

Introduction to Data Visualization

BAN140 - Section NBB /NCC

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

Week7 Reading Week



Week 8

Week Topics



Previous Week

- Cognitive load & Visual Perception

Current Week

- focus your audience's attention

focus your audience's attention

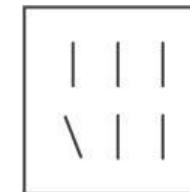
Chapter four: From Storytelling with Data: A Data Visualization Guide for Business Professionals, Wiley, 2017

Available online through Seneca Libraries: https://senecacollege-primo.hosted.exlibrisgroup.com/permalink/f/t3376v/01SENC_ALMA5146374280003226

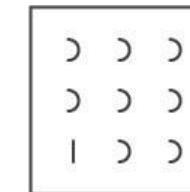
Pre-attentive attributes

Introduction

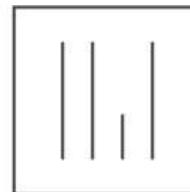
- Visualization elements that help direct your audience's attention to where you want to focus
- **Attention is the cognitive process of selectively concentrating on one aspect of the environment while ignoring other things**
- Pre-attentive attribute examples
 - Size
 - Color
 - Page position



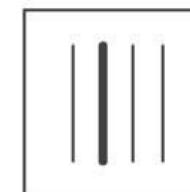
Orientation and collinearity



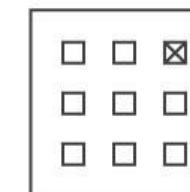
Curvature



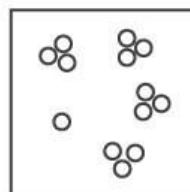
Length



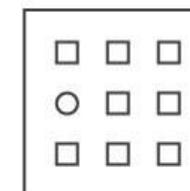
Width



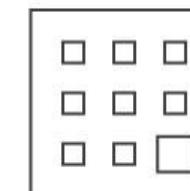
Added marks



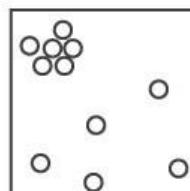
Numerosity



Shapes

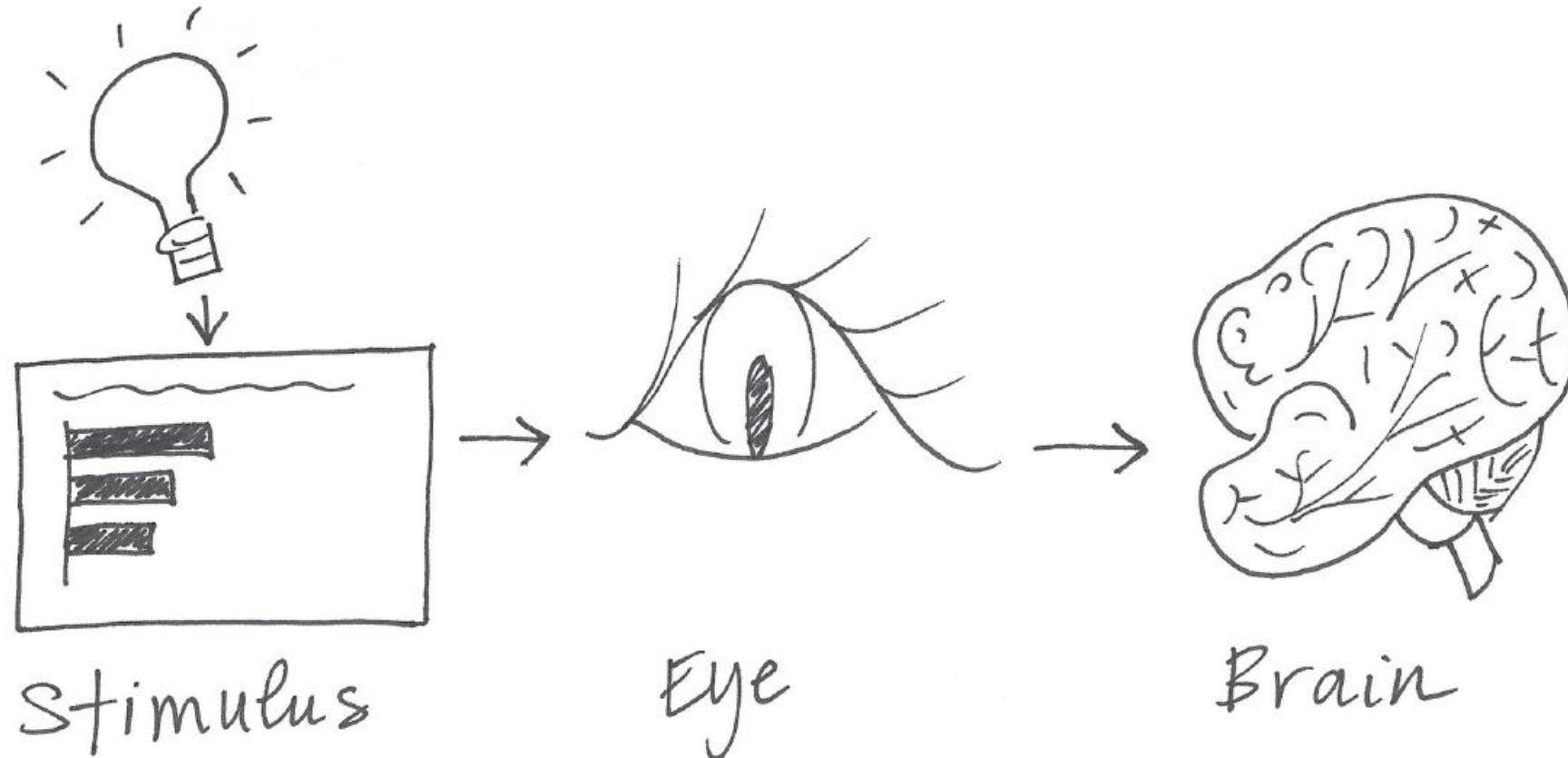


Size



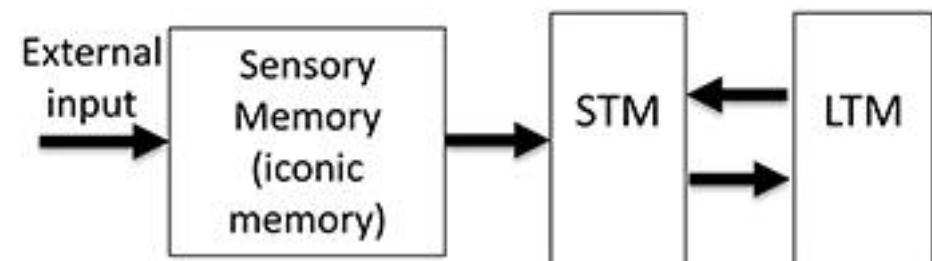
Spatial grouping

You see with your brain



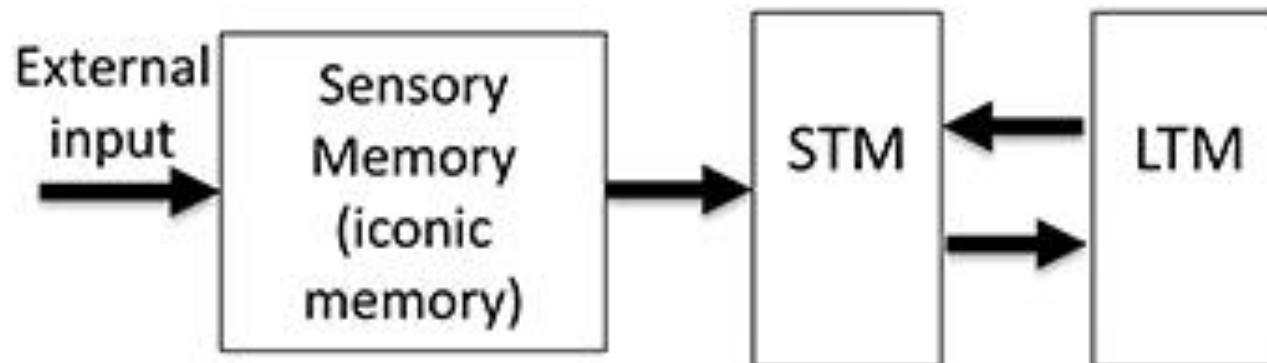
Three types of memory

- There are three types of memory that are important to understand as we design visual communications:
 - iconic memory,
 - short-term memory, and
 - long-term memory.



Iconic memory

- Information that stays in memory for a fraction of a second before you sub-consciously decide to remove the memory or move it to short-term memory
- Represents our ability to quickly pick up differences in our environment



Short-term memory

- People can keep about **four chunks** of visual information in their short-term memory at once
- Emphasizing a large amount of information on a visualization places an unnecessary burden on our audience, and thereby lose our ability to communicate effectively.
- **Annotation/labeling:** Gestalt principle of proximity
 - labeling the various data series directly will reduce cognitive load that needed to go back and forth between the legend and the data

Long-term memory

- Short term memory either goes to long term memory or our brain removes it. Aggregate of visual and verbal memory.
- Built up over a lifetime and is vitally important for pattern recognition and general cognitive processing.
- Picture triggered your audience long-time memory

In Summary

- People can keep 4 chunks of visual information in their short-term memory. The goal? Limit this cognitive load/burden.
- Using pre-attentive attributes enables our audience to see the few graph aspects we want them to see and keep in their short-term memory
- Paying attention to something takes effort and focus: high cognitive load.
- **But what catches your eye, like Gestalts, takes no effort at all: low cognitive load. (This is pre-attentive)**

Example: Count the number of 3's

756395068473

658663037576

860372658602

846589107830

Pre-attentive attributes: signal where to look

756395068473

658663037576

860372658602

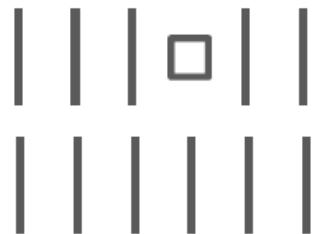
846589107830

The pre-attentive attribute of intensity of color

All in One: Pre-attentive attributes



Orientation



Shape



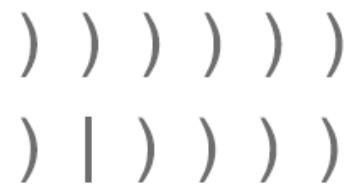
Line length



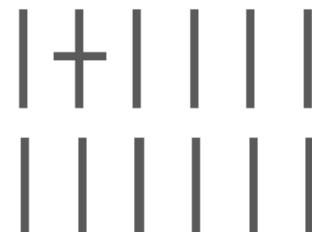
Line width



Size



Curvature



Added marks



Enclosure



Hue



Intensity



Spatial position



Motion

Using Pre-attentive attributes

- Leverage to help direct your audience's attention to where you want them to focus
 - It's pre-attentive and processed in visual cortex
 - **Easy to find, no cognitive load**
- Use to create a visual hierarchy of elements
 - First look here, then see this, then ...

Difference in Pre-attentive attributes

- Associating quantitative values with some of pre-attentive attributes
 - e.g. a long line representing a greater value than a short line
 - Not with color (which is greater: red or blue?!)
- Using suitable attributes for encoding
 - *Quantitative* information
 - Line length, spatial position, line width, size, intensity
 - Categorical information
 - Color

Pre-attentive attributes in text

No preattentive attributes

What are we doing well? Great Products. These products are clearly the best in their class.
Replacement parts are shipped when needed. You sent me gaskets without me having to ask. Problems are resolved promptly. Bev in the billing office was quick to resolve a billing issue I had. General customer service exceeds expectations. The account manager even called to check in after normal business hours.
You have a great company – keep up the good work!

Color

What are we doing well? Great Products. **These products are clearly the best in their class.**
Replacement parts are shipped when needed. You sent me gaskets without me having to ask. Problems are resolved promptly. Bev in the billing office was quick to resolve a billing issue I had. General customer service exceeds expectations. The account manager even called to check in after normal business hours.
You have a great company – keep up the good work!

Bold

What are we doing well? Great Products. These products are clearly the best in their class.
Replacement parts are shipped when needed. You sent me gaskets without me having to ask. Problems are resolved promptly. Bev in the billing office was quick to resolve a billing issue I had. General customer service exceeds expectations. The account manager even called to check in after normal business hours.
You have a great company – keep up the good work!

Italics

What are we doing well? Great Products. These products are clearly the best in their class.
Replacement parts are shipped when needed. You sent me gaskets without me having to ask. Problems are resolved promptly. Bev in the billing office was quick to resolve a billing issue I had. General customer service exceeds expectations. The account manager even called to check in after normal business hours.
You have a great company – keep up the good work!

Pre-attentive attributes in text

Size

What are we doing well? Great Products. These products are the best in their class. Replacement parts are shipped when needed. You sent gaskets

without me having to ask.

Problems are resolved promptly. Bev in the billing office was quick to resolve a billing issue I had. General customer service exceeds expectations. The account manager even called to check in after normal business hours. You have a great company – keep up the good work!

Outline (enclosure)

What are we doing well? Great Products. These products are clearly the best in their class. Replacement parts are shipped when needed. You sent me gaskets without me having to ask. Problems are resolved promptly. Bev in the billing office was quick to resolve a billing issue I had. General customer service exceeds expectations. The account manager even called to check in after normal business hours. You have a great company – keep up the good work!

Separate spatially

What are we doing well? Great Products. These products are clearly the best in their class. Replacement parts are shipped when needed. You sent me gaskets without me having to ask.

Problems are resolved promptly.

Bev in the billing office was quick to resolve a billing issue I had. General customer service exceeds expectations. The account manager even called to check in after normal business hours. You have a great company – keep up the good work!

Underline (added marks)

What are we doing well? Great Products. These products are clearly the best in their class. Replacement parts are shipped when needed. You sent me gaskets without me having to ask. Problems are resolved promptly. Bev in the billing office was quick to resolve a billing issue I had. General customer service exceeds expectations. The account manager even called to check in after normal business hours. You have a great company – keep up the good work!

Creating a visual hierarchy using pre-attentive attributes in text

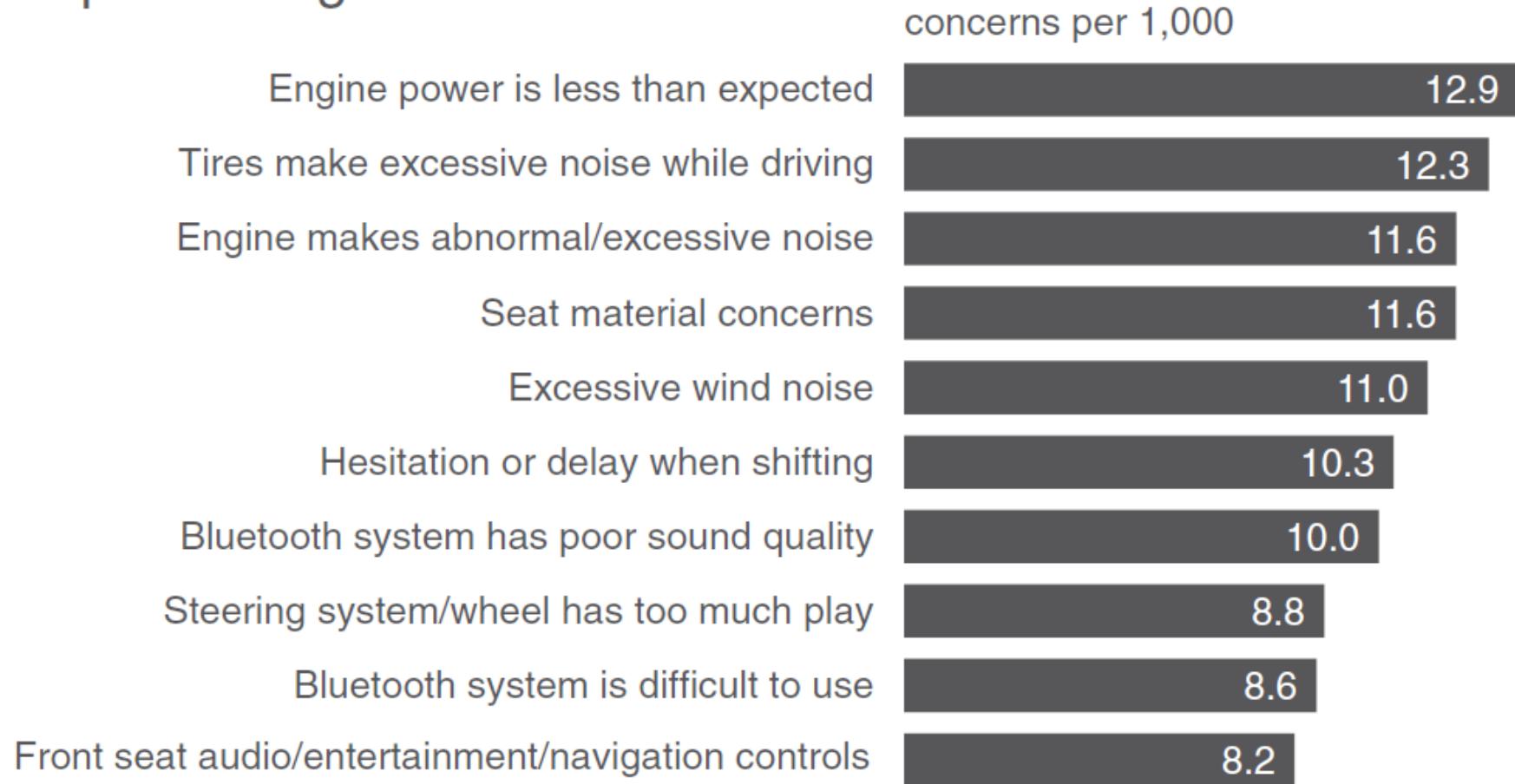
What are we doing well?

Themes & example comments

- **Great products:** "These products are clearly the best in class."
- **Replacement parts are shipped when needed:**
"You sent me gaskets without me having to ask, and I really needed them, too!"
- **Problems are resolved promptly:** "Bev in the billing office was quick to resolve a billing issue I had."
- **General customer service exceeds expectations:**
"The account manager even called after normal business hours.
You have a great company - keep up the good work!"

Pre-attentive attributes in graphs

Top 10 design concerns

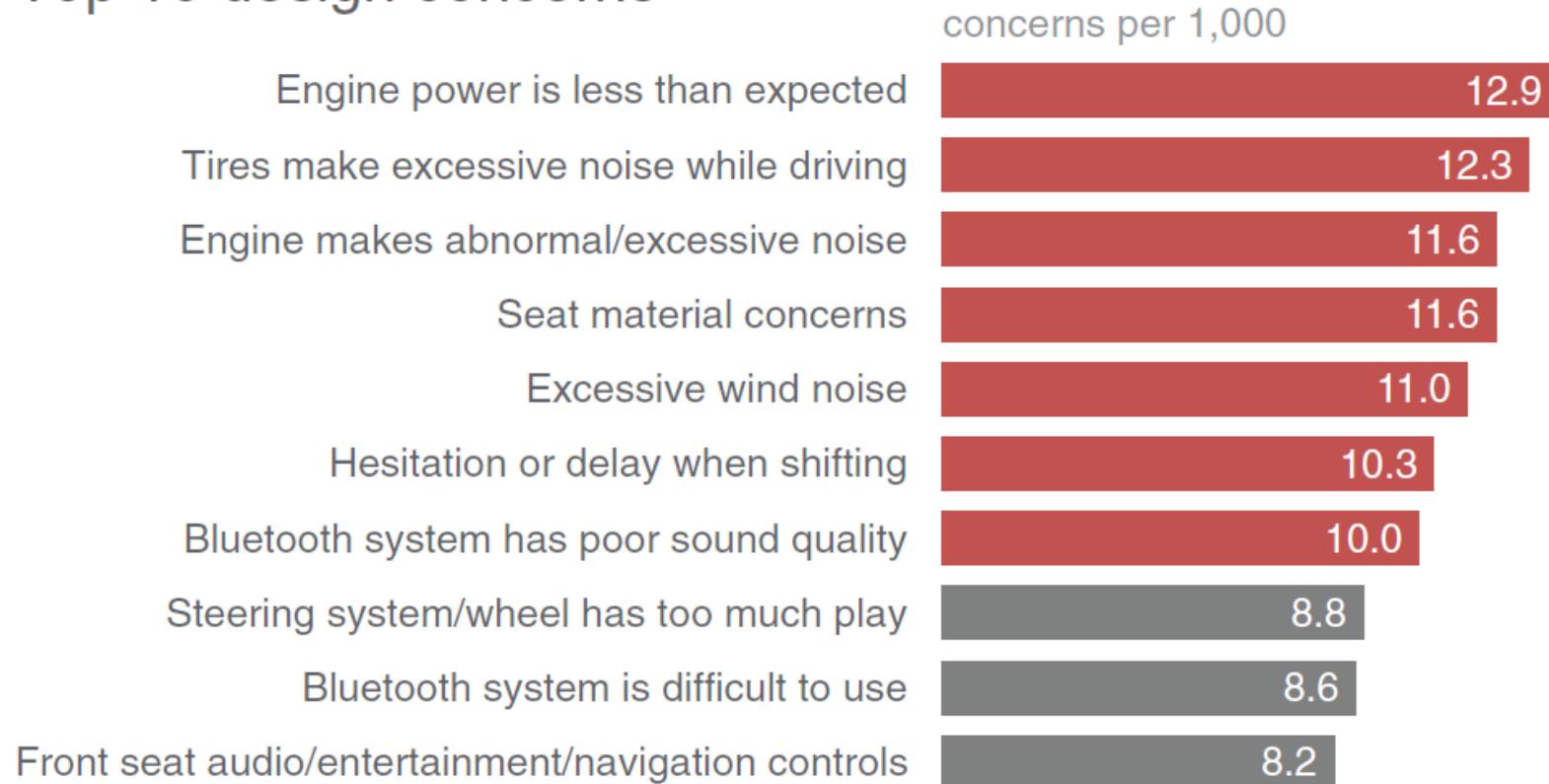


Leverage color to draw attention

7 of the top 10 design concerns have 10 or more concerns per 1,000.

Discussion: is this an acceptable default rate?

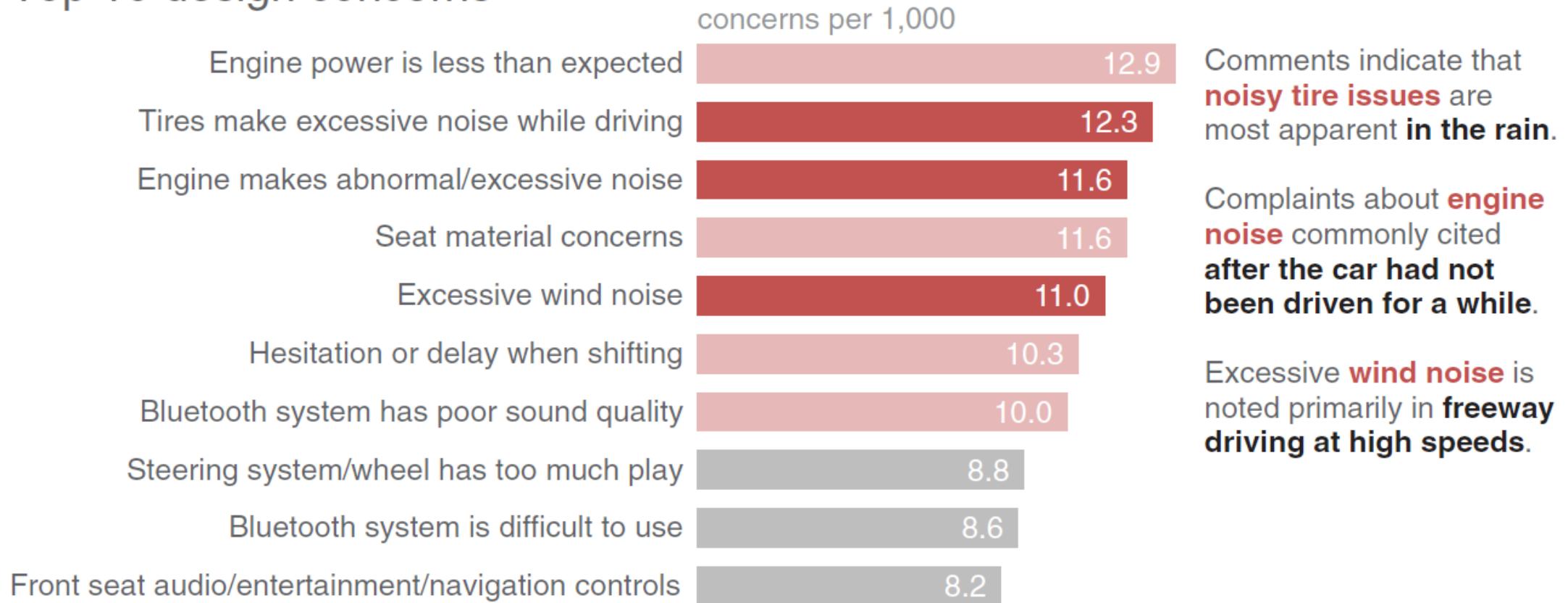
Top 10 design concerns



Create a visual hierarchy of information

Of the top design concerns, three are noise-related.

Top 10 design concerns



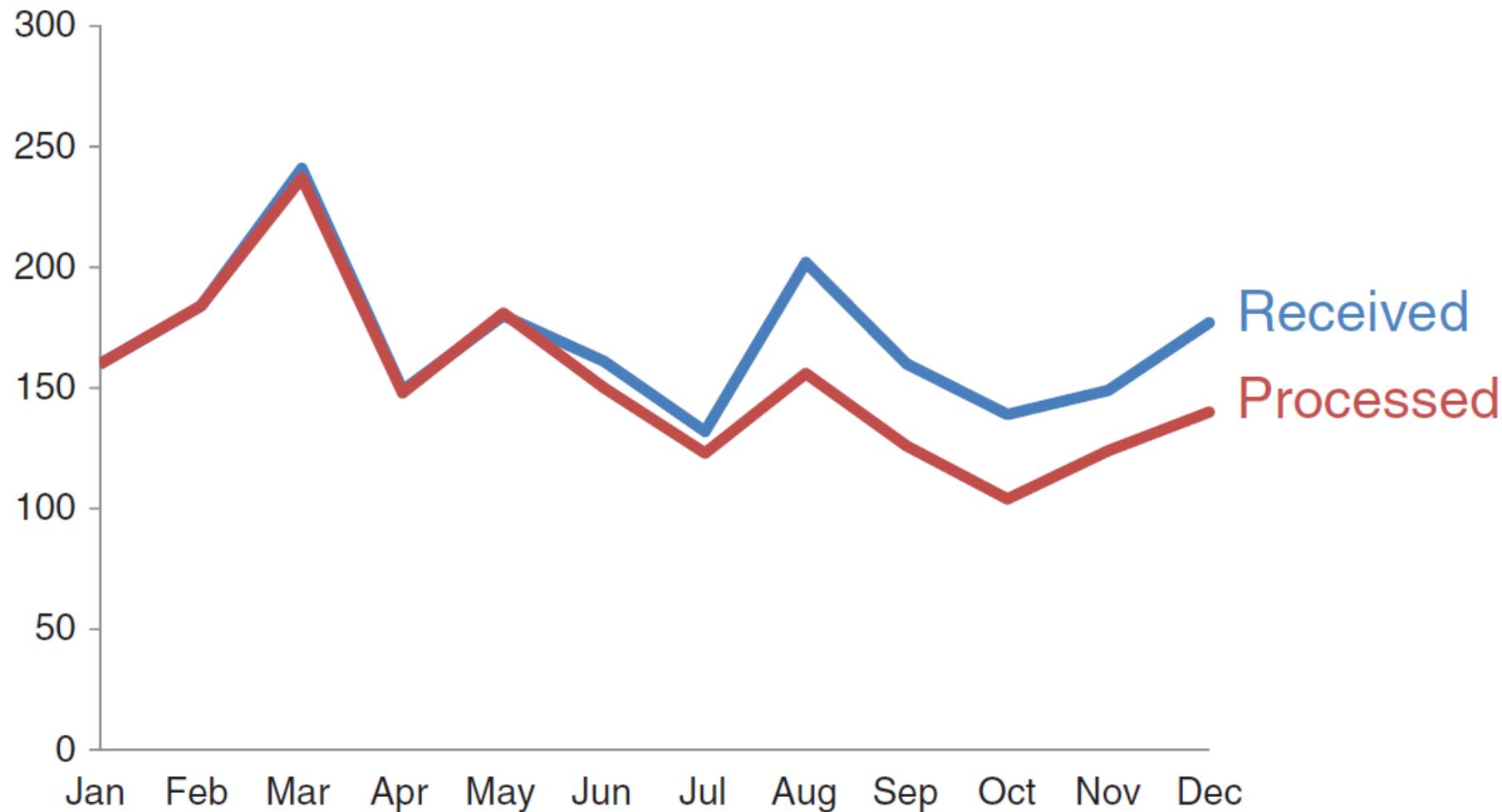
Warning!

- Highlighting one aspect can make other things harder to see!

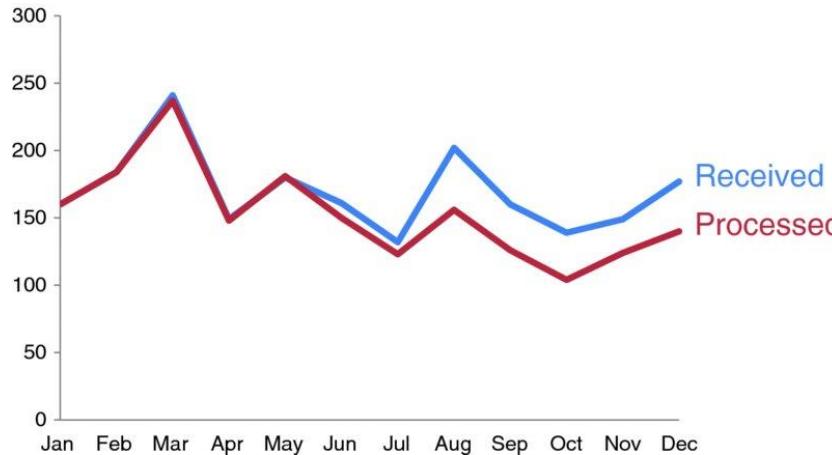
- Exploratory analysis:
 - You should mostly avoid the use of pre-attentive attributes for this reason.

- Explanatory analysis:
 - Leverage pre-attentive attributes for communicating a specific story to your audience visually.

Recall Decluttering Example



Example



Guidelines

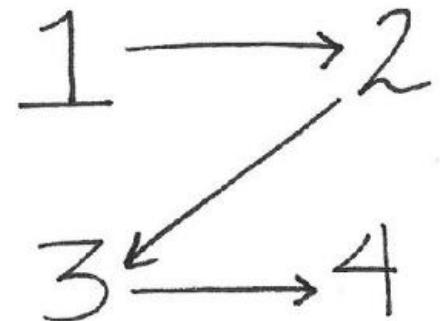
Guidelines: Size & Position

➤ Size

- Relative size denotes relative importance.
- If showing multiple things of roughly equal importance → size them similarly.
- If there is one really important thing → **make it BIG!**

➤ Position on page

- Leverage *the zigzag eye motions*
- Important thing at the top
- Make it familiar
- e.g. flow from top to bottom, positive on the right side of axis



Guidelines: Color

- Everything neutral (grey), except where you want to draw attention (blue?)

- Use sparingly!

- Sufficient contrast

- Varying saturations of one color

- Quantitative assumptions

- Use consistently!

- Use consistent colors if no change

Country Level Sales Rank Top 5 Drugs

Rainbow distribution in color indicates sales rank in given country from #1 (red) to #10 or higher (dark purple)

Country	A	B	C	D	E
AUS	1	2	3	6	7
BRA	1	3	4	5	6
CAN	2	3	6	12	8
CHI	1	2	8	4	7
FRA	3	2	4	8	10
GER	3	1	6	5	4
IND	4	1	8	10	5
ITA	2	4	10	9	8
MEX	1	5	4	6	3
RUS	4	3	7	9	12
SPA	2	3	4	5	11
TUR	7	2	3	4	8
UK	1	2	3	6	7
US	1	2	4	3	5

Top 5 drugs: country-level sales rank

RANK	1	2	3	4	5+
COUNTRY DRUG	A	B	C	D	E
Australia	1	2	3	6	7
Brazil	1	3	4	5	6
Canada	2	3	6	12	8
China	1	2	8	4	7
France	3	2	4	8	10
Germany	3	1	6	5	4
India	4	1	8	10	5
Italy	2	4	10	9	8
Mexico	1	5	4	6	11
Russia	4	3	7	9	12
Spain	2	3	4	5	11
Turkey	7	2	3	4	8
United Kingdom	1	2	3	6	7
United States	1	2	4	3	5

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>