THE GESTALT PRINCIPLES

VISUAL PROCESSING

Perception is fragmented – eyes are continuously scanning.

Visual thinking seeks patterns
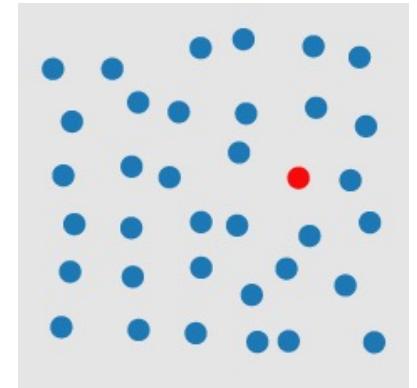
- **Pre-attentive processes:** fast, instinctive, efficient, multitasking
  gather information and build patterns:

  features → patterns → objects
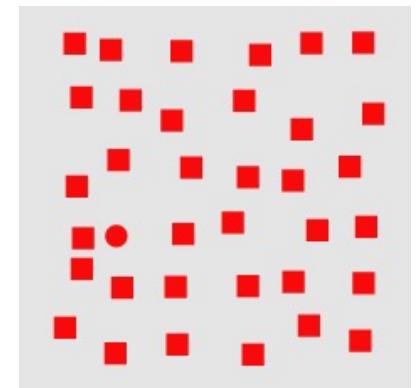
- **Attentive processes:** slow, deliberate, focused
  discover features in the patterns:

  objects → patterns → features

pre-attentive

attentive

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How many 6's
In the next slide?

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28694080860 9876
934858674 8676
29673030 3986739
396749 967749674

2869408609876

9348586748676

2967303986739

3967496749674

2869408660 9876

9348586748676

2967303986739

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286940860 9876

9348586748676

2967303 986739

396749674 9674

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9348586748676
29673039867 39
39674967 49674

2233333444444566666666666666677777888888889999999000

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999999999

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9999999

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5
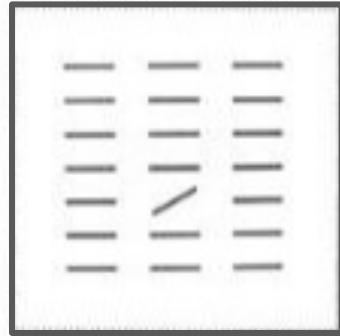
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9348586748676
2967309867339
396749674

PRE-ATTENTIVE ATTRIBUTES
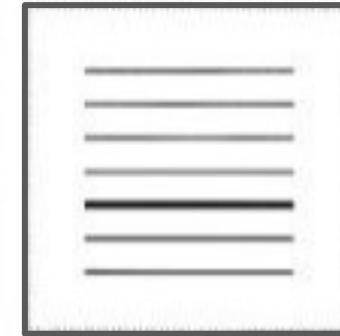


line orientation
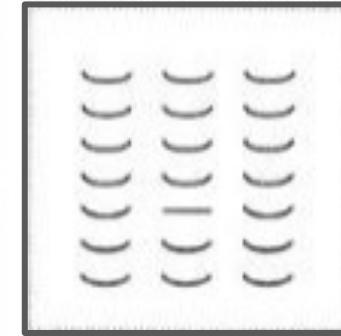
line length
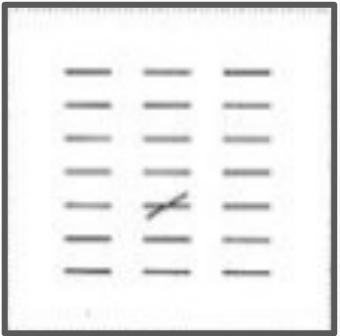
line weight
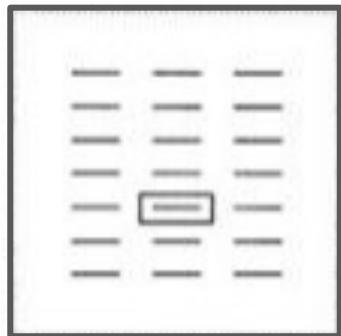
curvature

added marks

enclosure

color/hue

intensity/value

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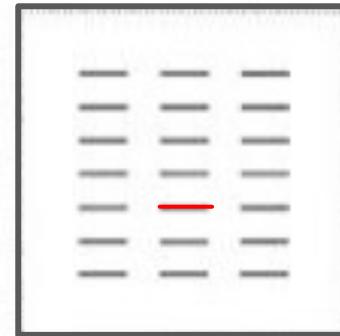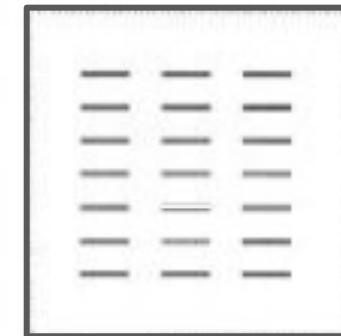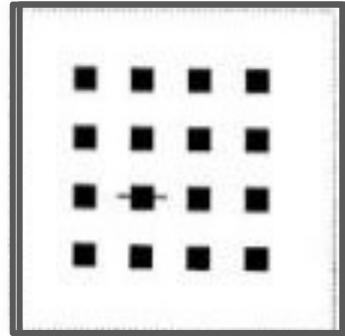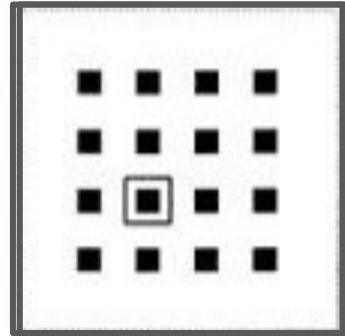
PRE-ATTENTIVE ATTRIBUTES
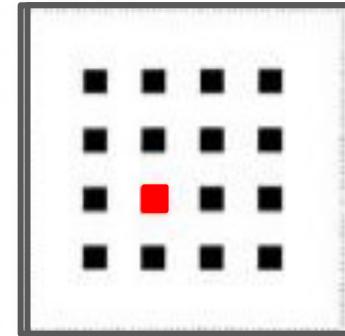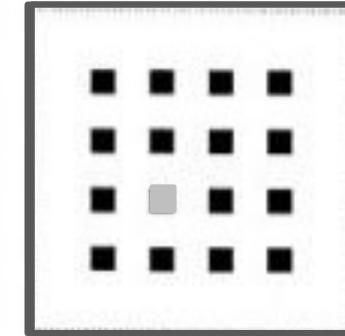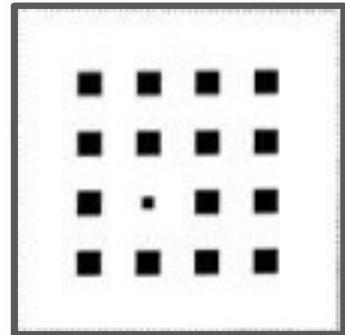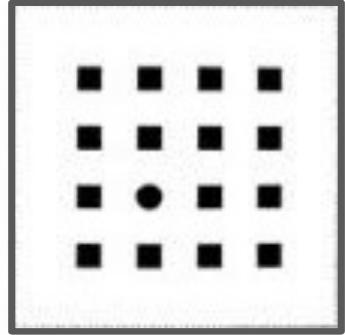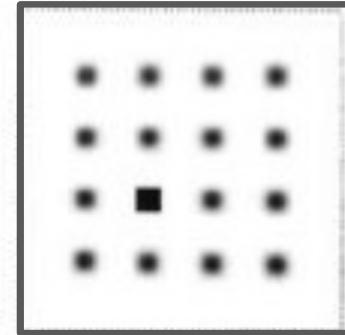
added marks · enclosure · color/hue · intensity/value
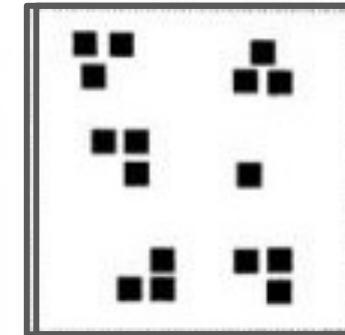
shape · size · sharpness · numerosity

PRE-ATTENTIVE ATTRIBUTES

Pre-attentive attributes are the domain of iconic memory (brief): they

- help to define a hierarchy of focus

- push non-message impacting components into the background

Use pre-attentive attributes to help **emphasize the story** (but don't overdo them):

- easier to do in Excel and R, harder in Power BI

Challenge: highlighting one aspect of a chart can make other aspects harder to see.

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GESTALT PRINCIPLES

What are the Gestalt Principles?

- Principles/laws of human perception.

- They describe how humans group similar elements, recognize patterns and simplify complex images when they perceive objects.

- Designers use them to organize content on charts, dashboards, websites, and other interfaces so that they be **aesthetically pleasing** and **easy to understand**.

GESTALT PRINCIPLES

Background:

- "Gestalt" is German for "unified whole".

- The first principles were devised in the 1920s by German psychologists Wertheimer, Koffka ("the whole is greater than the sum of the parts") and Kohler

- Their aim: understand how humans gain meaning from the chaotic stimuli around them.

- They identified a set of laws which address the natural compulsion to find order in disorder.

- According to this, the mind "informs" what the eye sees by **perceiving a series of individual elements as a whole**.

GESTALT PRINCIPLES
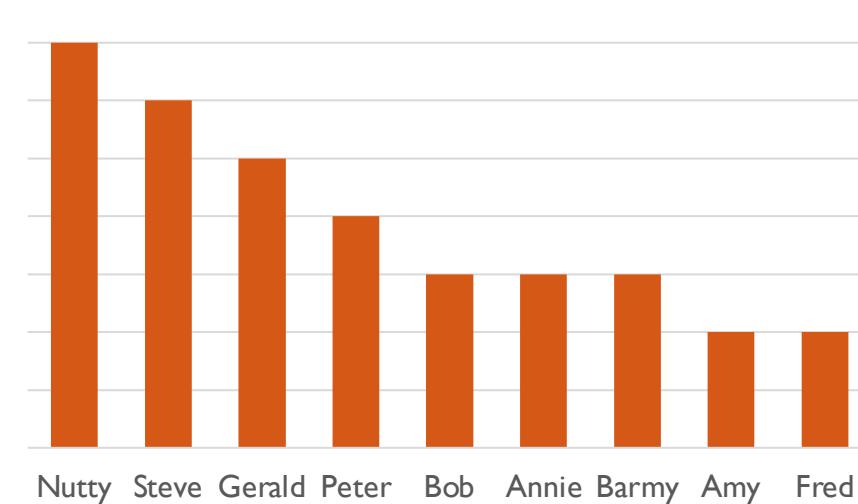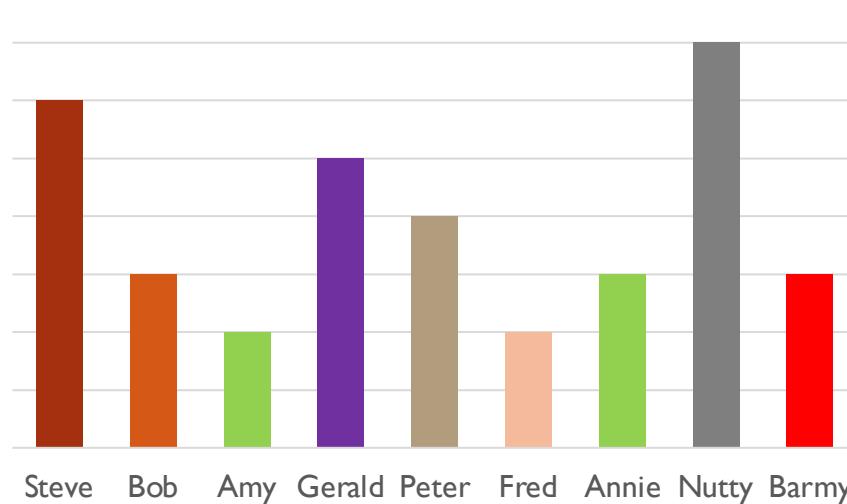
Principles:

- simplicity
- continuation
- proximity
- similarity (invariance)
- focal point
- isomorphic correspondence
- figure / ground duality
- common fate
- closure*
- uniform connectedness*

SIMPLICITY

The brain has a preference for **simplicity** – it tends to process simple patterns faster than patterns that are more complex.

**Lesson:** arrange data simply and logically wherever possible.
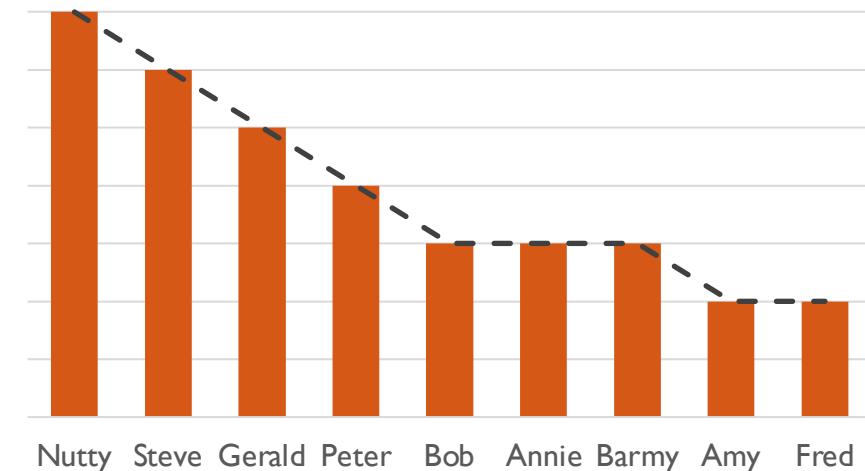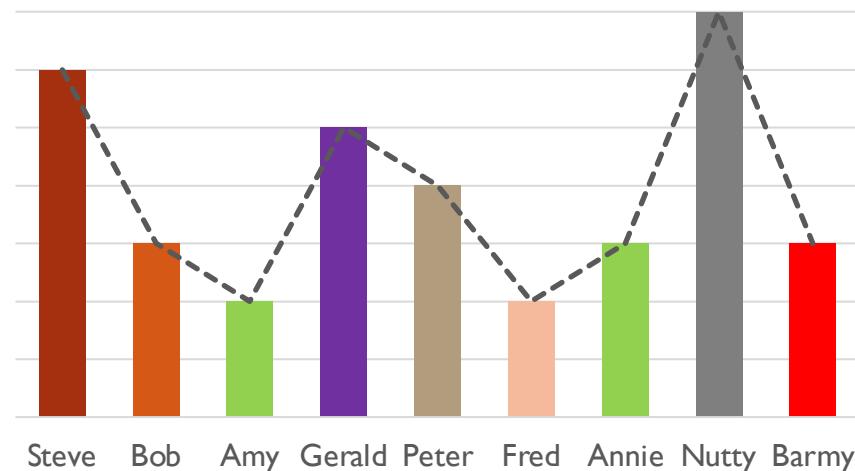
CONTINUATION

Our eyes group things that are **aligned** (e.g. sorted from high to low) with each other.

In the chart on the right the eyes follow a **continuous path**; it makes the whole chart more readable because of the continuous downward direction

Lesson: arrange objects in a line to facilitate grouping and comparison.

PROXIMITY
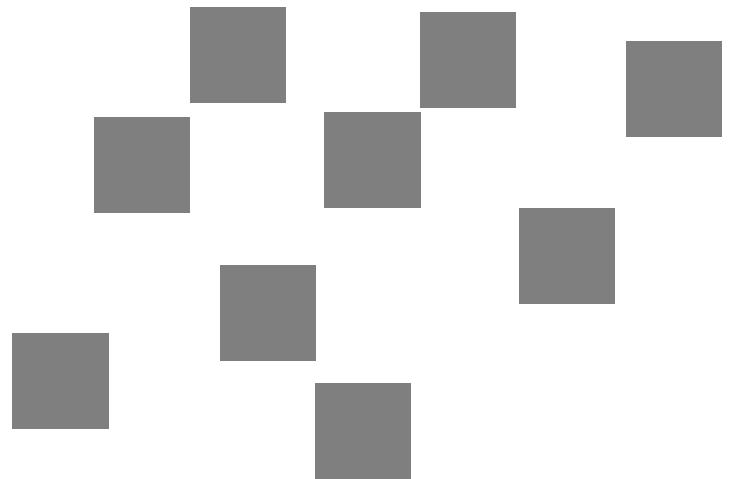
Objects/shapes that are **in proximity** (close) to one another appear to form **groups**.

The effect generated by the collected group is more "powerful" than that generated by separate elements.

Elements which are grouped together create the **illusion** of shapes/planes in space, even if the elements are not touching.

**Lesson:** understand the chart's priorities and create groupings through proximity that support those priorities.

PROXIMITY

VS.

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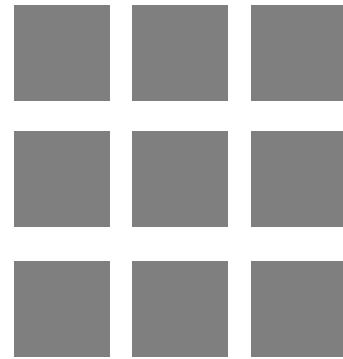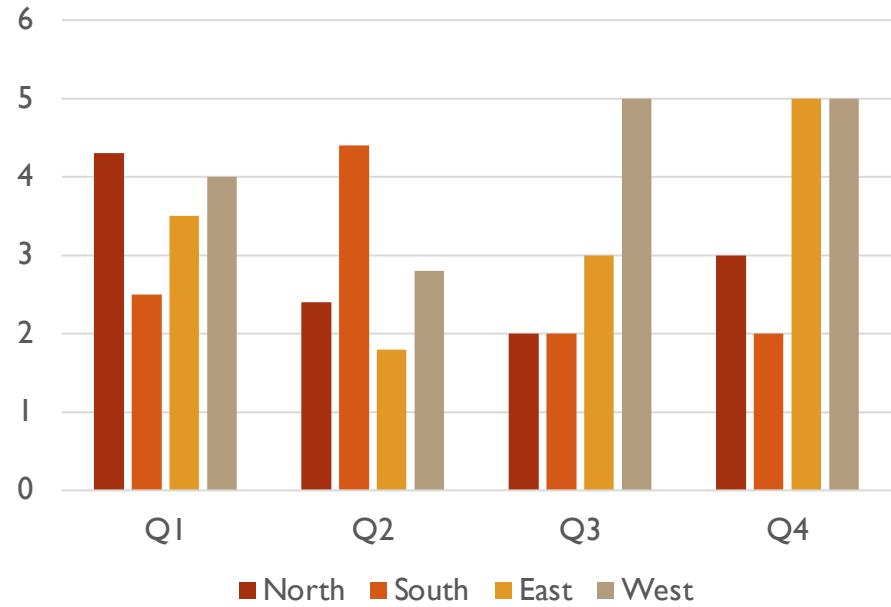
PROXIMITY

vs.

PROXIMITY

VS.

PROXIMITY

VS.
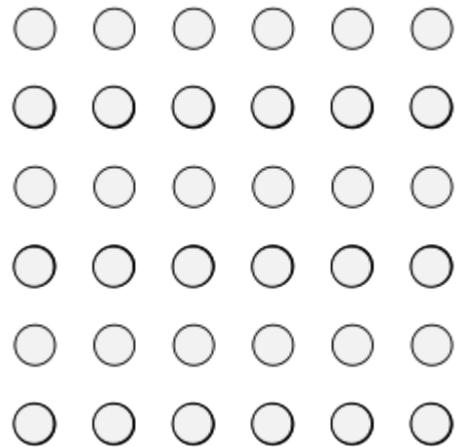
SIMILARITY (INVARIANCE)

Similarity: stimuli that physically resemble each other are viewed as part of the same object; stimuli that don't are viewed as part of a different object.
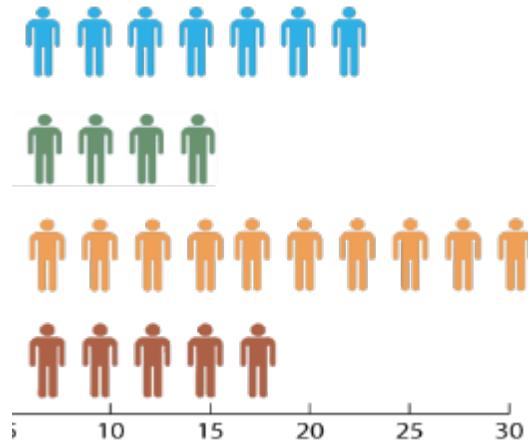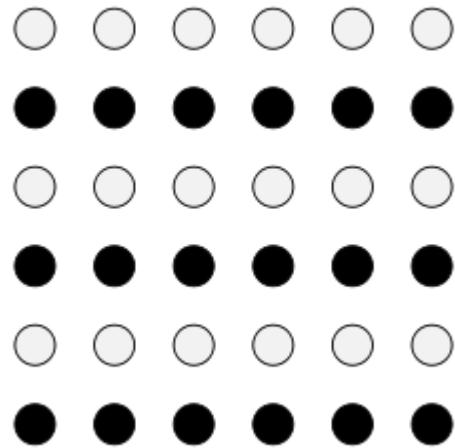
Similarity and proximity often come together to form a **Visual Hierarchy**. Either principle can dominate the other, depending on their application and combination.

Lesson: use similar characteristics to establish relationships and to encourage groupings of objects.

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# SIMILARITY (INVARIANCE)
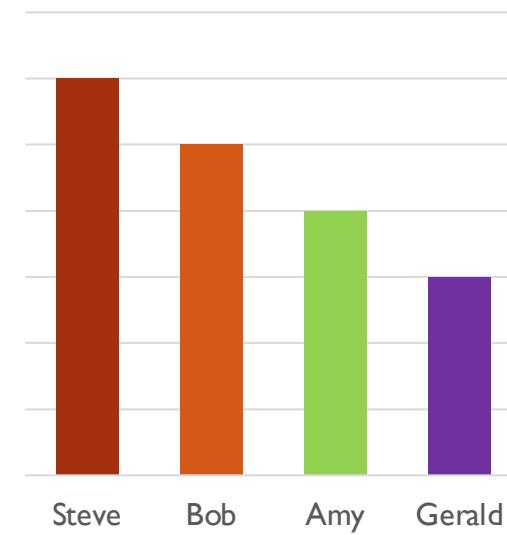
SIMILARITY (INVARIANCE)
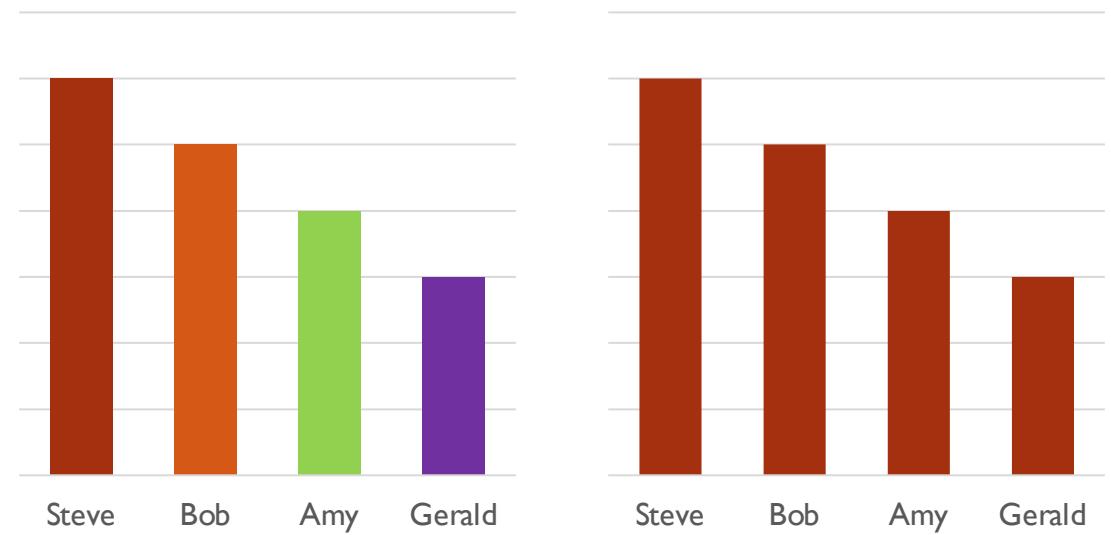
In the examples above, similarity dominates over proximity: we see rows before we see columns.

SIMILARITY (INVARIANCE)

# SIMILARITY (INVARIANCE)
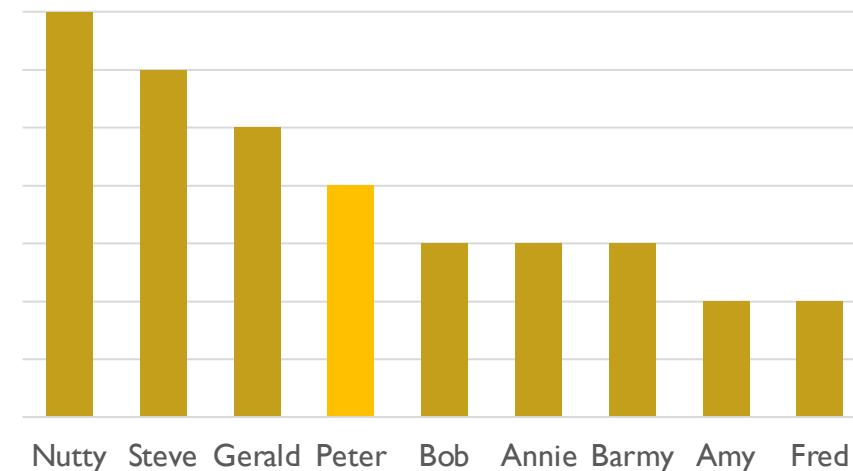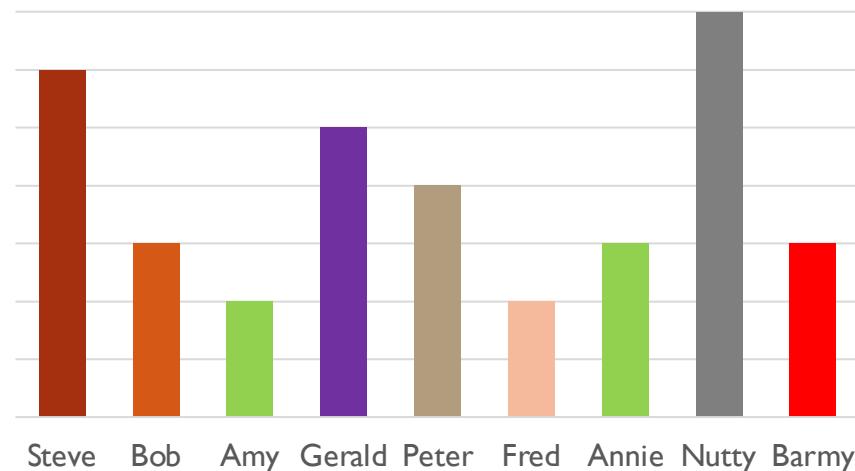
Making things similar can reduce cognitive load (cf. last graph colour).

FOCAL POINT

In opposition to similarity, the **focal point** principle states that distinctive-looking objects can create a focal point.

To highlight one salesperson's performance, make their bar graph color different.

Lesson: use different characteristics to highlight and create focal points.
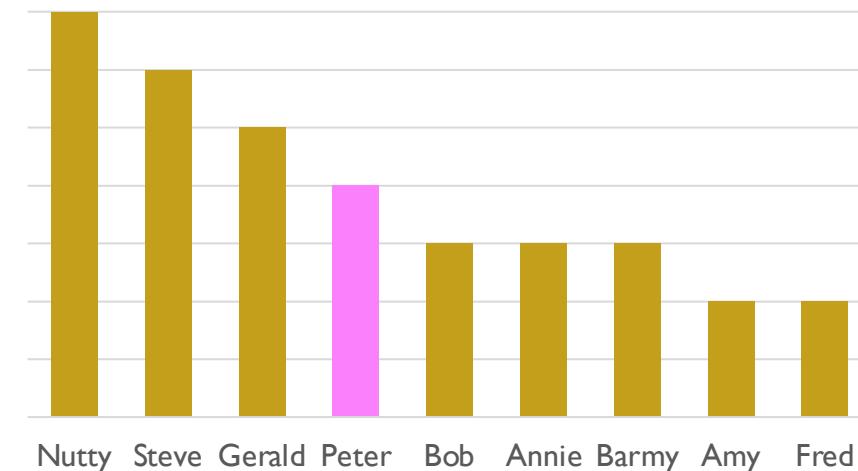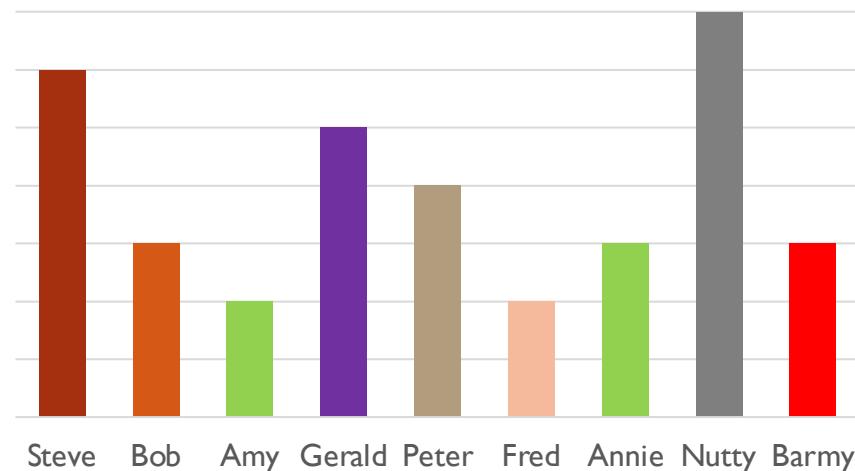
FOCAL POINT

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ISOMORPHIC CORRESPONDENCE

People interpret and respond to images based on past/shared experiences (in particular, for the selection of chart colours).

Red is often associated with **bad** and **green** with **good** (colour-blindness?). We can colour-code charts accordingly.

Lesson: stick to well-established conventions and best practices (even if boring!)
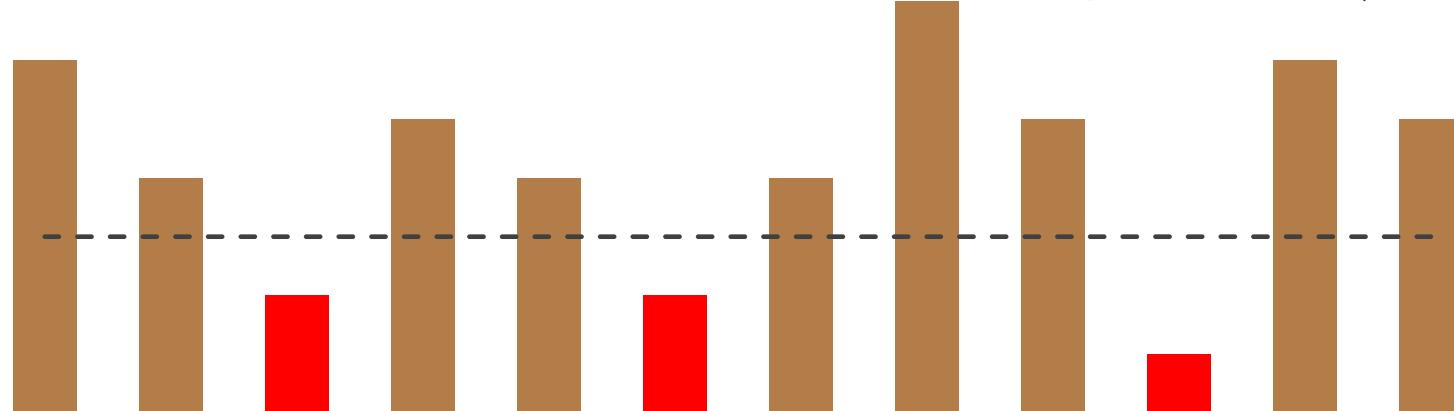
FIGURE / GROUND DUALITY

Chart elements are either perceived as **figures** (focus) or as (back)**ground**.

Foreground objects are **promoted** by the brain, background objects are **demoted**.
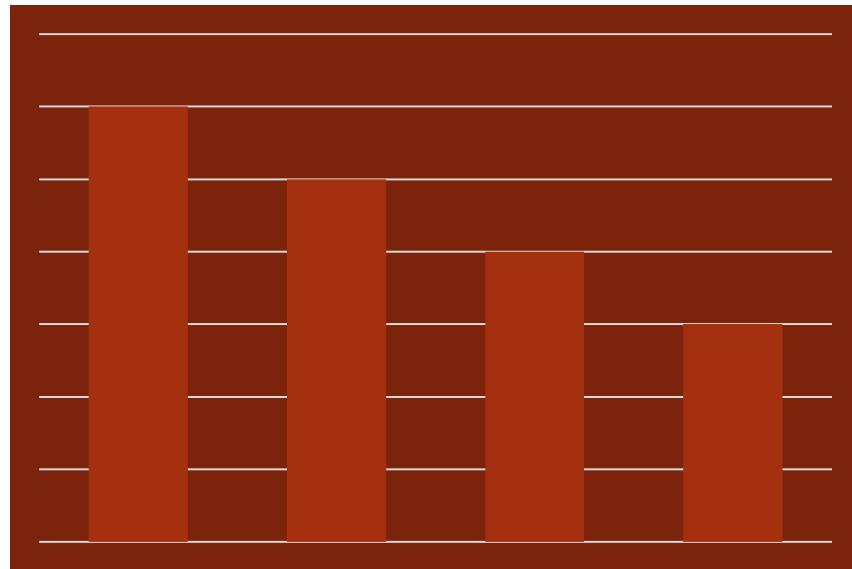
Strong contrast makes it easier to distinguish between the two types of objects.

Lesson: ensure there is enough contrast between the chart foreground (figures) and their background.

FIGURE / GROUND DUALITY

Because of the low contrast between the figure and background in the chart on the left, there is an **additional cognitive load**.

Increasing the contrast on the right improves readability.
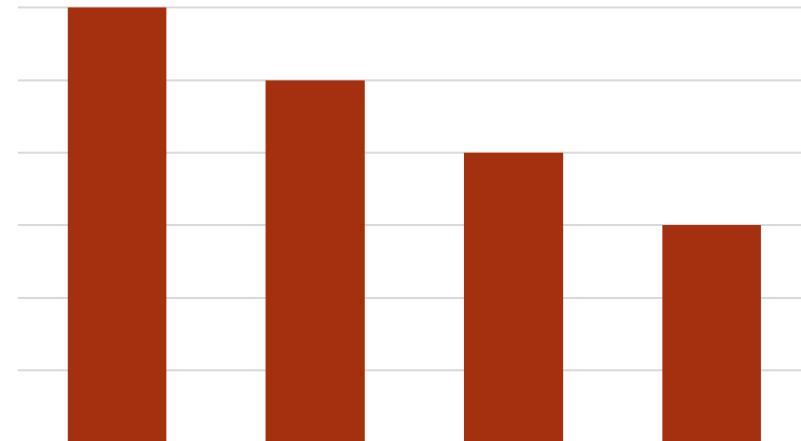
vs.

FIGURE / GROUND DUALITY

Because of the low contrast between the figure and background in the chart on the left, there is an **additional cognitive load**.

Increasing the contrast on the right improves readability.

vs.

DECLUTTERING

DECLUTTERING

CLUTTER IS THE ENEMY!
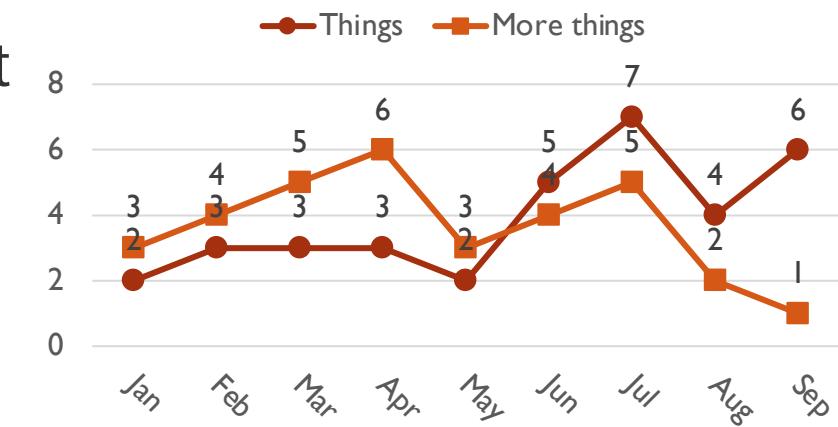
- every element on a page adds **cognitive load**

- identify anything that isn't adding value and **remove**

- think of cognitive load as mental effort required to process information (lower is better)

- Tufte refers to the **data to ink ratio** – "the larger the share of a graphic's ink devoted to data, the better"

- in *Resonate*, Duarte refers to this as "**maximizing the signal-to-noise ratio**" where the signal is the information or the story we want to communicate.

DECLUTTERING

Use the **Gestalt Principles** to organize/highlight data in the chart.

Align all the elements (graphs, text, lines, titles, etc).

- DON'T rely on eye, use position boxes and values

Charts:

- remove border, gridlines, data markers

- clean up axis labels

- label data directly

DECLUTTERING
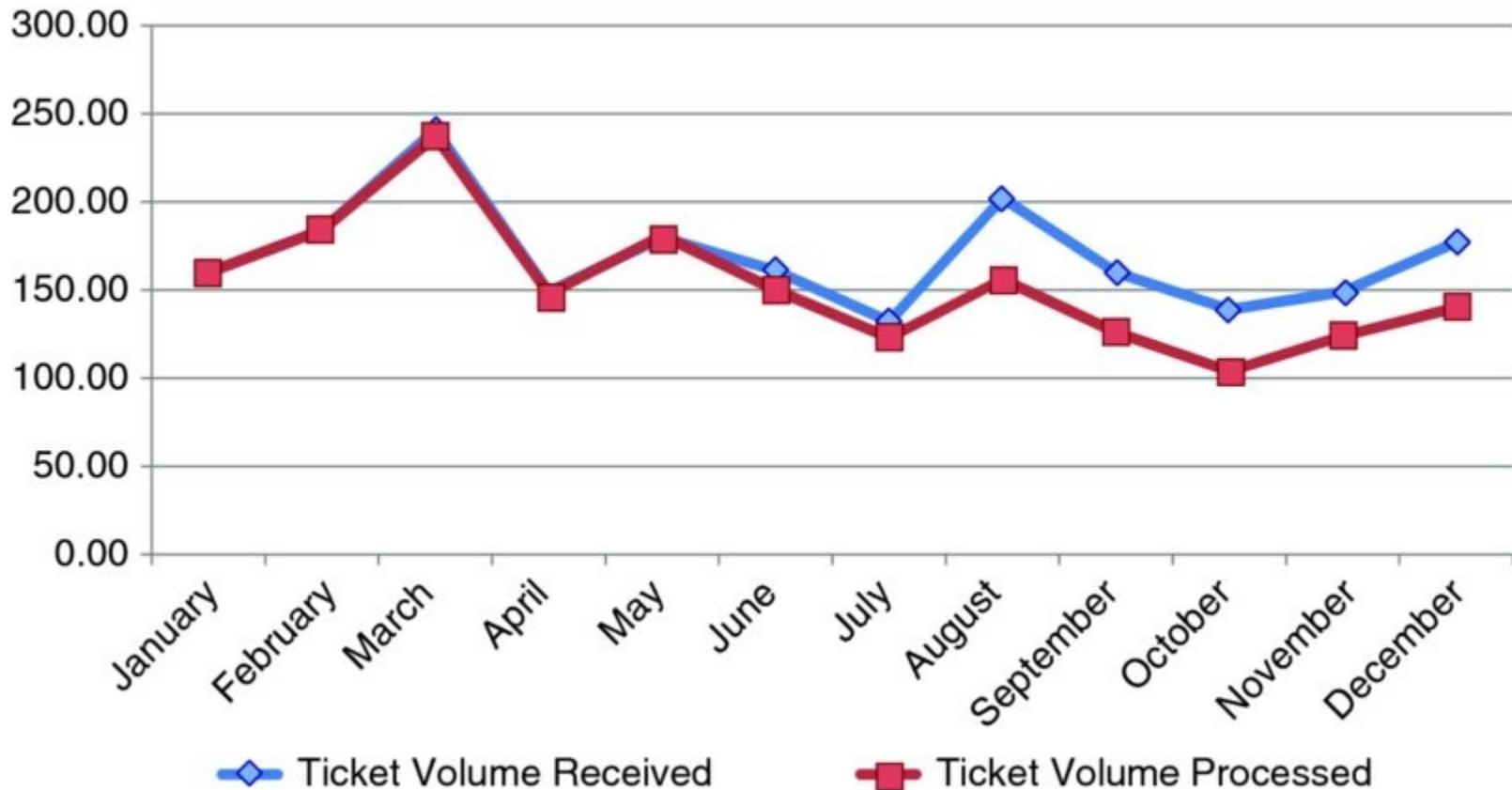
Use **consistent** font, font size, colour and alignment.

Don't rotate text to anything other than 0 or 90 degrees.
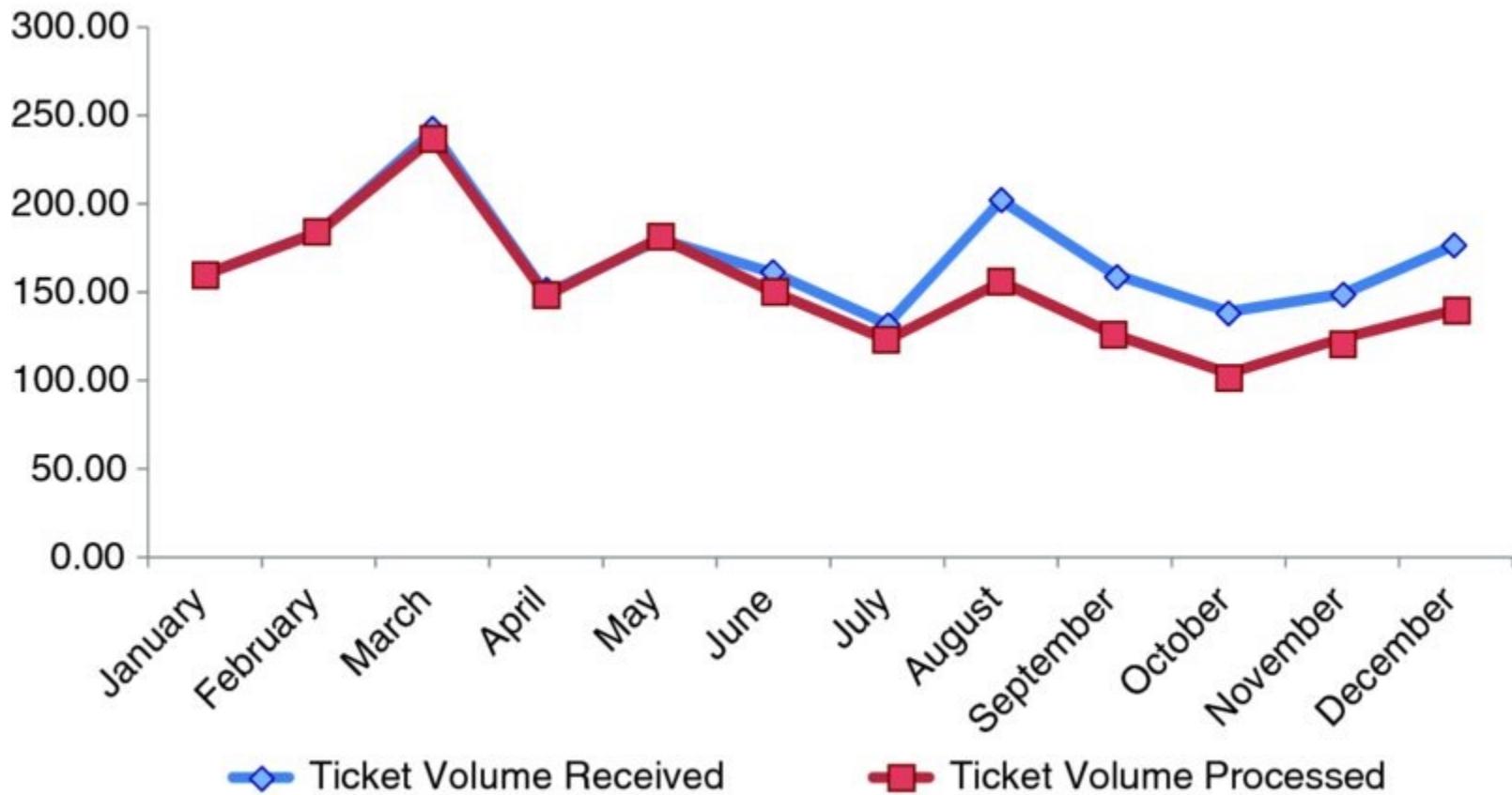
Use **white space:**

- margins should remain free of text and visuals

- don't stretch visuals to edge of page or too close to other visuals

- think of white space as a border

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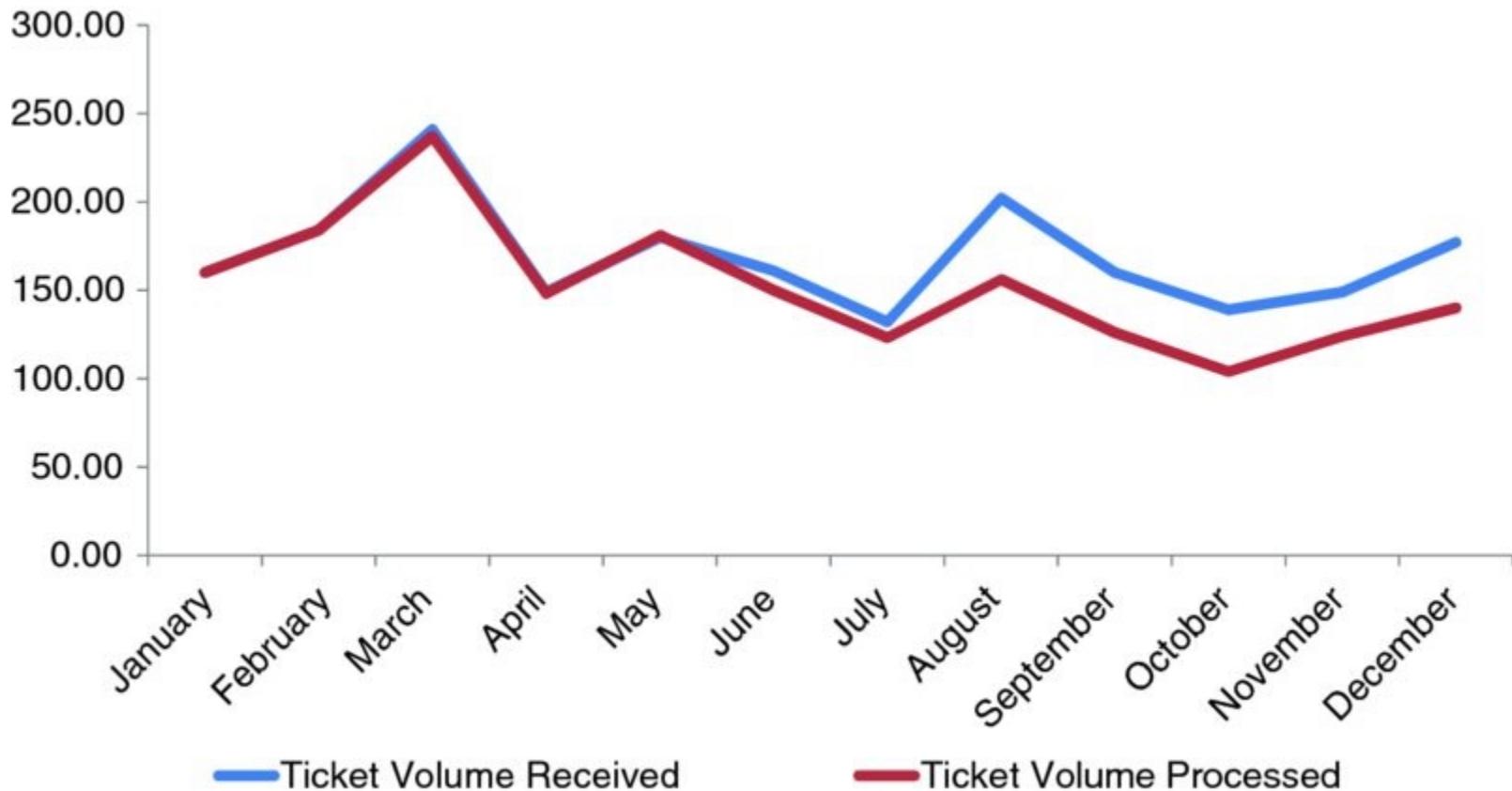
DECLUTERING – STEP-BY-STEP EXAMPLE
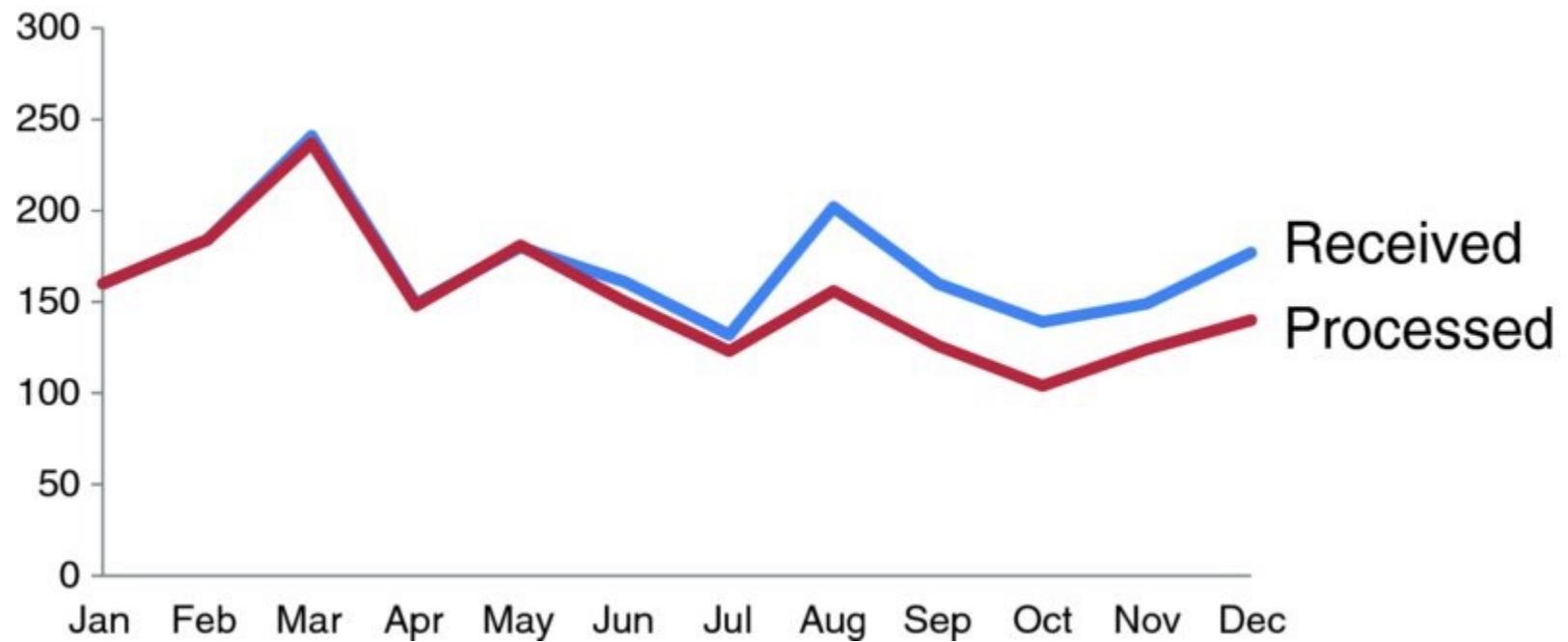
# 1. REMOVE CHART BORDER & GRIDLINES
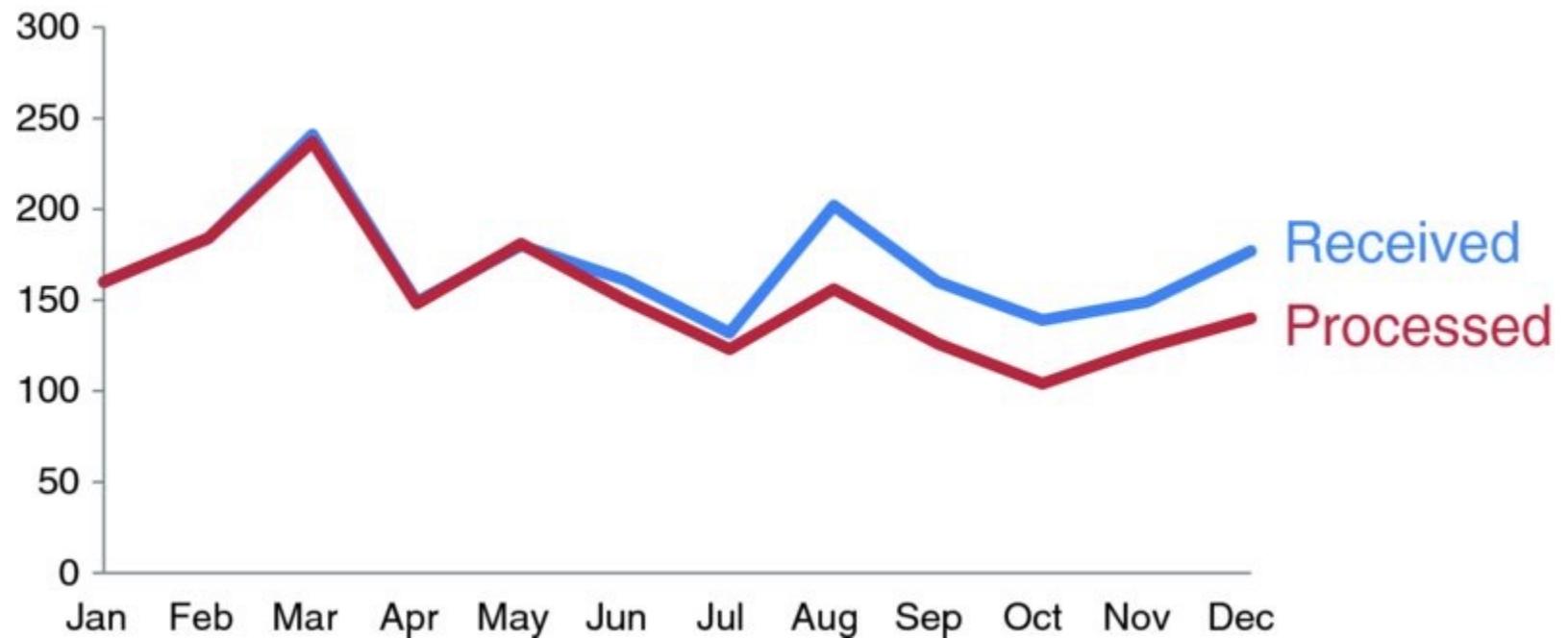
2. REMOVE DATA MARKERS



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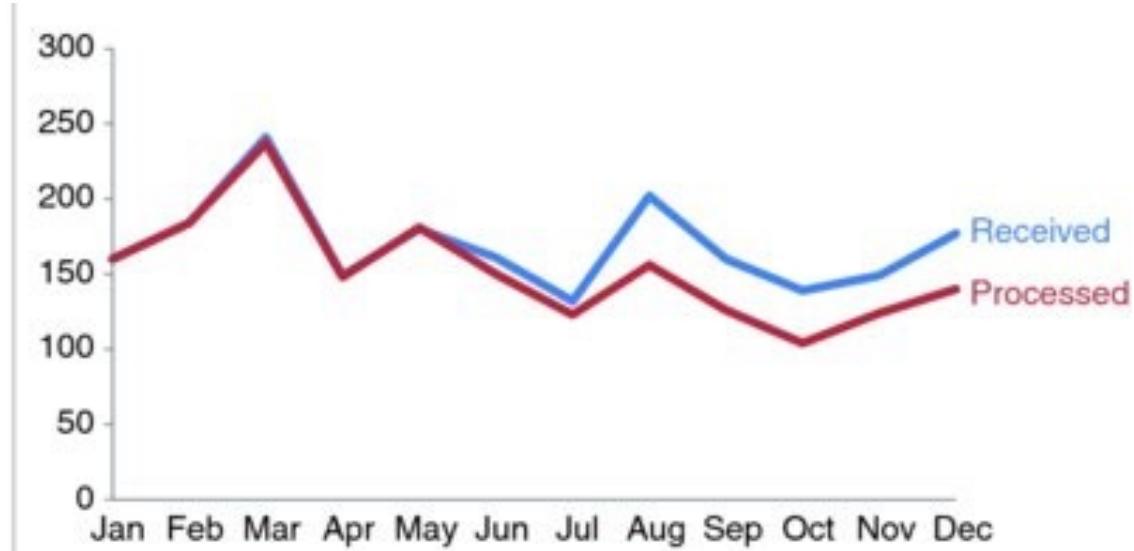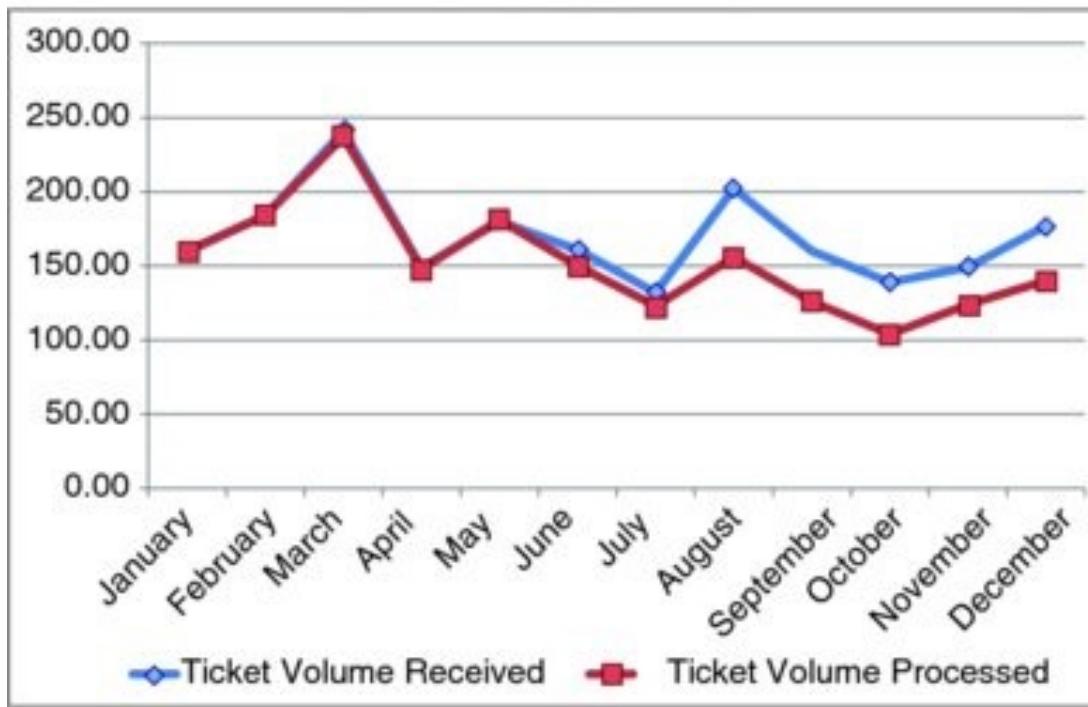
3. CLEAN UP AXIS LABELS

4. COLOUR CODE THE LINES

5. BEFORE & AFTER

EXERCISE

Select a few charts (either among the examples we have seen so far, or something you have seen at work).

Are they too cluttered?

Does the answer depend on the audience?
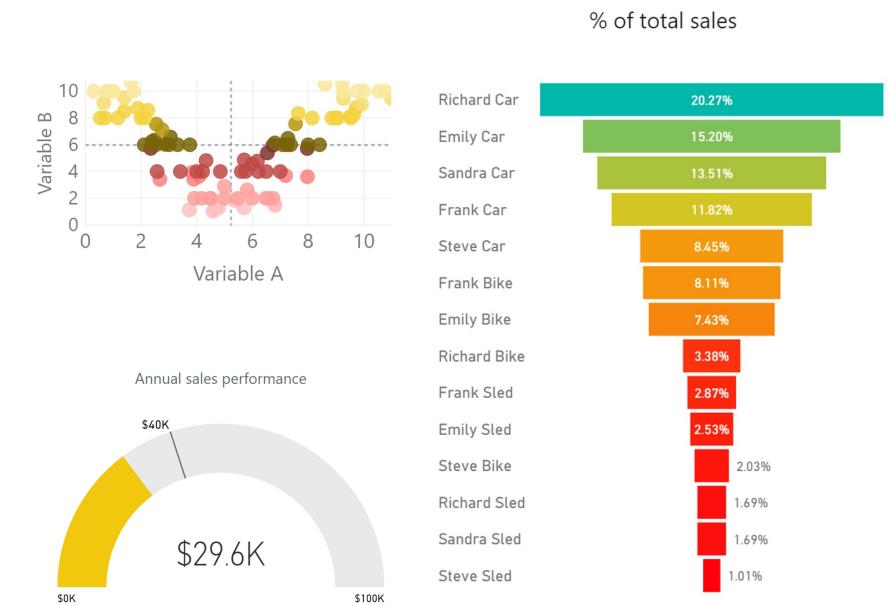
Provide some decluttering suggestions.

SIZE, COLOUR, AND POSITION

SIZE

Size: assuming that the chart has been decluttered

- things of equal importance size similarly

- other things scale to importance

% of total sales

Richard Car 20.27%
Emily Car 15.20%
Sandra Car 13.51%
Frank Car 11.82%
Steve Car 8.45%
Frank Bike 8.11%
Emily Bike 7.43%
Richard Bike 3.38%
Frank Sled 2.87%
Emily Sled 2.53%
Steve Bike 2.03%
Richard Sled 1.69%
Sandra Sled 1.69%
Steve Sled 1.01%

Annual sales performance

$40K

$29.6K

$0K $100K
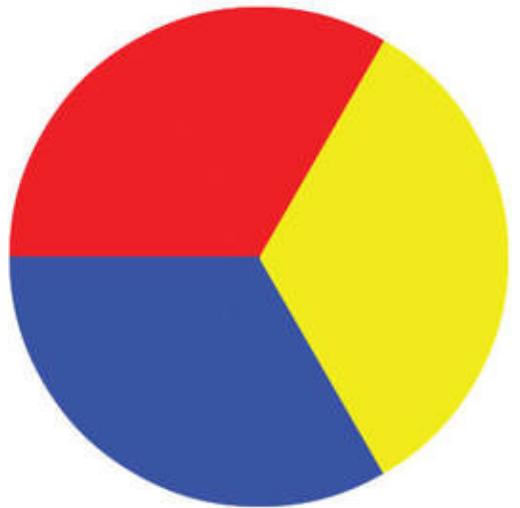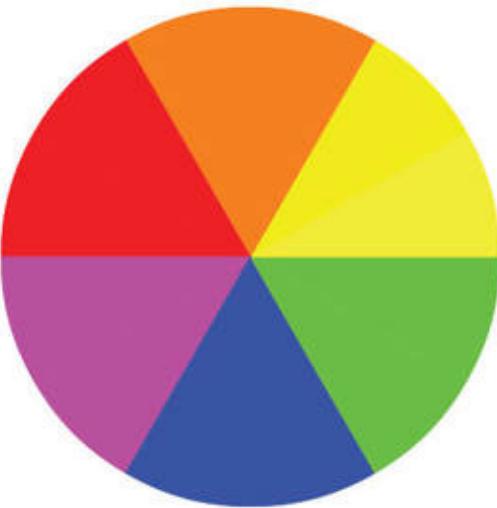
COLOUR THEORY

Colour theory (complicated topic – here is a start):

- http://www.deanenettles.com/webexamples/colorexamples/

- https://www.sessions.edu/color-calculator/

Colour wheels:

Primary Colours   Secondary Colours   Tertiary Colours

COLOUR SCHEMES

Achromatic (colourless, using only blacks, whites and grays)

Monochromatic (1-colour schemes)

Complementary (colours directly across from each other on the colour wheel)

Split complementary (2 of the 3 colors are adjacent; 1 of the colours is opposite)

COLOUR SCHEMES

Split-Left and ***Split-Right Complementary*** ("split" colours are either to the left or right of the complementary colour)

Analogous (any 3 adjacent primary, secondary, or tertiary colours on the colour wheel)

***Colour Diad*** (2 colours that are 2 colours apart on the color wheel)
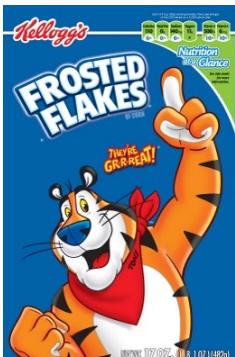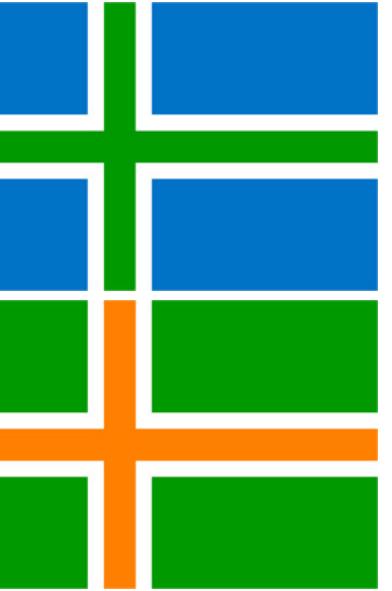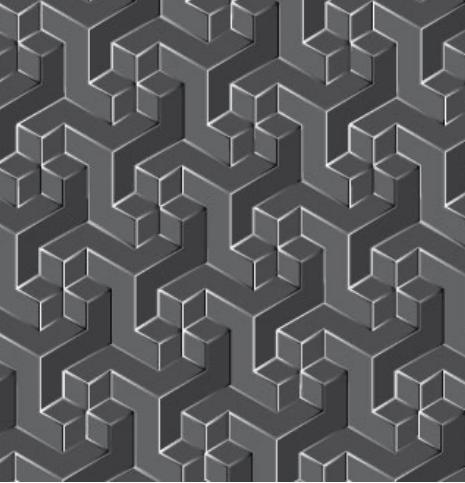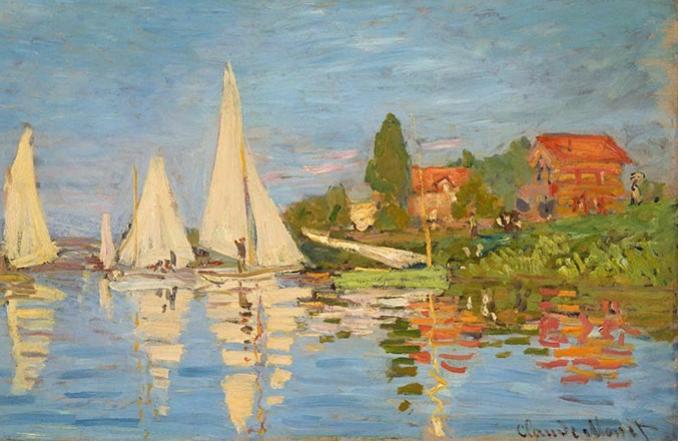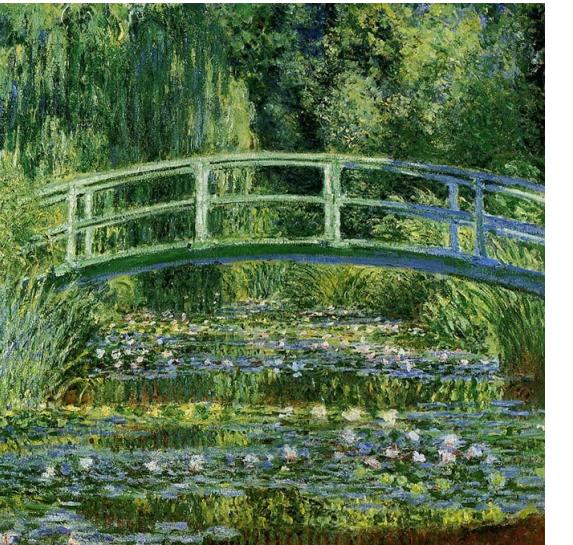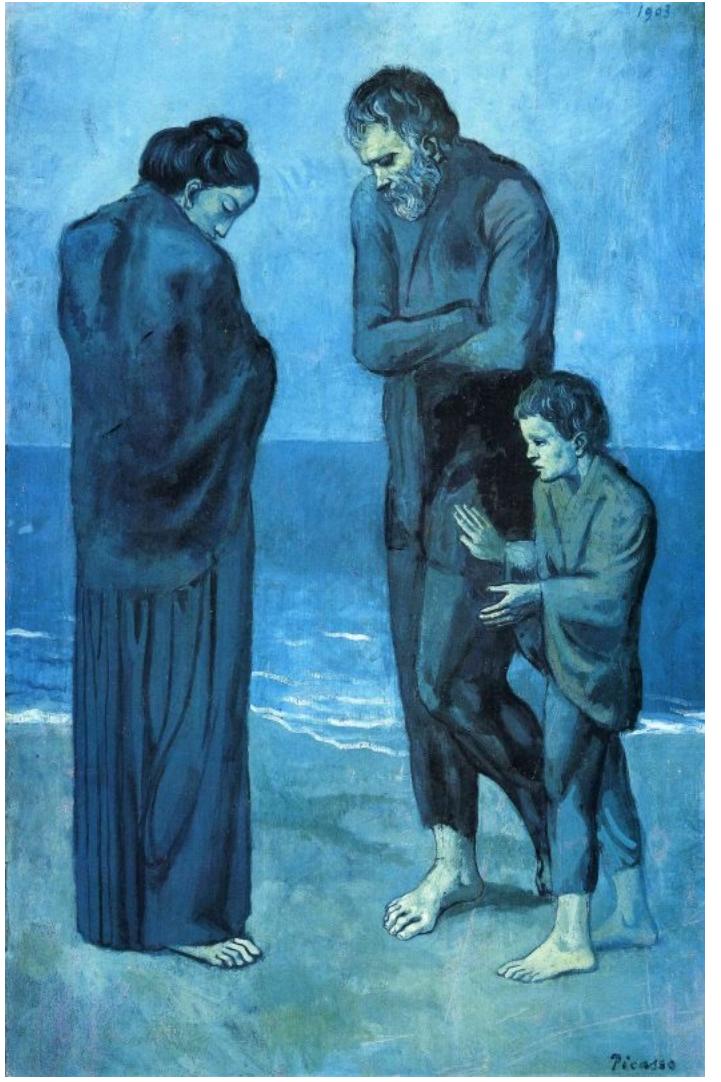
Colour Triad (3 colours, equally distant from each other on the colour wheel)
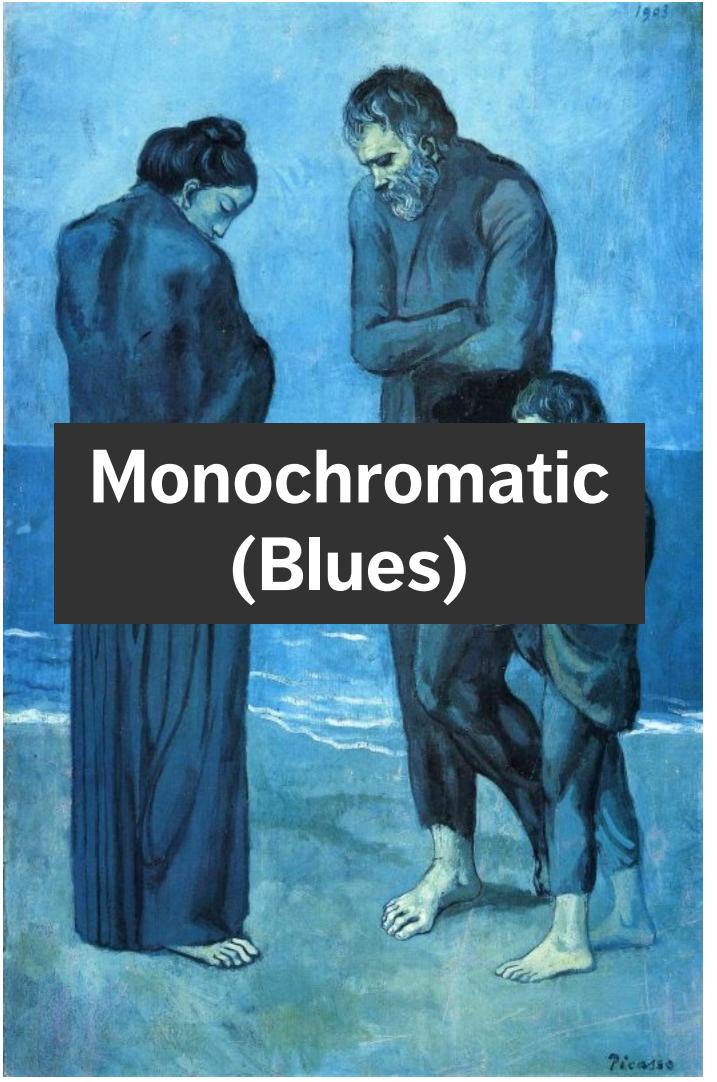
Colour Tetrad (4 or more colors on the colour wheel)
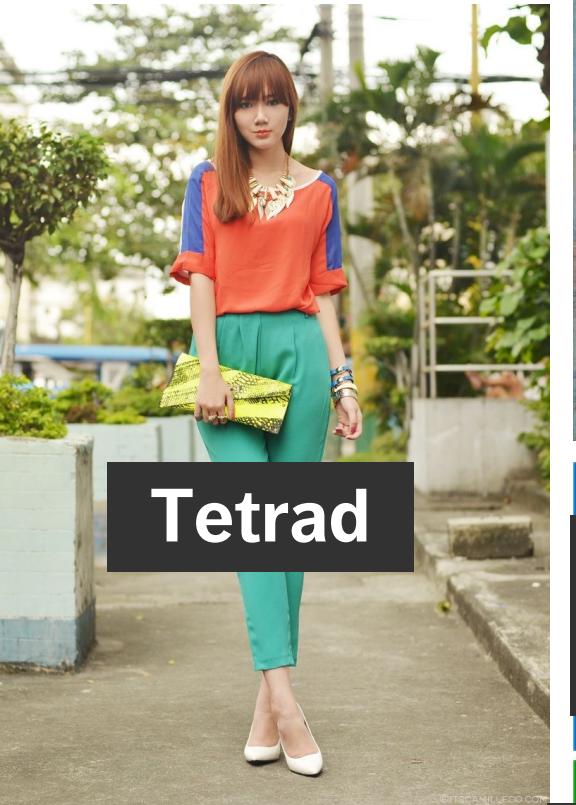
Can you identify the colour schemes underlying each of these images?

Monochromatic (Blues)

Tetrad

Split Complementary (Green, Orange & Blue)

Achromatic

Diad (Blue & Green)

Diad (Green & Orange)

Triad (Primary Colors)

Analogous (Green & Yellow)

Diad (Red & Violet)

Complementary

Can you identify the colour schemes underlying each of these images?
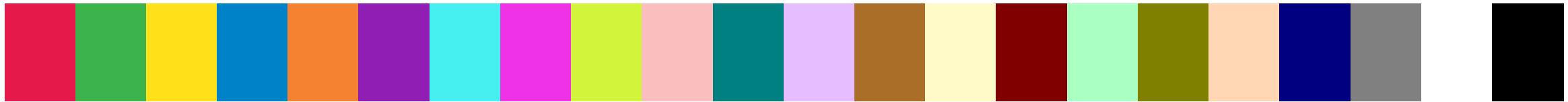
COLOUR PALETTES

Group 1	Group 2	Group 3	Group 4

Zeileis, Hornik & Murrell
24 Distinct Colours

Hex	RGB	Display	Group	Hex	RGB	Display	Group
#023FA5	(2,63,165)		1	#11C638	(17,198,56)		3
#7D87B9	(125,135,185)		1	#8DD593	(141,213,147)		3
#BEC1D4	(190,193,212)		1	#C6DEC7	(198,222,199)		3
#D6BCC0	(214,188,192)		1	#EAD3C6	(234,211,198)		3
#BB7784	(187,119,132)		1	#F0B98D	(240,185,141)		3
#8E063B	(142,6,59)		1	#EF9708	(239,151,8)		3
#4A6FE3	(74,111,227)		2	#0FCFC0	(15,207,192)		4
#8595E1	(133,149,225)		2	#9CDED6	(156,222,214)		4
#B5BBE3	(181,187,227)		2	#D5EAE7	(213,234,231)		4
#E6AFB9	(230,175,185)		2	#F3E1EB	(243,225,235)		4
#E07B91	(224,123,145)		2	#F6C4E1	(246,196,225)		4
#D33F6A	(211,63,106)		2	#F79CD4	(247,156,212)		4

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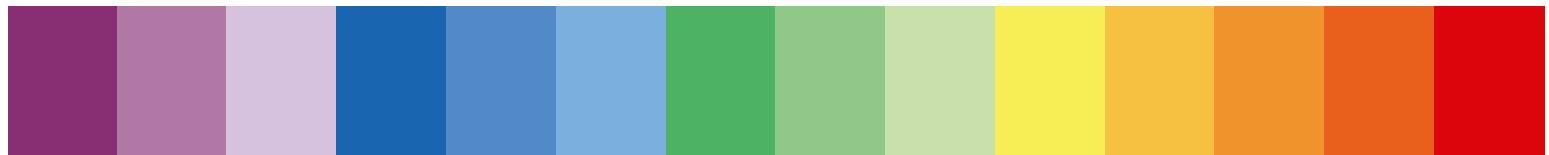
COLOUR PALETTES

Kelly's 22 Colours of Maximum Contrast
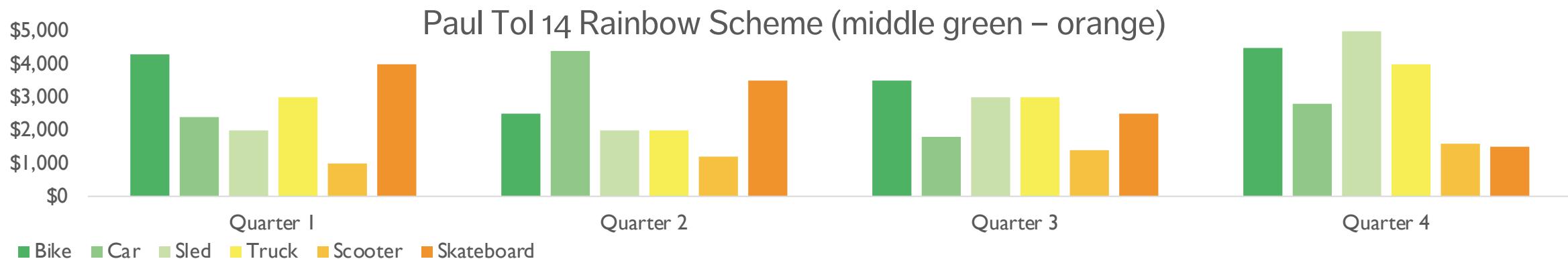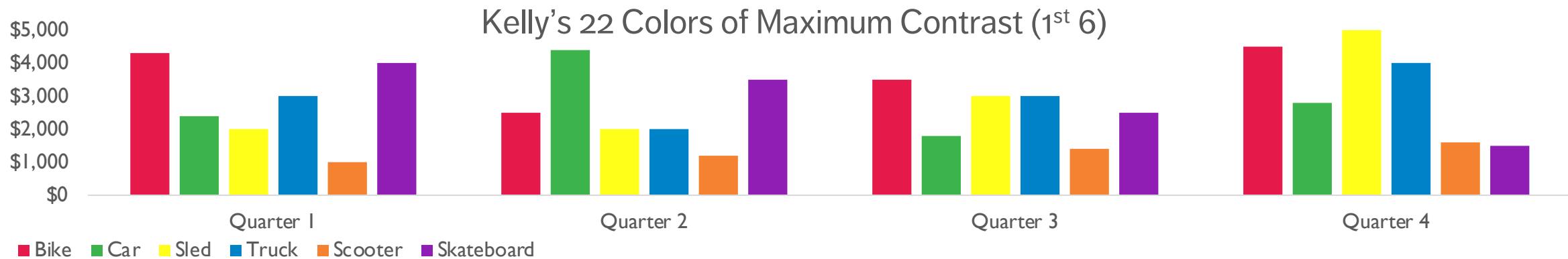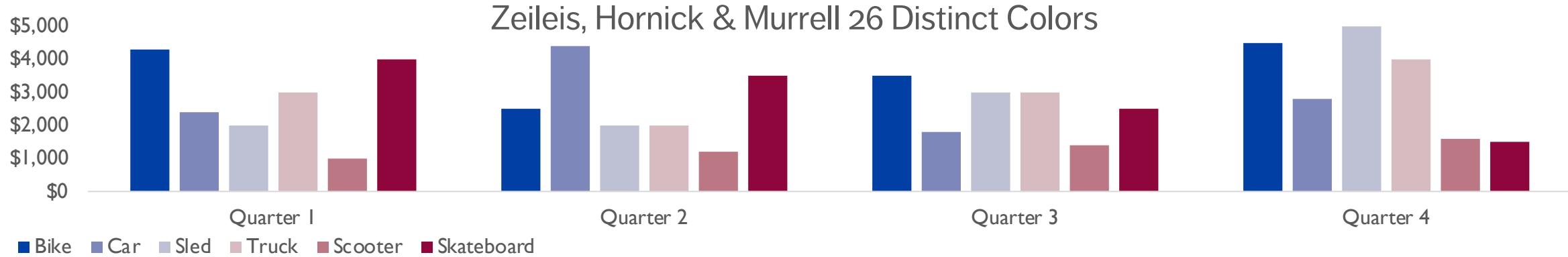
Name	Hex	RGB	Display	Name	Hex	RGB	Display
Red	#e6194b	(230, 25, 75)		Lavender	#e6beff	(230, 190, 255)	
Green	#3cb44b	(60, 180, 75)		Brown	#aa6e28	(170, 110, 40)	
Yellow	#ffe119	(255, 225, 25)		Beige	#fffac8	(255, 250, 200)	
Blue	#0082c8	(0, 130, 200)		Maroon	#800000	(128, 0, 0)	
Orange	#f58231	(245, 130, 48)		Mint	#aaffc3	(170, 255, 195)	
Purple	#911eb4	(145, 30, 180)		Olive	#808000	(128, 128, 0)	
Cyan	#46f0f0	(70, 240, 240)		Coral	#ffd8b1	(255, 215, 180)	
Magenta	#f032e6	(240, 50, 230)		Navy	#800000	(0, 0, 128)	
Lime	#d2f53c	(210, 245, 60)		Grey	#808080	(128, 128, 128)	
Pink	#fabebe	(250, 190, 190)		White	#FFFFFF	(255, 255, 255)	
Teal	#008080	(0, 128, 128)		Black	#000000	(0, 0, 0)	

COLOUR PALETTES

**Paul Tol
14 Colour
Rainbow Scheme**

Hex	RGB	Display	Hex	RGB	Display
#882E72	(136,46,114)		#90C987	(144,201,135)	
#B178A6	(177,120,166)		#CAE0AB	(202,224,171)	
#D6C1DE	(214,193,222)		#F7EE55	(247,238,85)	
#1965B0	(25,101,176)		#F6C141	(246,193,65)	
#5289C7	(82,137,199)		#F1932D	(241,147,45)	
#7BAFDE	(123,175,222)		#E8601C	(232,96,28)	
#4EB265	(78,178,101)		#DC050C	(220,5,12)	

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Zeileis, Hornick & Murrell 26 Distinct Colors

Bike • Car • Sled • Truck • Scooter • Skateboard

Kelly's 22 Colors of Maximum Contrast (1st 6)

Bike • Car • Sled • Truck • Scooter • Skateboard

Paul Tol 14 Rainbow Scheme (middle green – orange)

Bike • Car • Sled • Truck • Scooter • Skateboard
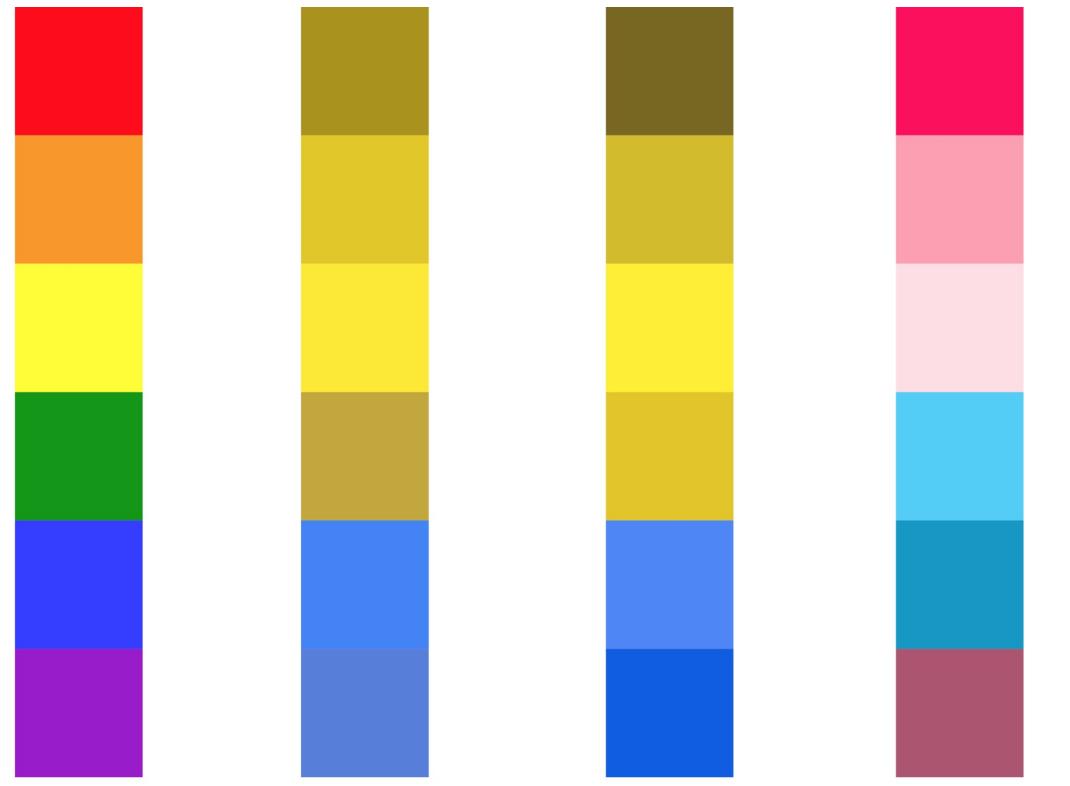
COLOURBLINDNESS

A sizeable proportion of the population (~8%) is **colourblind**, to some degree.

Charts that rely on colours might fail to convey the full extent of the data story to a significant proportion of the audience.

Consider using **contrast-friendly** palettes, and **not using colour alone** to convey the data story.

tritanomal   dueteranope   protanope   tritanerope

normal dichromat   dichromats

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COLOUR TIPS

When it comes to colour, **less is more**: use it sparingly (graphic designers are taught to "get it right, in black and white").

Based on the Gestalt Principles, **monochrome** schemes can be particularly effective.

When appropriate, pick scheme based on corporate identity (this maximizes buy in).
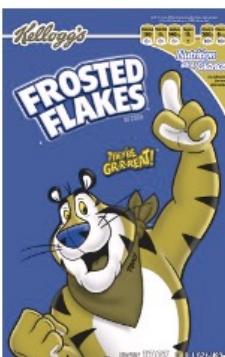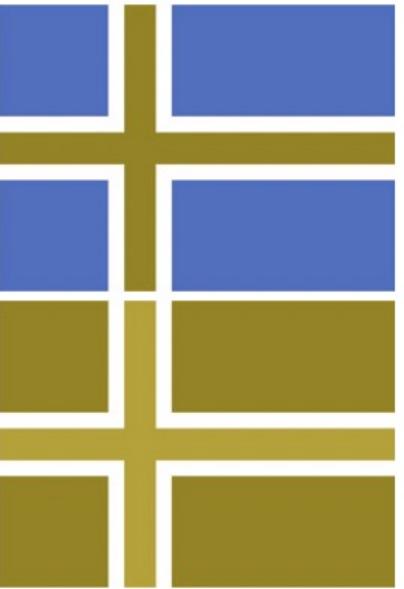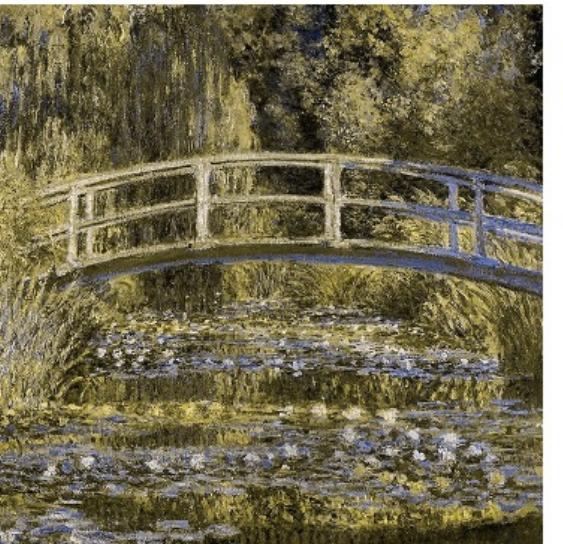
Create a template (and stick to it).

Upload images to see what charts look like in various flavours of colour-blindness:

- https://www.color-blindness.com/coblis-color-blindness-simulator (there are other tools)

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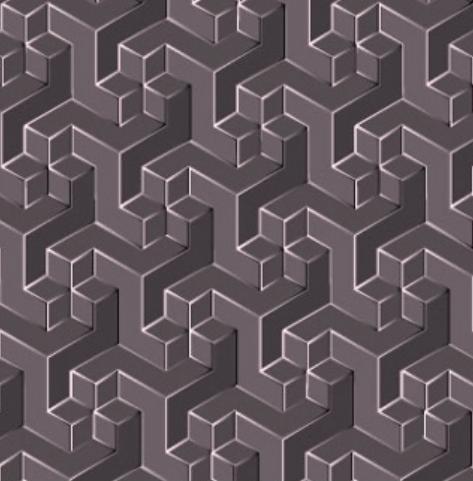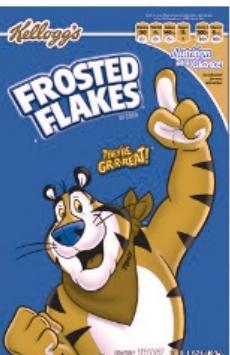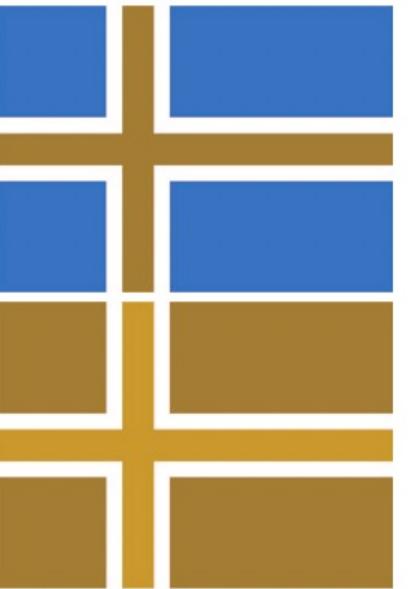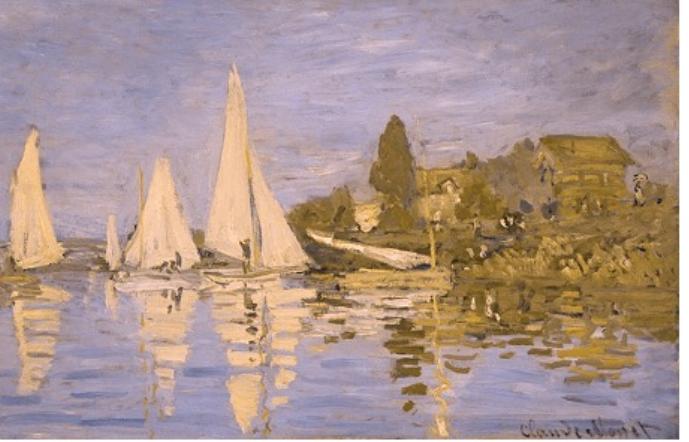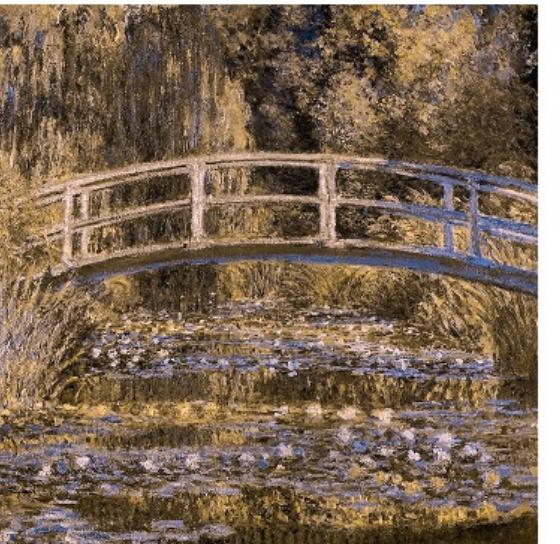
Dichromatic
protanopia
(red-blind)
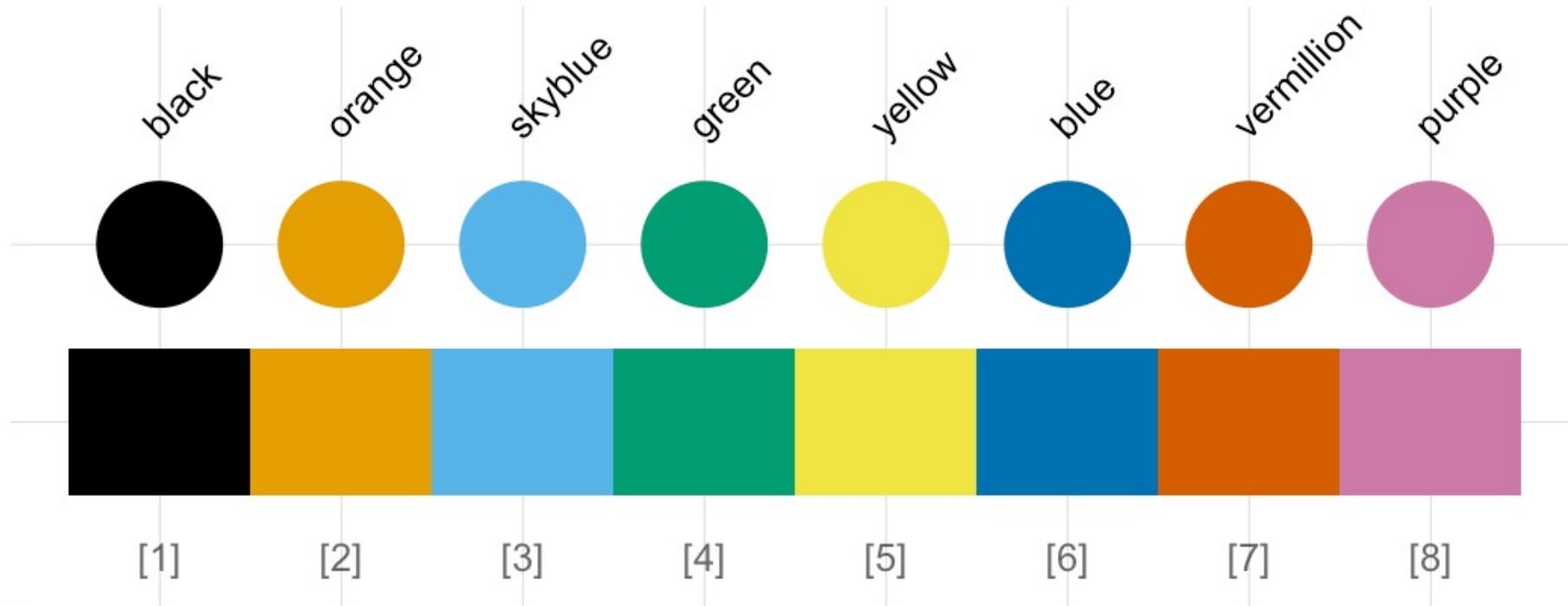
Dichromatic
deuteranopia
(green-blind)

Color-blind friendly color scale (Okabe & Ito, 2002)
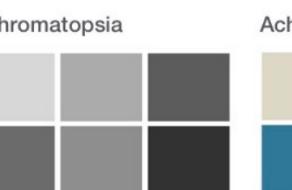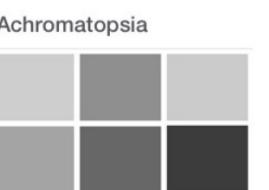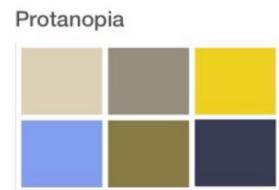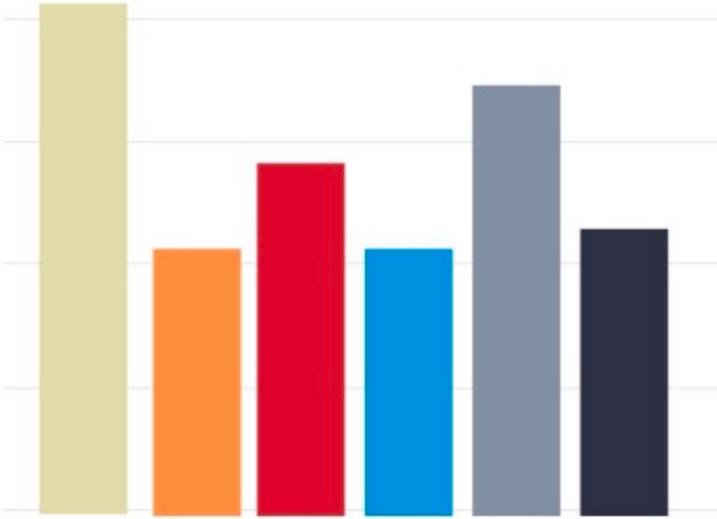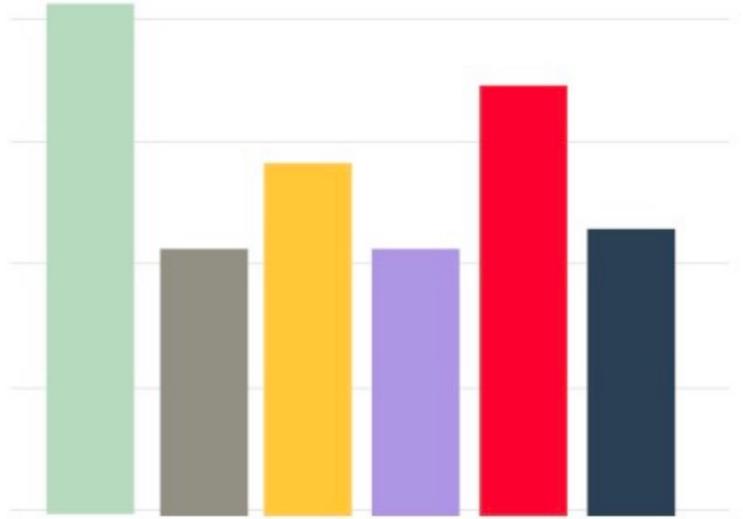
	black	orange	skyblue	green	yellow	blue	vermillion	purple
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Hex:	#000000	#E69F00	#56B4E9	#009E73	#F0E442	#0072B2	#D55E00	#CC79A7
R:	0	230	86	0	240	0	213	204
G:	0	159	180	158	228	114	94	121
B:	0	0	233	115	66	178	0	167

#BDD9BF, #929084, #FFC857 #A997DF, #E5323B, #2E4052

#E1DAAE, #FF934F, #CC2D35, #058ED9, #848FA2, #2D3142
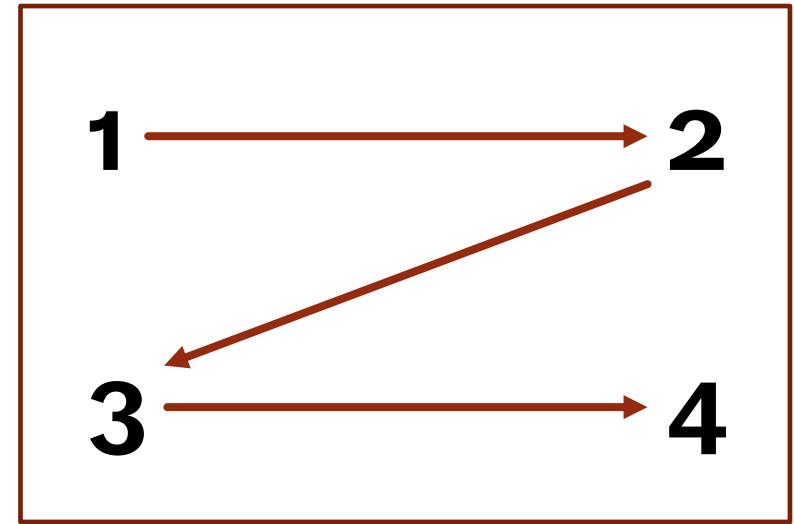
SIZE, COLOUR, AND POSITION

How should the elements be placed in a chart or a dashboard?

In the West, most people start at the top left and zig-zag all the way to the bottom right.

Simple rule: don't make people work too hard

- main message: top left/top right

- info in order of preference

- people concentrate less as they scan so get less complex as you move to bottom corner

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ACCESSIBILITY

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A WORD ABOUT ACCESSIBILITY

A table can be translated to Braille, but that's not always possible for charts.

Describing the features and emerging structures in a visualization is a possible solution... **if they can be spotted.**

Analysts must produce clear and meaningful visualizations, but they must also describe them and their features in a fashion that allows all to "see" the insights.

This requires them to have "seen" all the insights, which is not always necessarily the case (if at all possible).

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A WORD ABOUT ACCESSIBILITY

Data Perception:

- texture-based representations

- text-to-speech

- sound/music

- odor-based or taste-based representations (?!?)

Sonifications:

- TRAPPIST Sounds : TRAPPIST-1 Planetary System Translated Directly Into Music

- Listening to data from the Large Hadron Collider, L. Asquith

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A WORD ABOUT ACCESSIBILITY

Frank ↘ @FrankElavsky · 1h

Resources we could use more of (1/?):

Low vision (~30% of all people):

- High contrast text
- High contrast elements
- Using texture, shape, units
- Designing with zoom/magnification
- Using Hierarchy and Focus
- Using annotations or guides

💬 1   ⟲ 7   ♡ 42   ⬆

A WORD ABOUT ACCESSIBILITY

Frank ꙮ **@FrankElavsky · 1h**

Resources we could use more of (2/?):

Functional/motor impairment (~13% of all people in US):

- Keyboard interactivity/navigation
- UI alternatives to in-chart controls (brushing, subselecting, etc)
- Alternative data navigation schemes
- Scrollytelling alternates

💬 1   ⟲ 5   ♡ 30   ⬆

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A WORD ABOUT ACCESSIBILITY

Frank ⤳ @FrankElavsky · 1h

Resources we could use more of (3/?):

Cognitive disability (~11% of all people in US):

- Captions, summaries, clear titles, and plain text alternatives
- Reducing visual complexity
- Forgivable user interactions
- Use of hierarchy
- Assistive design (how-to-read guides, help)

💬 1   ⟲ 6   ♡ 31   ⬆

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A WORD ABOUT ACCESSIBILITY

Frank ↝ @FrankElavsky · 1h   ₀₀₀

Resources we could use more of (4/?):

Attention deficit/hyperactive disorder (~9% of all people in US):

- Clear, short text summaries
- Object constancy
- Motion design and animation
- Use of breadcrumbs
- Interaction history (with undo/redo functions)
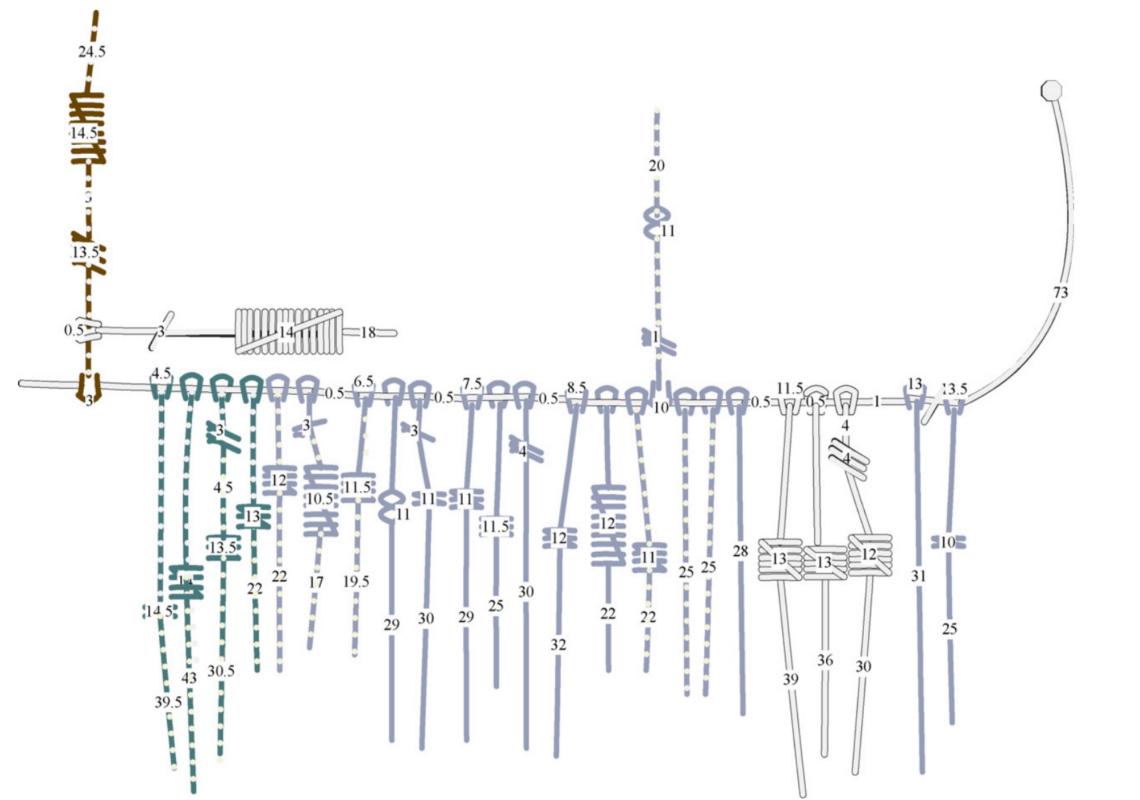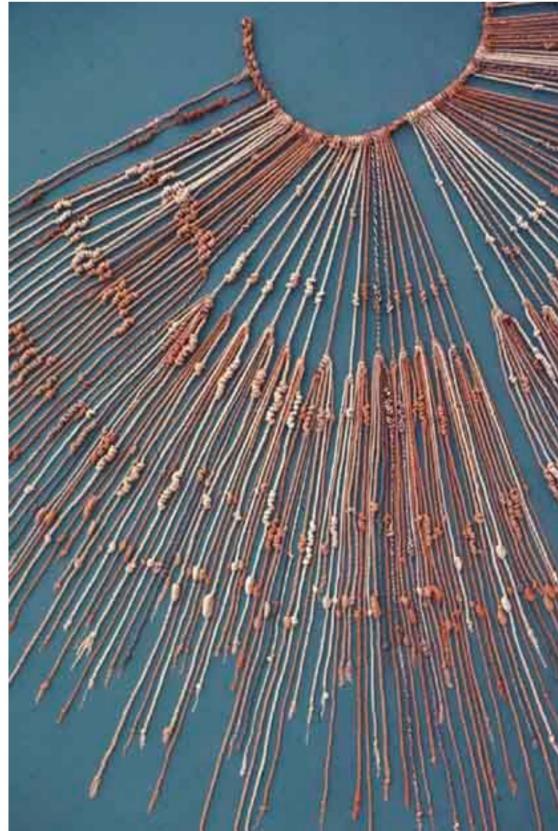
💬 2   ⟲ 4   ♡ 21   ⬆

PHYSICALIZATIONS

Inca Quipus
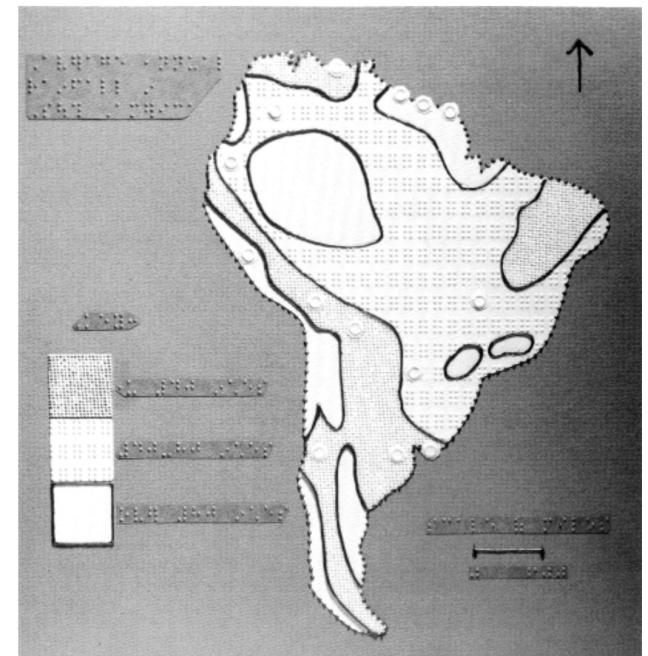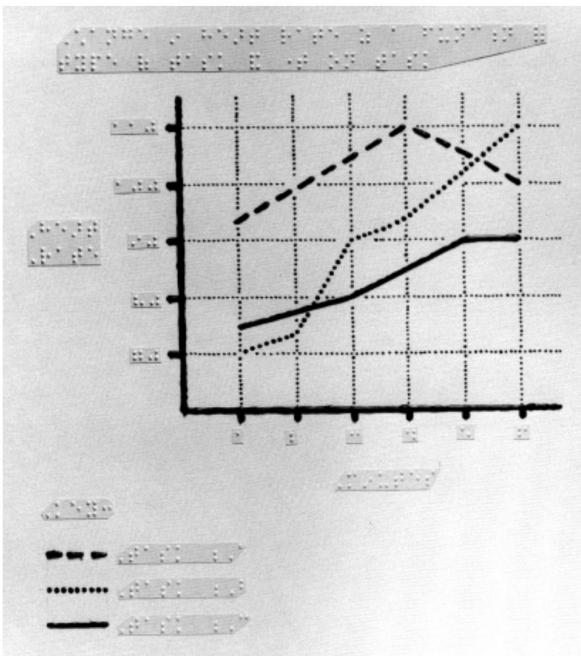
- used as a data storage device

- it is believed that **color**, **relative position of knots**, **knot types**, and **rope length** were used to encode the variables.
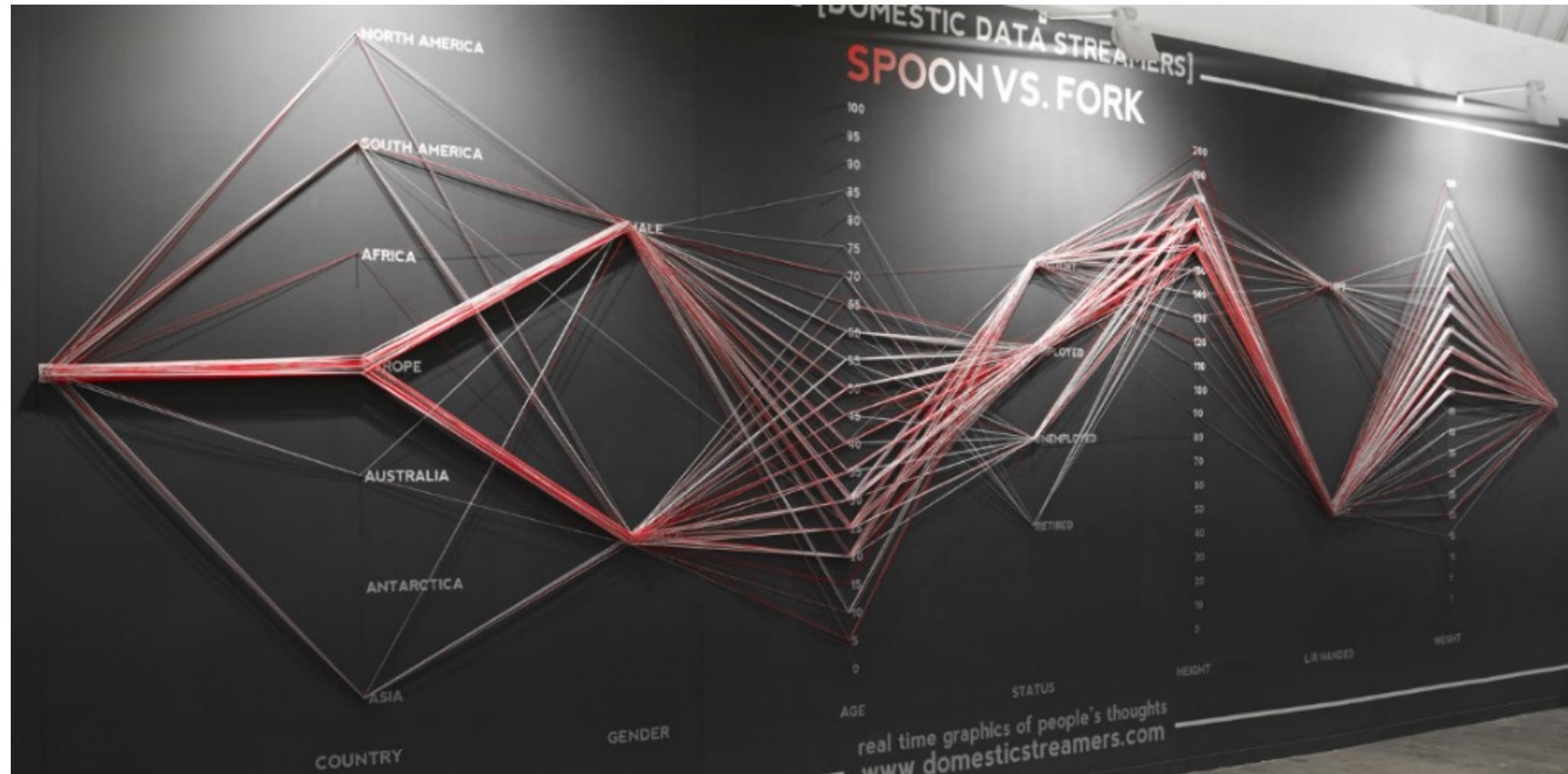
PHYSICALIZATIONS

Tactile Infographics

- **thermoform:** heated sheet of plastic sealed on a physical model

- **swell paper:** thermoform-lite

- **tactile map variables:** vibration, flutter, pressure, temperature, size, shape, texture, grain, orientation, and elevation.

- **audio tactile maps:** use software with audio files to convey information as the user's finger rolls over features or symbols

Spoon vs. Fork

Are there any issues with data collection? Where do you think this event took place? Is the spoon/fork question a red herring?