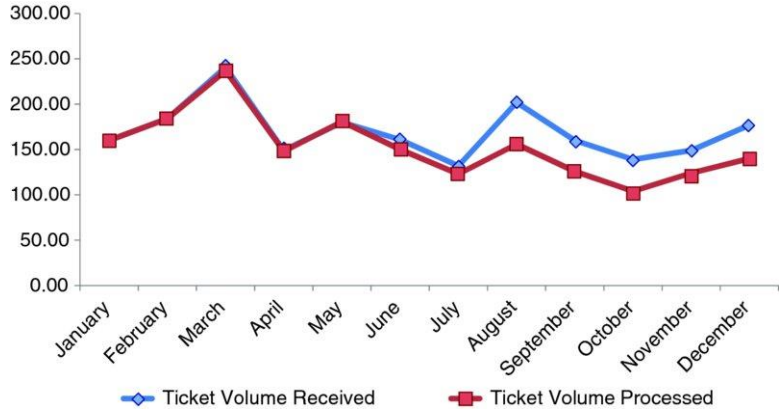
- Removes clutter; greater contrast

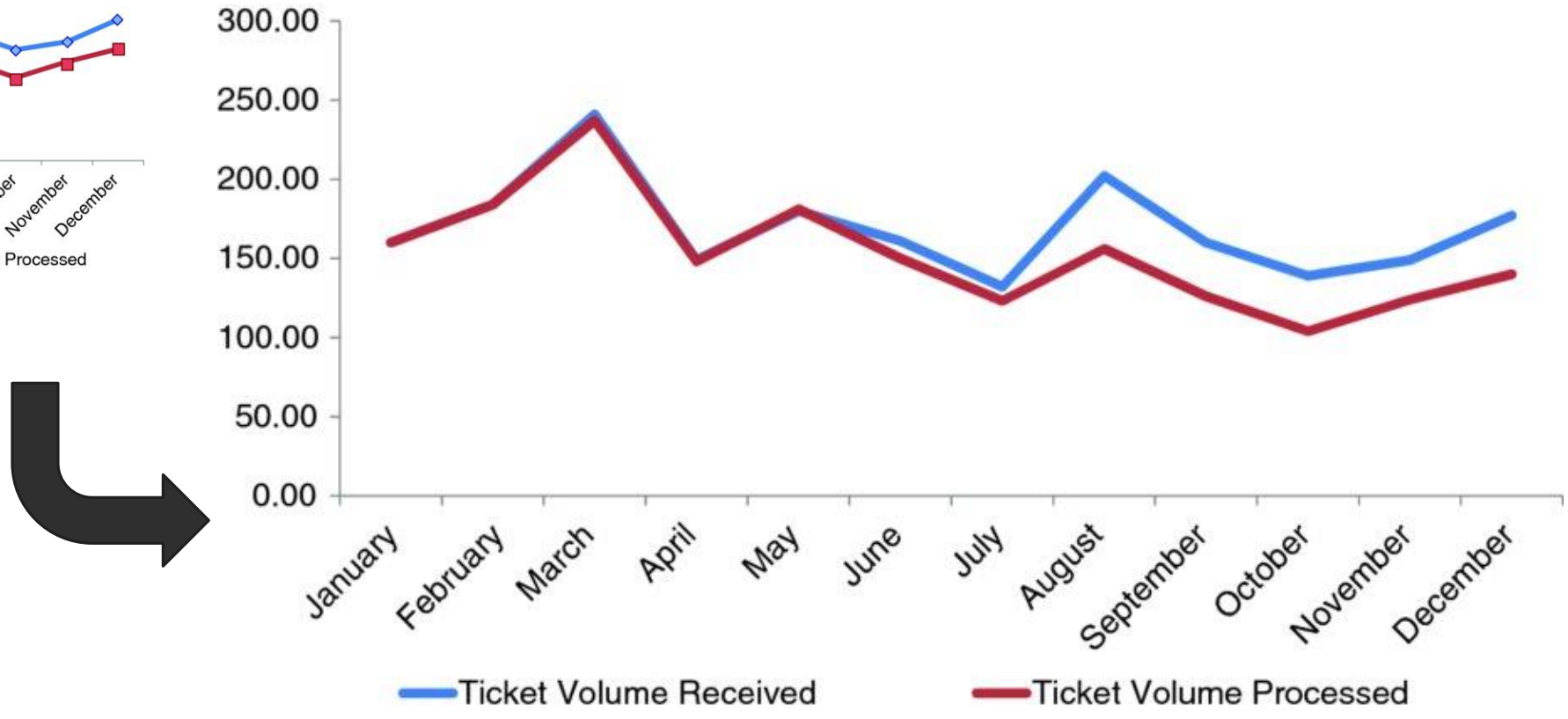




3- Remove data markers

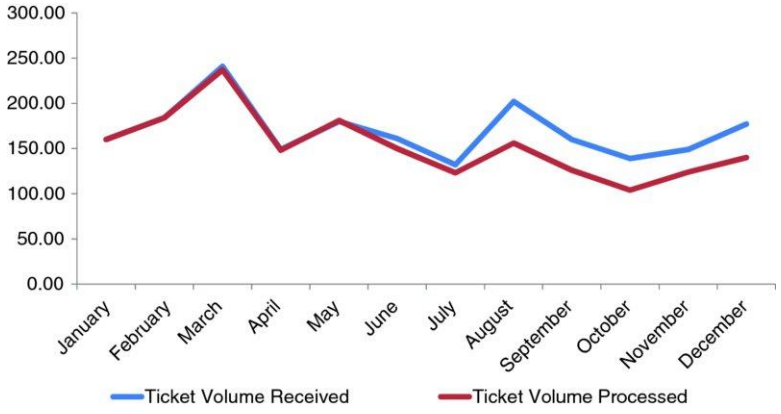
- Lower cognitive load

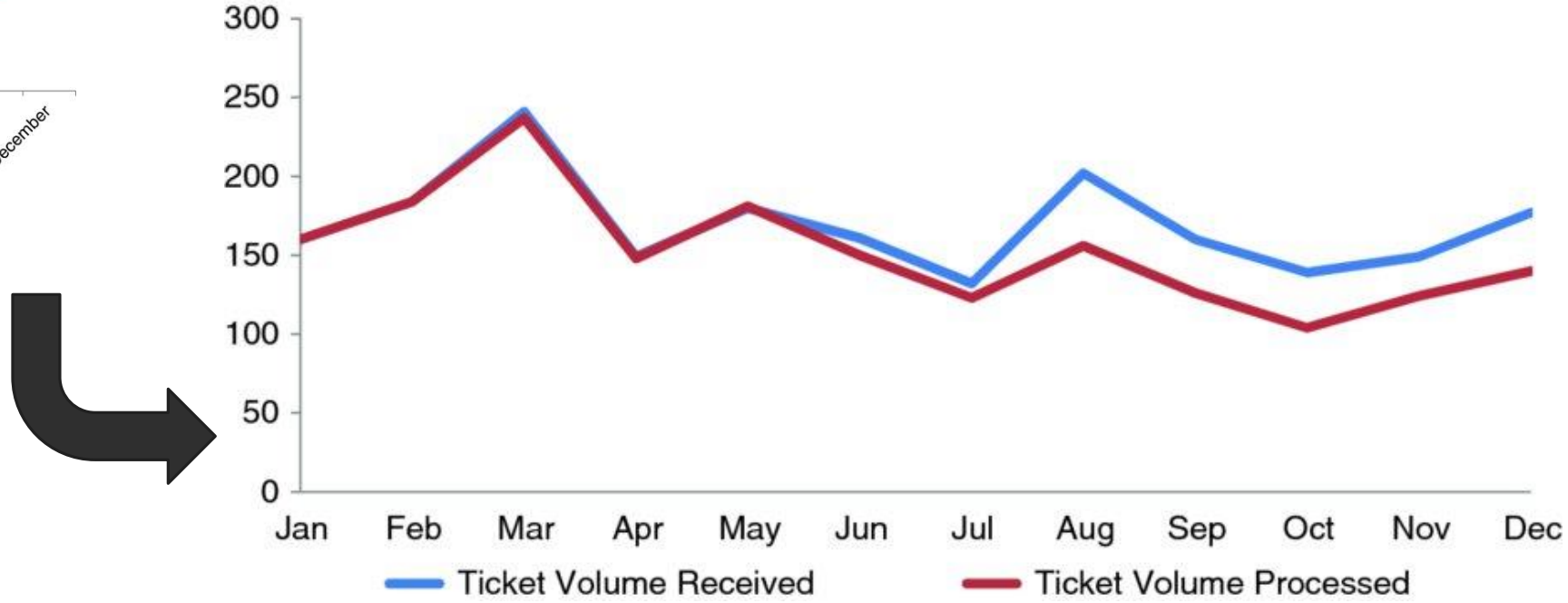




4- Clean up axis labels

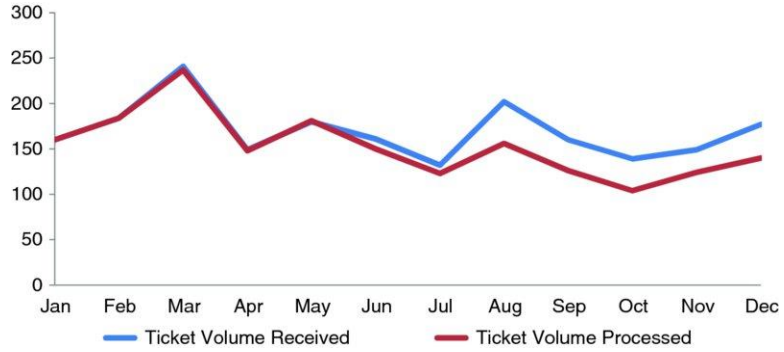
- Lower cognitive load; eliminate diagonal text

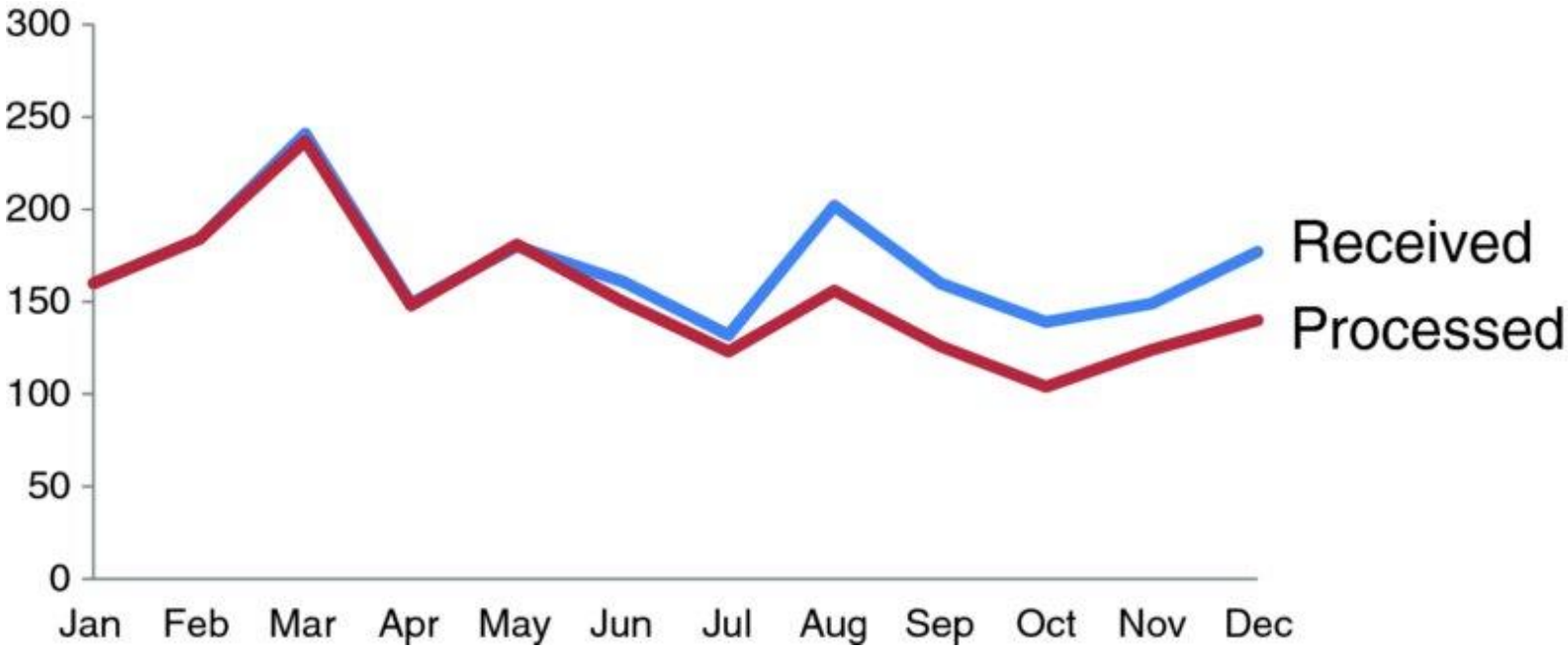




5- Label data directly

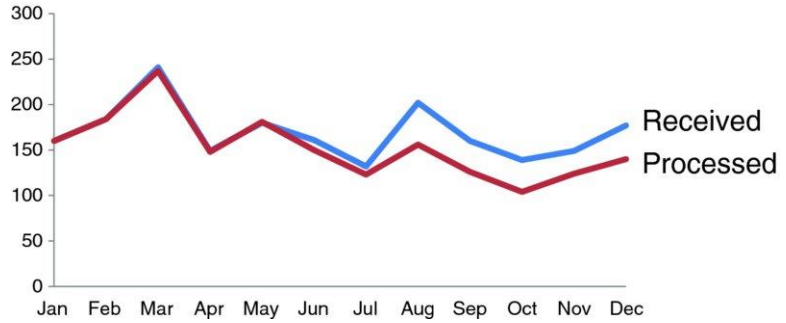
- Based on Gestalt principle of proximity

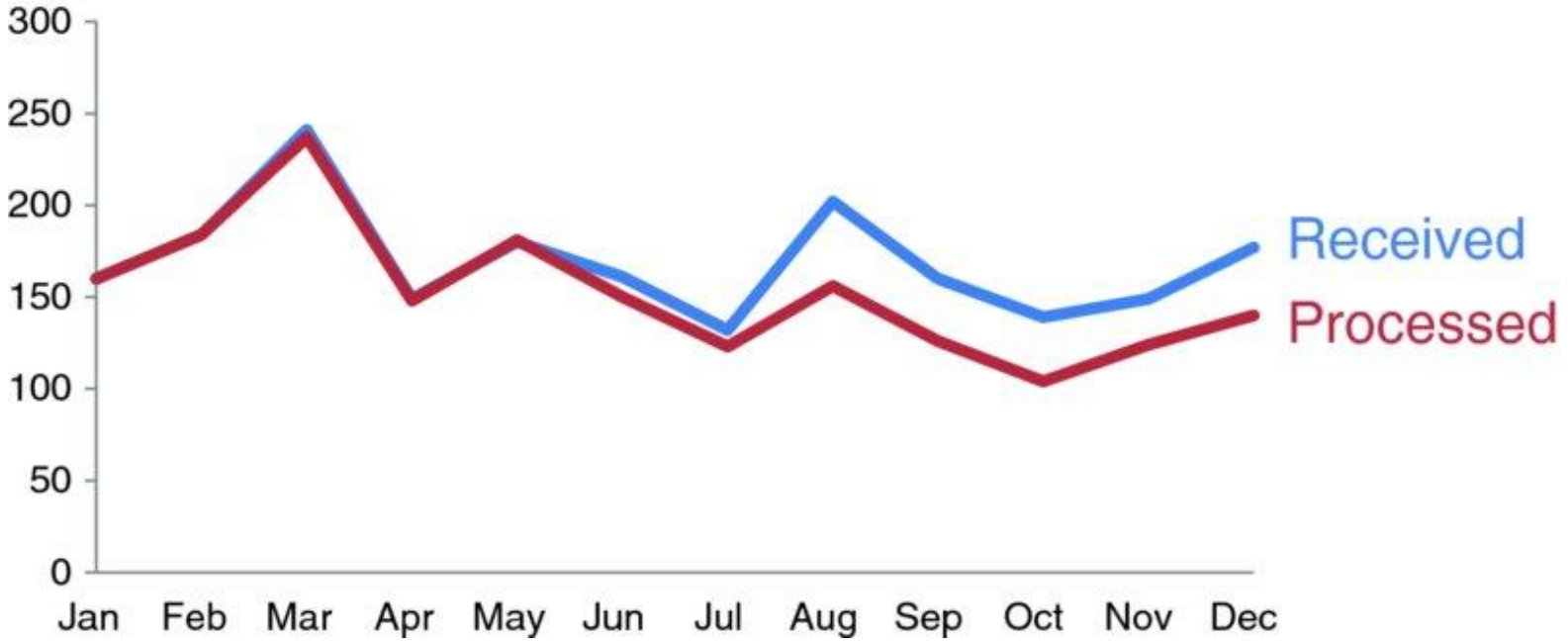




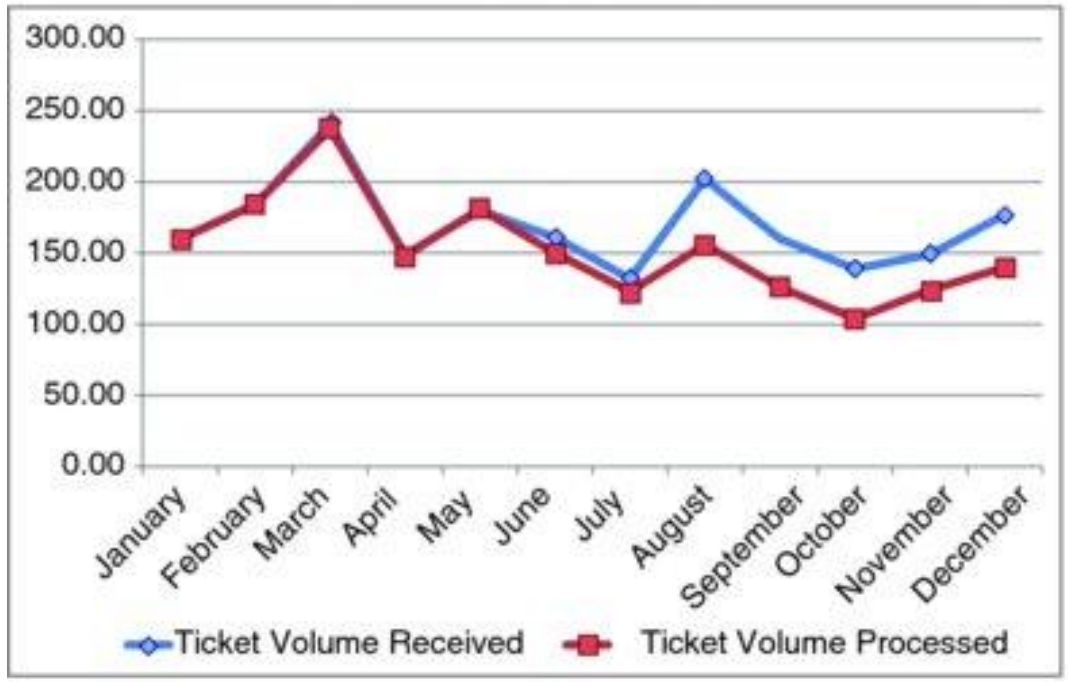
6- Leverage consistent colour

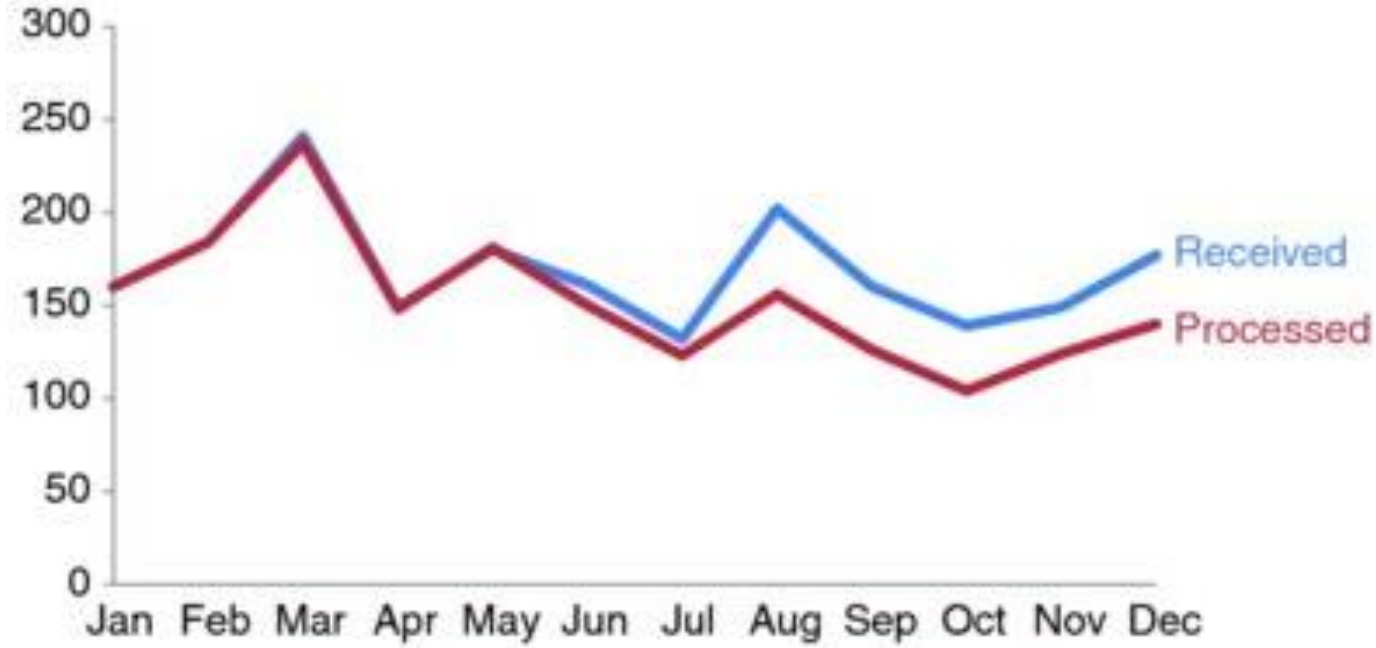
- Based on Gestalt principle of similarity





Before-and-after

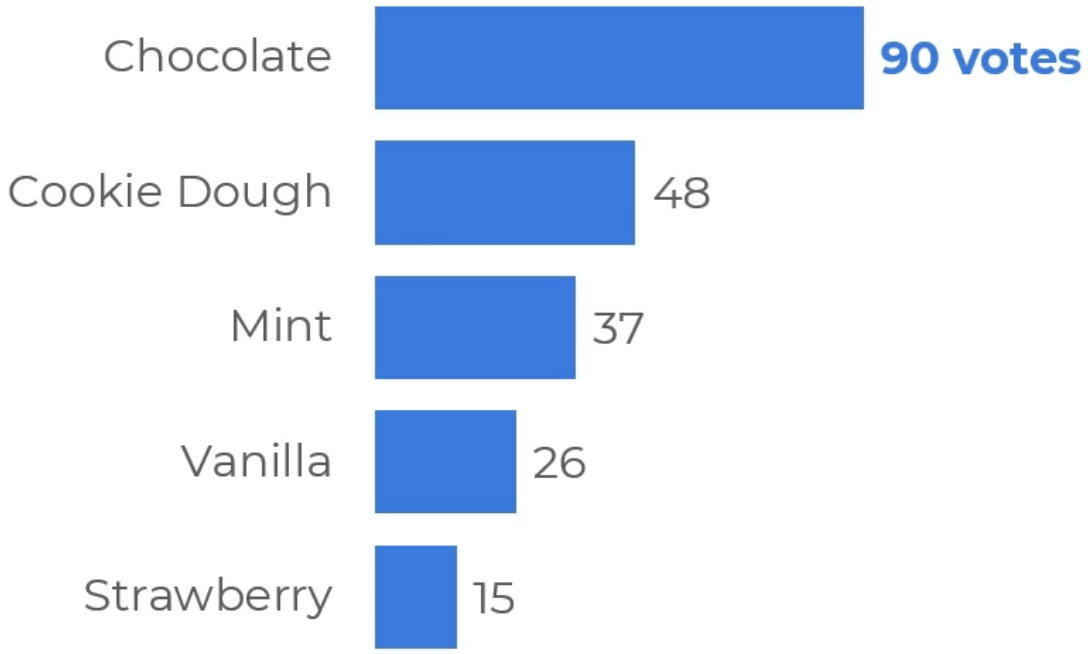




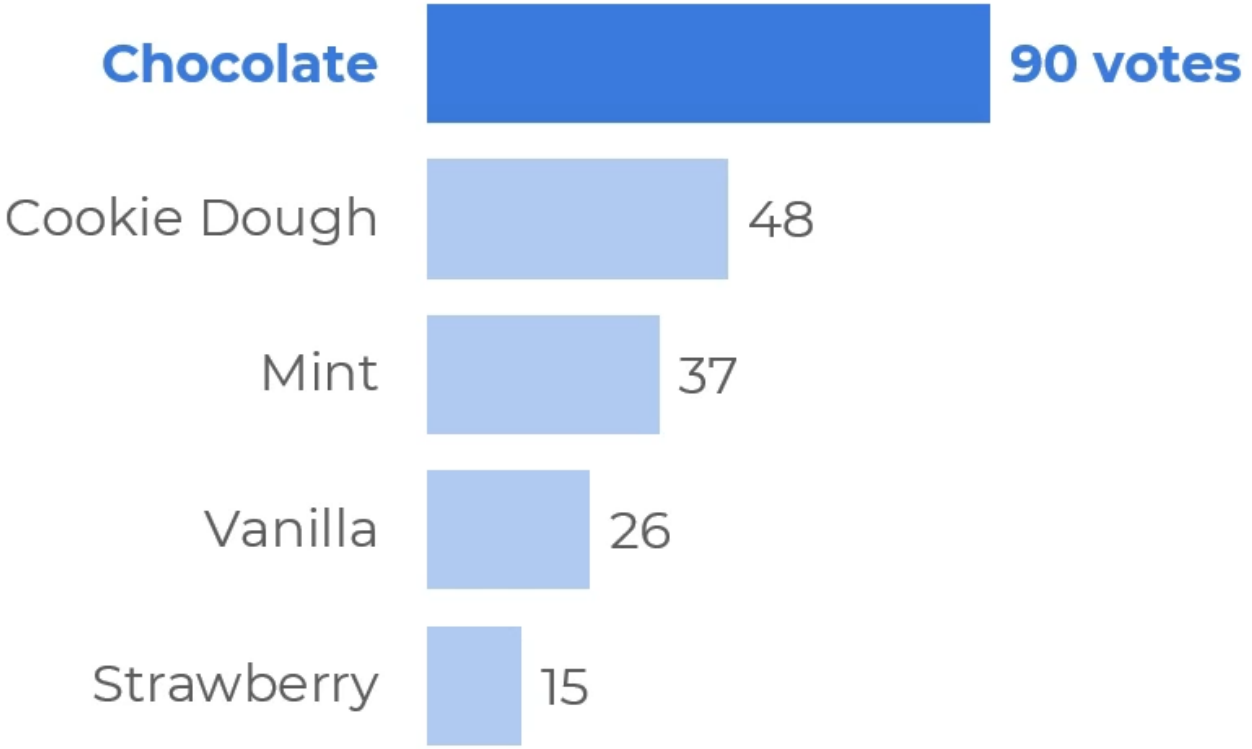
In Class Examples

Example 1

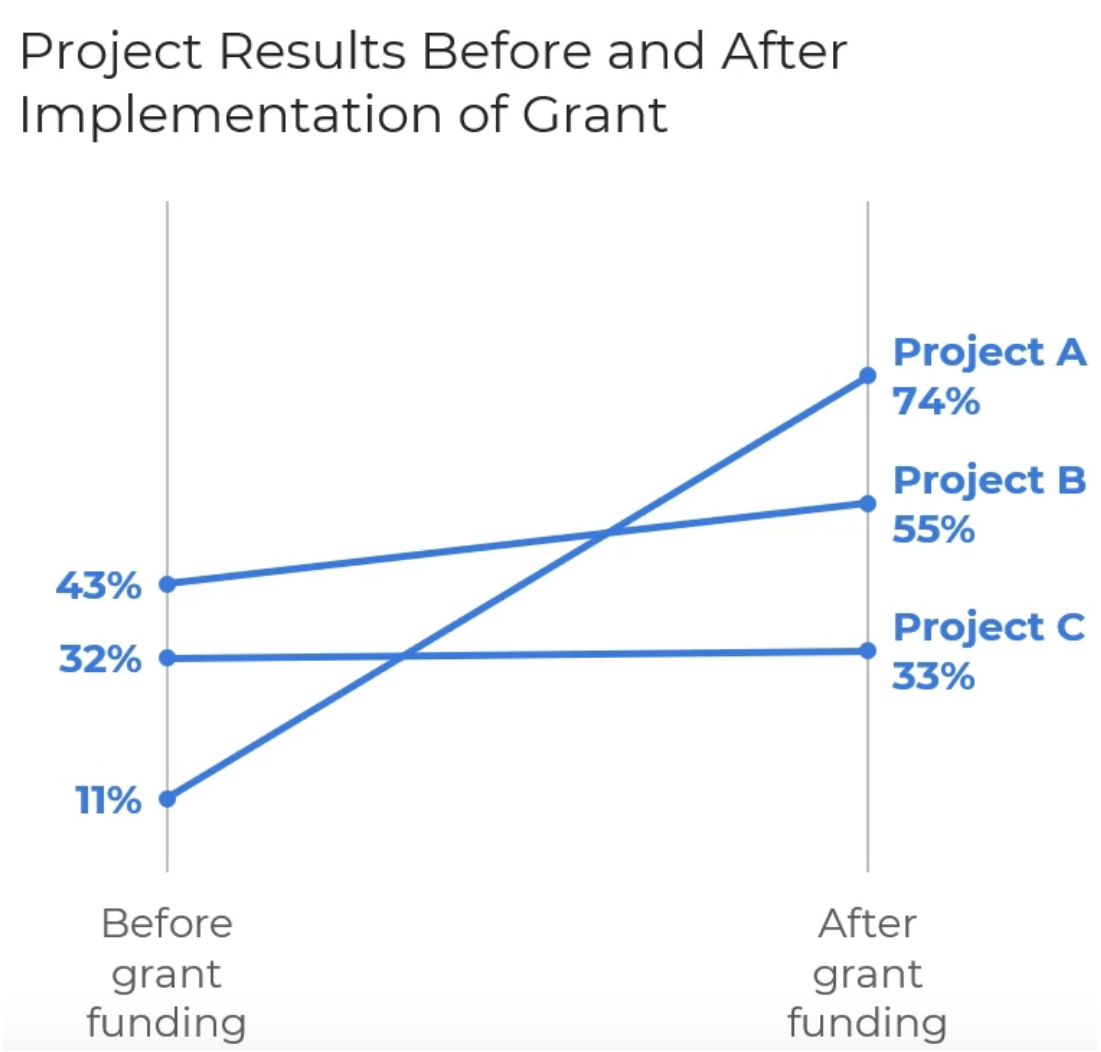
Ice cream flavor preferences based on 2018 survey of 216 elementary school students

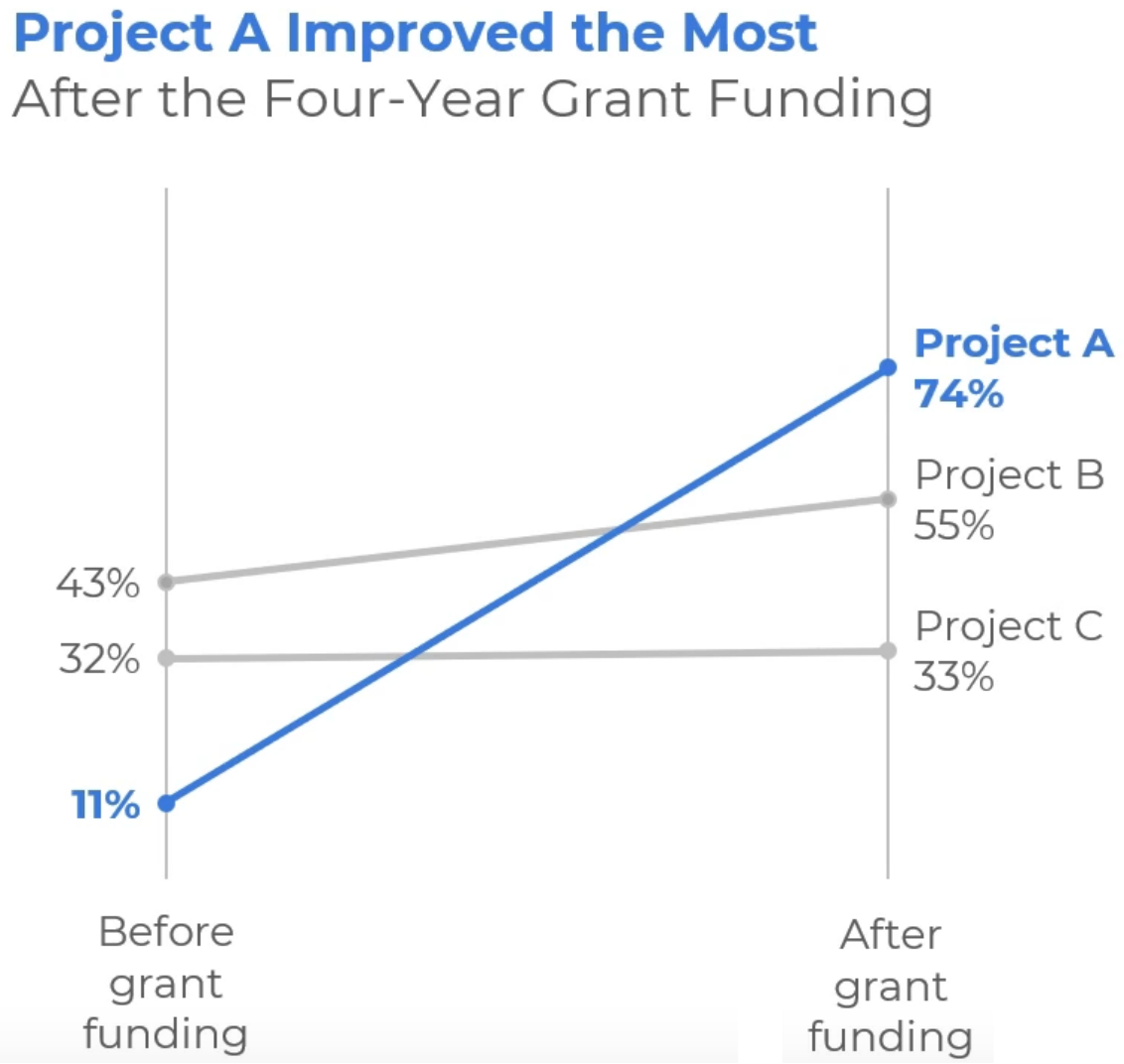


Chocolate was the most popular ice cream flavor among the 216 students who voted in the survey

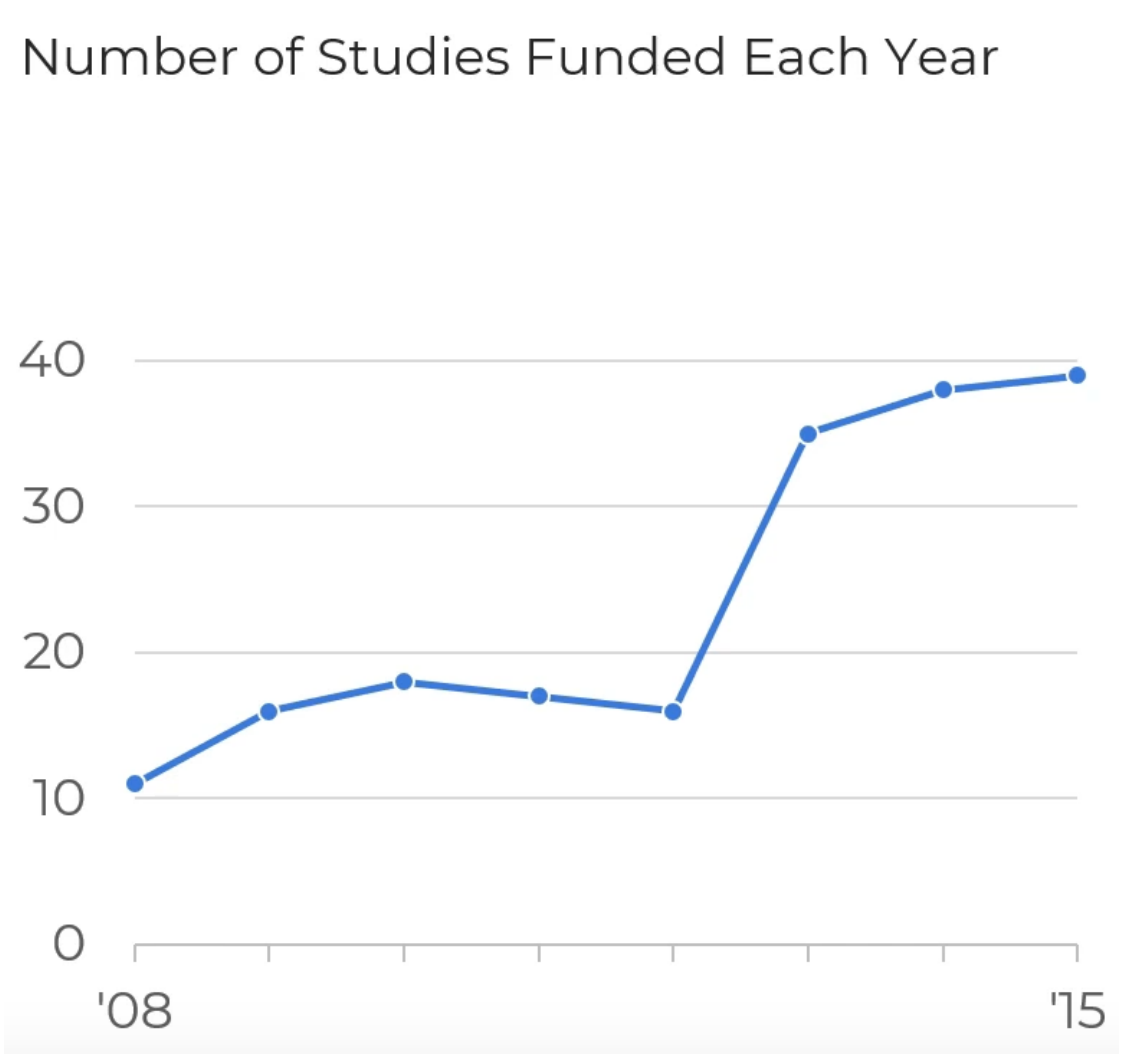


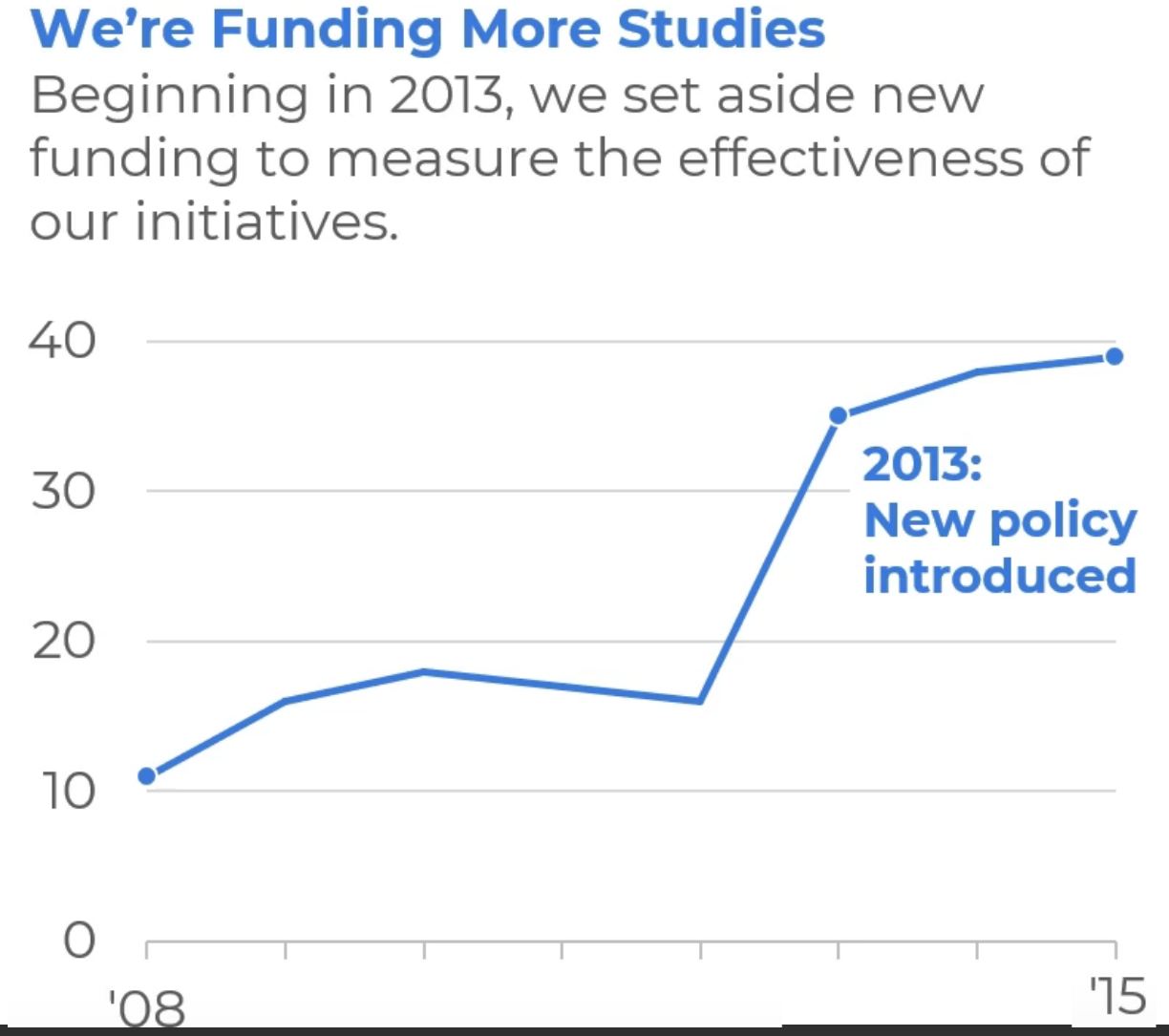
Example2


Project Results Before and After Implementation of Grant
Project A
74%
Project B
55%
Project C
33%
43%
32%
11%
Before grant funding
After grant funding


Project A Improved the Most
After the Four-Year Grant Funding
Project A
74%
Project B
55%
Project C
33%
43%
32%
11%
Before grant funding
After grant funding

Example3


Number of Studies Funded Each Year
40
30
20
10
0
'08
'15


We're Funding More Studies
Beginning in 2013, we set aside new funding to measure the effectiveness of our initiatives.
40
30
20
10
0
'08
'15
2013:
New policy
introduced

References and Resources

- [Knaflic] Cole Nussbaumer Knaflic, **Storytelling with Data: A Data Visualization Guide for Business Professionals**, Wiley, 2017
  - Available online through Seneca Libraries: https://senecacollege-primo.hosted.exlibrisgroup.com/permalink/f/t3376v/01SENC_ALMA5146374280003226
- [Ryan] Lindy Ryan, **Visual Data Storytelling with Tableau**, Pearson Addison-Wesley, 2018
  - Available online through Seneca Libraries: https://senecacollege-primo.hosted.exlibrisgroup.com/permalink/f/t3376v/01SENC_ALMA5167006190003226
- [Healy] Kieran Healy, **Data Visualization: A Practical Introduction**, Princeton University Press, 2018.
  - Available (hardcopy) at Seneca Libraries: https://senecacollege-primo.hosted.exlibrisgroup.com/permalink/f/t3376v/01SENC_ALMA2172469250003226
- **A Reader on Data Visualization:** https://mschermann.github.io/data_viz_reader/
- **Data visualization:** https://en.wikipedia.org/wiki/Data_visualization
- **Section 5: Data concepts** https://www.statcan.gc.ca/eng/dli/guide/section5