Color, Clarity & Deception

The Human Factor

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March 2019

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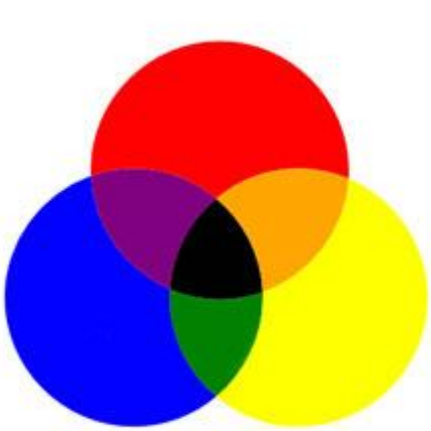
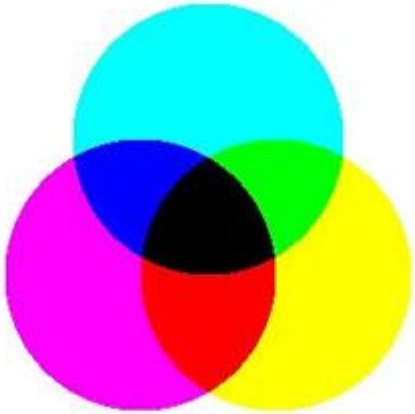
Color

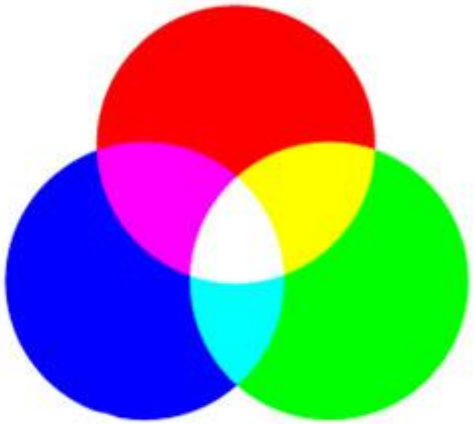
Color Models



RYB



CMYK



RGB

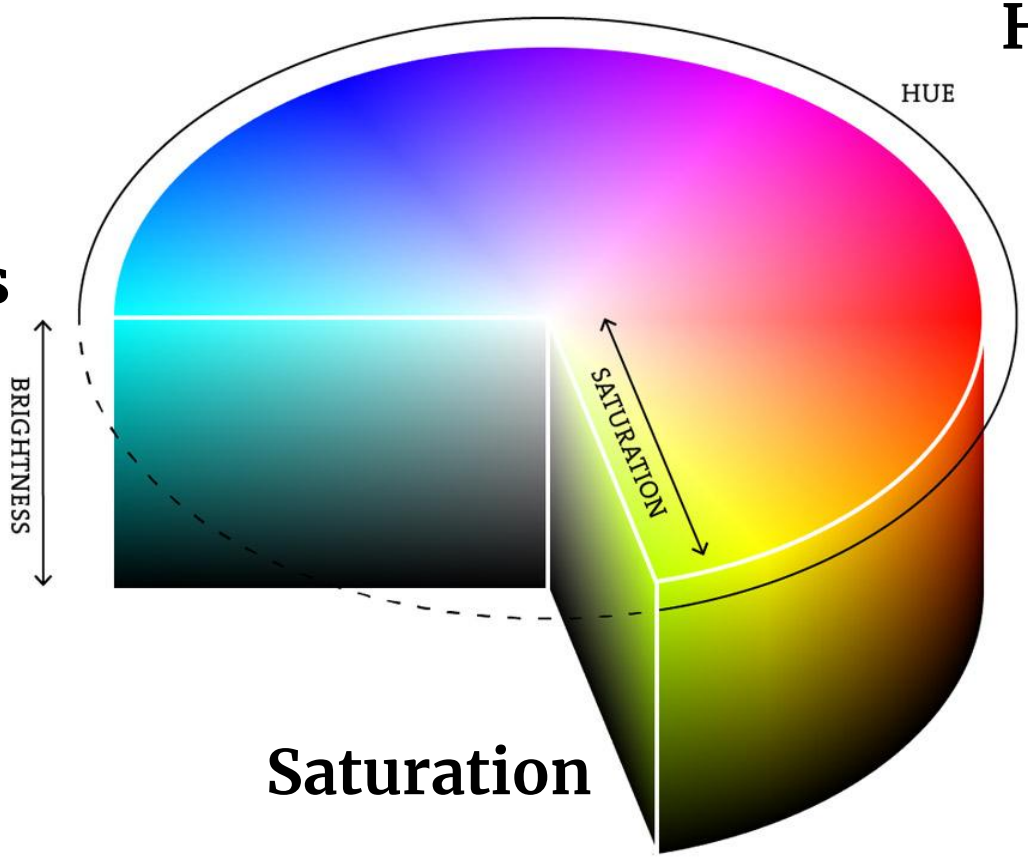
Subtractive Models

Additive Models

HSB Model

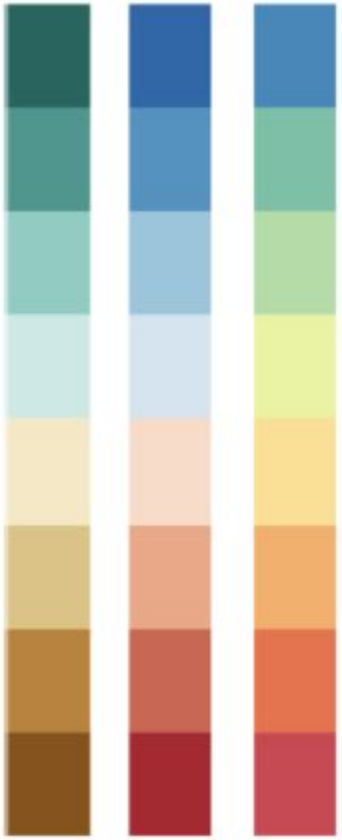
Hue

Brightness



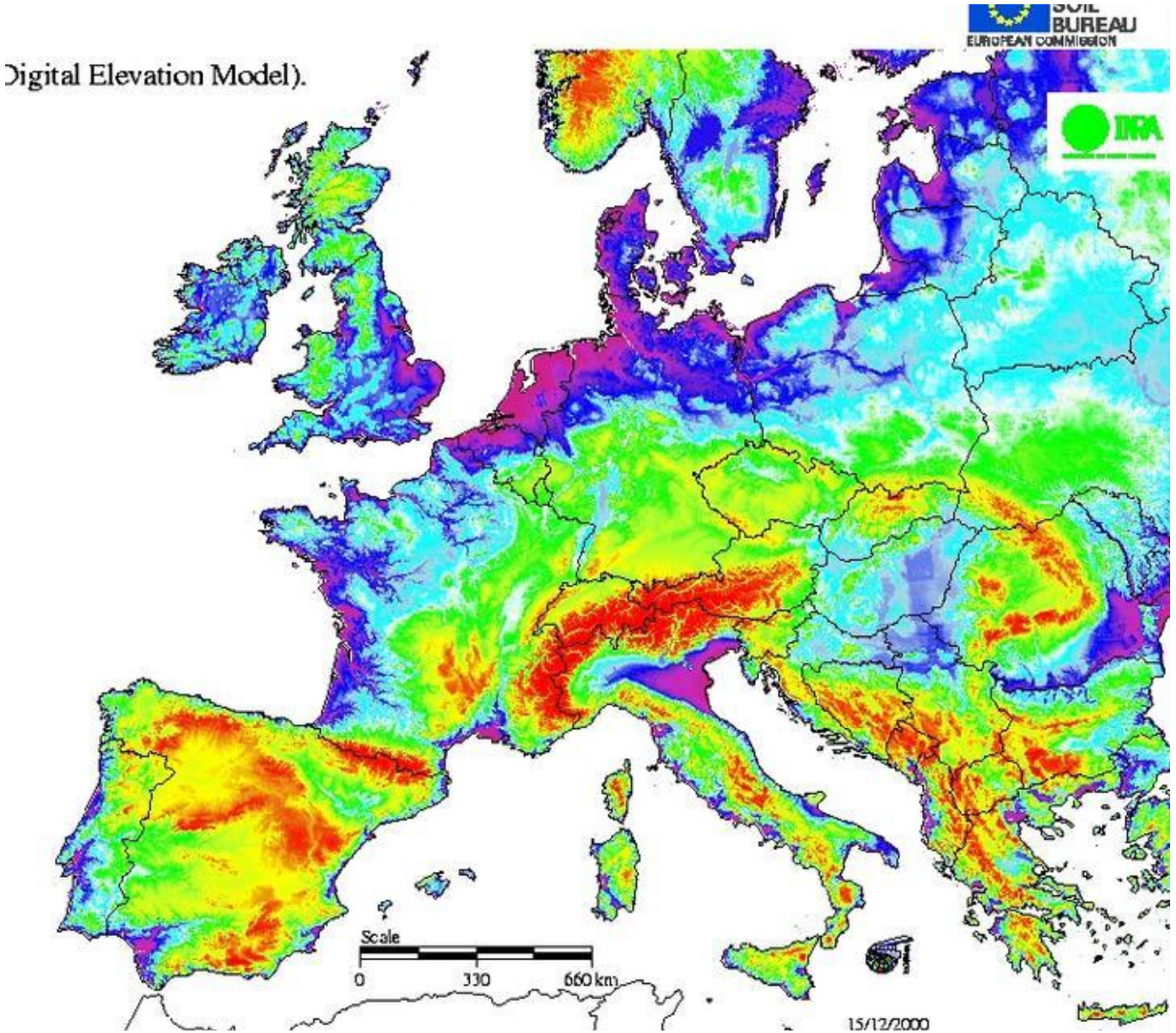
Saturation

Color Scales

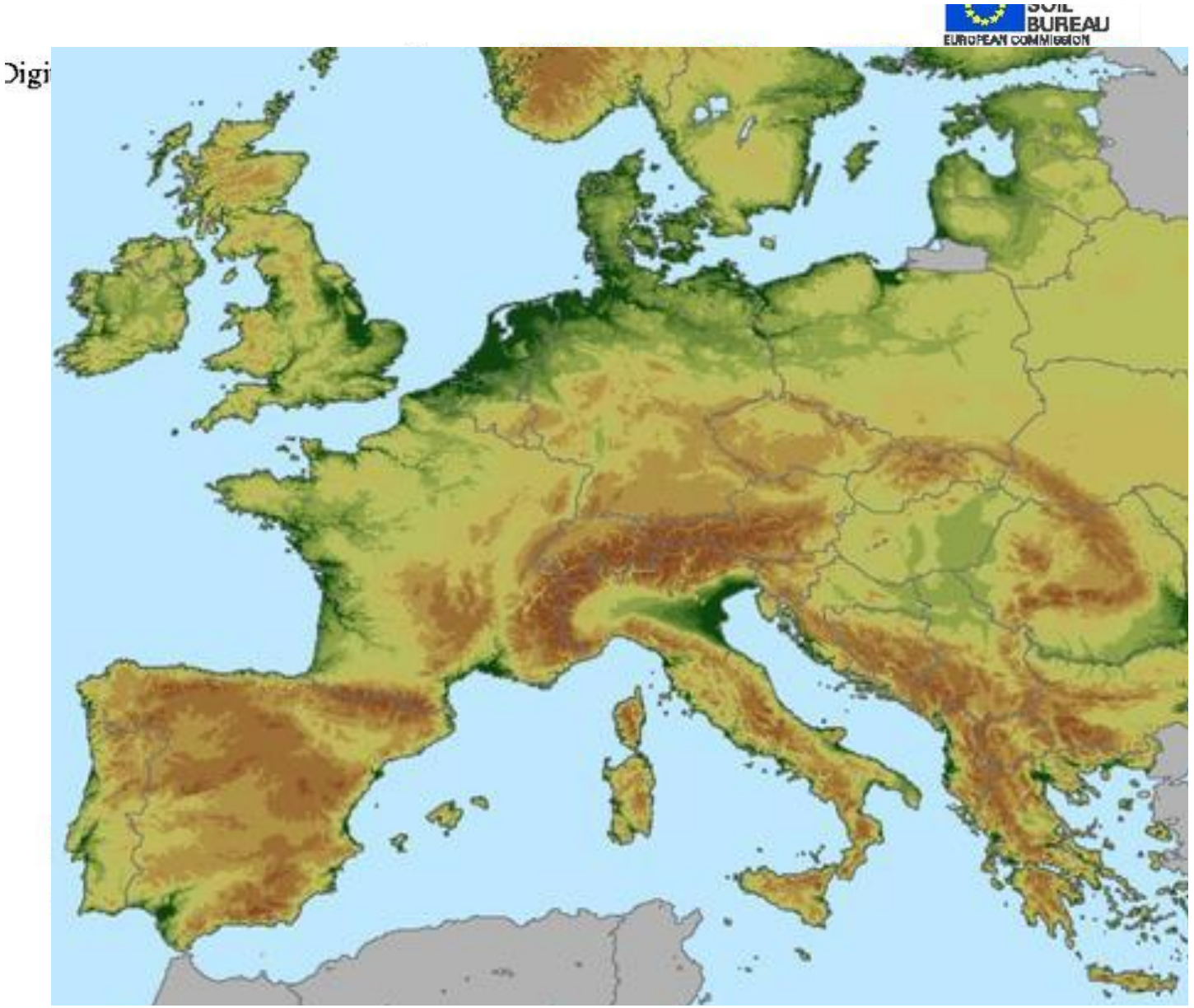


diverging

Rainbow Colormap



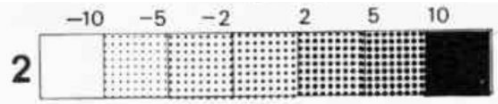
Rainbow Colormap



Rainbow Scale Considerations

Map 1

1



2

4

10

Color (mis)use

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

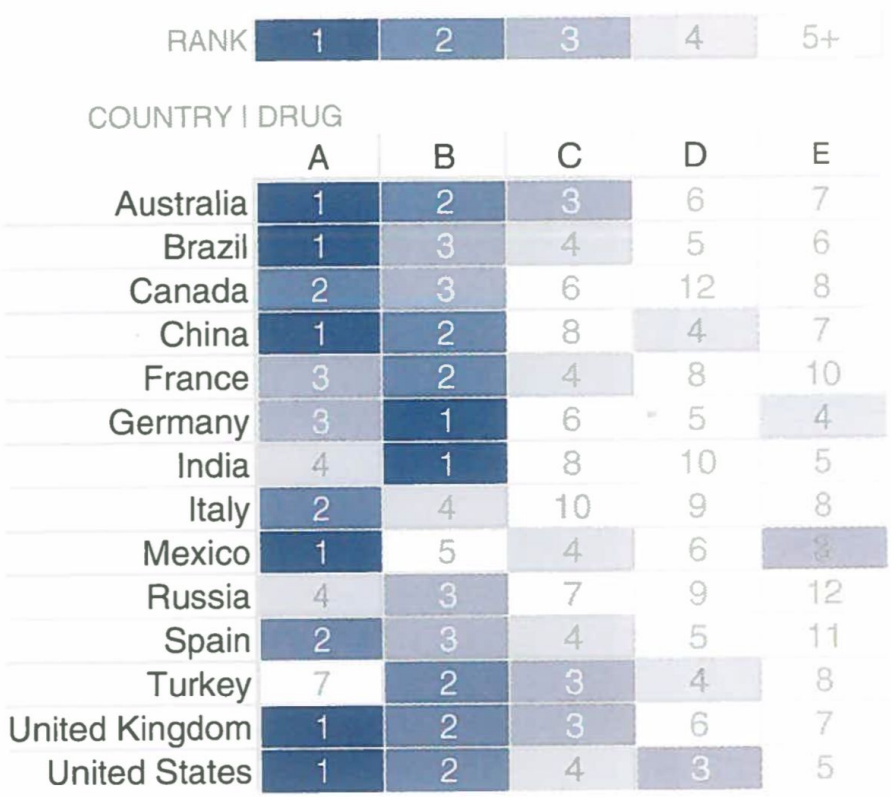
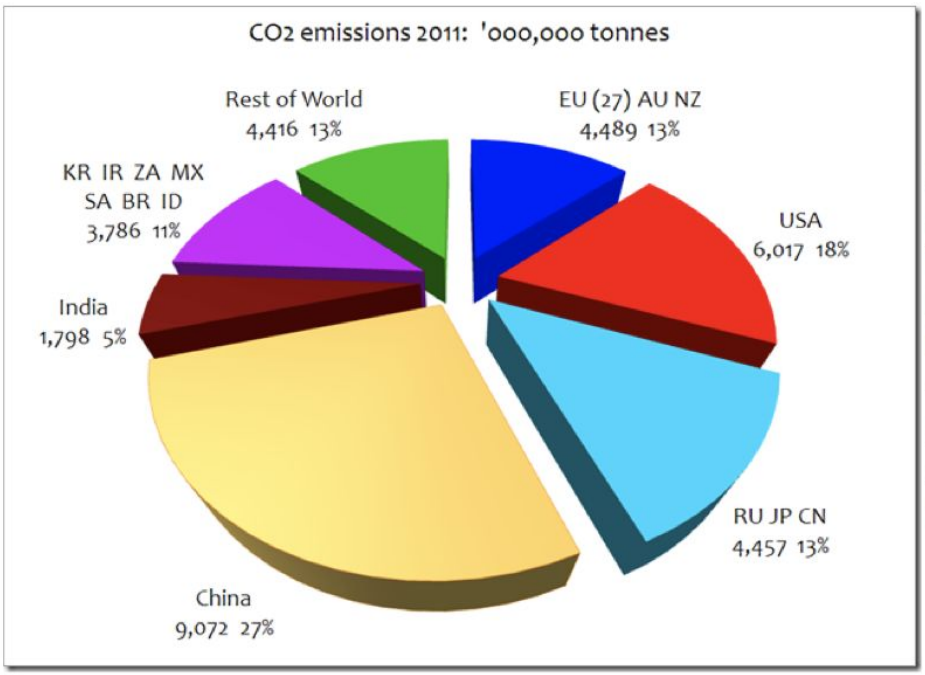
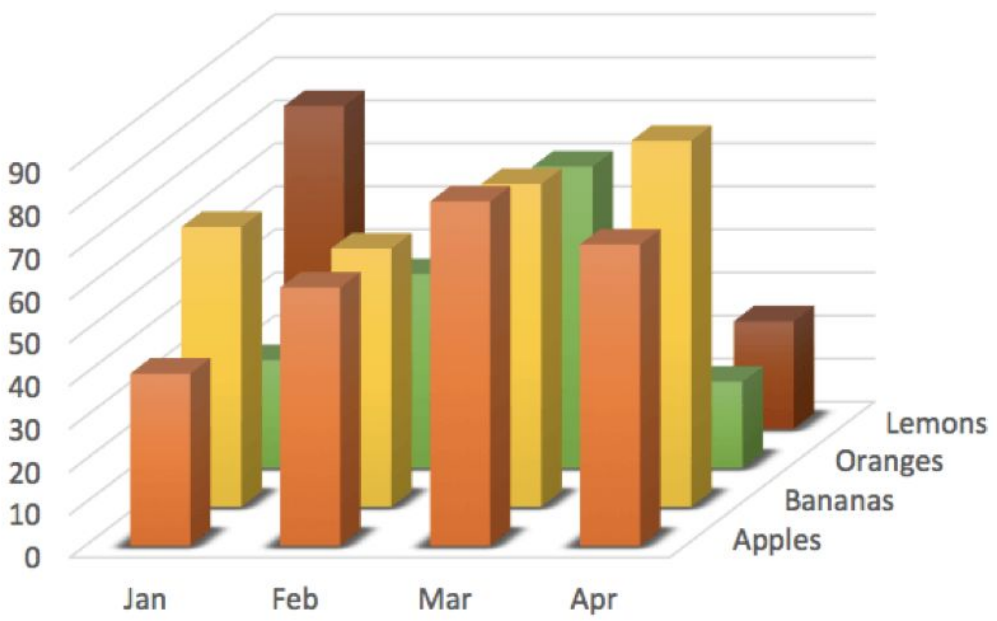
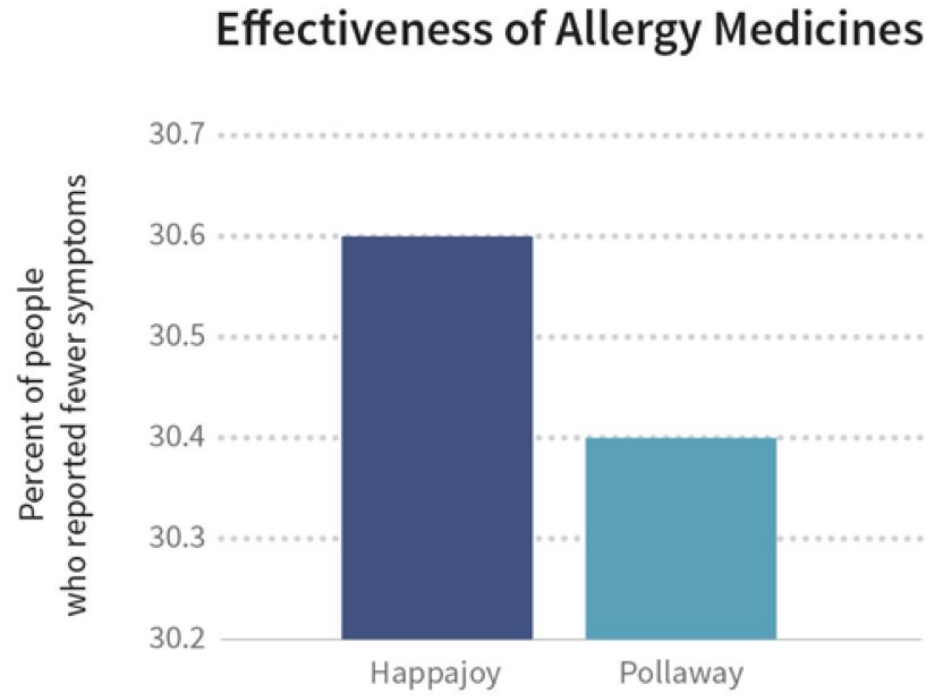


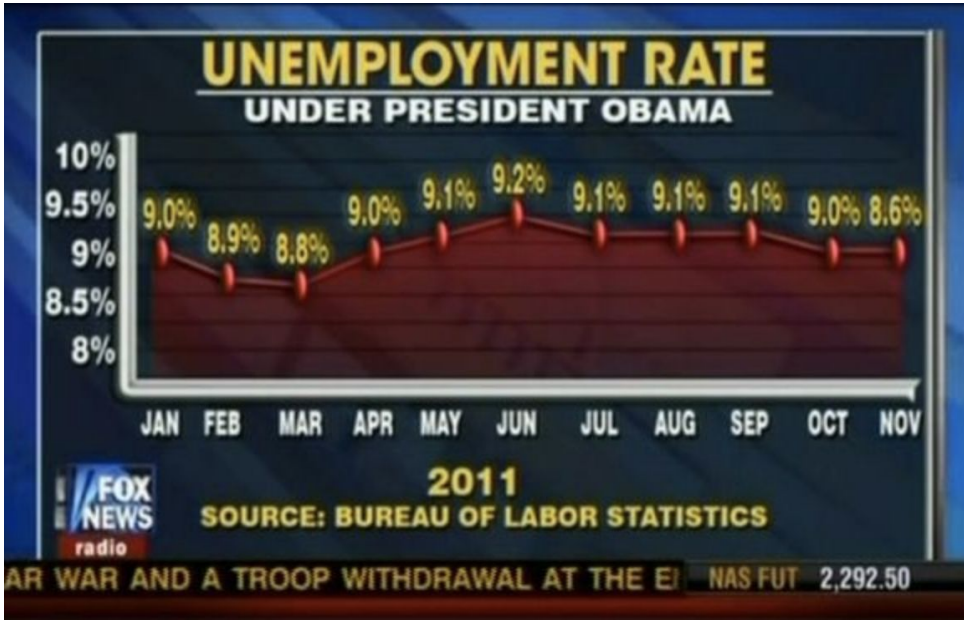
FIGURE 4.15 Use color sparingly

Deception


CO2 emissions 2011: '000,000 tonnes
Rest of World
4,416 13%
EU (27) AU NZ
4,489 13%
KR IR ZA MX
SA BR ID
3,786 11%
USA
6,017 18%
India
1,798 5%
RU JP CN
4,457 13%
China
9,072 27%


90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
Lemons
Oranges
Bananas
Apples

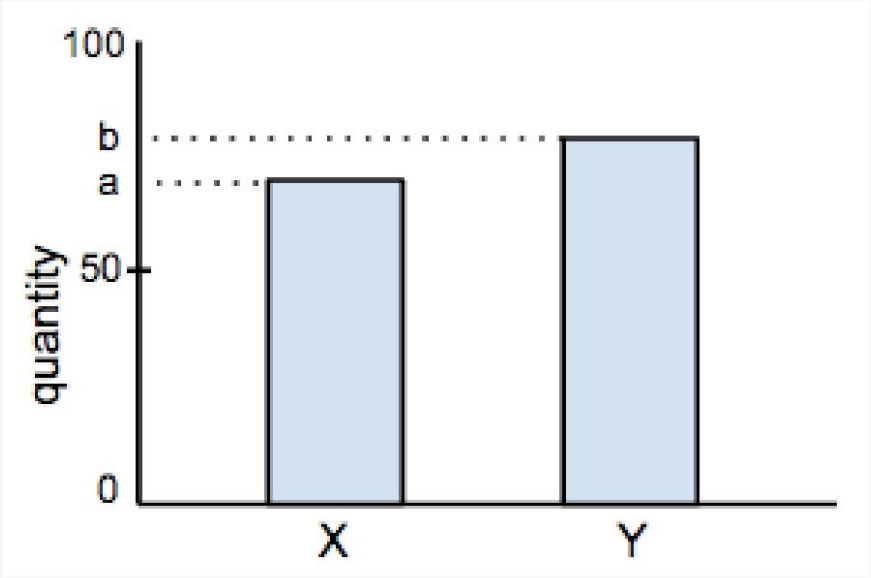

Effectiveness of Allergy Medicines
Percent of people who reported fewer symptoms
30.7
30.6
30.5
30.4
30.3
30.2
Happajoy
Pollaway


UNEMPLOYMENT RATE
UNDER PRESIDENT OBAMA
10%
9.5%
9%
8.5%
8%
9.0%
8.9%
8.8%
9.0%
9.1%
9.2%
9.1%
9.1%
9.1%
9.0%
8.6%
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV
2011
SOURCE: BUREAU OF LABOR STATISTICS
FOX NEWS radio
AR WAR AND A TROOP WITHDRAWAL AT THE E
NAS FUT 2,292.50

How [not] to lie with X

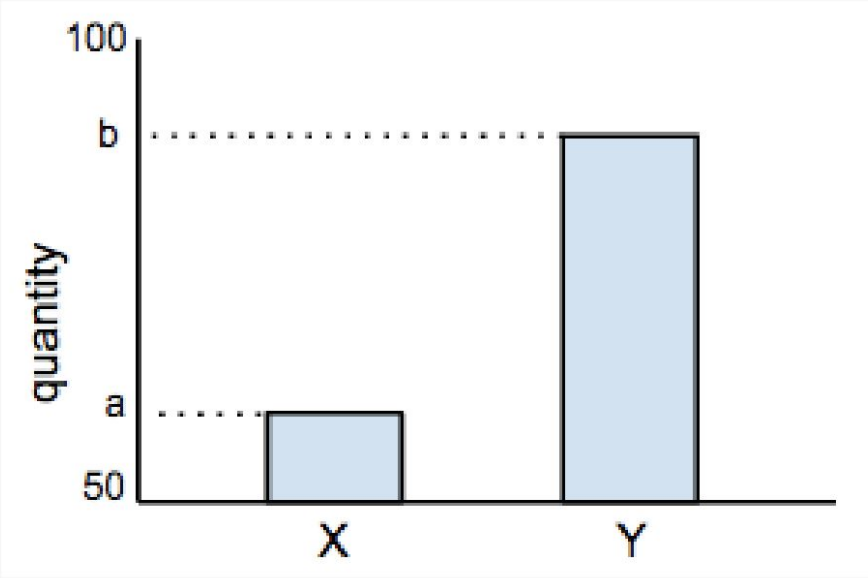
- Huff, D. (1993). ***How to lie with statistics***. WW Norton & Company.
- King, G. (1986). **How not to lie with statistics**: Avoiding common mistakes in quantitative political science. *American Journal of Political Science*, 666-687.
- Jones, G. E. (2011). ***How to lie with charts***. LaPuerta Books and Media.
- Monmonier, M. (2018). ***How to lie with maps***. University of Chicago Press.
- Rogowitz, B. E., Treinish, L. A., & Bryson, S. (1996). **How not to lie with visualization**. *Computers in Physics*, *10*(3), 268-273.
- Pandey, A. V., Rall, K., Satterthwaite, M. L., Nov, O., & Bertini, E. (2015, April). **How deceptive are deceptive visualizations?**: An empirical analysis of common distortion techniques. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (pp. 1469-1478). ACM.

Trunkated Axes



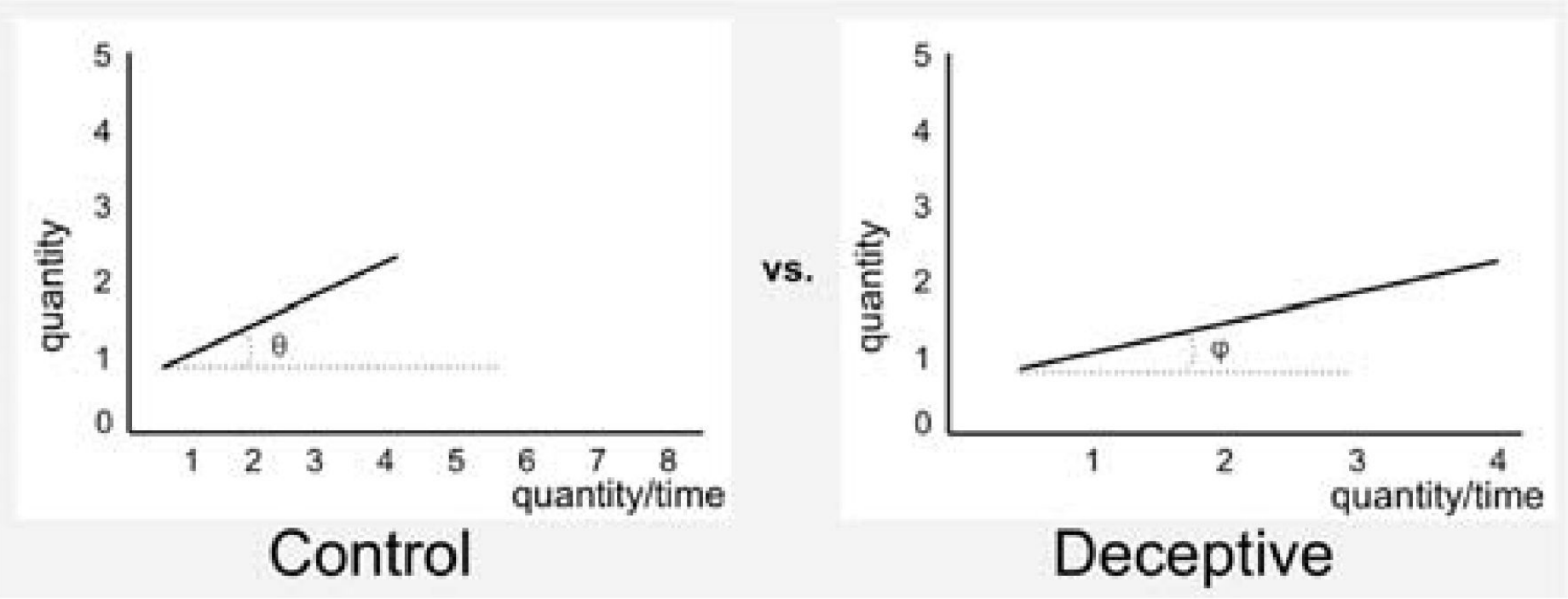
Control

vs.

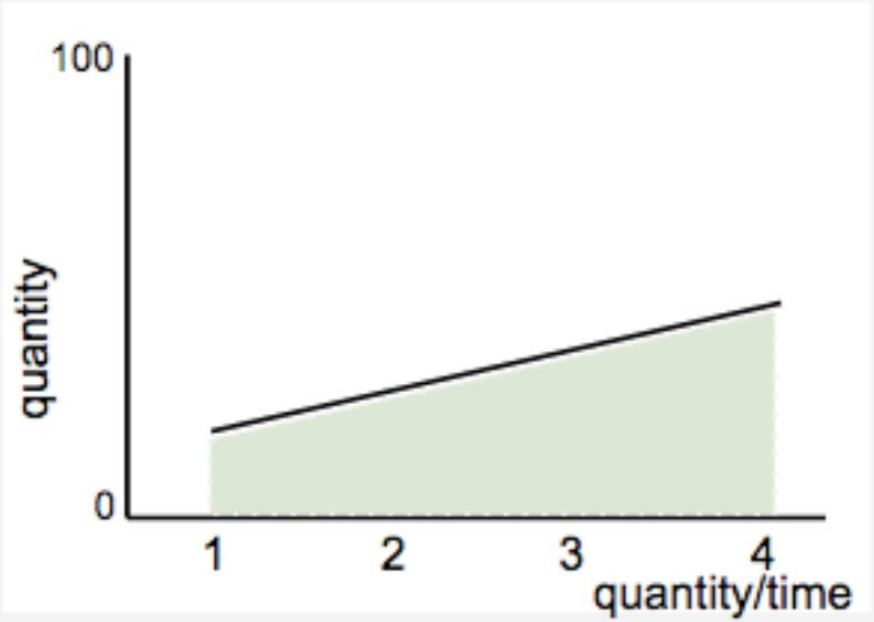


Deceptive

Slopes 45%

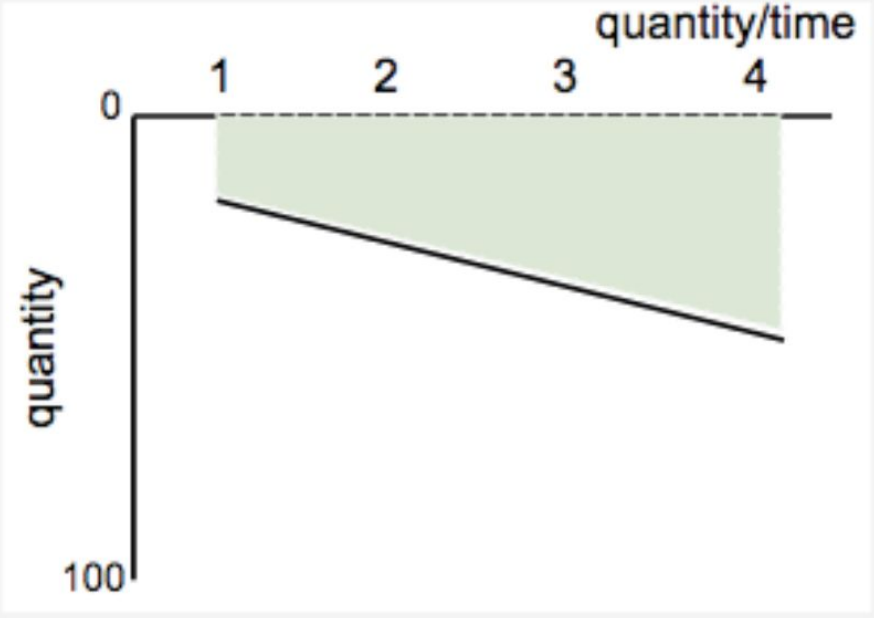

5
4
3
2
1
0
quantity
θ
1 2 3 4 5 6 7 8
quantity/time
Control
vs.
5
4
3
2
1
0
quantity
φ
1 2 3 4
quantity/time
Deceptive

Inverse charts



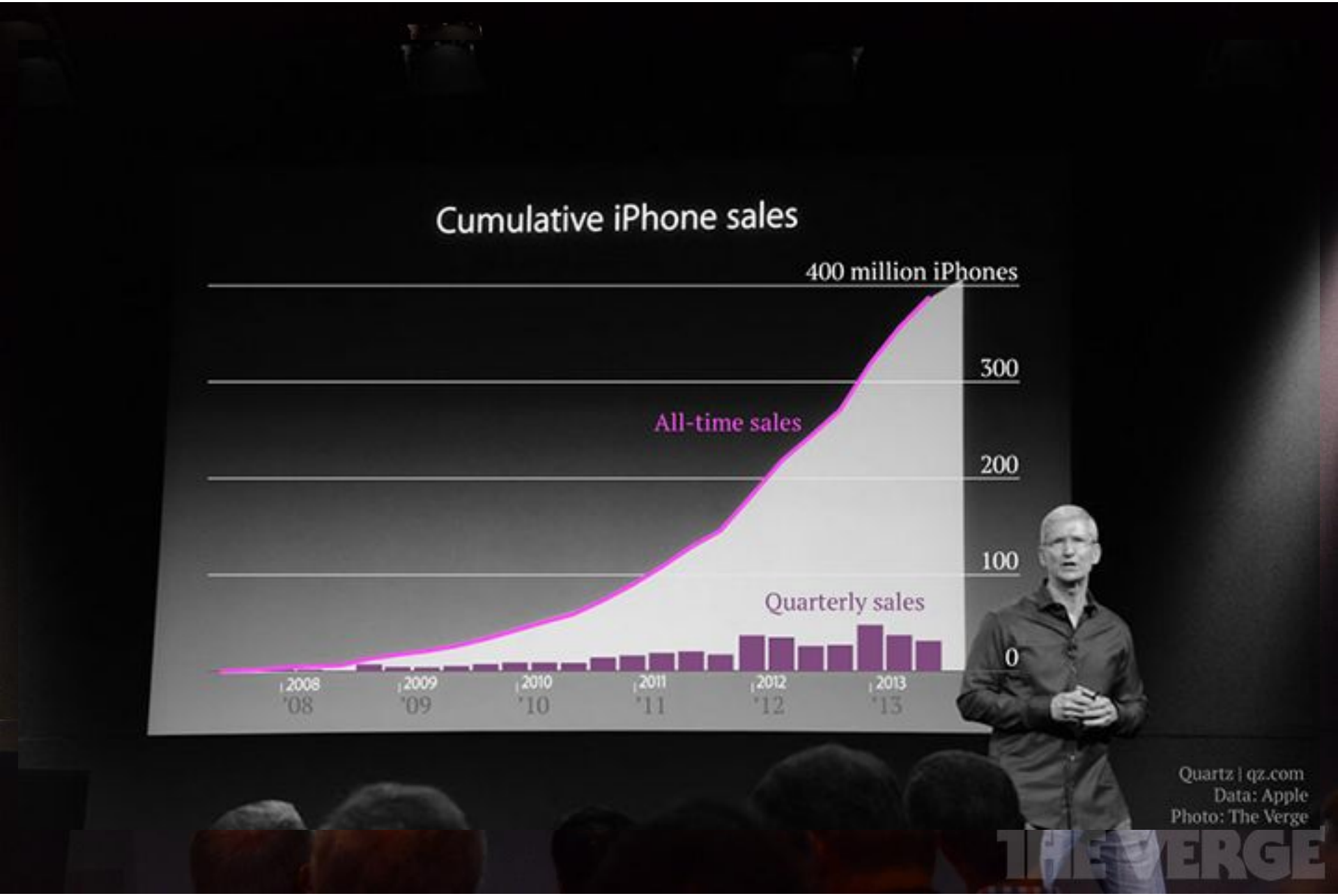
Control

vs.

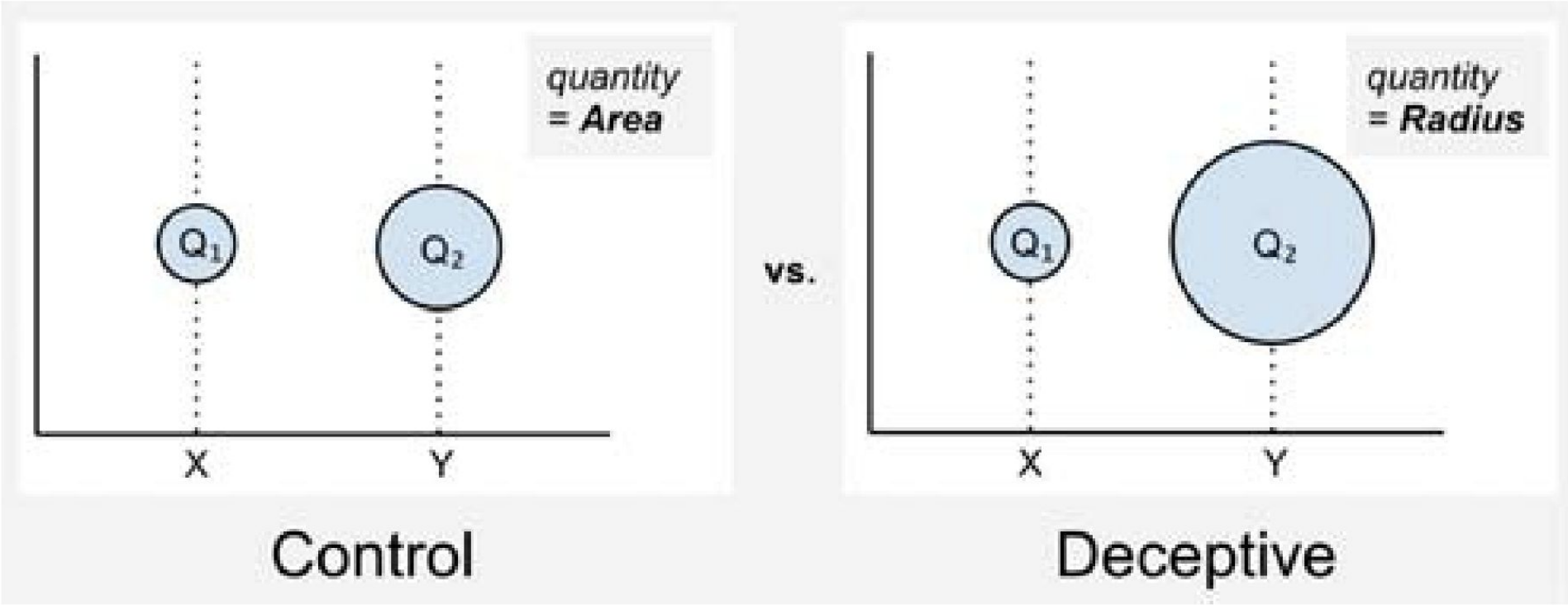


Deceptive

Cumulative iPhone sales
2008
2009
2010
2011
2012
2013
THE VERGE


Cumulative iPhone sales
400 million iPhones
300
200
100
0
All-time sales
Quarterly sales
2008
'08
2009
'09
2010
'10
2011
'11
2012
'12
2013
'13
Quartz | qz.com
Data: Apple
Photo: The Verge
THE VERGE

Wrong sizes


quantity
= Area
Q1
Q2
X
Y
vs.
quantity
= Radius
Q1
Q2
X
Y
Control
Deceptive

User study Results

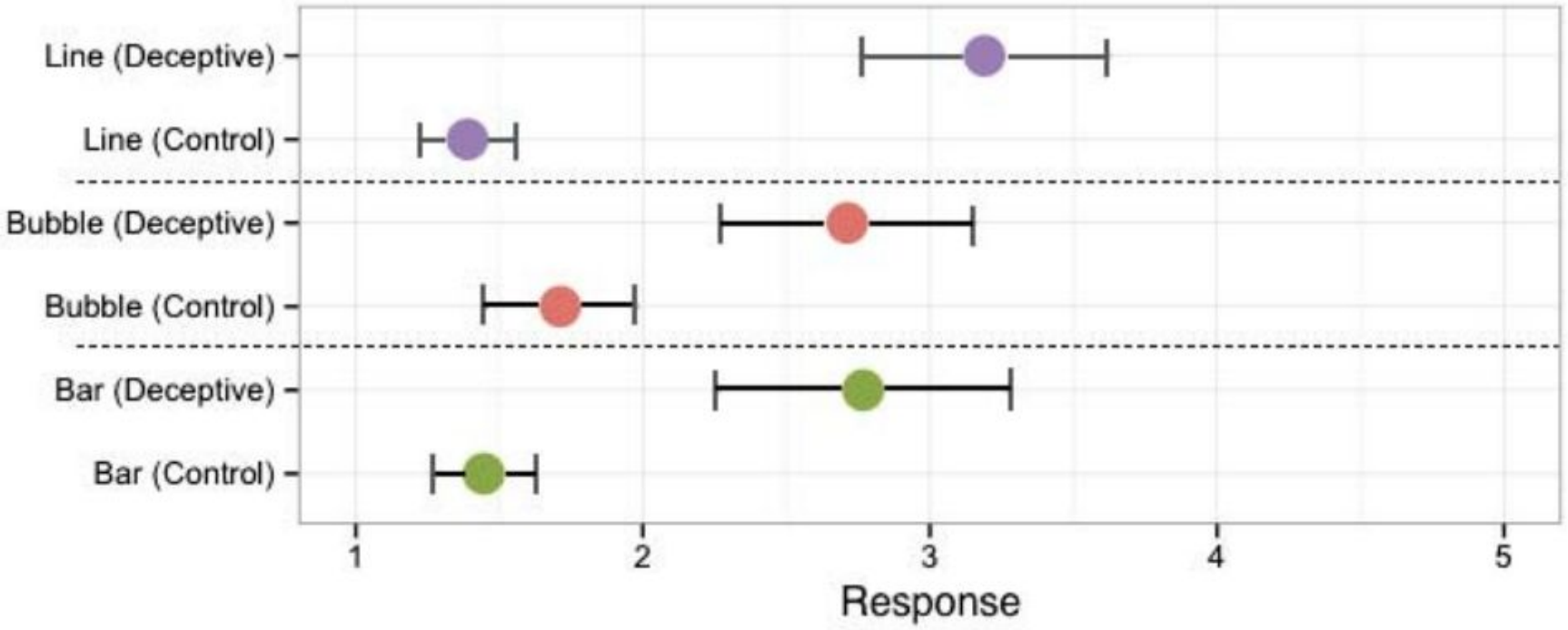


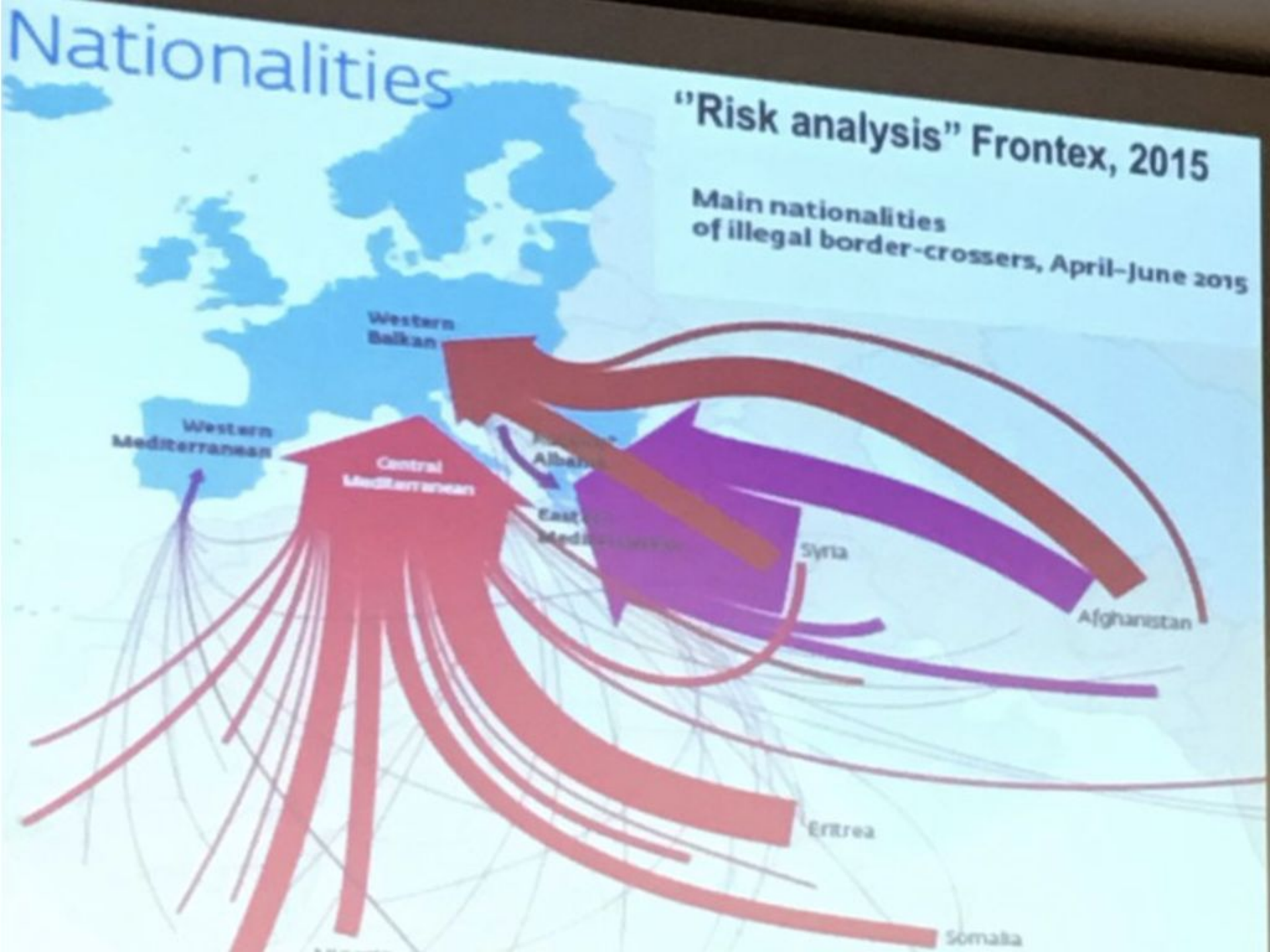
Figure 8. Average participant response with 95% confidence interval, when exposed to a treatment.

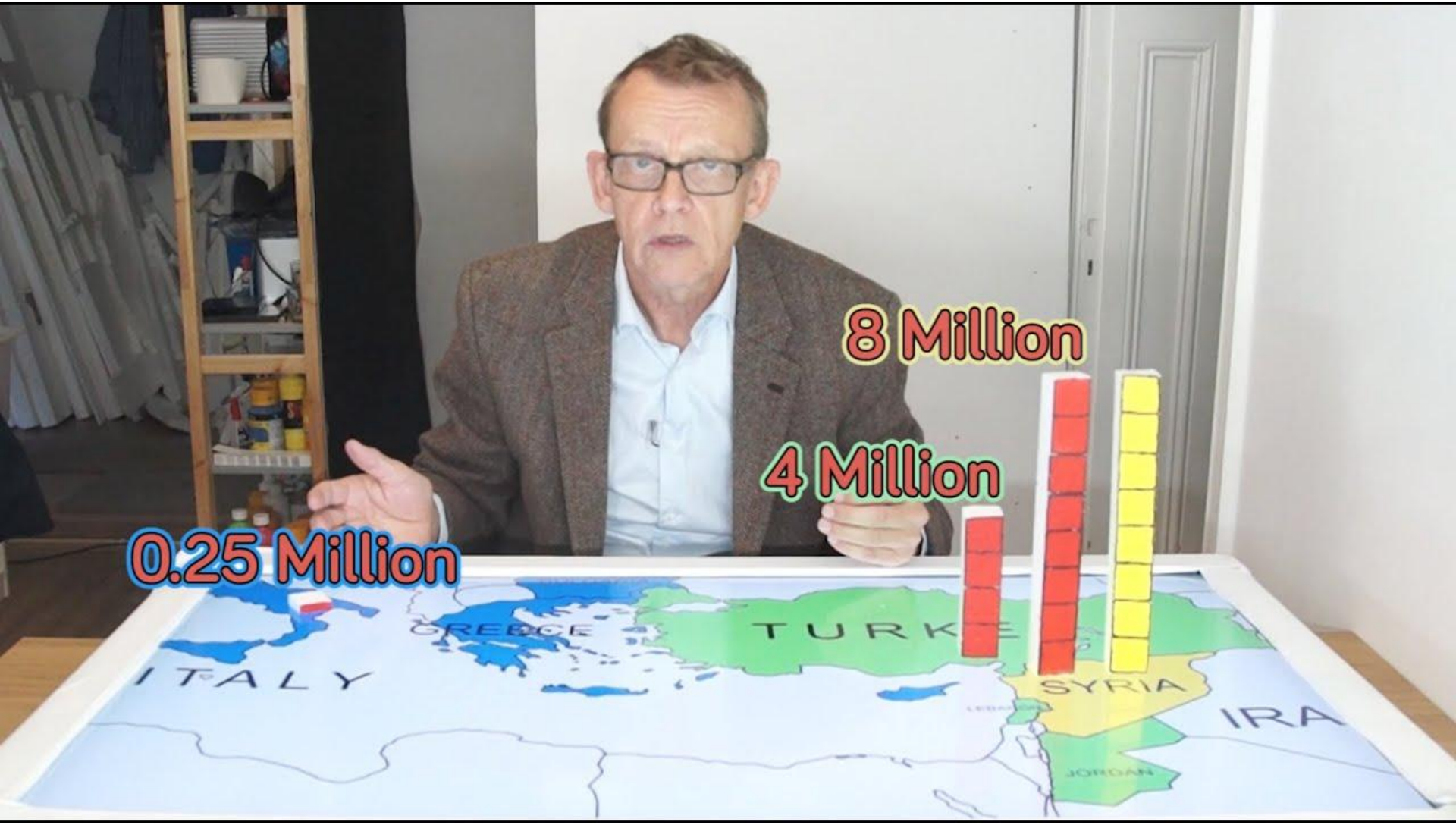
Common flaws (from 8 graphics only..)

1. Missing **scales**
2. **3D** distortion
3. **3D** occlusion
4. Missing **color** contrast
5. **Colors** are too similar
6. Not B/W safe
7. overuse of **texture**
8. **Volume** as visual variable
9. Un-proportional **mappings**
10. Truncated **axes**
11. Missing **titles**
12. Missing axis **labels**
13. Unnecessary shapes/**ink**
14. Incomplete **data**

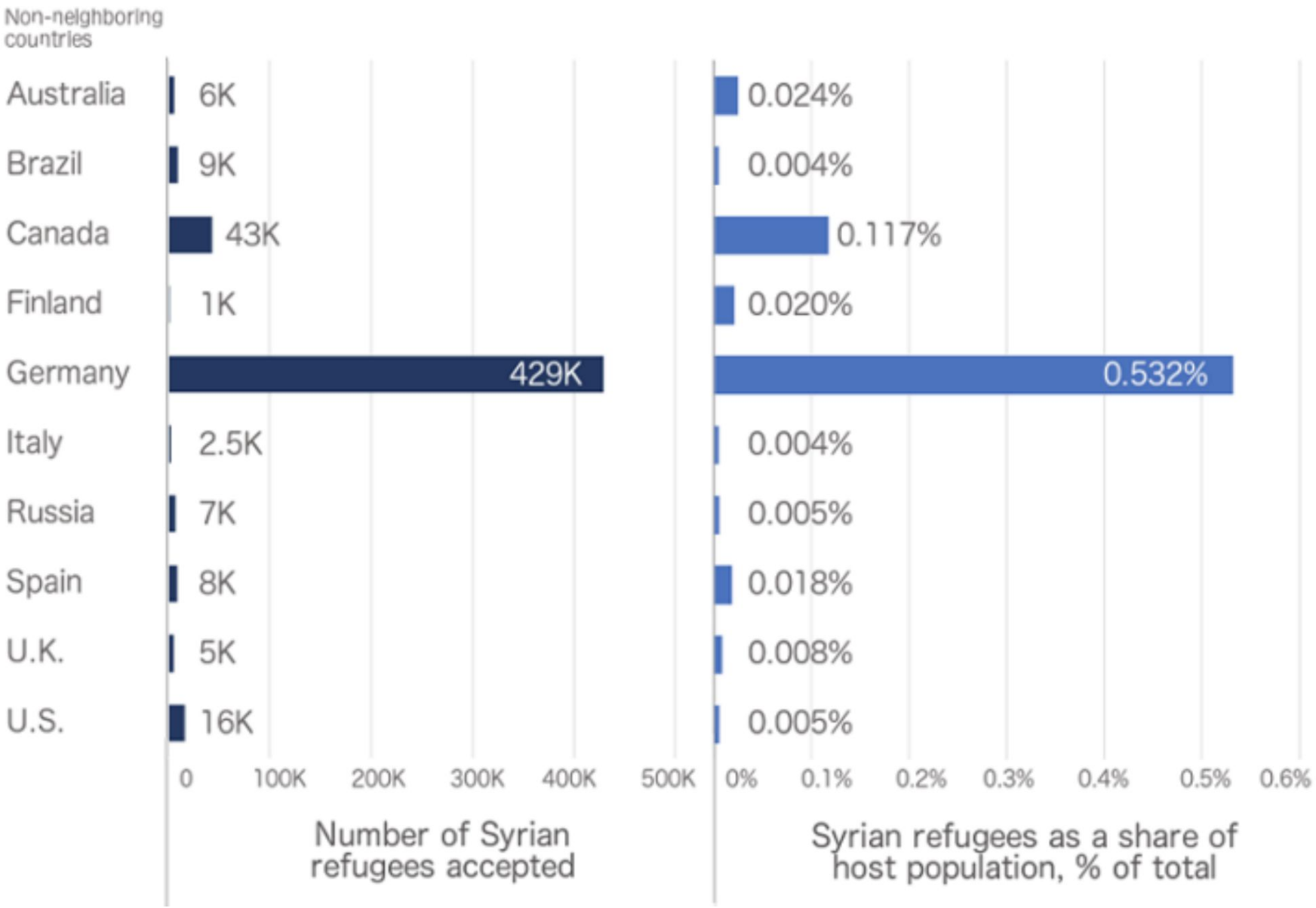
1. Wrong **legends**
2. Bad visual **mappings**
3. **Uncommon** / unknown design choices
4. Too much **clutter**
5. **Misplaced** data points
6. Long lines, which are hard to follow
7. Missing **legends**
8. **Too much** information in one graphic
9. **Missing** descriptions
10. **Overlapping** graphical elements
11. **Too many** charts in one

Nationalities

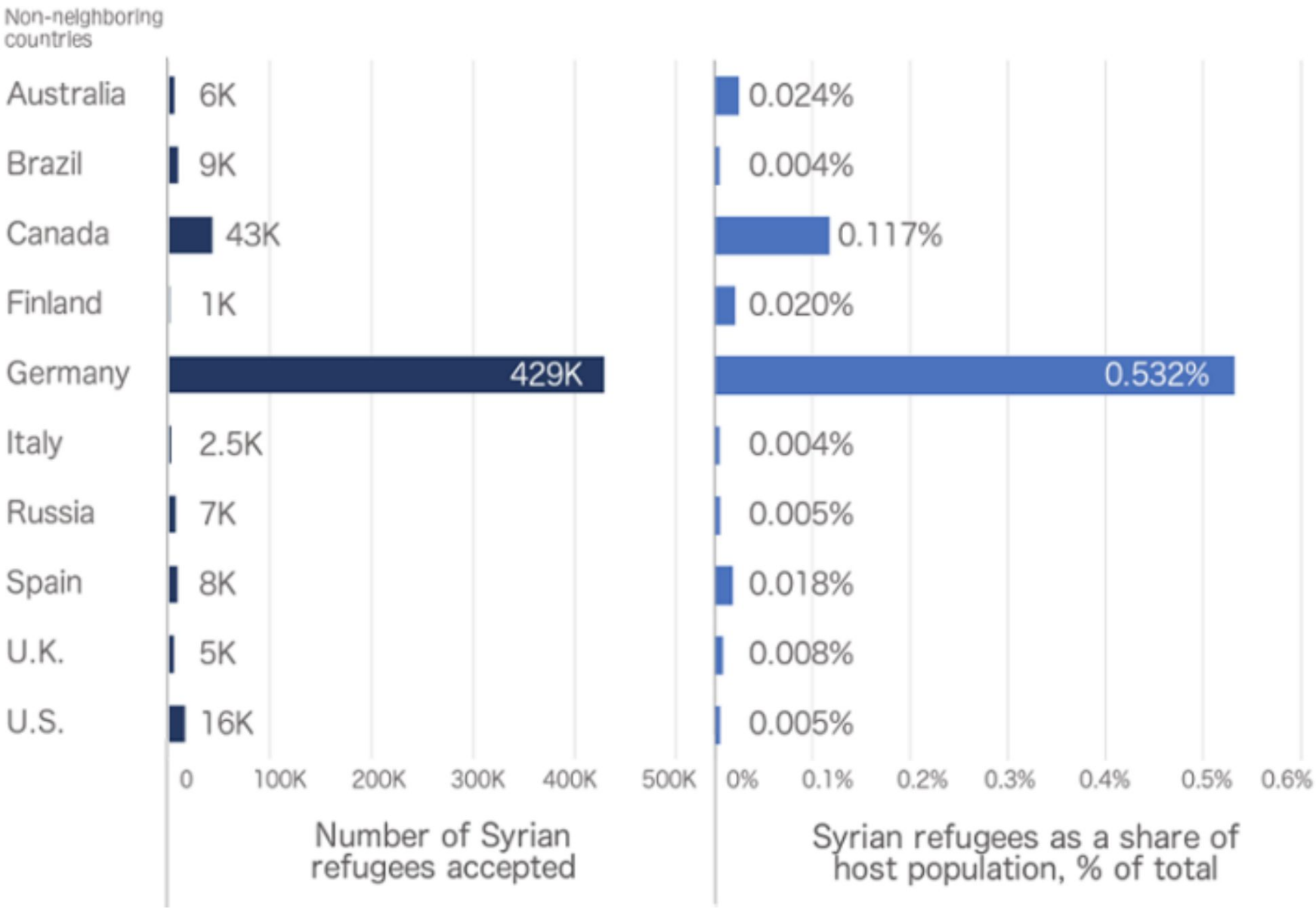



8 Million
4 Million
0.25 Million
ITALY
SYRIA
IRA

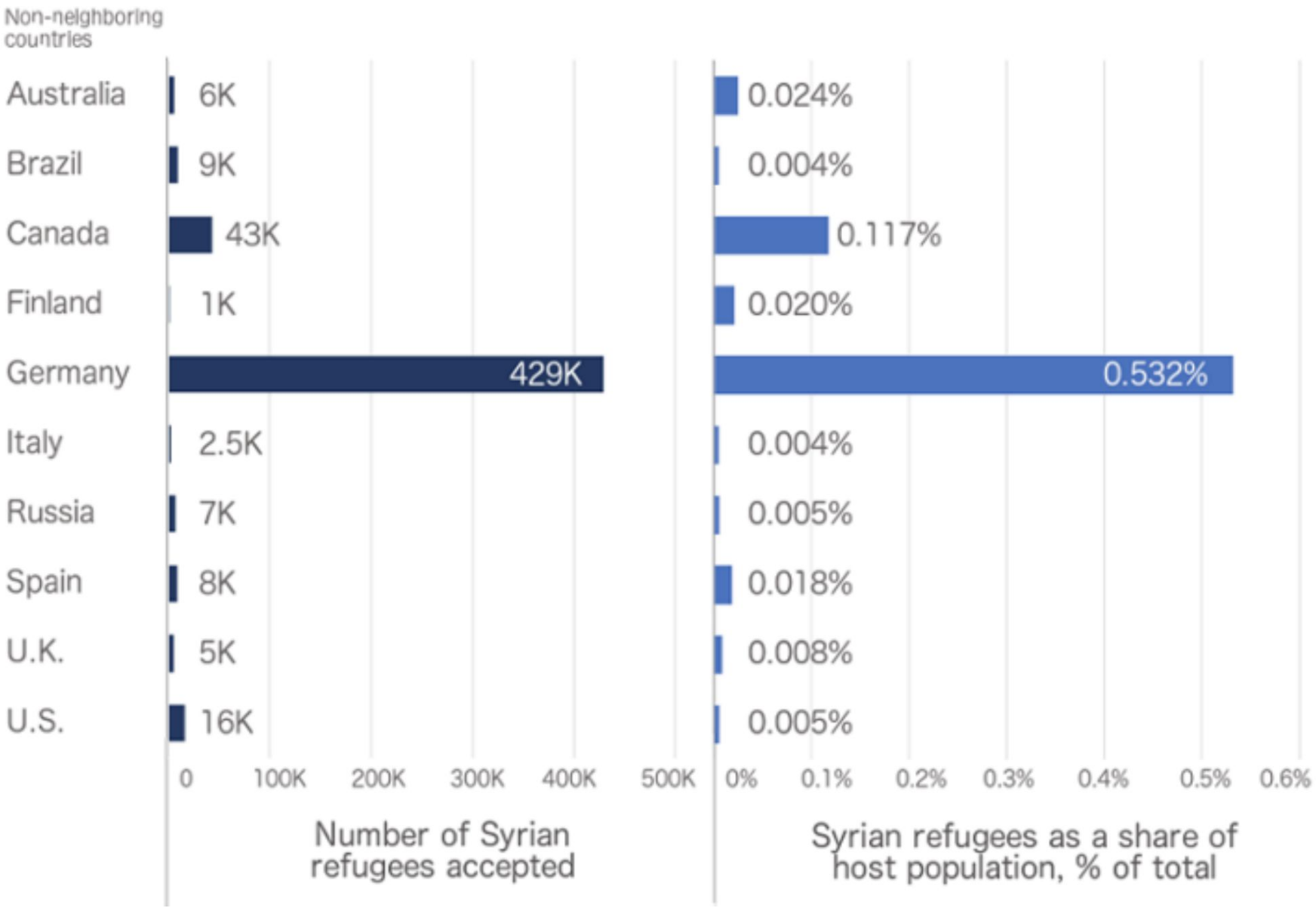
Letting in Potential Killers?



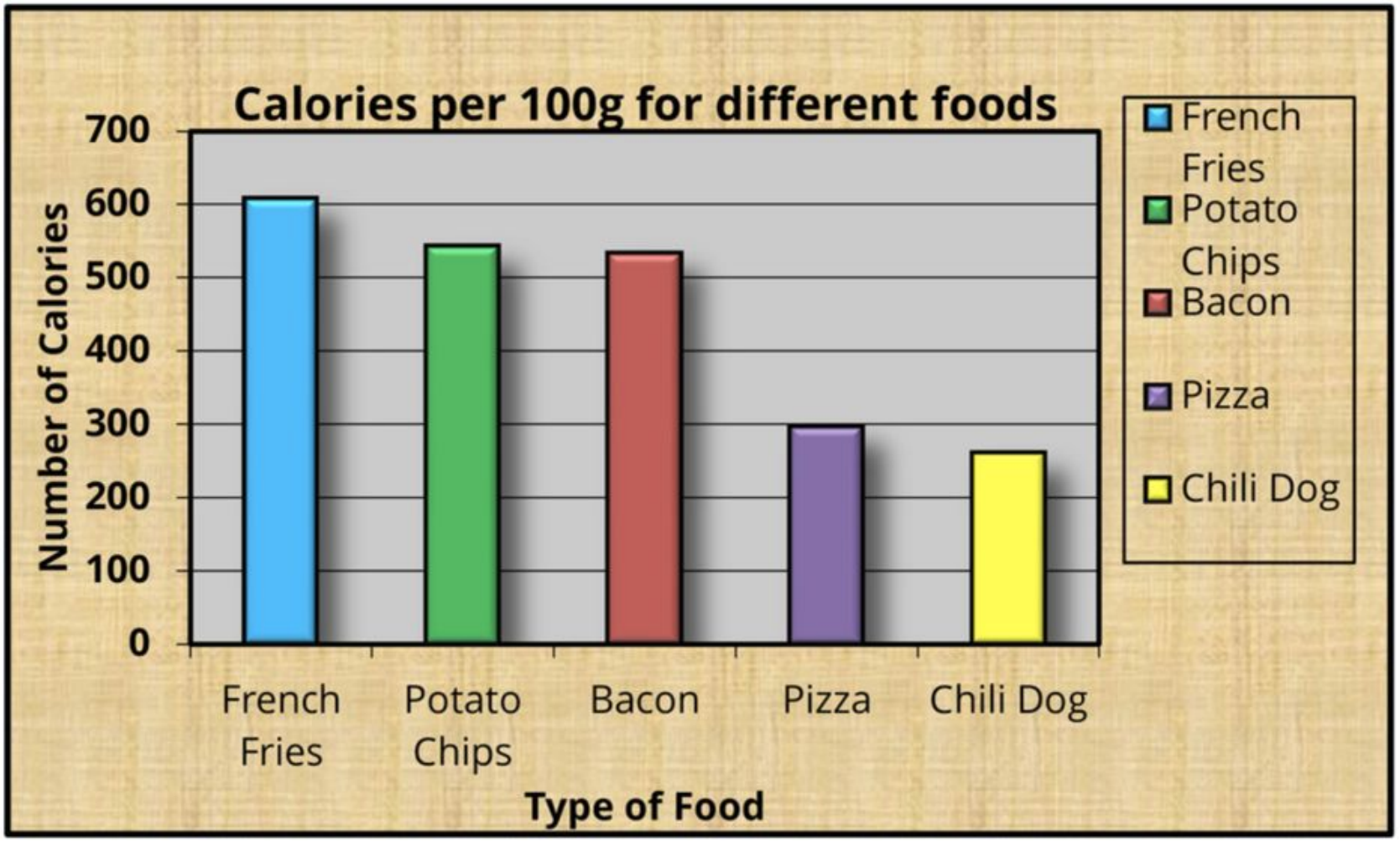
We must do our share!



Syrian Refugee Distribution:

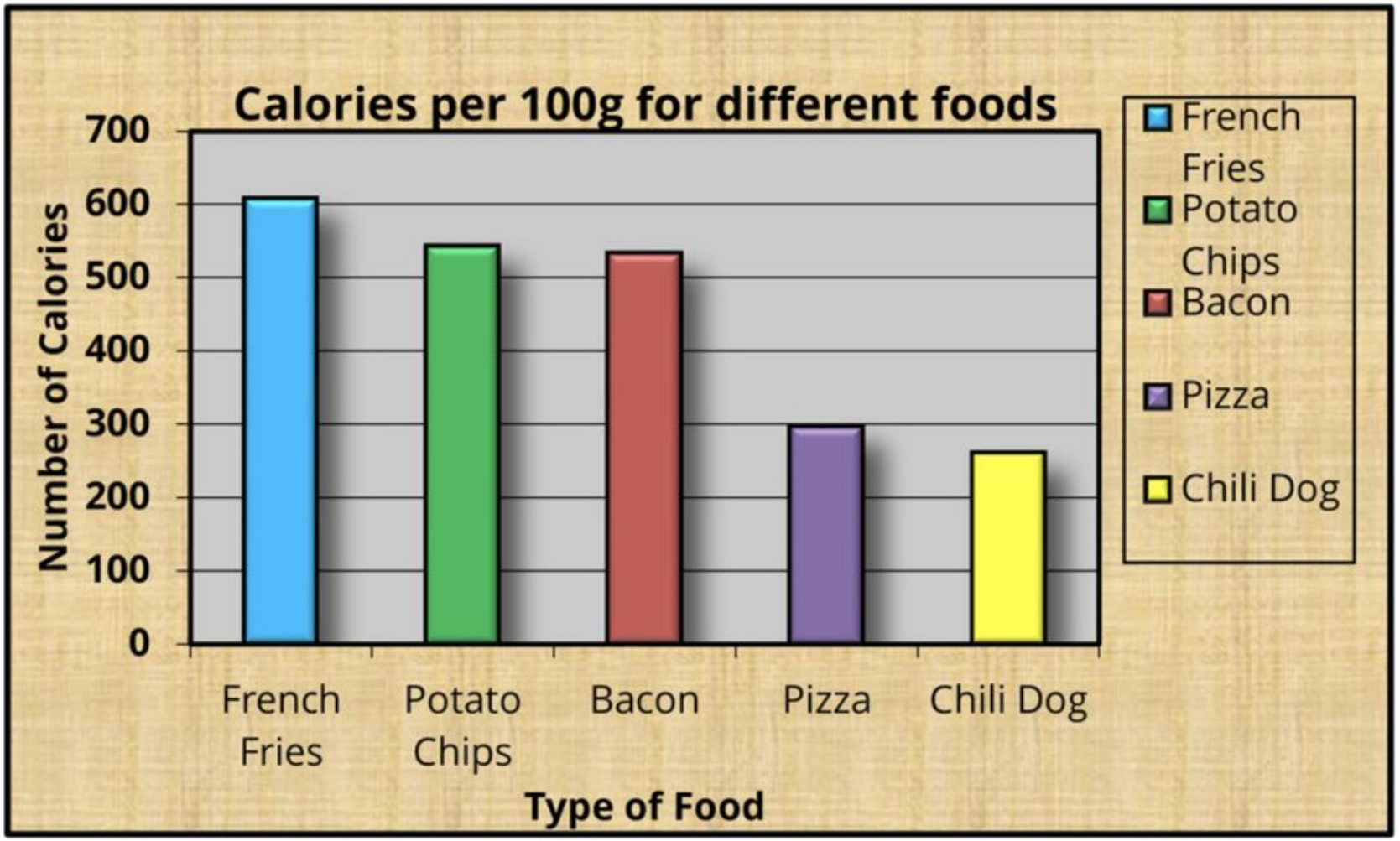


Clarity

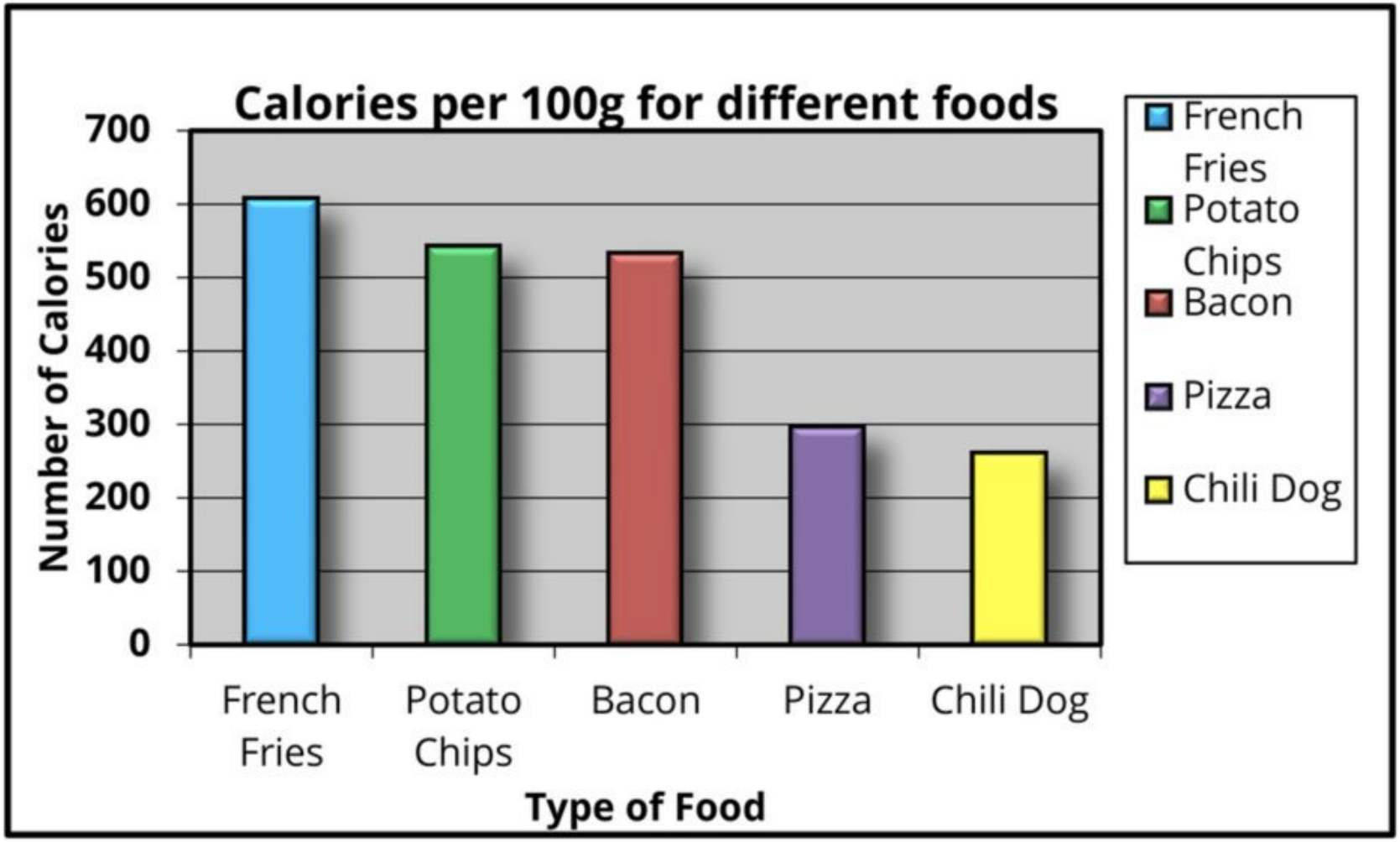

Calories per 100g for different foods
Number of Calories
700
600
500
400
300
200
100
0
French Fries
Potato Chips
Bacon
Pizza
Chili Dog
Type of Food
French Fries
Potato Chips
Bacon
Pizza
Chili Dog

$$\text{Data-Ink Ratio} = \frac{\text{Data-Ink}}{\text{Total Ink used to represent the graphic}}$$

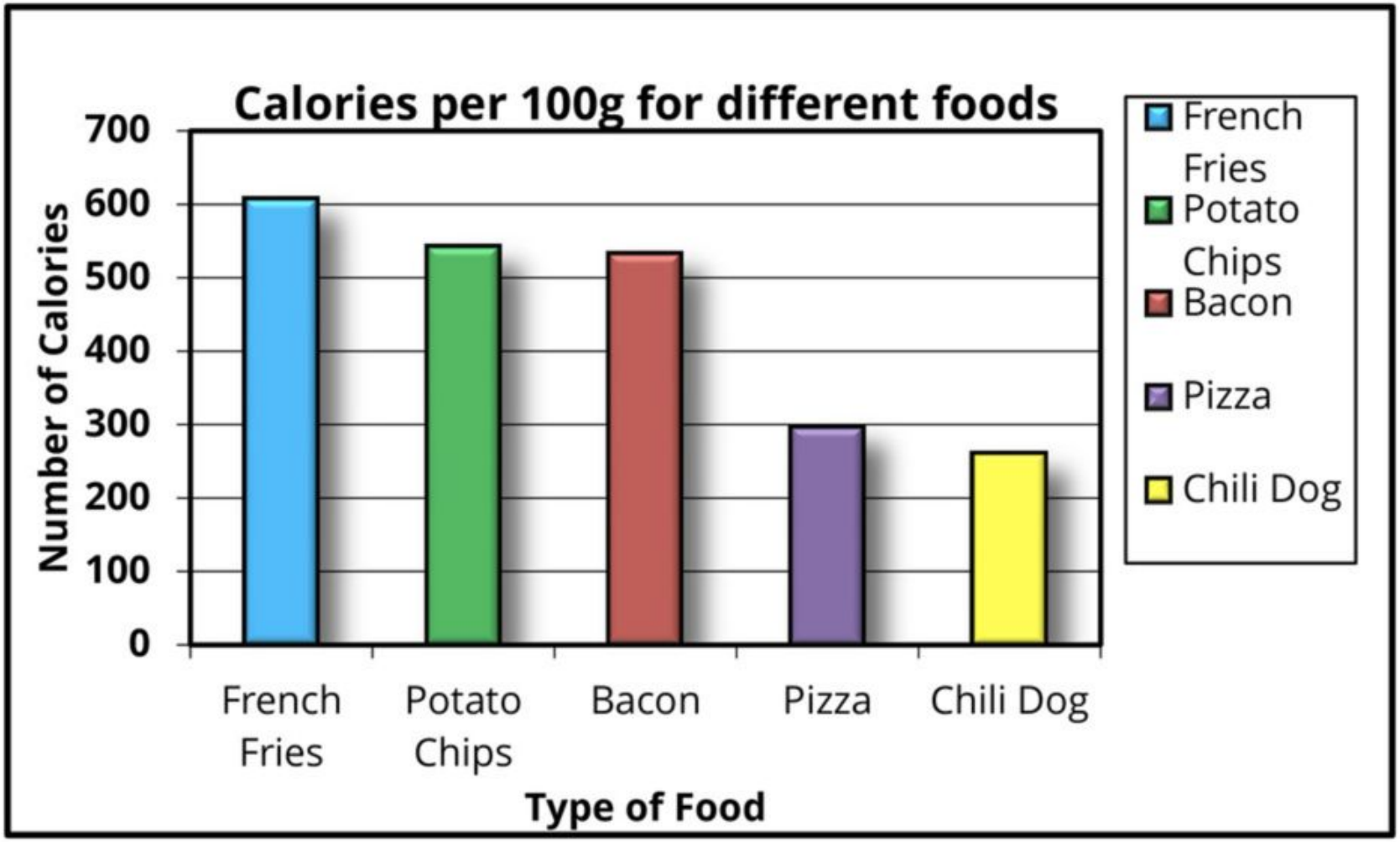
Remove backgrounds



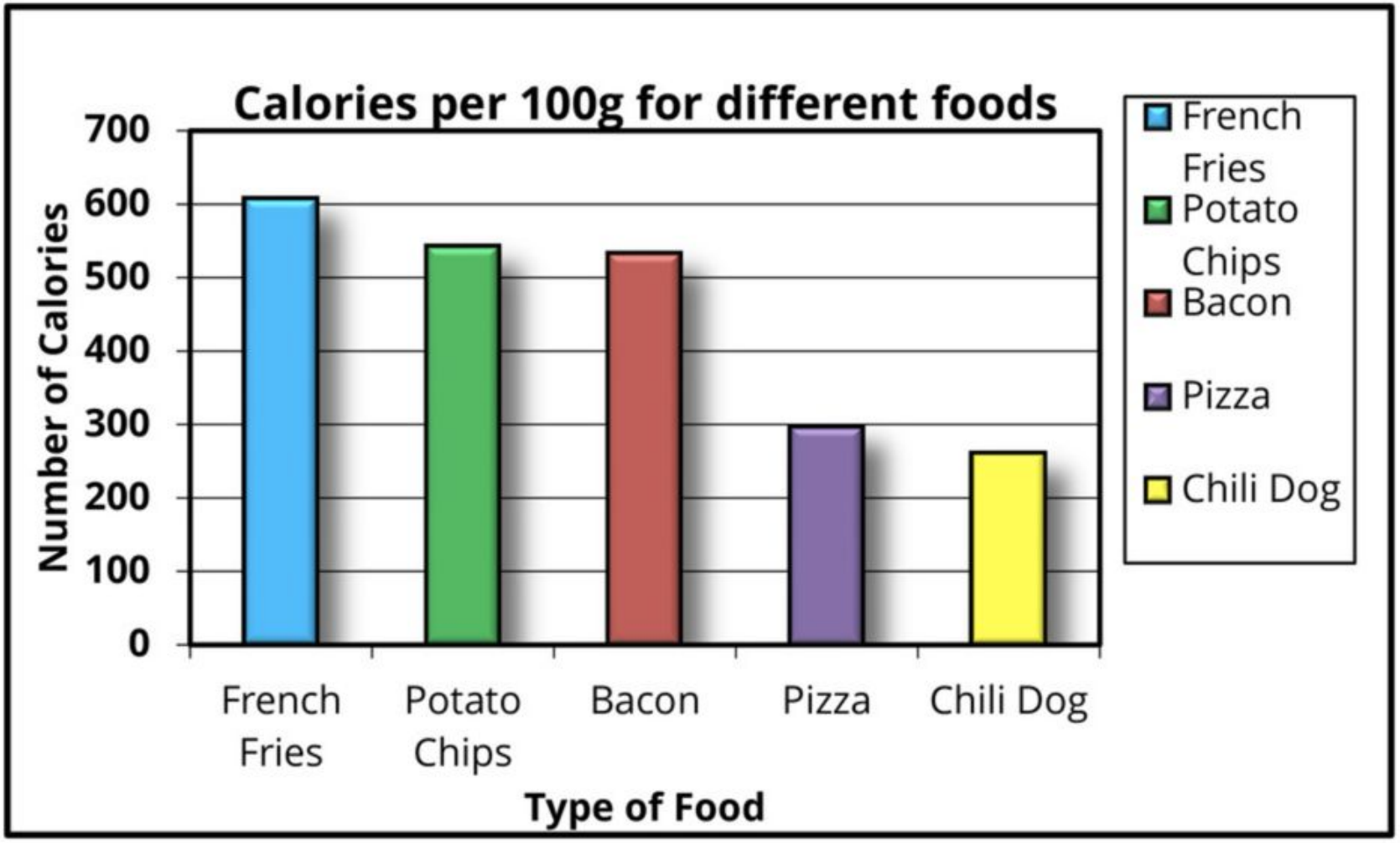
Remove backgrounds



Remove backgrounds



Remove redundant labels



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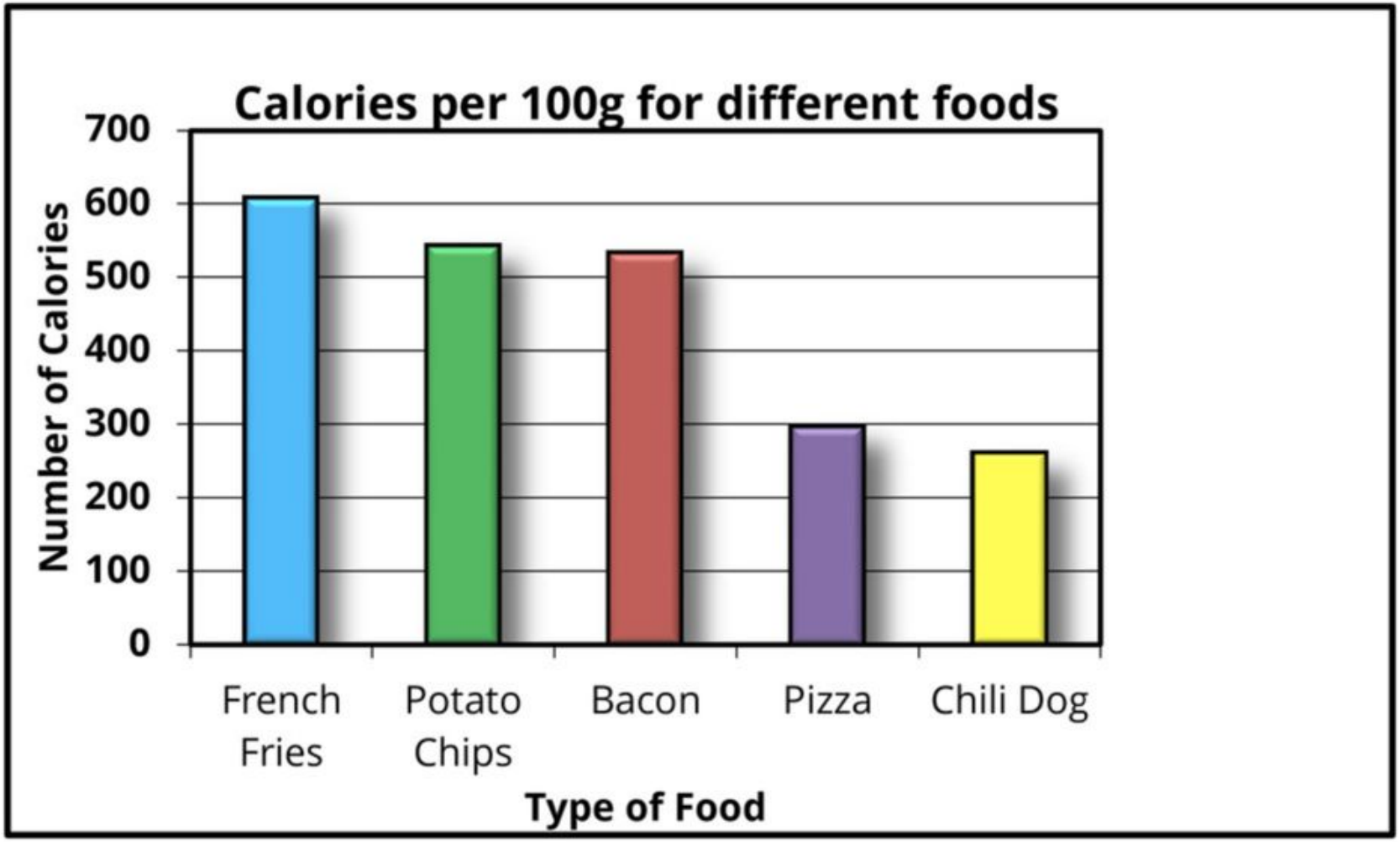
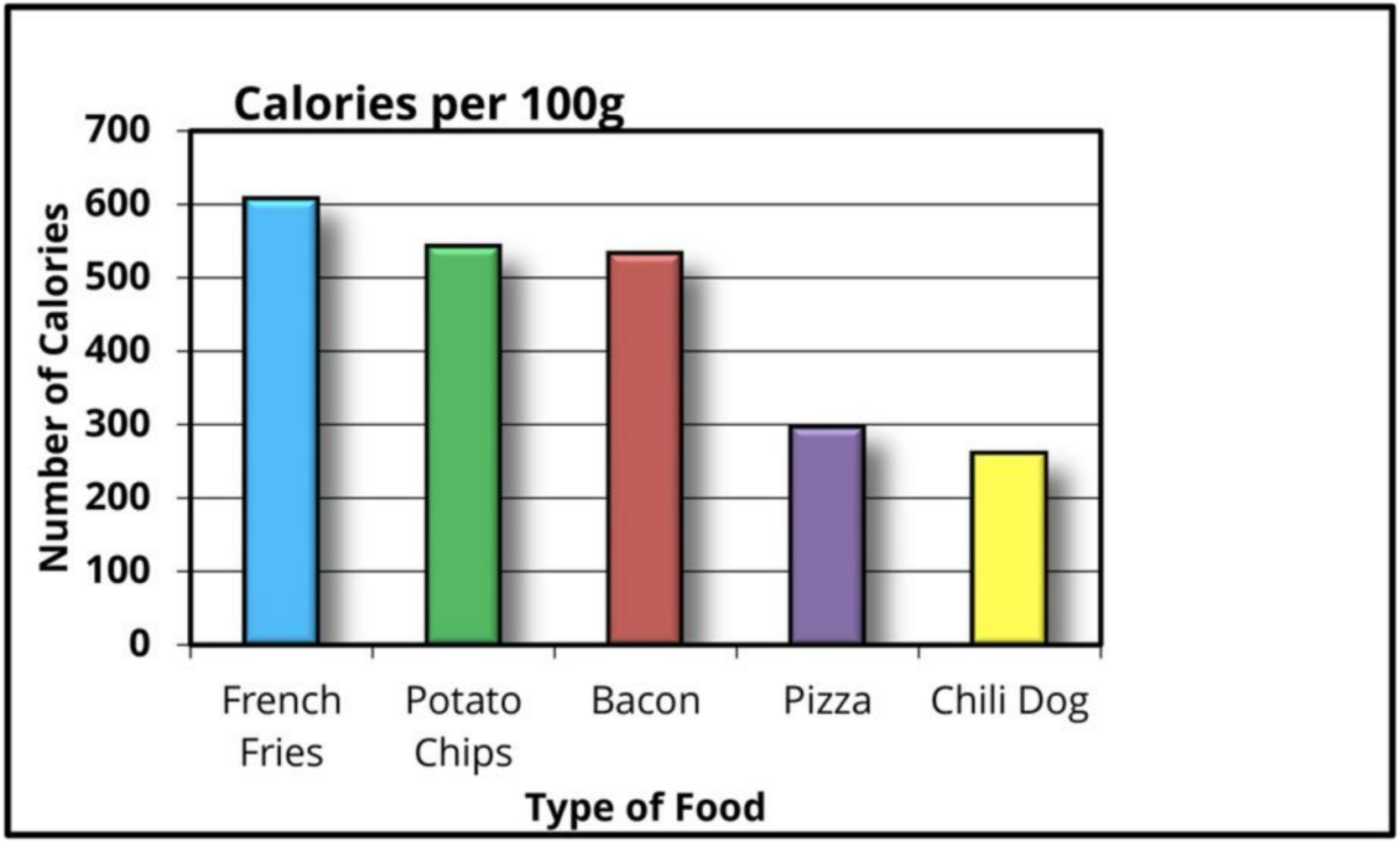
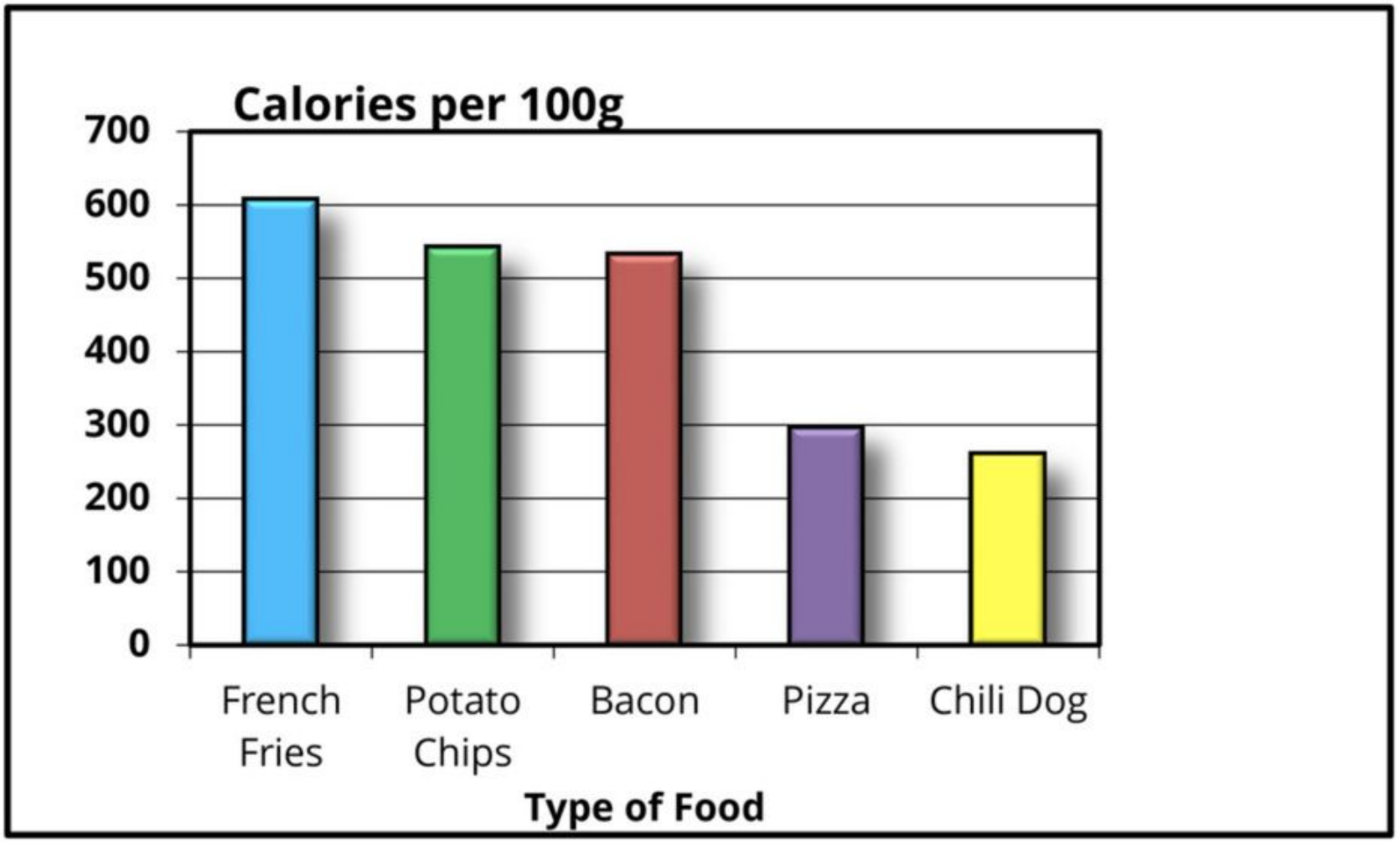


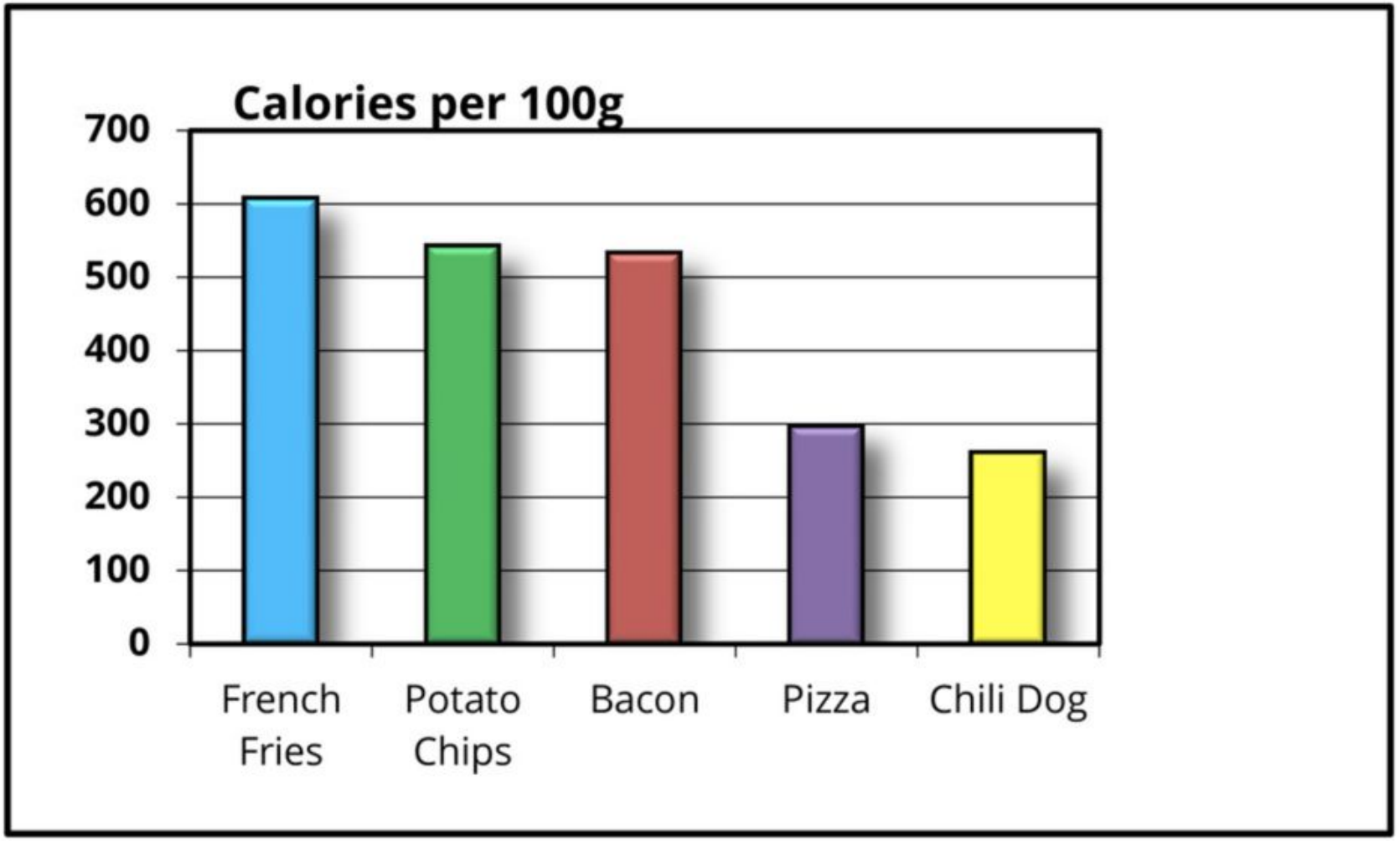
Remove redundant labels



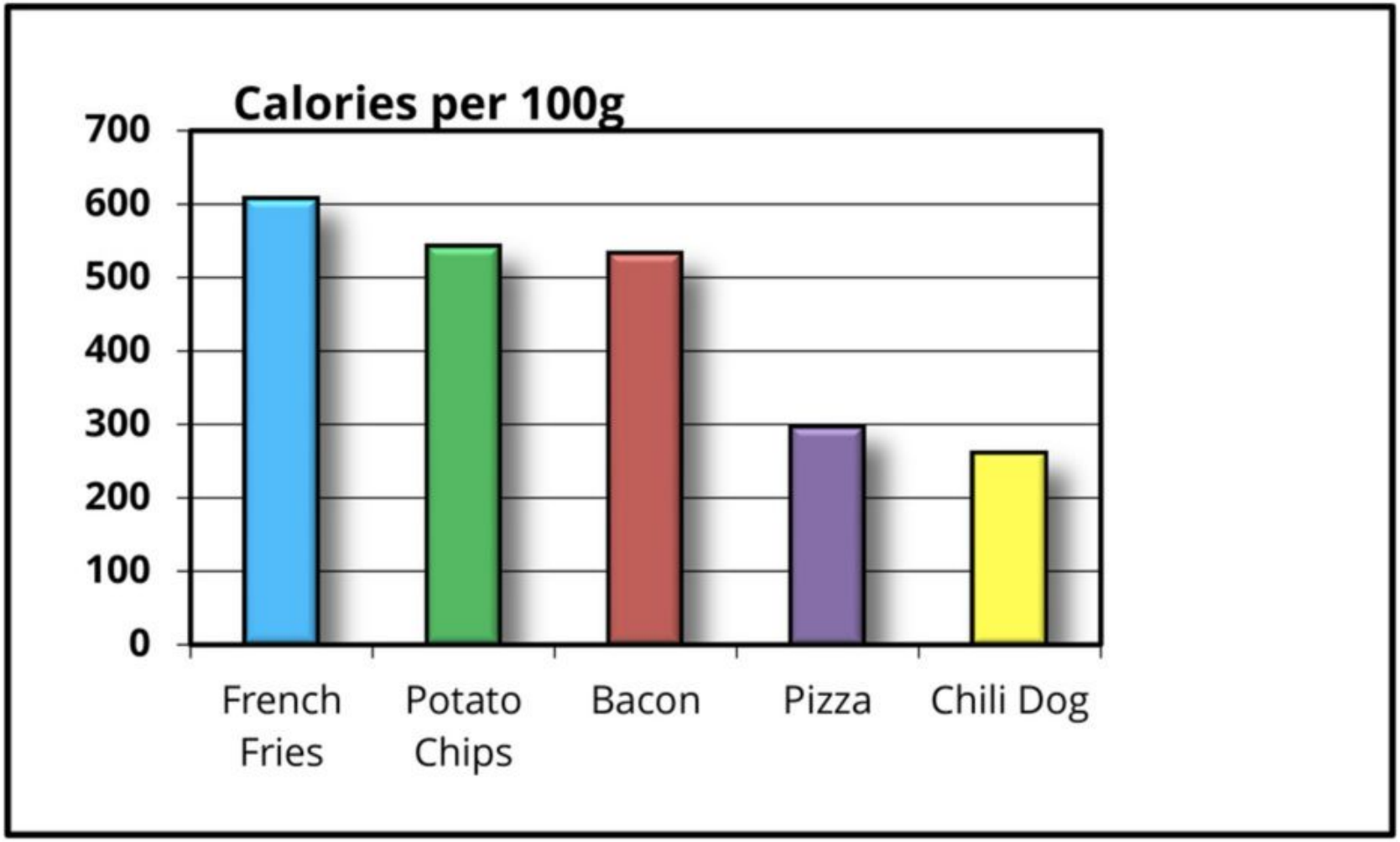
Remove redundant labels



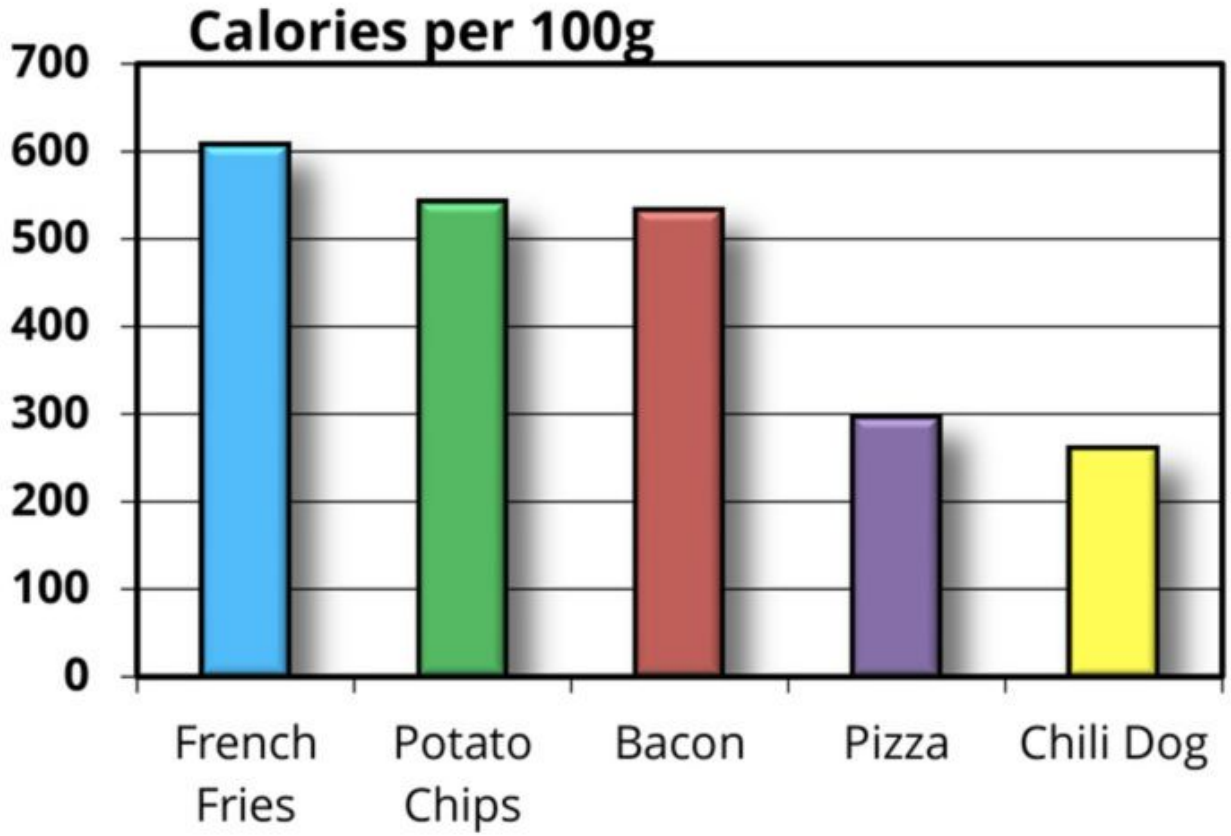
Remove redundant labels



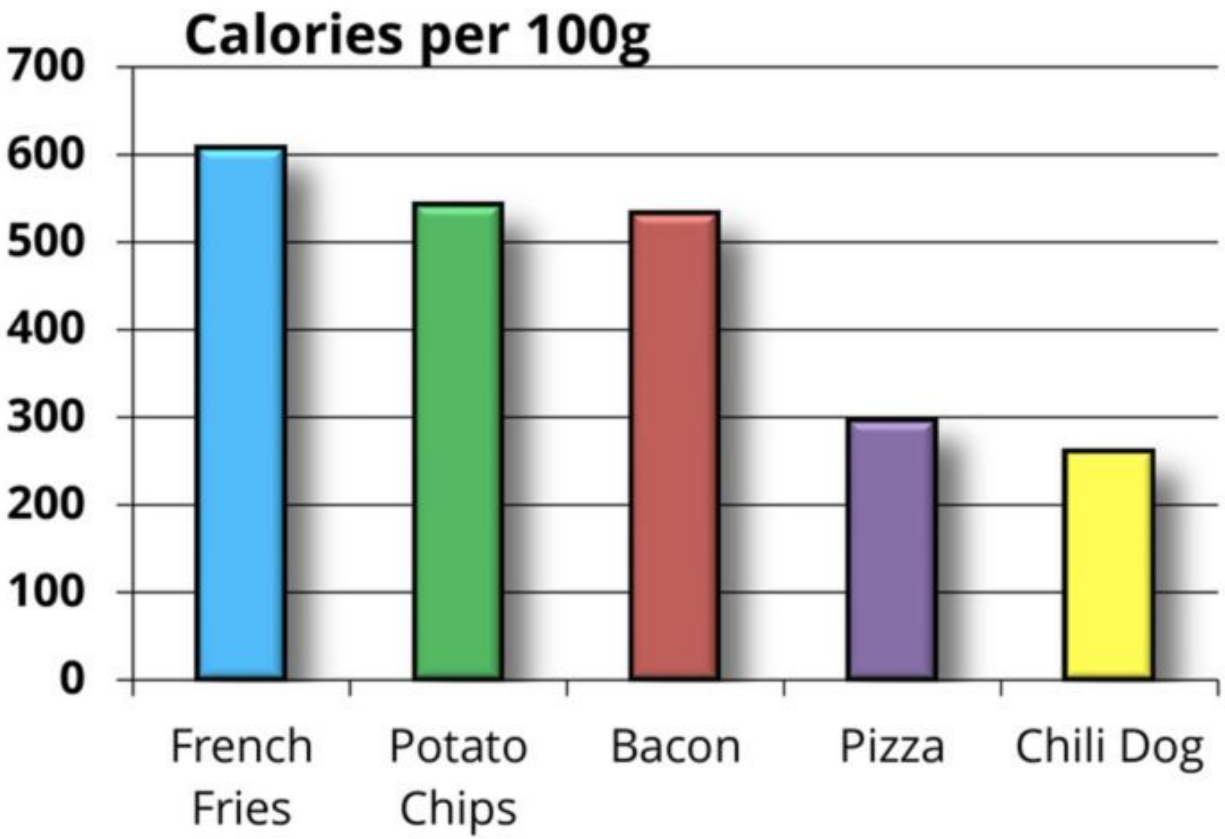
Remove borders



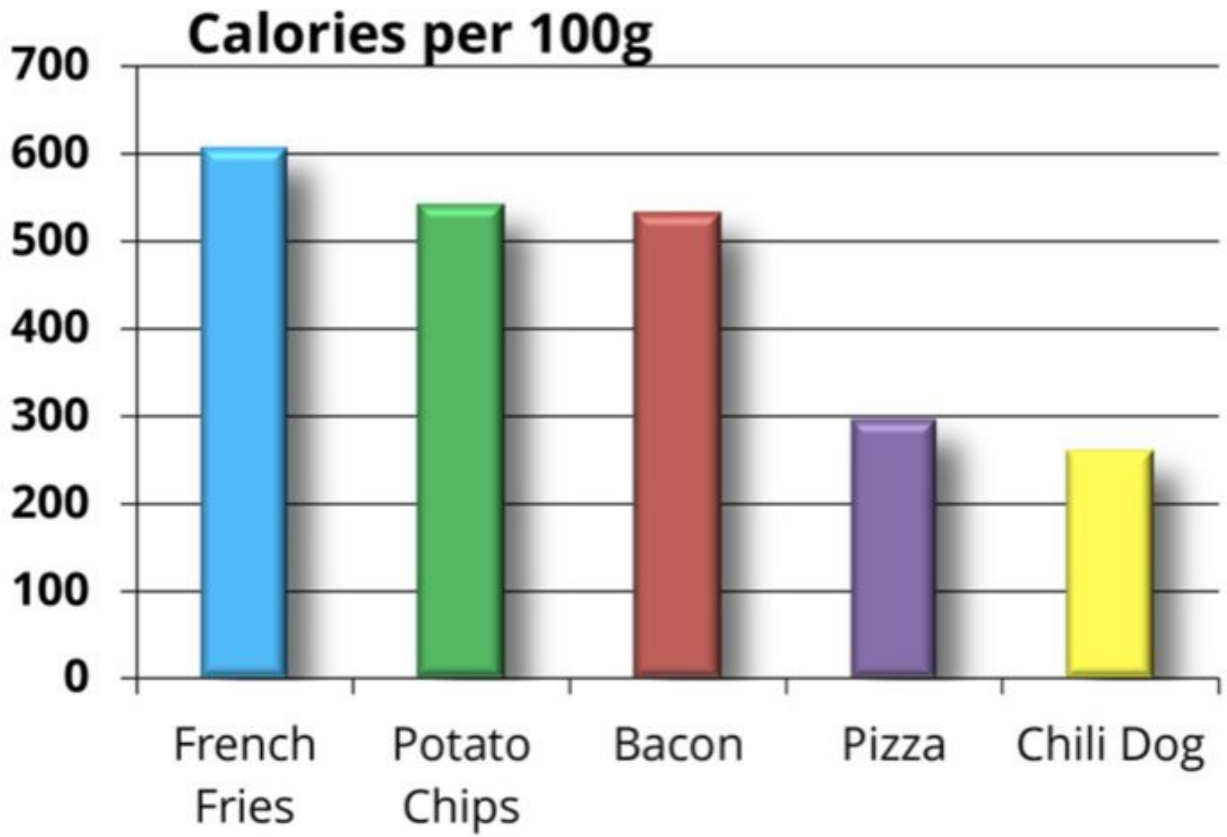
Remove borders



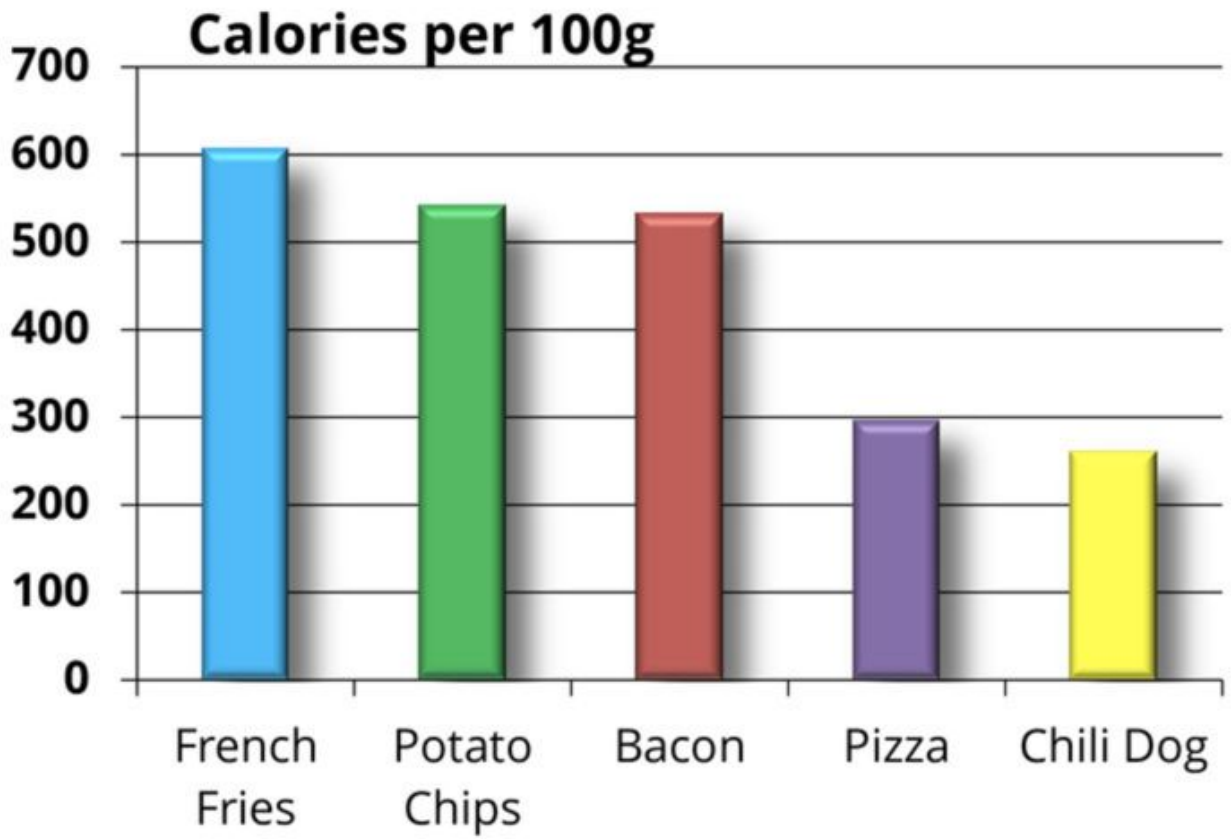
Remove borders



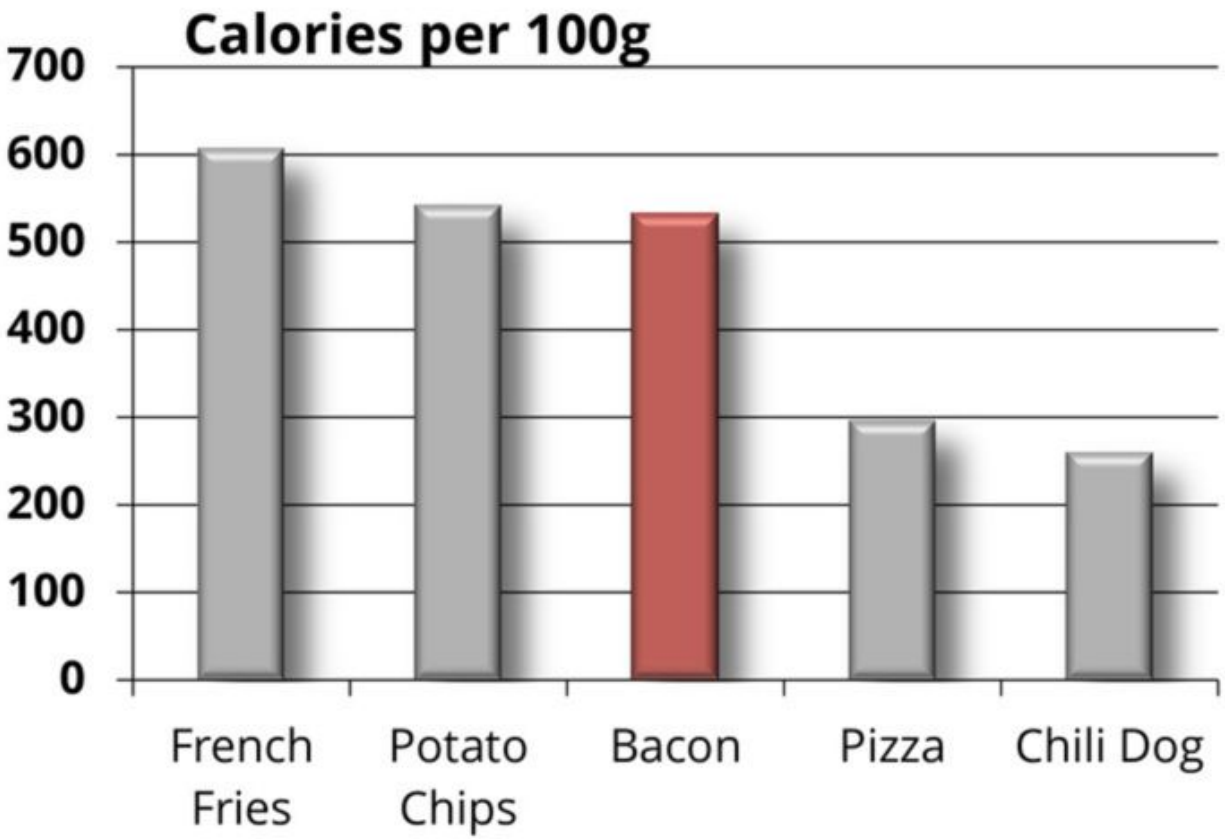
Remove borders



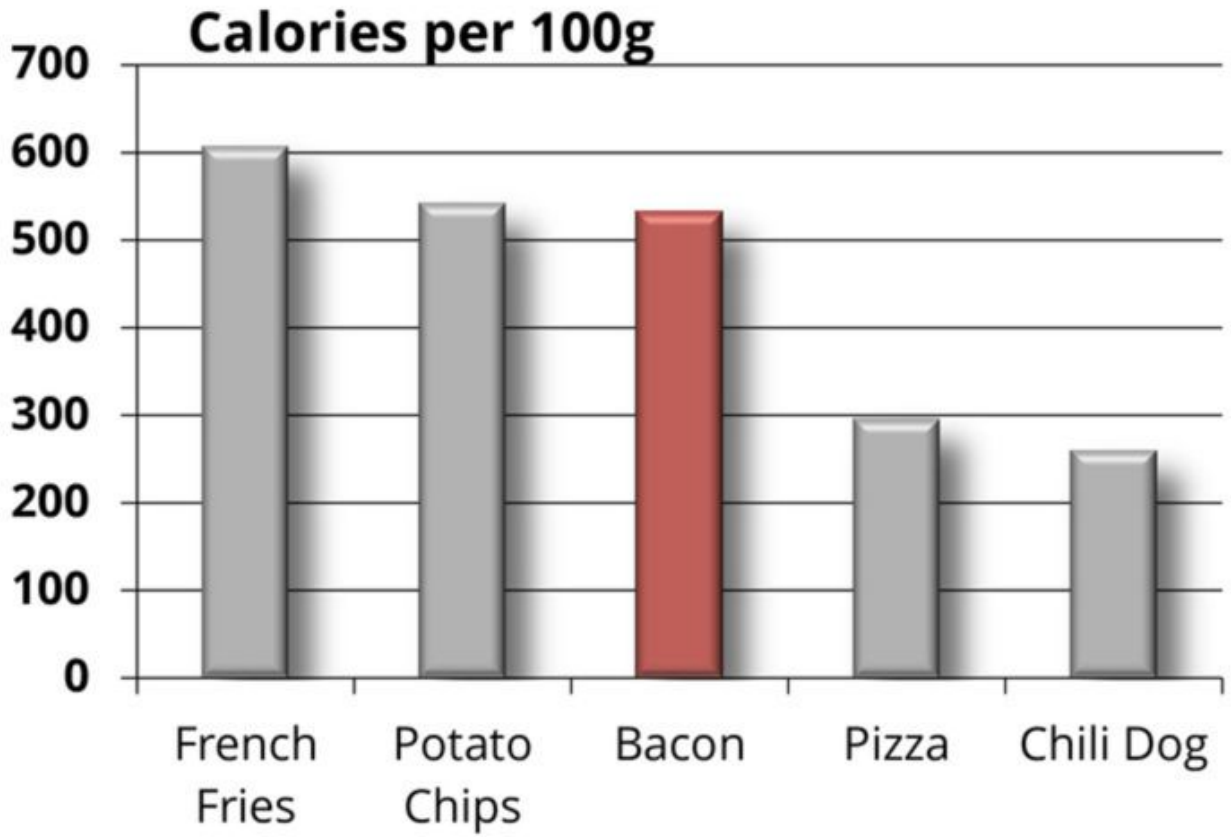
Reduce colors



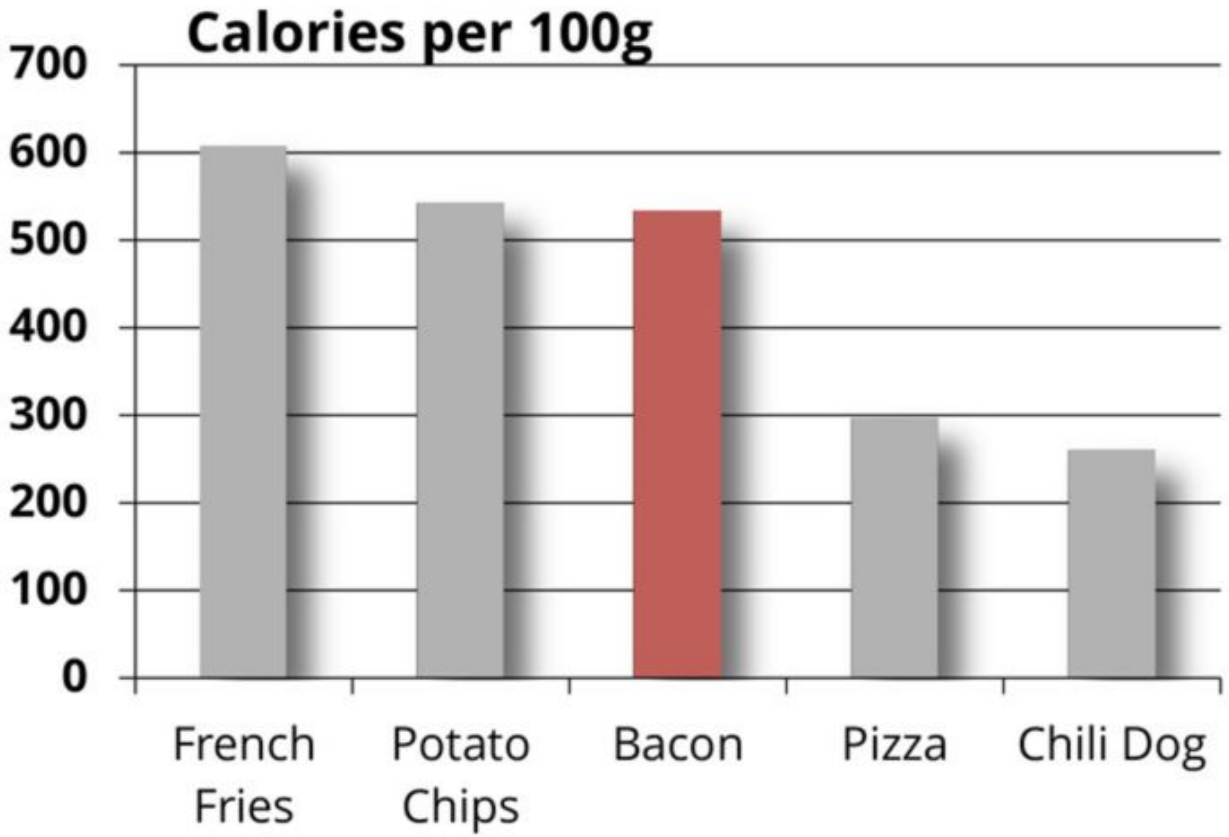
Reduce colors



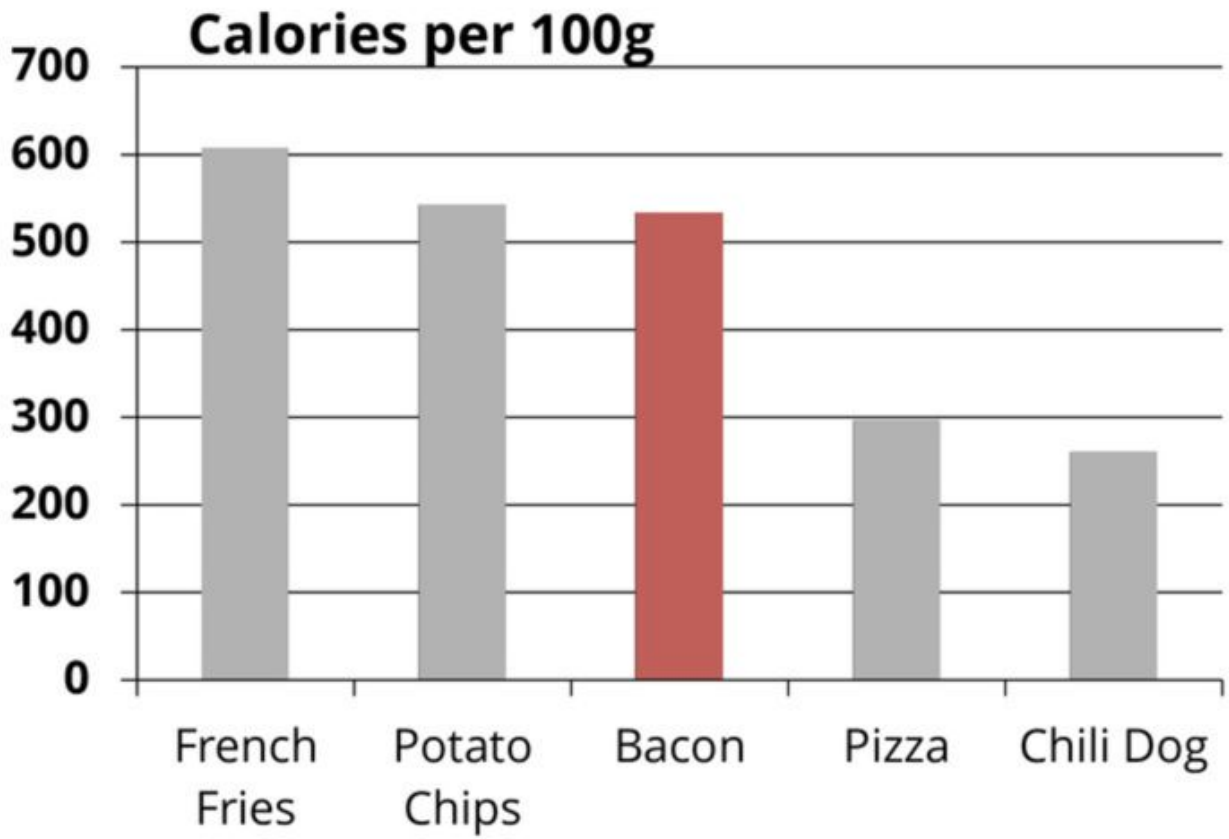
Remove special effects



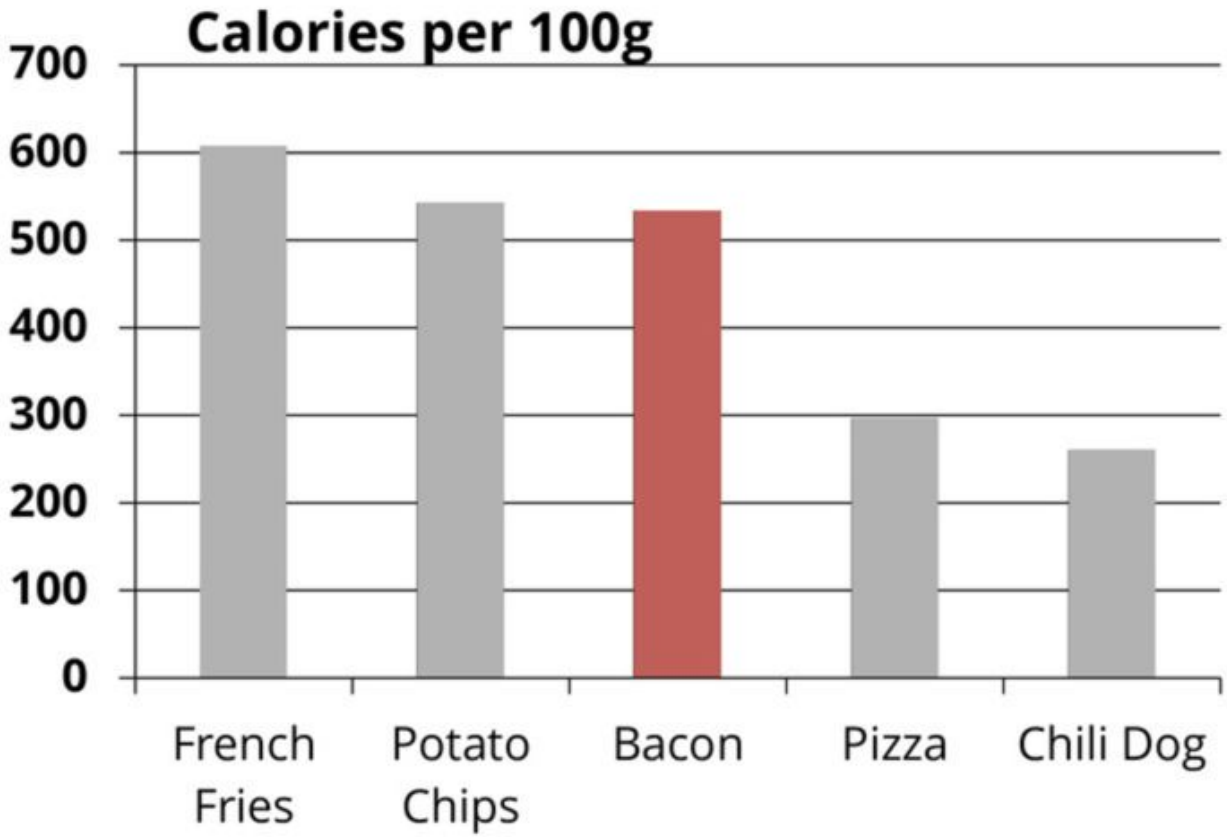
Remove special effects



Remove special effects



Remove bolding



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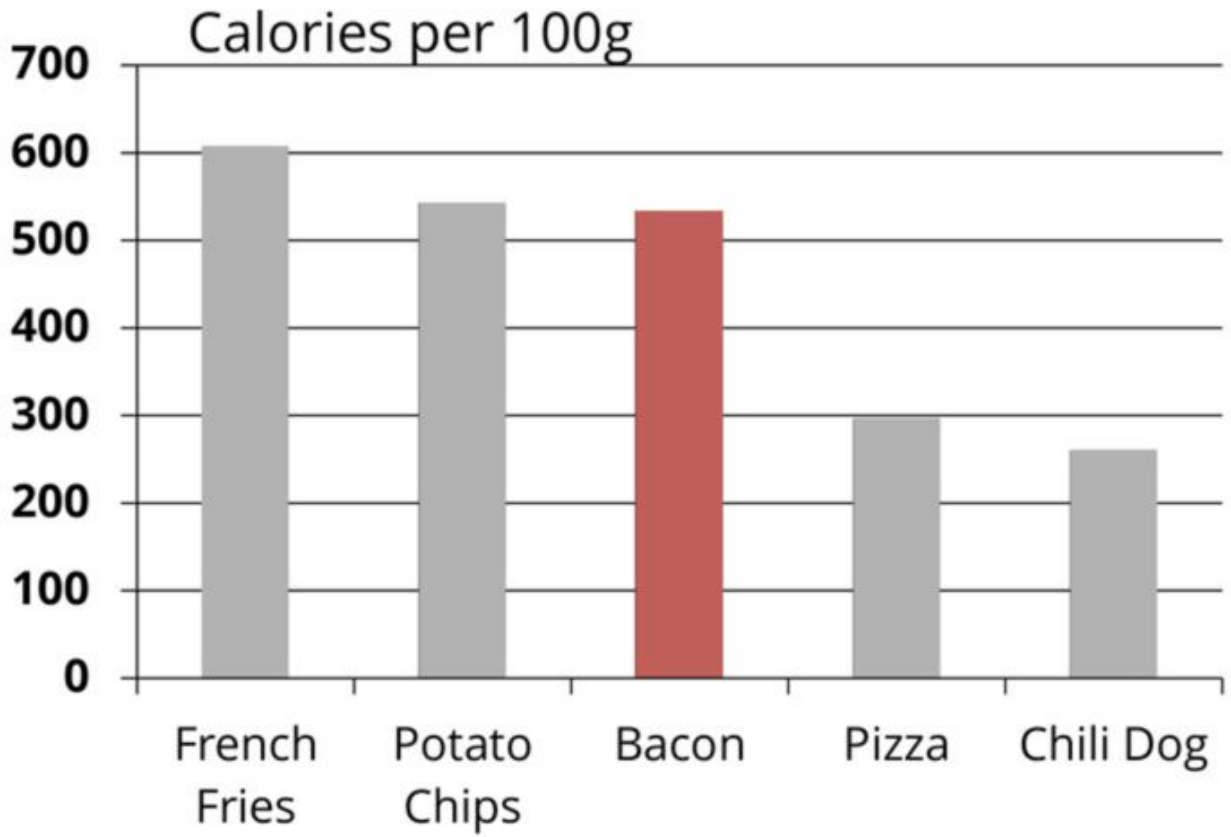

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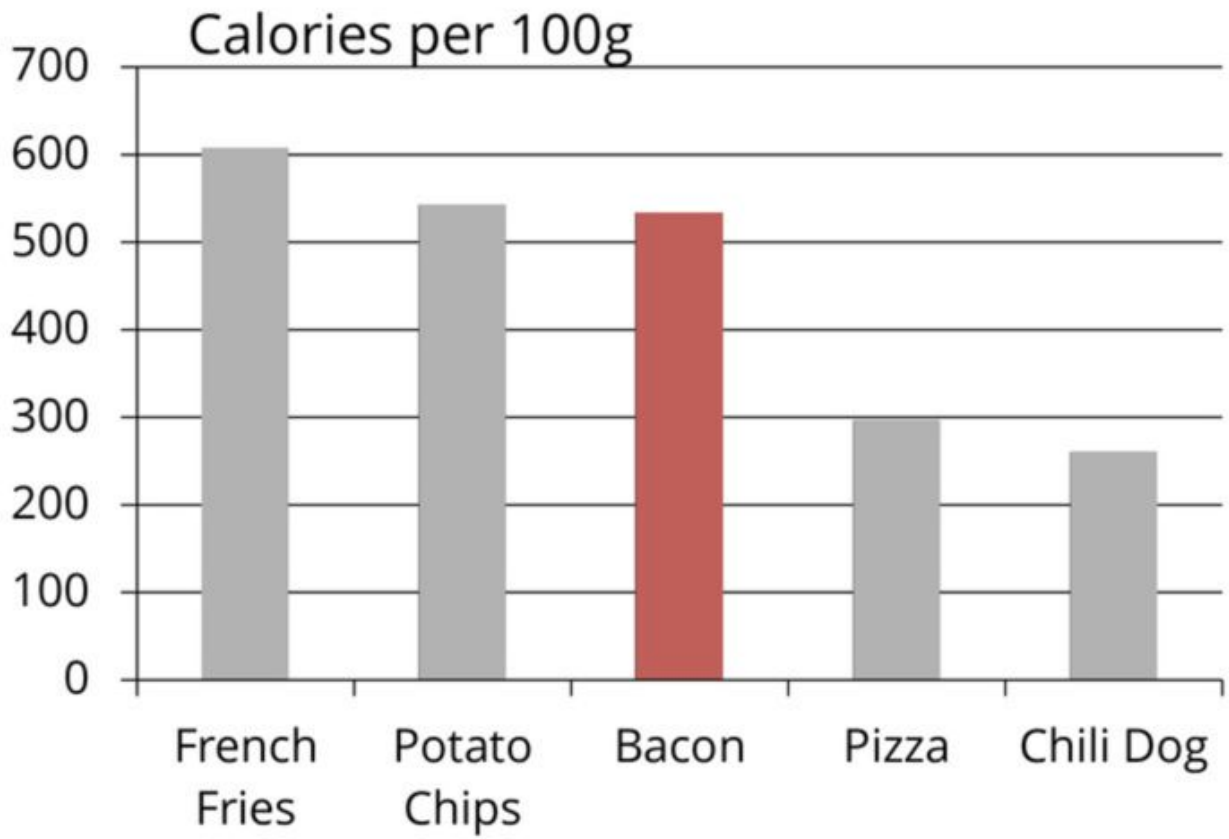
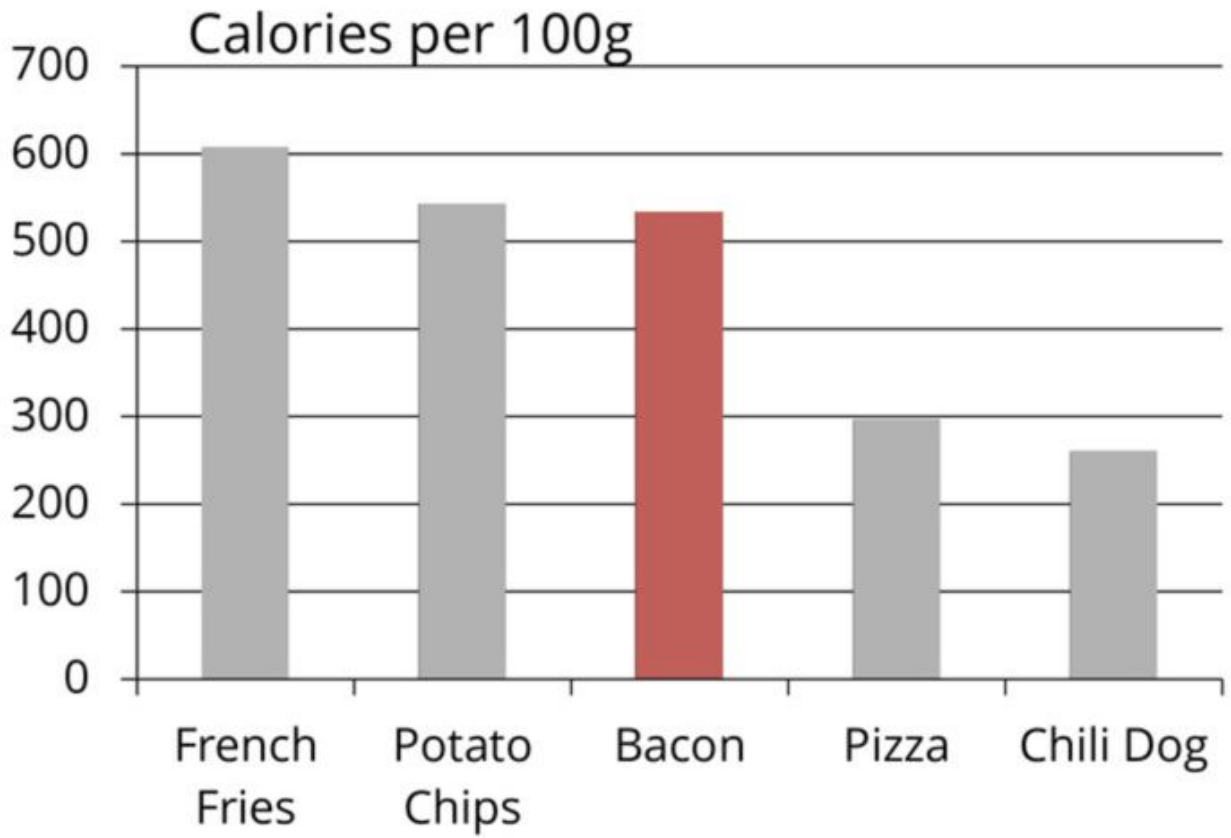


Lighten labels



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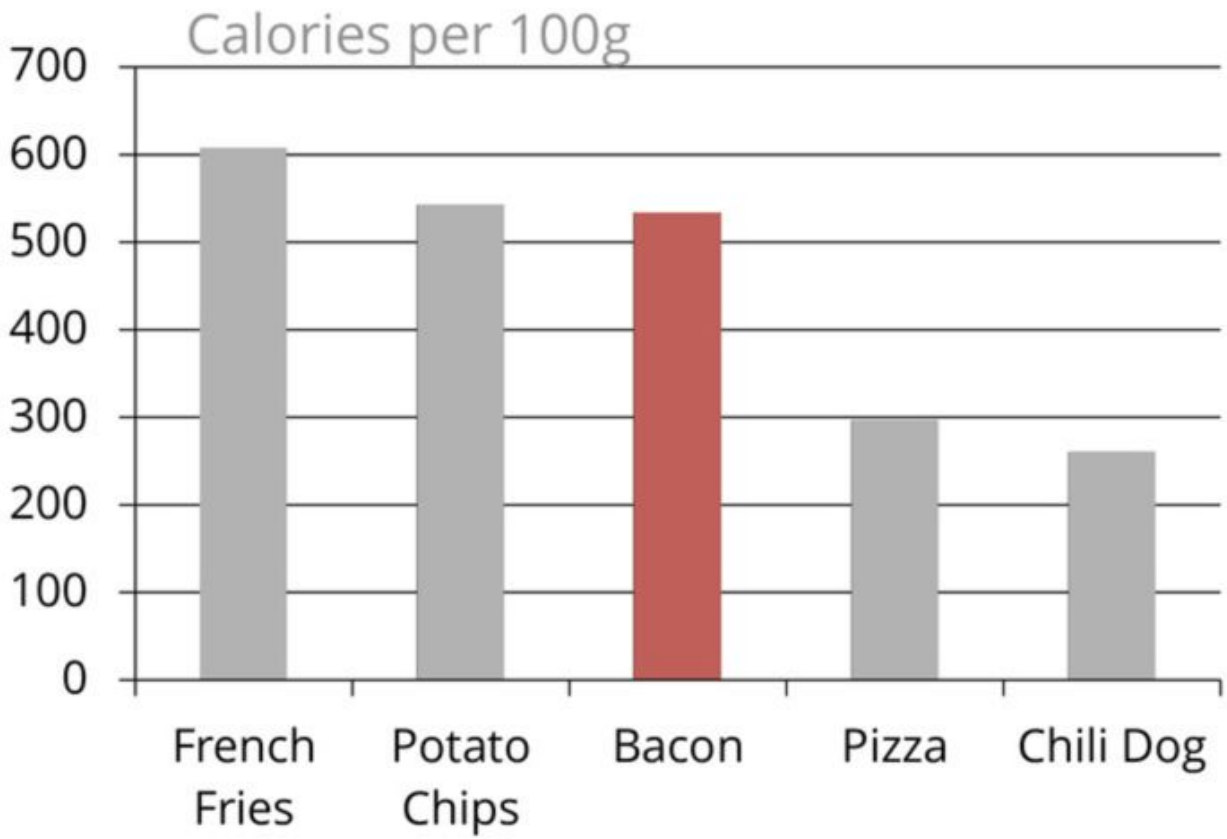
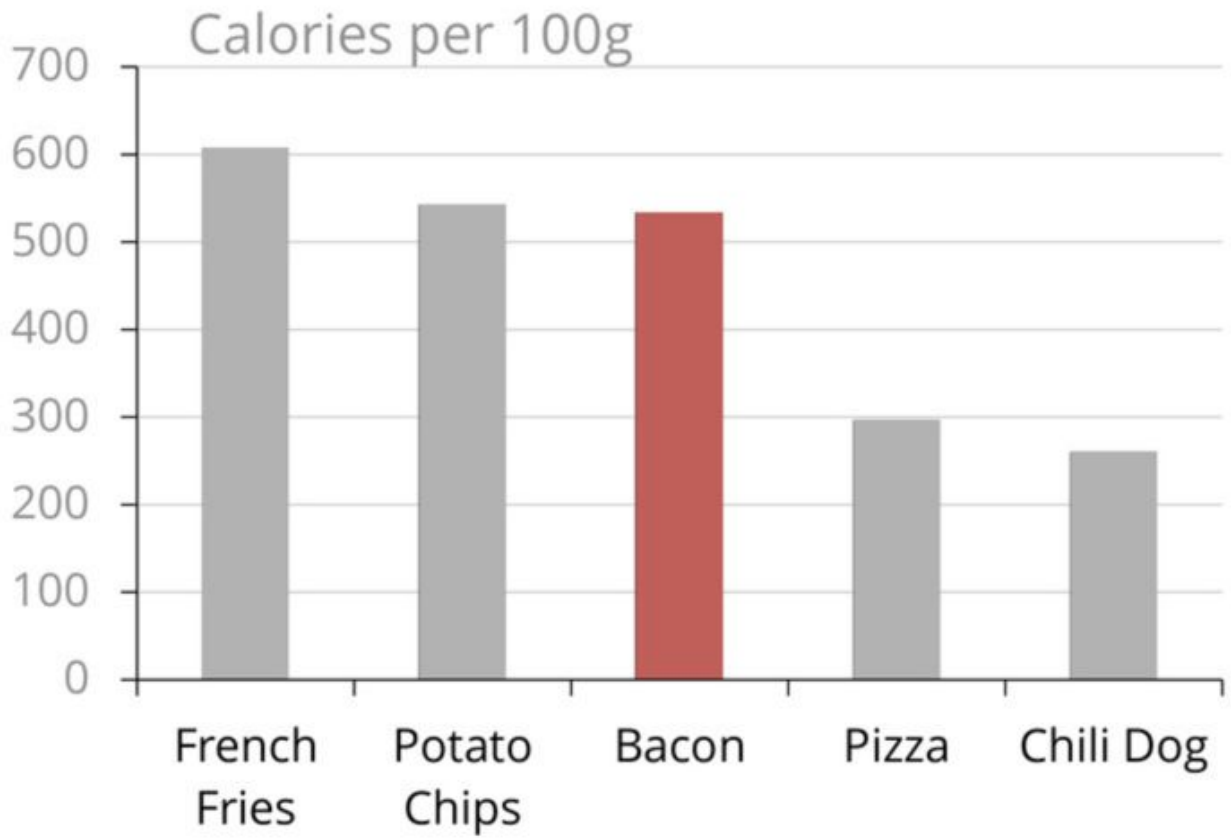
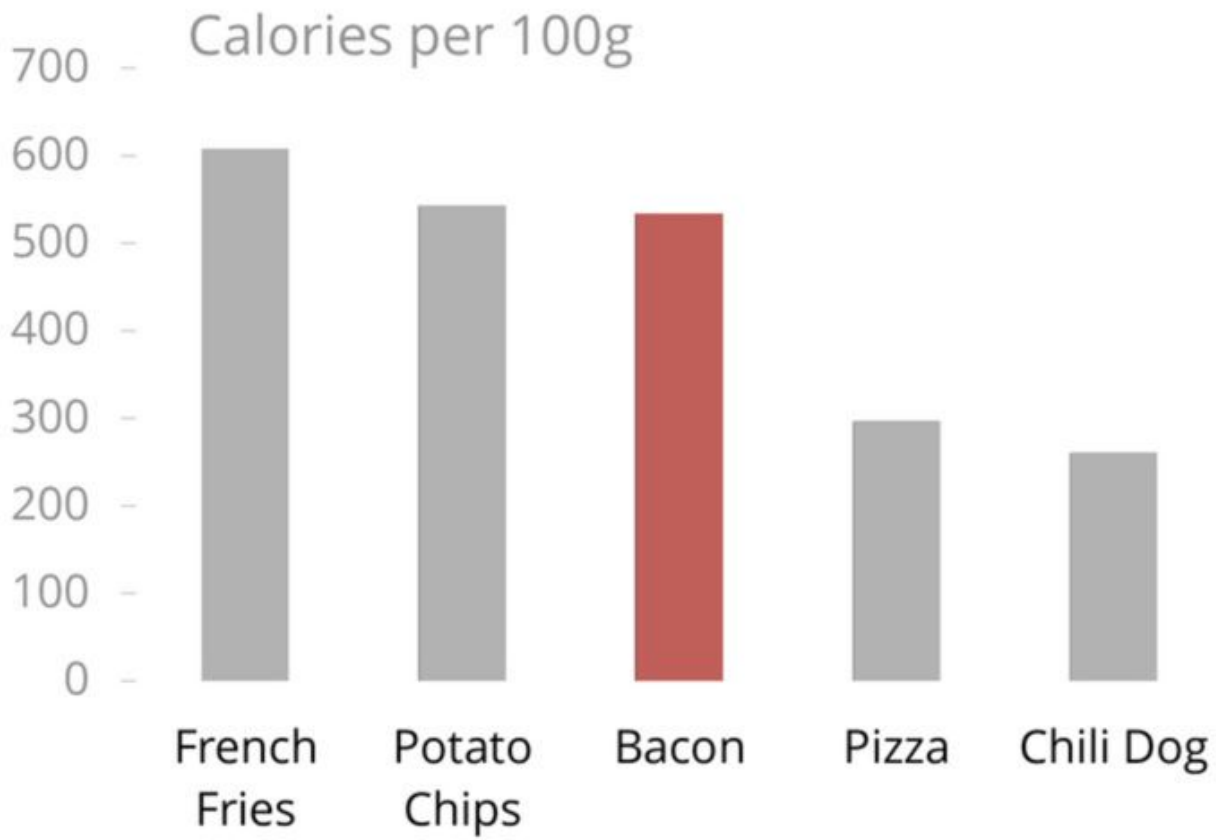


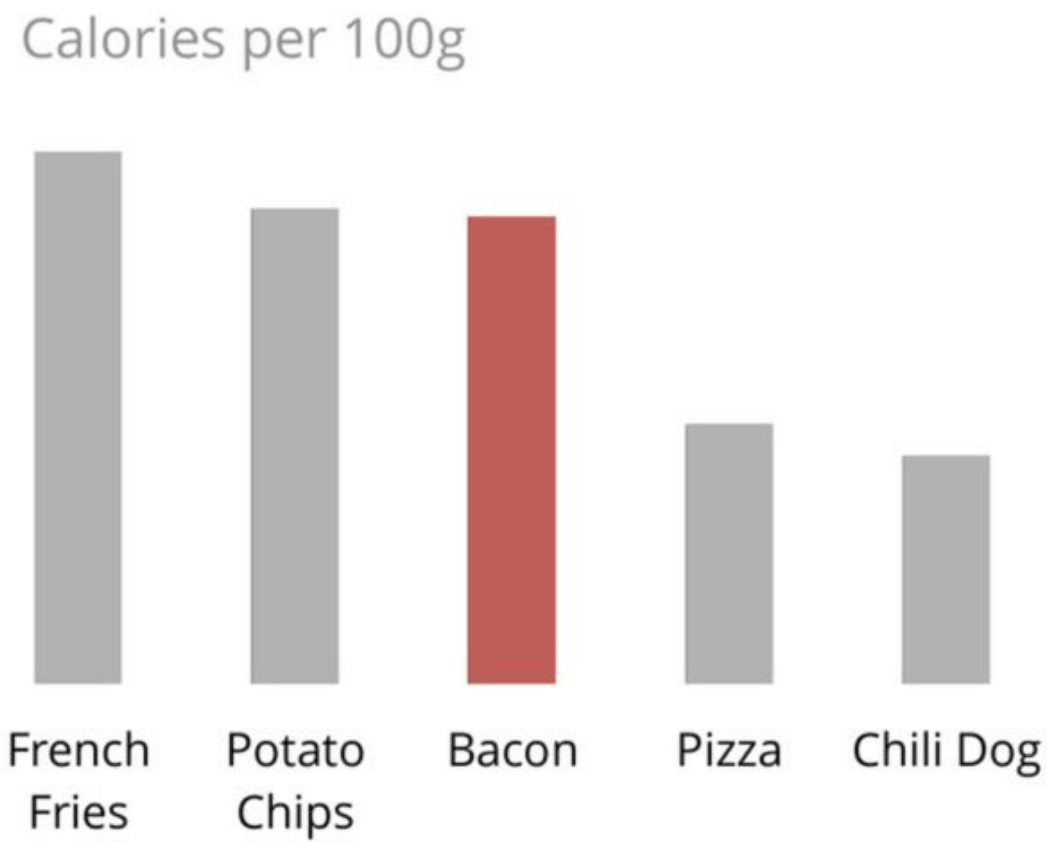
Lighten lines



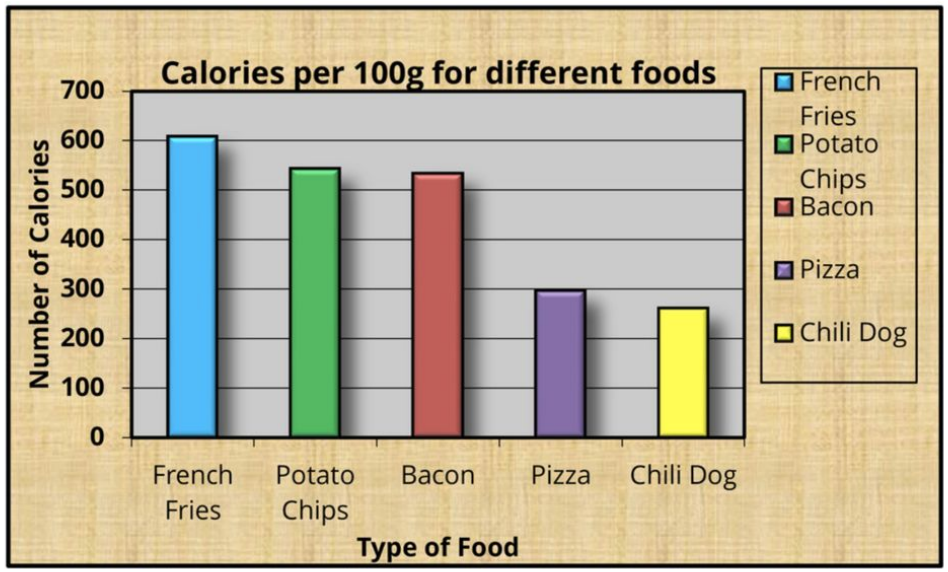
Direct label

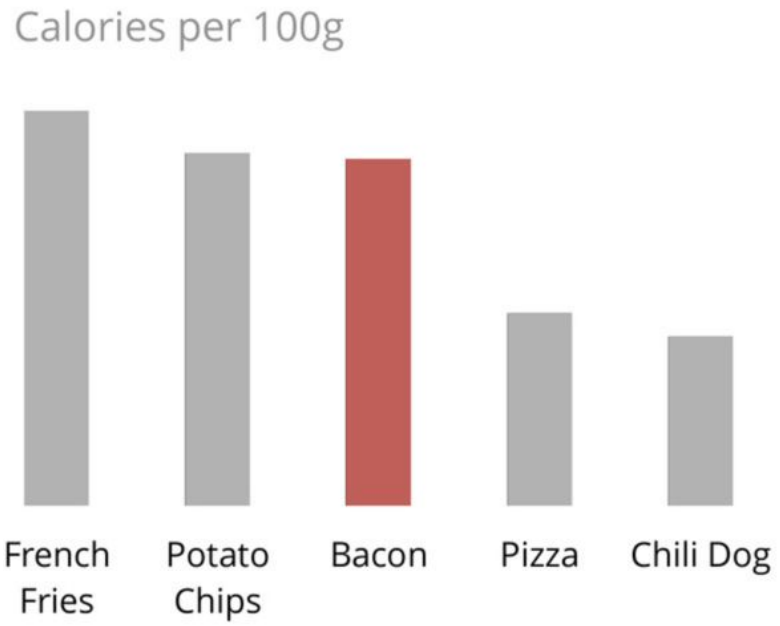


Direct label

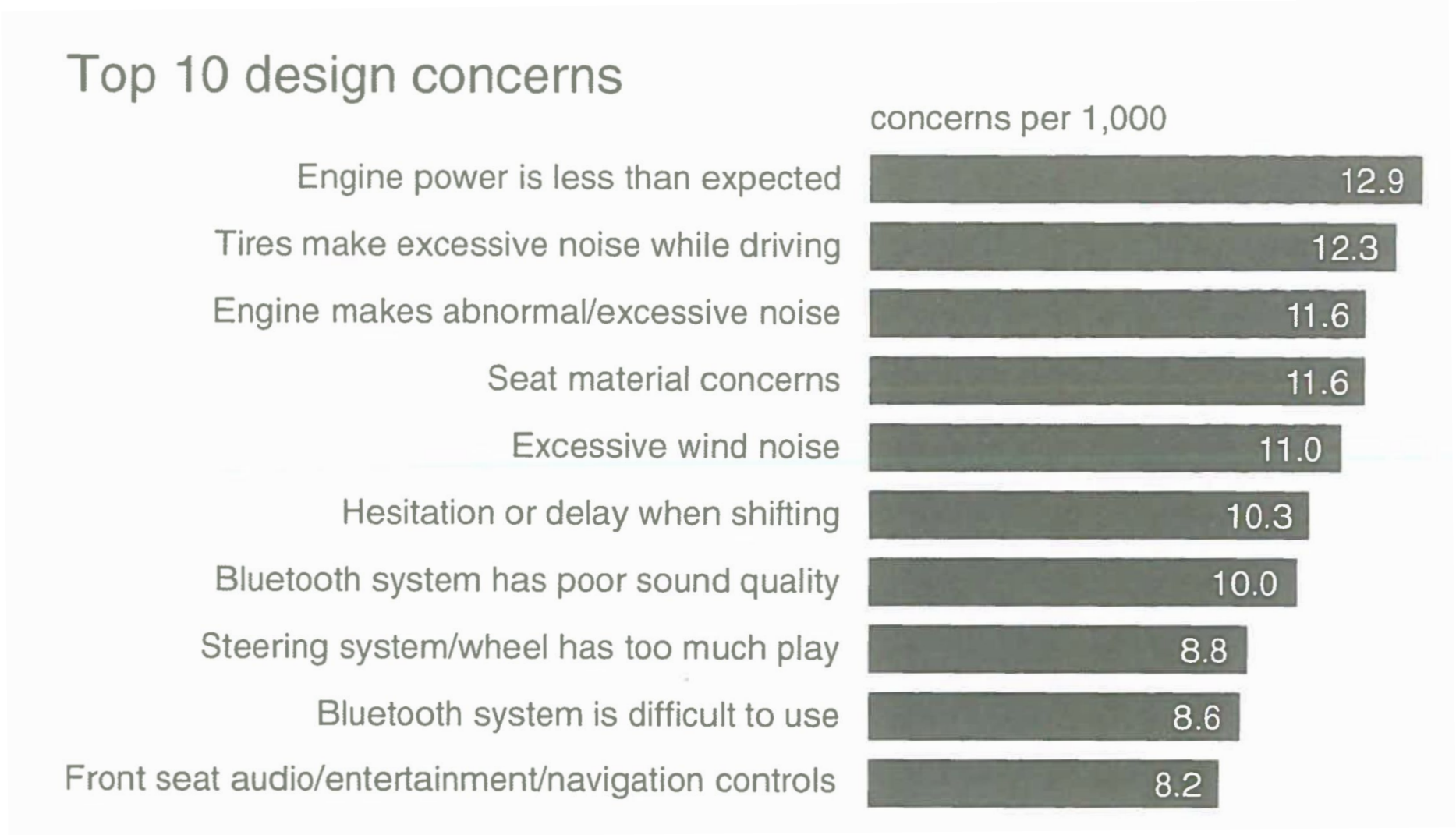


Data-ink ratio

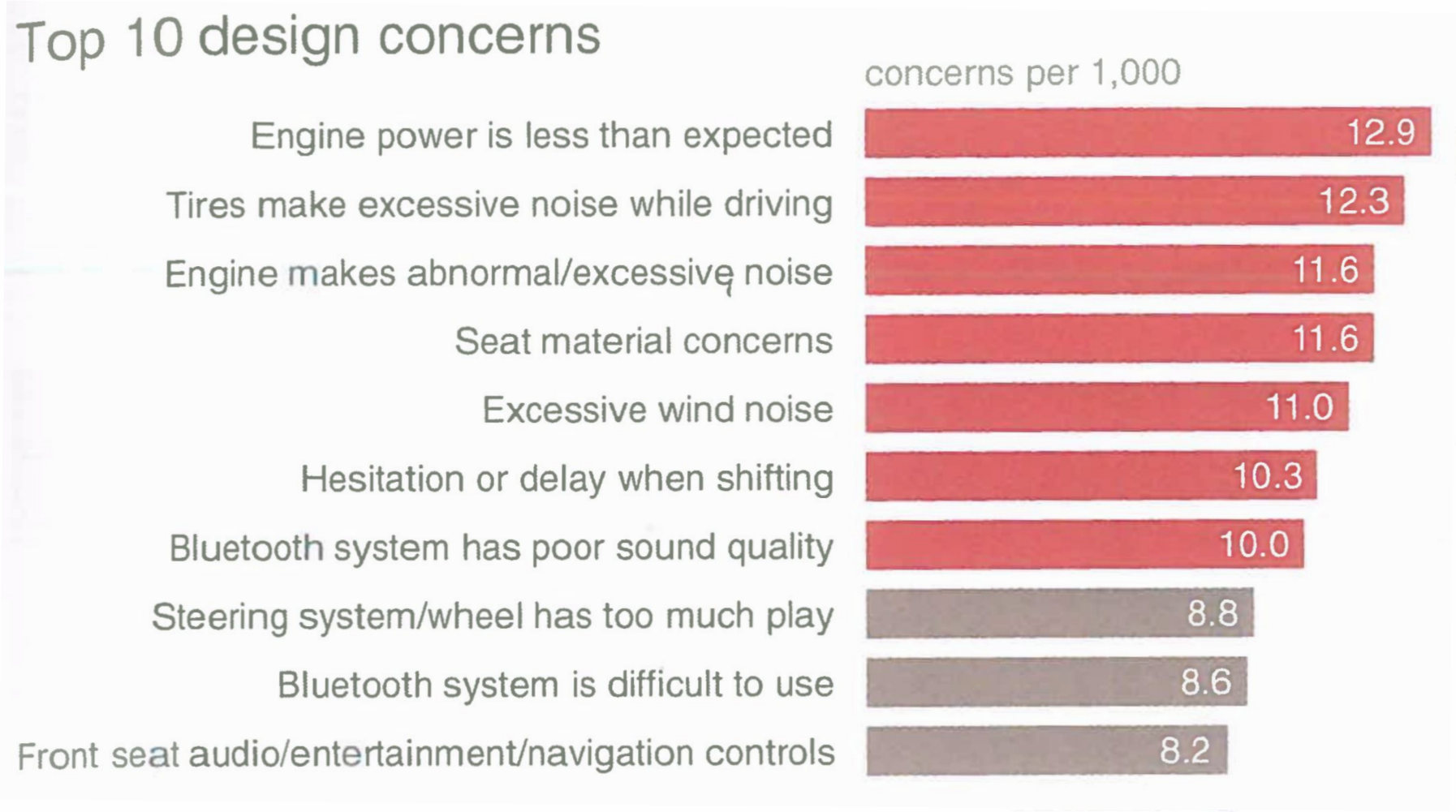




Highlight


Top 10 design concerns
concerns per 1,000
Engine power is less than expected
12.9
Tires make excessive noise while driving
12.3
Engine makes abnormal/excessive noise
11.6
Seat material concerns
11.6
Excessive wind noise
11.0
Hesitation or delay when shifting
10.3
Bluetooth system has poor sound quality
10.0
Steering system/wheel has too much play
8.8
Bluetooth system is difficult to use
8.6
Front seat audio/entertainment/navigation controls
8.2

Highlight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Highlight

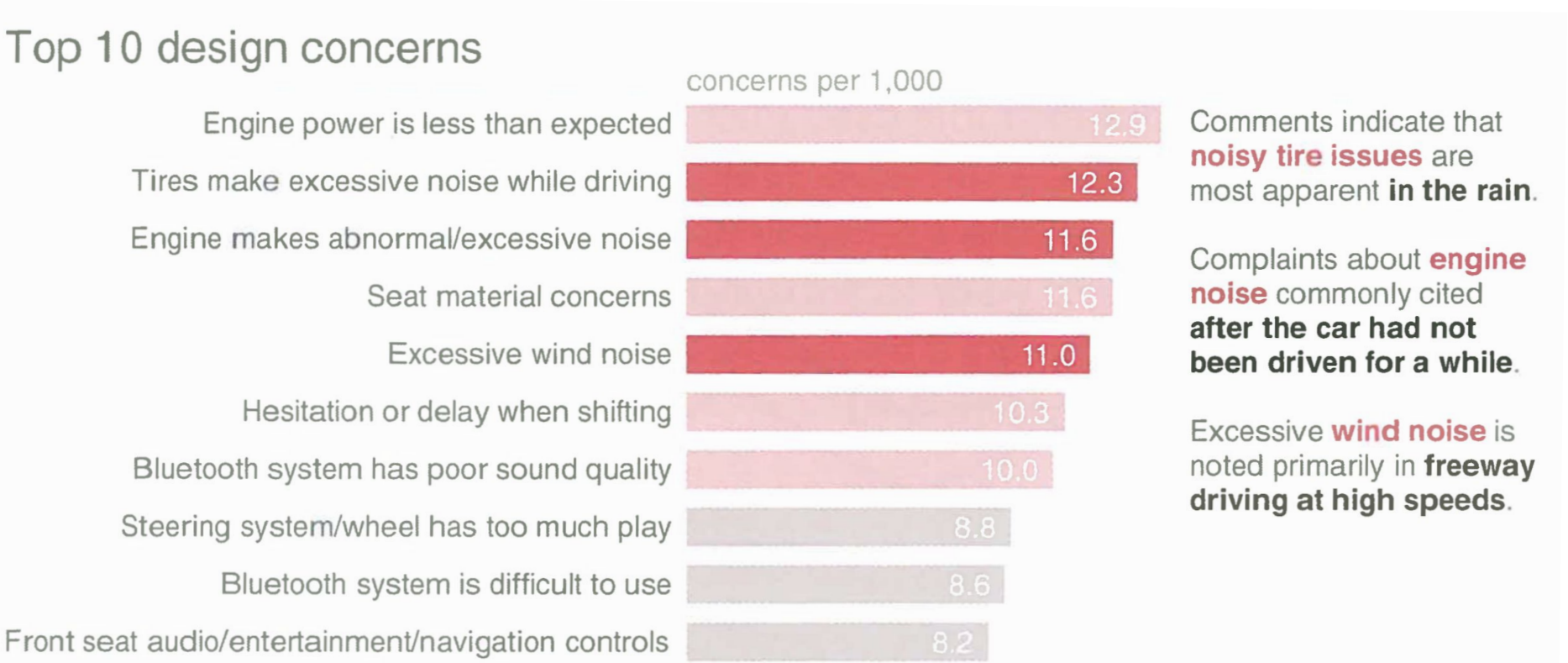
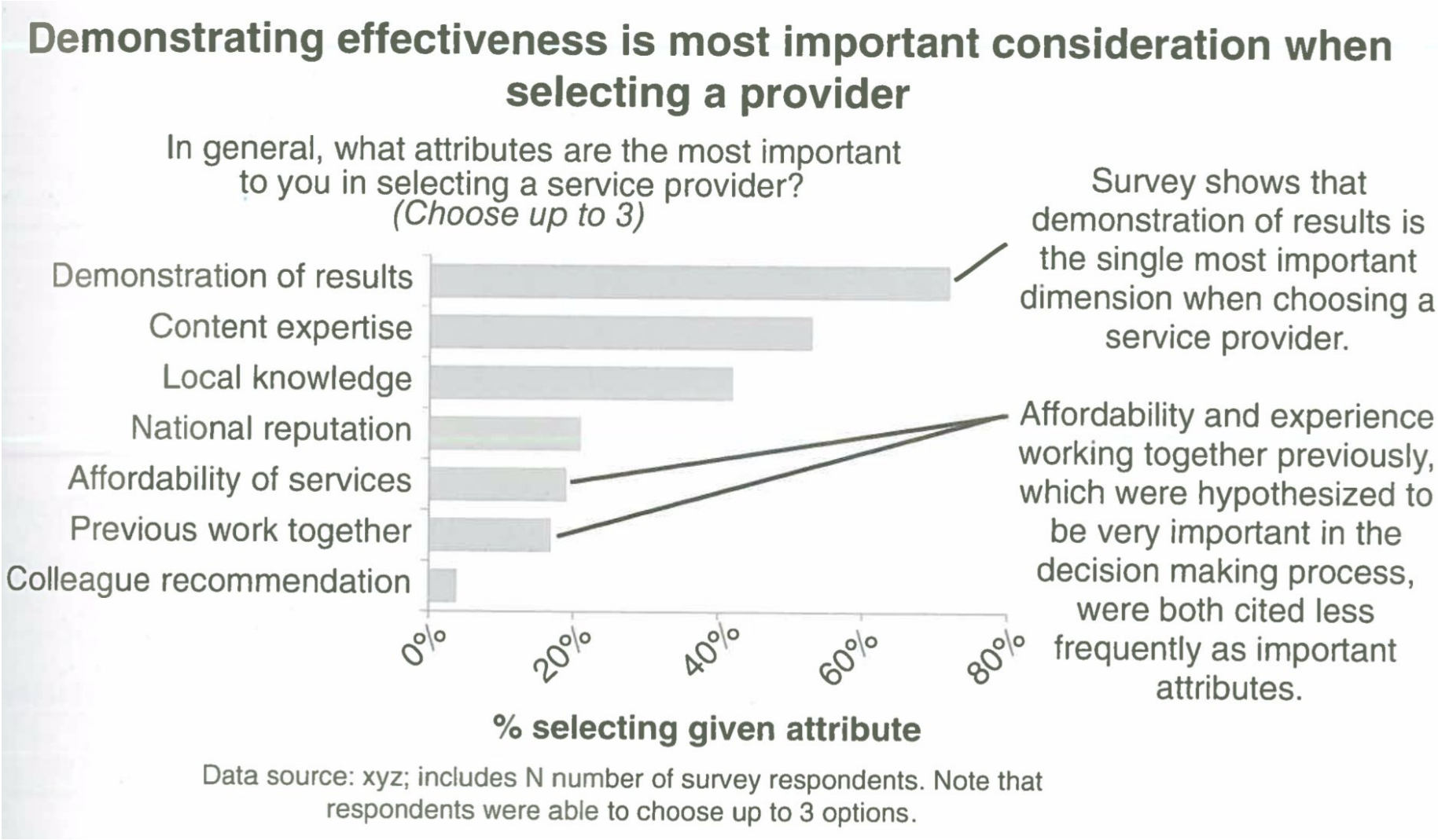


FIGURE 4.9 Create a visual hierarchy of information

Layout

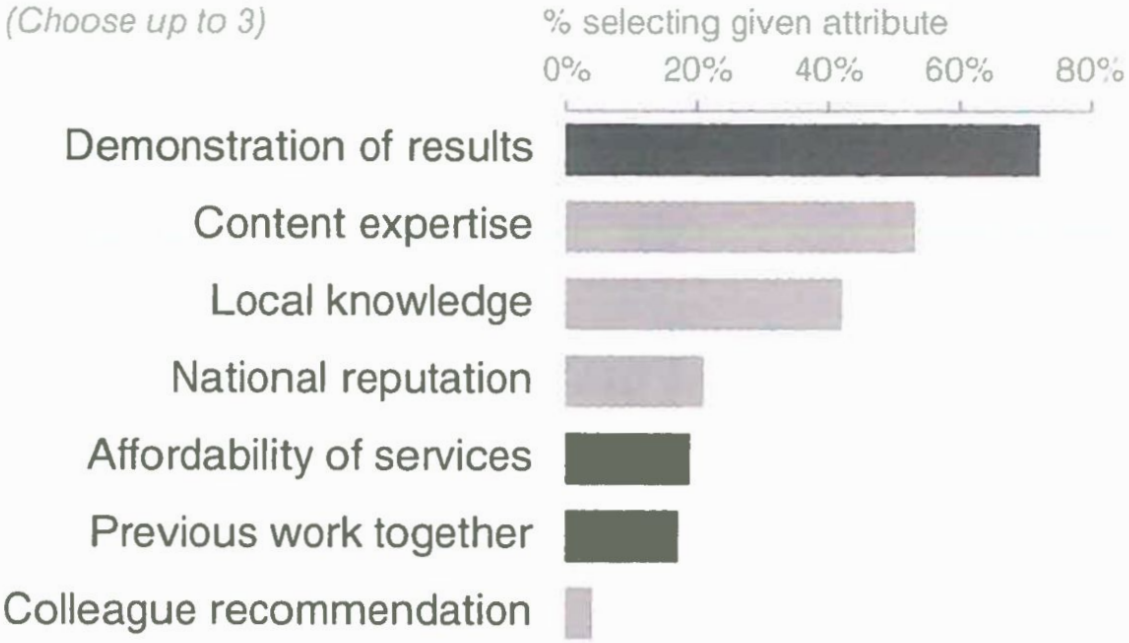

Demonstrating effectiveness is most important consideration when selecting a provider
In general, what attributes are the most important to you in selecting a service provider? (Choose up to 3)
Demonstration of results
Content expertise
Local knowledge
National reputation
Affordability of services
Previous 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.

Layout

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.
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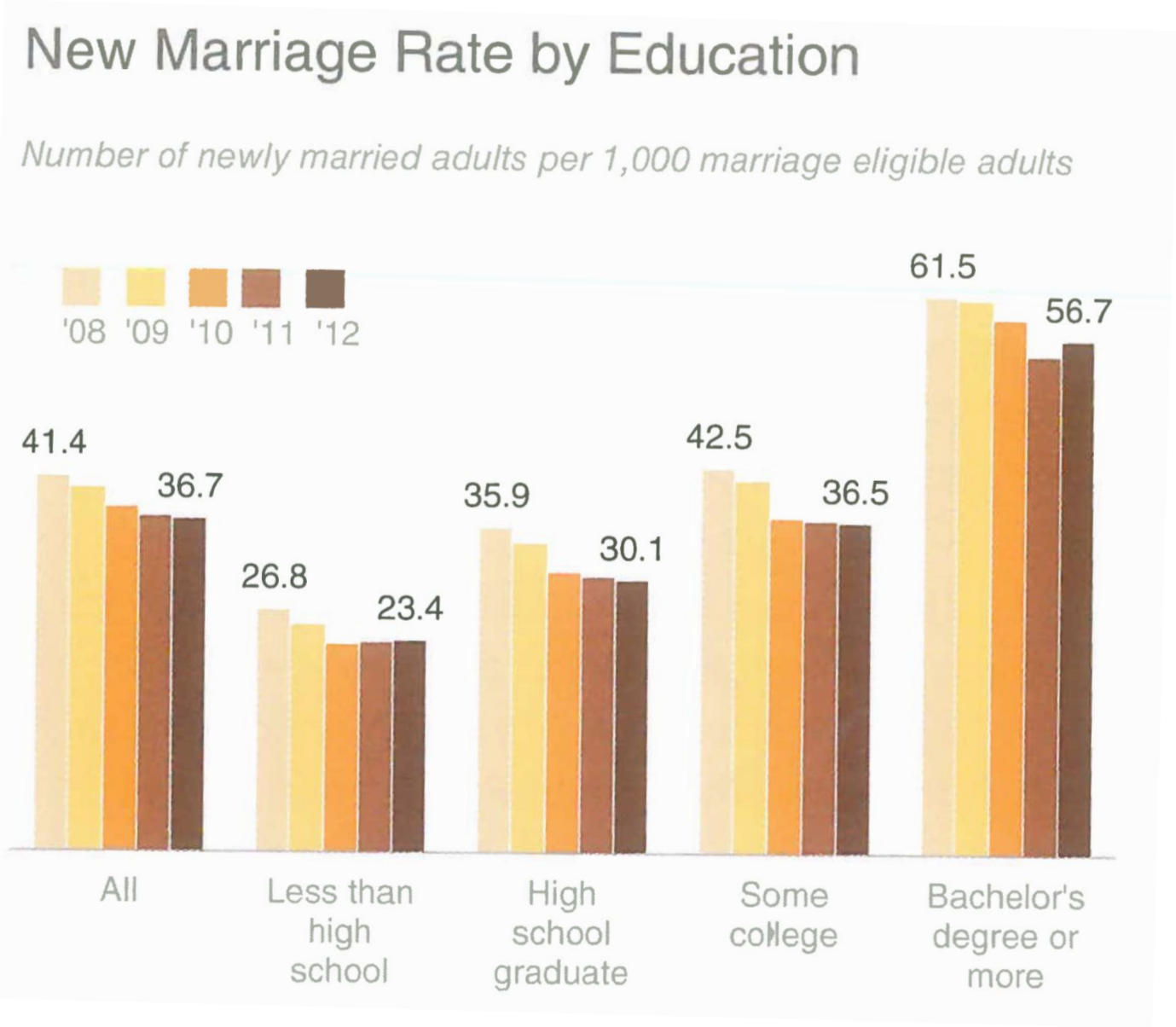
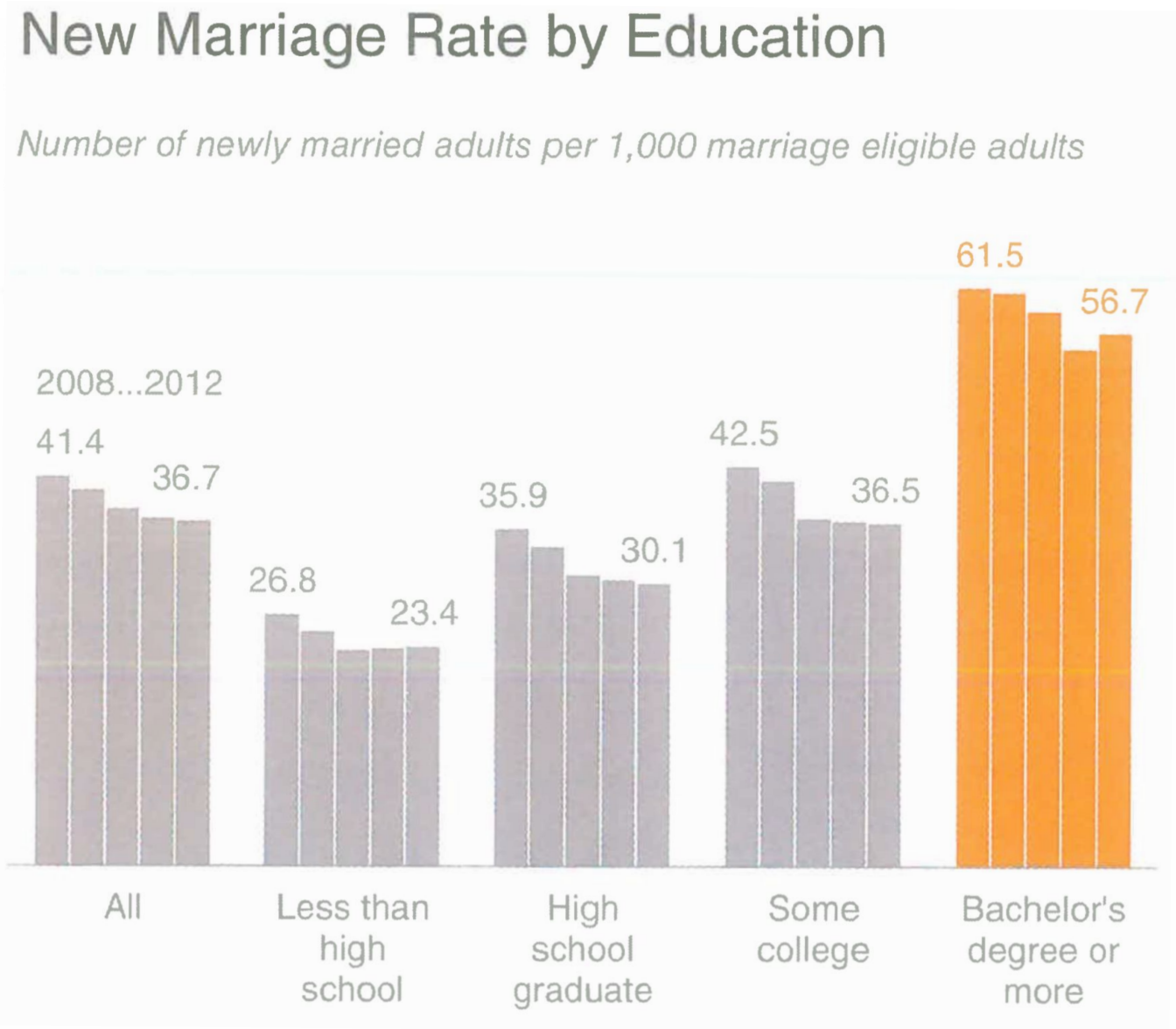
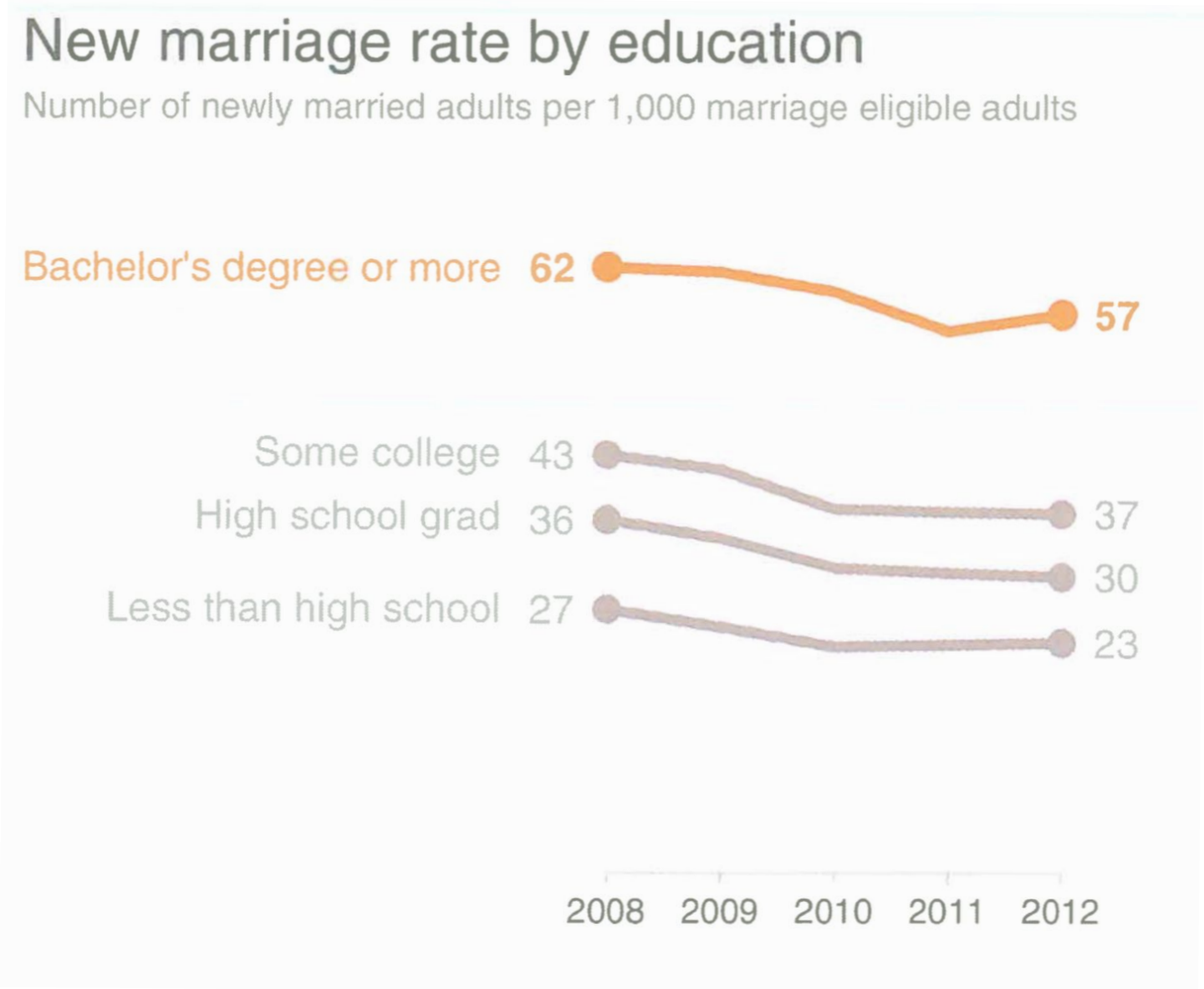
Message


New Marriage Rate by Education
Number of newly married adults per 1,000 marriage eligible adults
'08 '09 '10 '11 '12
41.4
36.7
26.8
23.4
35.9
30.1
42.5
36.5
61.5
56.7
All
Less than high school
High school graduate
Some college
Bachelor's degree or more

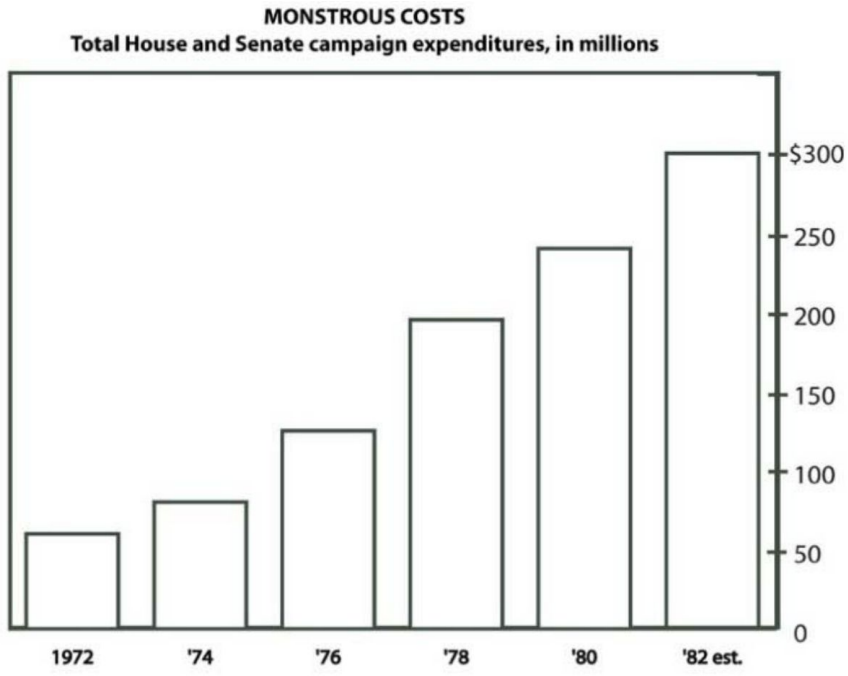
Message


New Marriage Rate by Education
Number of newly married adults per 1,000 marriage eligible adults
2008...2012
41.4
36.7
26.8
23.4
35.9
30.1
42.5
36.5
61.5
56.7
All
Less than high school
High school graduate
Some college
Bachelor's degree or more

Message

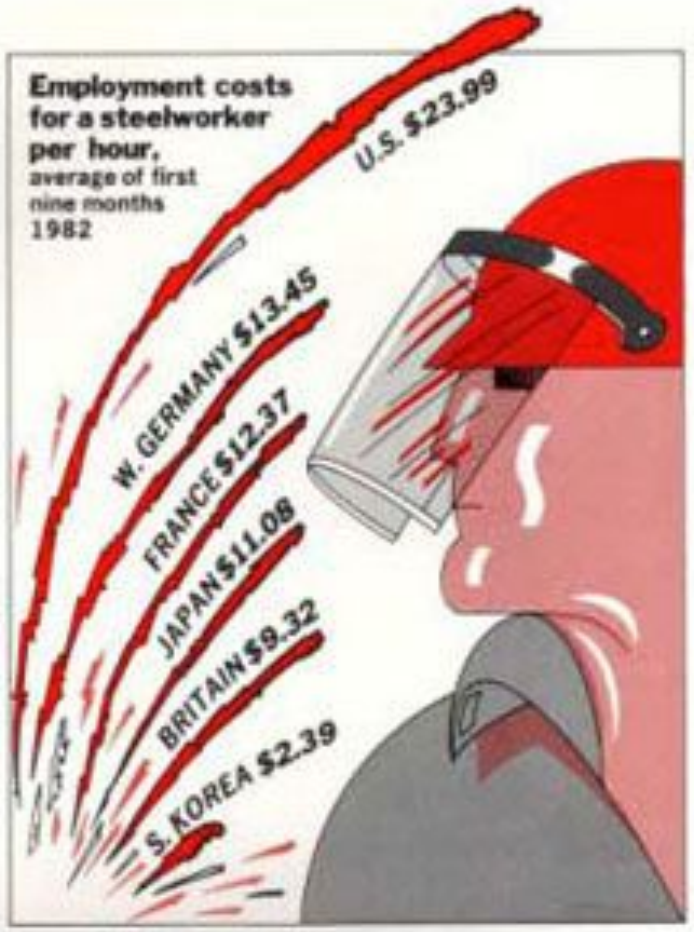

New marriage rate by education
Number of newly married adults per 1,000 marriage eligible adults
Bachelor's degree or more
62
57
Some college
43
37
High school grad
36
30
Less than high school
27
23
2008
2009
2010
2011
2012

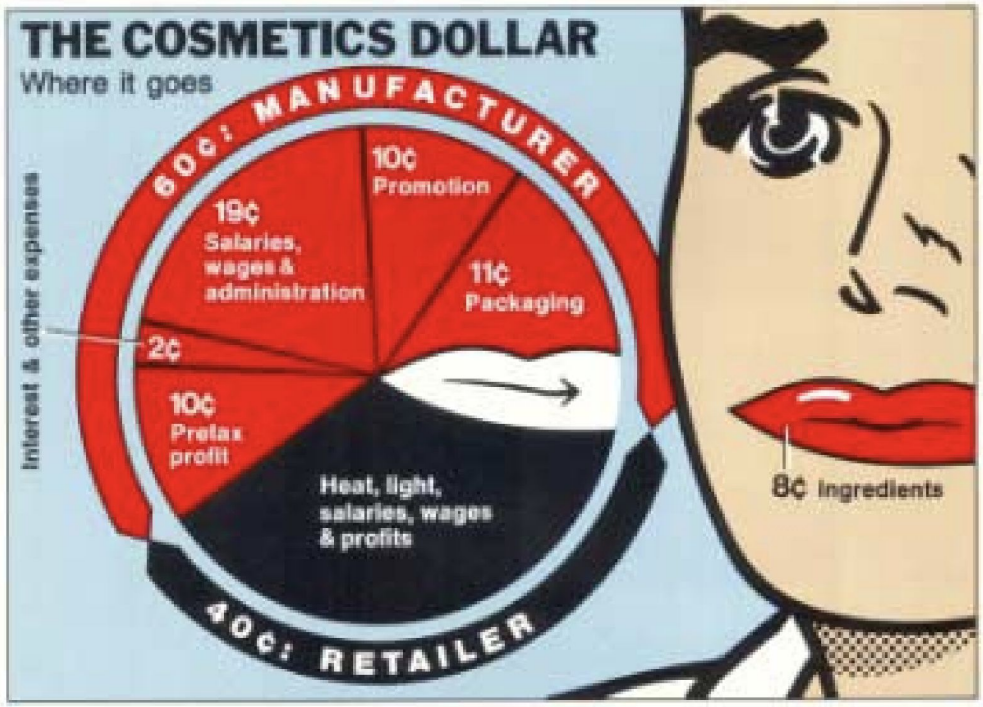
Embellishment



Understanding of embellished charts not worse, but recall after some weeks, much higher.

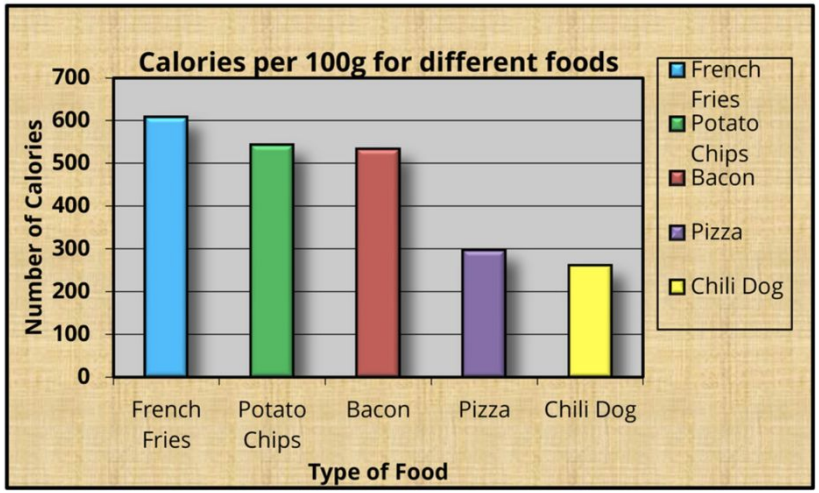
Embellishment: **Metaphors**





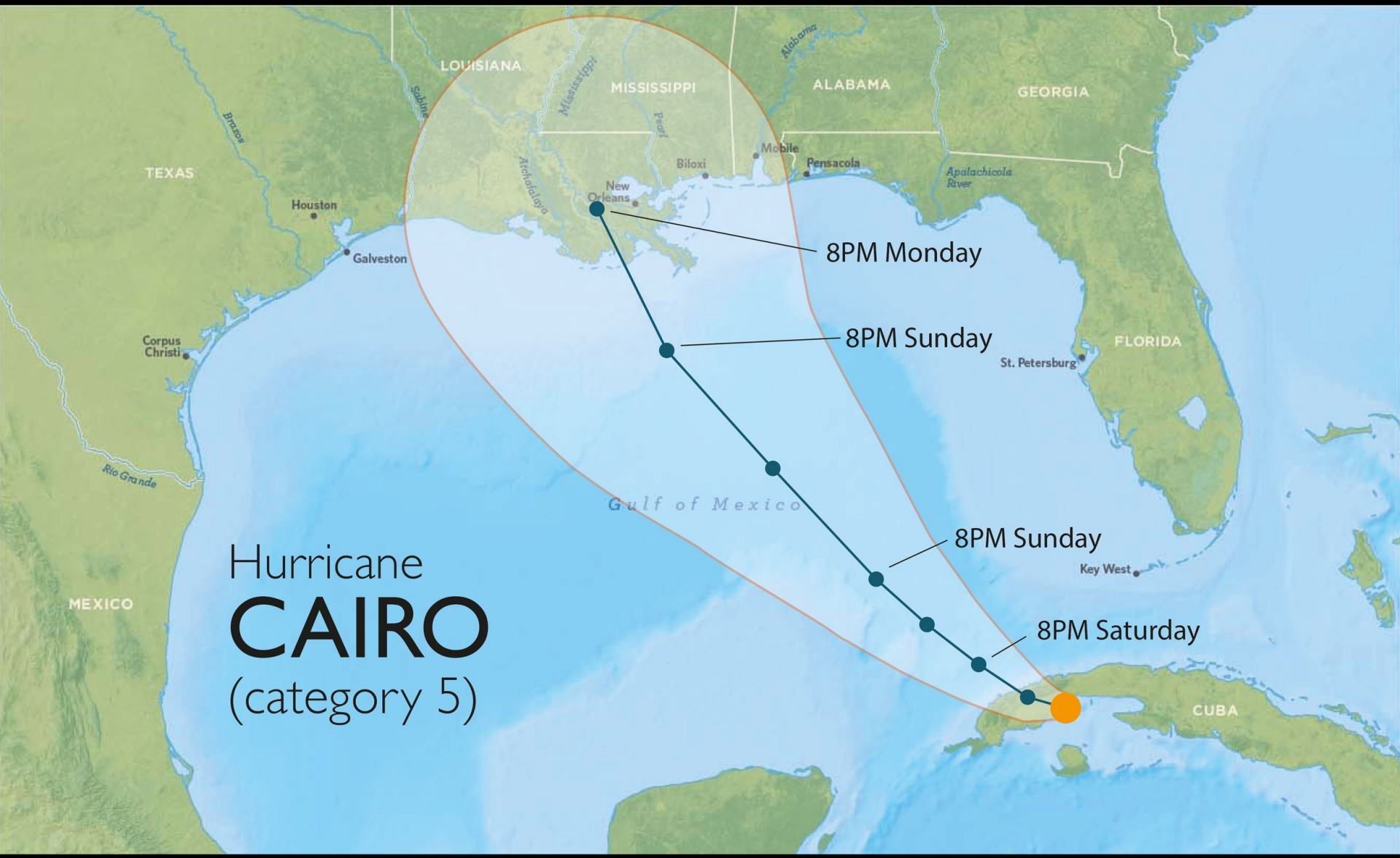
Embellishment

≠



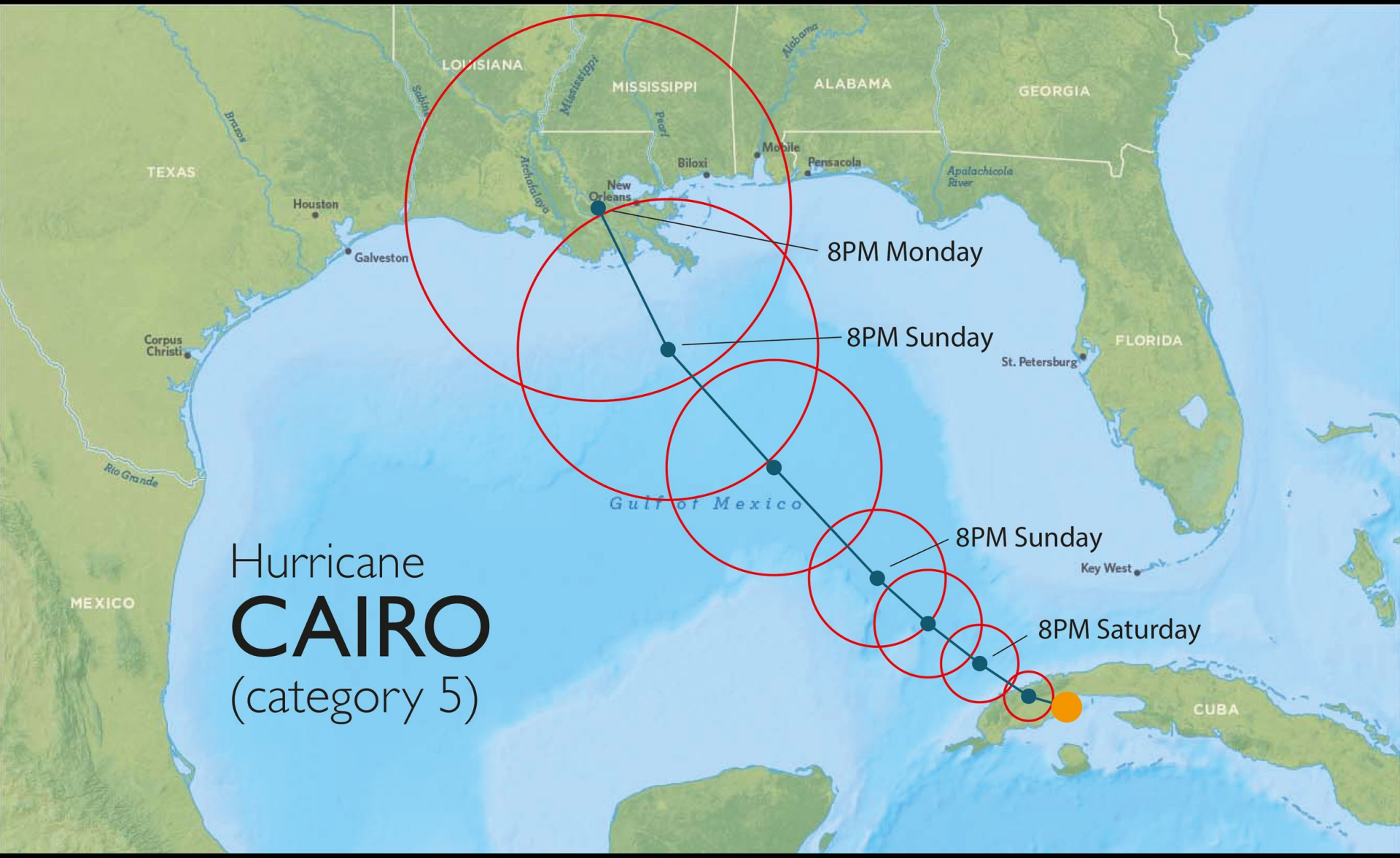
Metaphor

Distractors

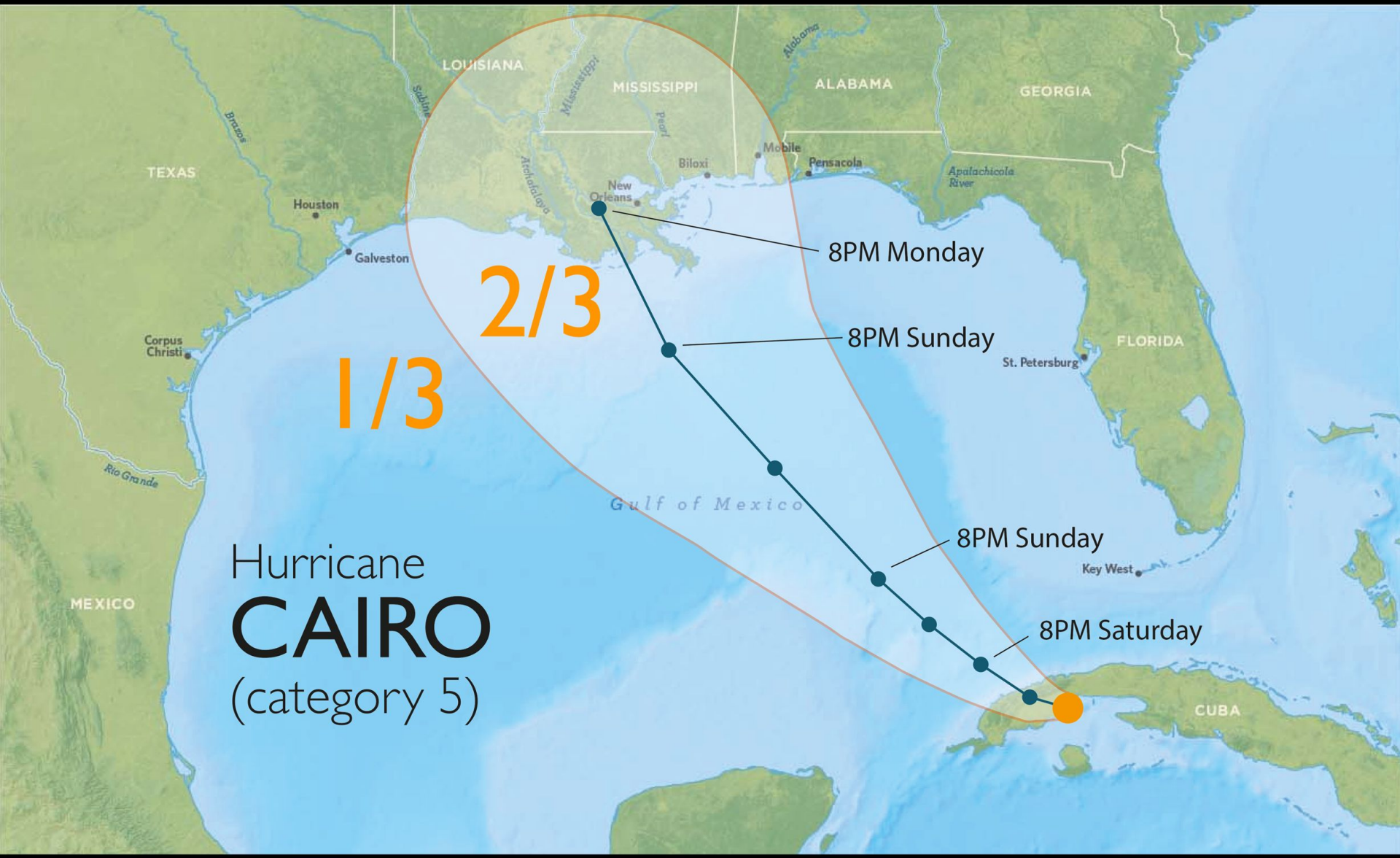


What you show

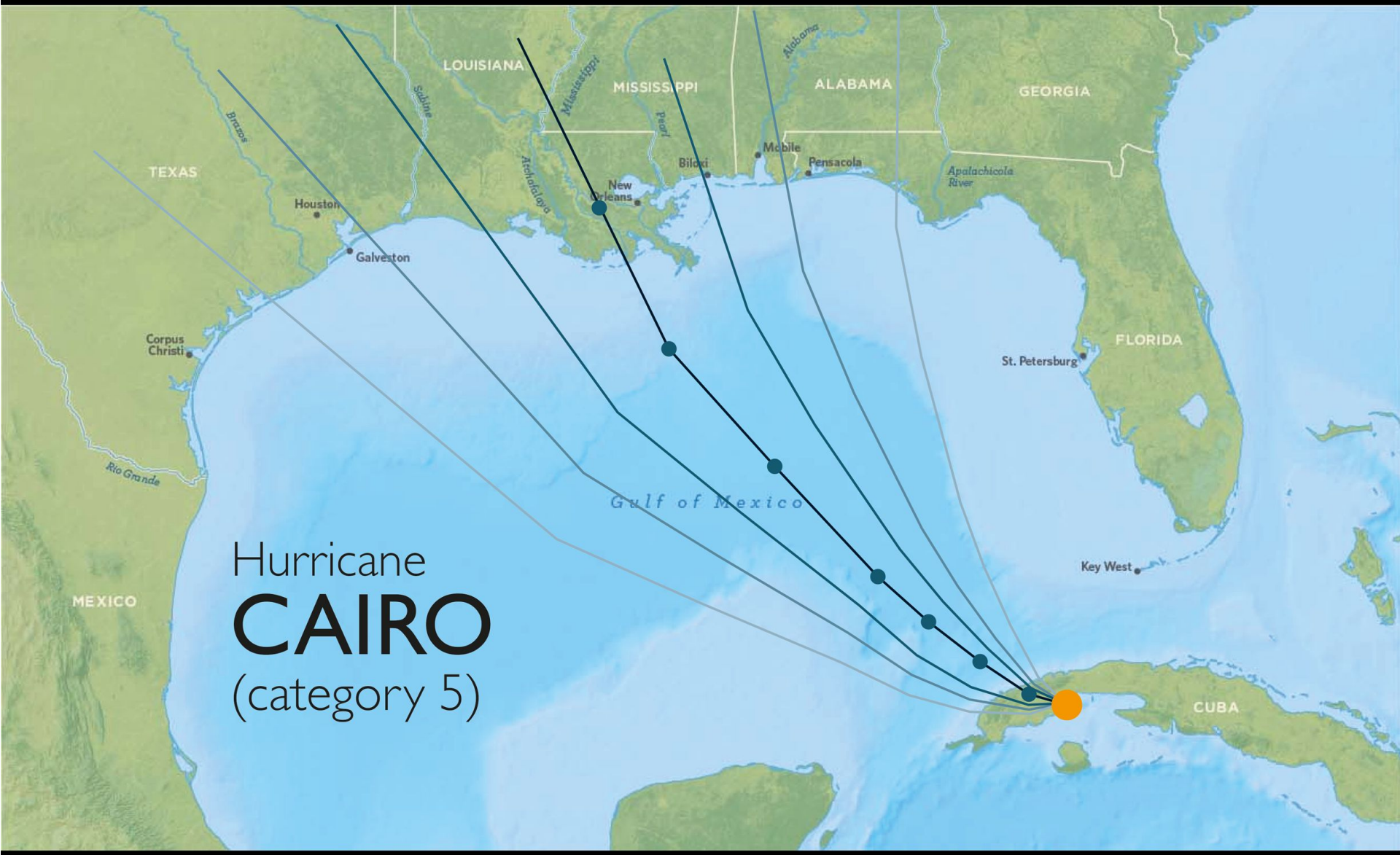
What I think some people see



What the cone is based on



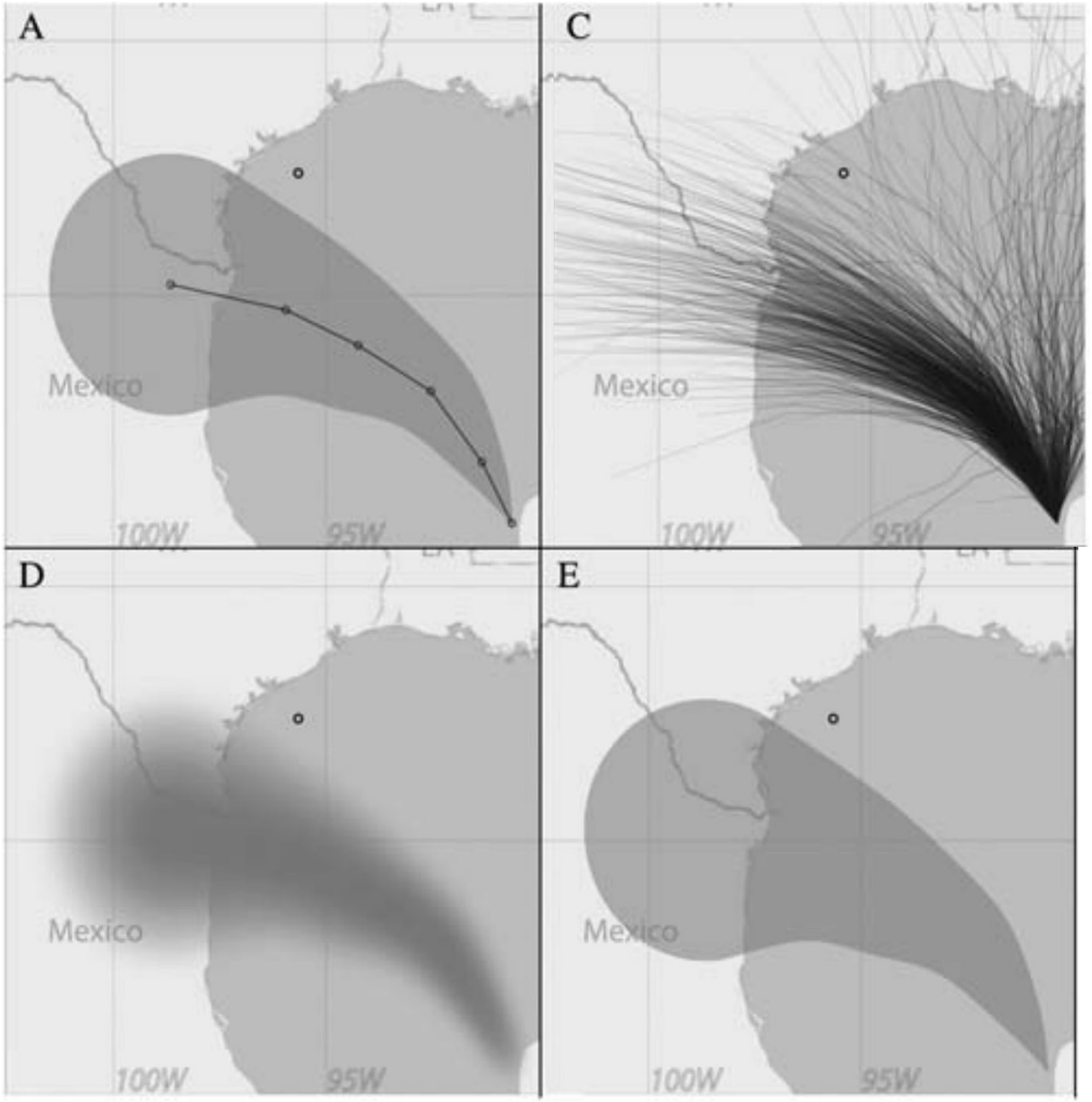
What non-scientists are not aware of (cone is just 66% probability)

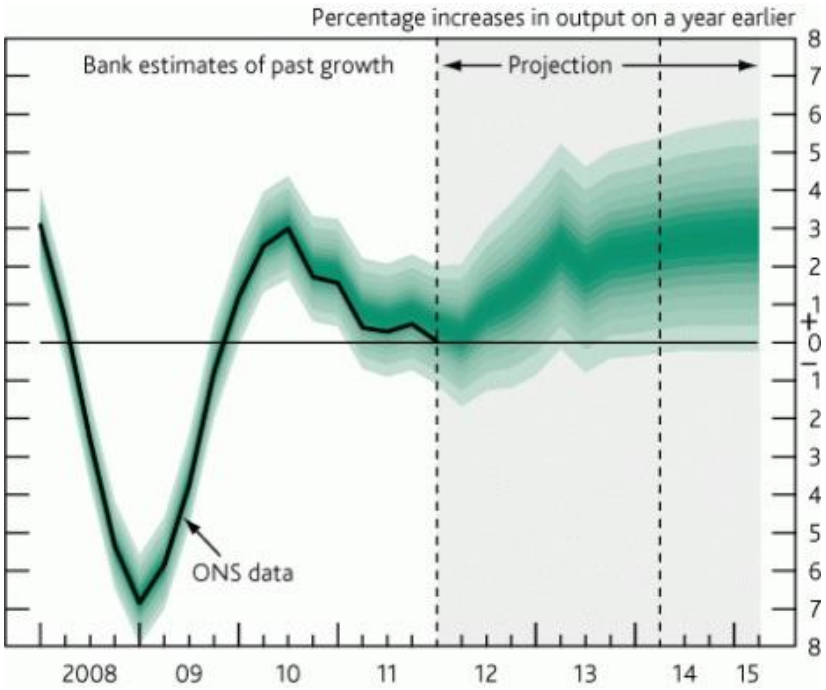
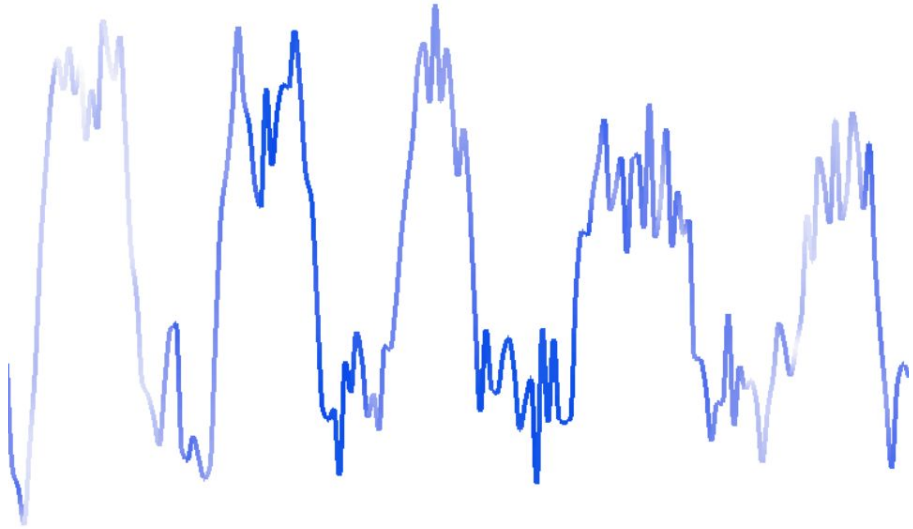
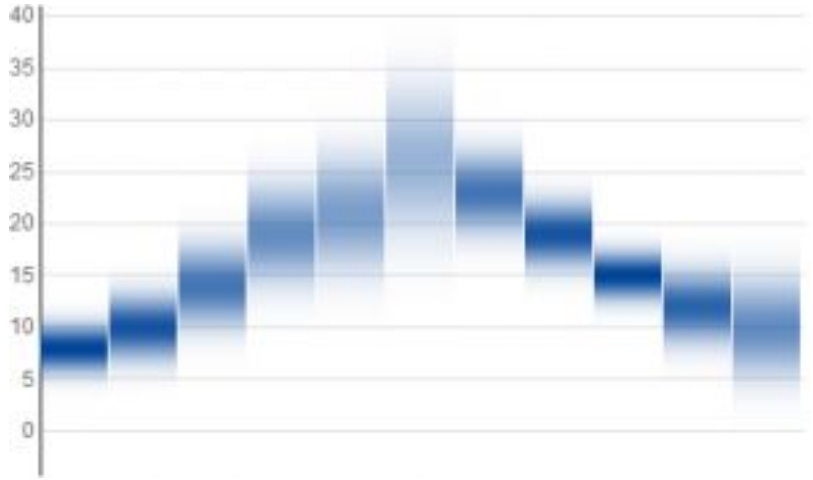


What we could be showing instead

What all this may mean!

Uncertainty



Ruginski et al,: Non-expert interpretations of hurricane forecast uncertainty visualizations, 2012

Uncertainty