Seeing Is Believing! Good Graphic Design Principles for Medical Research

Track 15: Statistical Science and Quantitative Thinking

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Today's Session

- **Motivators for Use of Graphs in Medical Research**

  Susan Duke, MS

  Director, Benefit Risk Evaluation, Global Clinical Safety and Pharmacovigilance,GlaxoSmithKline

- **Not every graph is a good one: Examples of improvements to commonly used graphs**

  Brenda Crowe, PhD

  Sr. Research Advisor, Global Statistical Sciences, Eli Lilly and Company

- **Spaghetti, Lasagna, and Cooking Up Graphs from Scratch**

  Richard Forshee, PhD

  Associate Director, Office of Biostatistics and Epidemiology, CBER, FDA

What you can learn from this session

- Discuss motivations for use of good statistical graphics principles, with examples
- Illustrate ways to improve the quality and transparency of statistical graphics in medical research
- Describe a new framework for selecting the appropriate graph type for the situation at hand

Motivators for Use of Graphs in Medical Research

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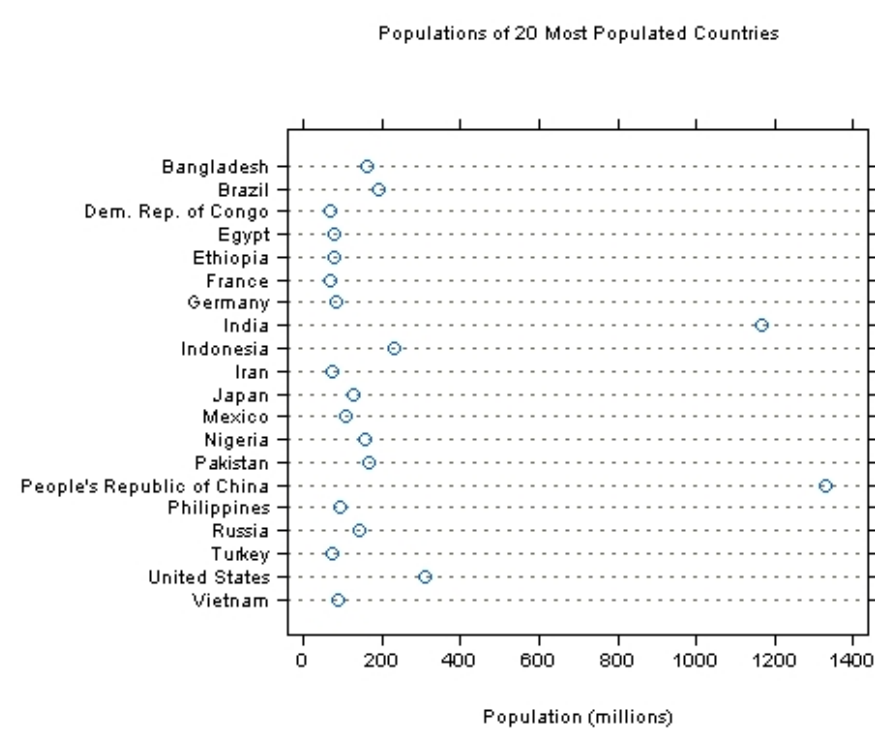
Motivators for Well-Designed Graphics in Medical Research

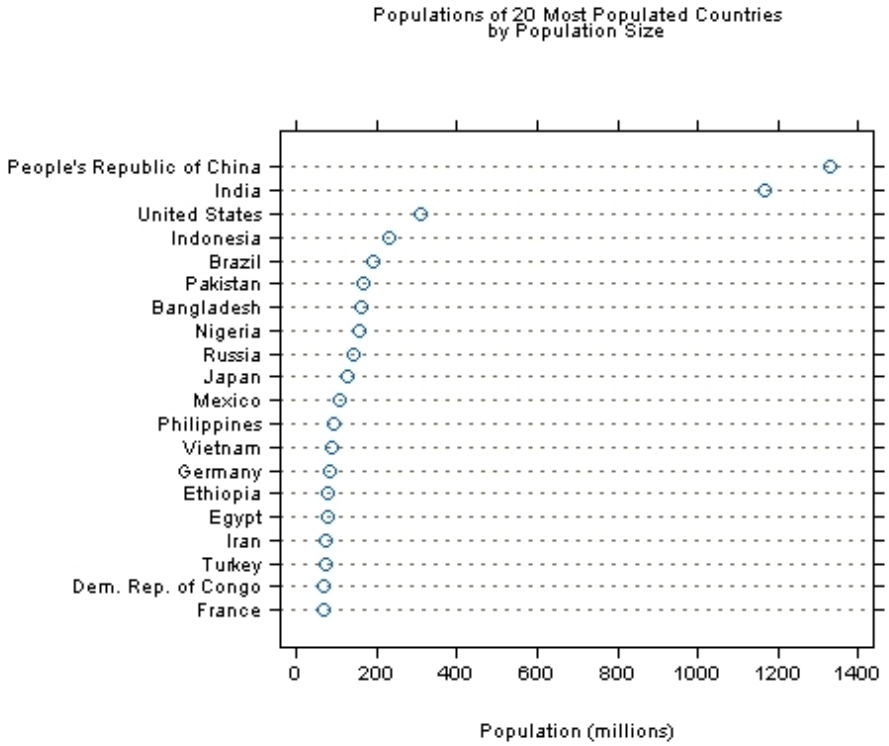
1. Visual decoding
2. It's what the masters did (Tukey, Cleveland, Tufte)
3. Human's keen visual perception often best choice for signal detection
4. Why not?

Visual Decoding

Table Look-Up vs Pattern Perception

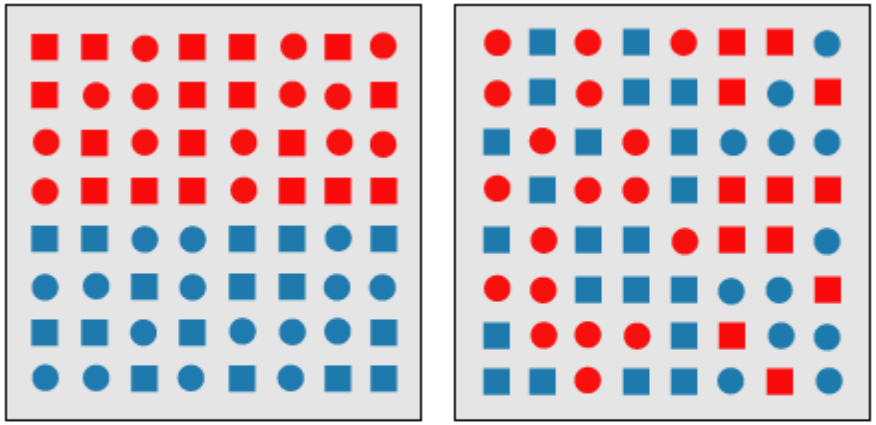


Source: Wikipedia



Concept from William Cleveland, The Elements of Graphing Data
Graphs by Susan Duke, GSK

Visual Decoding



(a) (b)

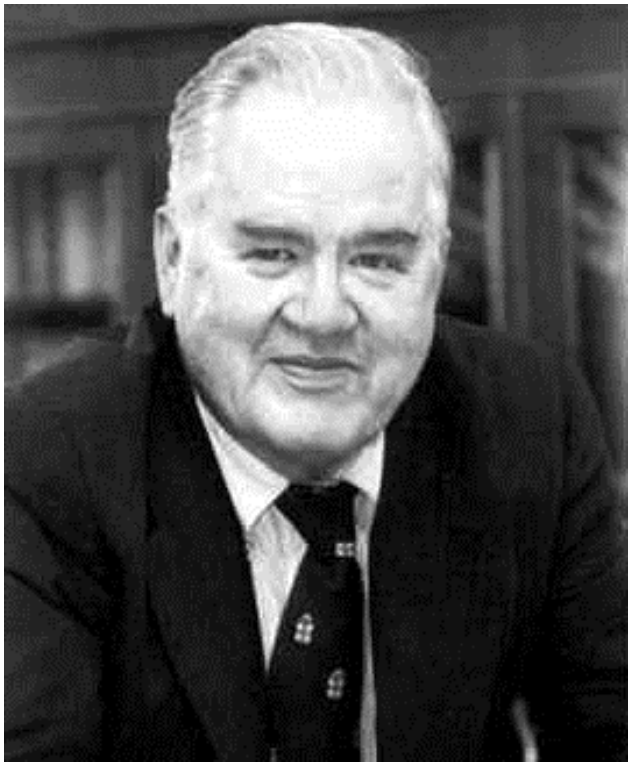
Fig. 4: An example of a boundary detection from Treisman's experiments: (a) a boundary defined by a unique feature hue (red circles and red squares on the top, blue circles and blue squares on the bottom) is preattentively classified as horizontal; (b) a boundary defined by a conjunction of features (red circles and blue squares on the left, blue circles and red squares on the right) cannot be preattentively classified as vertical

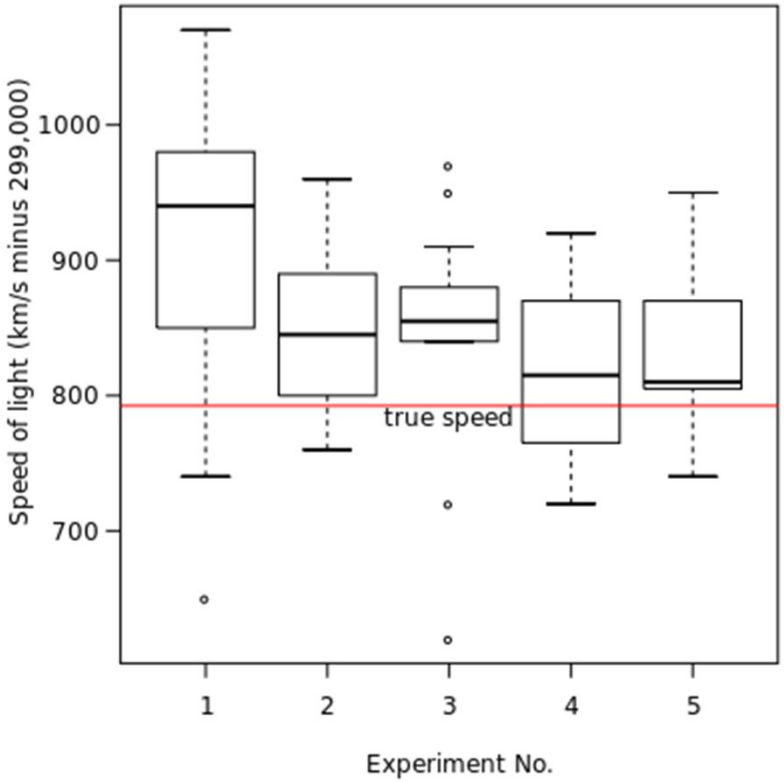
See more at http://www.csc.ncsu.edu/faculty/healey/PP/index.html

Good Graphics Practices

- John Tukey
- Edward Tufte
- William Cleveland
- Safety Graphics Wiki

John Tukey
Best known for the Boxplot





http://en.wikipedia.org/wiki/John_Tukey

Tukey's Recommendations from 1990

"Data-Based Graphics: Visual Display in the Decades to Come"

"We need to pay serious and continuing attention to securing:

a) Immediate and strong impact
b) Easy flow of attention across parallel elements
c) Planning to show phenomena, not numbers
d) Attention to both prospecting for what the data might show and transfer (to others)
e) Partnership with computation
f) Put disproportionate response to work"

Statistical Science 1990 5(3): 327-339

Tufte on Analytical Reasoning

“Be approximately right rather than exactly wrong." John W. Tukey

"The first principle is that you must not fool yourself--and you are the easiest person to fool." Richard Feynman

Ask questions.

Develop and fine-tune *a sense of the relevant,* both for identifying the key leverage points in any problem and also for examining large amounts of information to find the rare diamonds in the sand.

Nearly all serious analysis requires multivariate-thinking, comparison-thinking, and causal-thinking. Develop such thinking.

http://www.edwardtufte.com/bboard/q-and-a-fetch-msg?msg_id=0002bA

William Cleveland

"Visualization is critical to data analysis. It provides a front line of attack, revealing intricate structure in data that cannot be absorbed in any other way. We discover unimagined effects, and we challenge imagined ones."

- "Tools matter… There are exceptionally powerful visualization tools, and there are others, some well known, that rarely outperform the best ones."

- "Our tendency is to be mislead into thinking we are absorbing relevant information when we see a lot. But the success of a visualization tool should be based solely on the amount we learn about the phenomenon under study. "

http://www.stat.purdue.edu/~wsc/visualizing.html

Safety Graphics Wiki
General Principles

1. **Content** Every graph should stand on its own
2. **Communication** Tailor each graph to its primary communication purpose
3. **Information** Maximize the data-to-ink ratio **Annotation** Provide legible text and information
4. **Annotation** Provide legible text and information
5. **Axes** Design axes to aid interpretation of a graph
6. **Styles** Make symbols and plot lines distinct and readable
7. **Colors** Make use of color if appropriate for the medium of communication
8. **Techniques** Use established techniques to clarify the message
9. **Types of plots** Use the simplest plot that is appropriate for the information to be displayed

http://www.ctspedia.org/do/view/CTSpedia/BestPractices

Visual perception for signal detection

Event	Drug A (%)	Drug B (%)	RR/OR	Low95%	Up95%
ARTHRALGIA	3.5	0.5	7.0	1.6	31.3
NAUSEA	19.0	4.6	4.1	2.6	6.9
ANOREXIA	3.5	0.9	3.9	1.2	13.1
HEMATURIA	3.2	0.9	3.6	1.0	12.2
INSOMNIA	6.0	1.9	3.2	1.3	7.5
VOMITING	8.6	2.8	3.1	1.5	6.2
DYSPEPSIA	9.7	3.7	2.6	1.4	4.9
WEIGHT DECREASE	2.1	0.9	2.3	0.6	9.0
PAIN	3.9	1.9	2.1	0.8	5.3
DIARRHEA	20.9	10.6	2.0	1.4	2.8
FATIGUE	3.7	1.9	1.9	0.7	5.1
FLATULENCE	4.6	2.8	1.6	0.7	3.7
DIZZINESS	6.7	4.2	1.6	0.8	3.1
ABDOMINAL PAIN	14.2	9.3	1.5	1.0	2.4
RESPIRATORY DISORDER	2.6	1.9	1.4	0.5	4.0
HEADACHE	8.4	6.5	1.3	0.7	2.3
INJURY	7.0	5.6	1.2	0.7	2.3
GASTROESOPHAGEAL REFLUX	2.6	2.3	1.2	0.4	3.3
BACK PAIN	5.3	4.6	1.2	0.6	2.3
HYPERKALEMIA	2.1	1.9	1.1	0.4	3.4
RASH	2.1	1.9	1.1	0.4	3.4
SINUSITIS	6.5	6.0	1.1	0.6	2.0
INFECTION VIRAL	6.9	5.8	1.1	0.6	2.1
UPPER RESP TRACT INFECTION	10.8	10.3	1.0	0.7	1.5
MYALGIA	2.8	2.9	1.0	0.4	2.6
URINARY TRACT INFECTION	2.8	2.8	1.0	0.4	2.6
COUGHING	6.0	6.0	1.0	0.5	1.9
MELENA	2.8	3.2	0.9	0.3	2.2
RHINITIS	3.9	5.1	0.8	0.4	1.7
BRONCHITIS	2.6	3.7	0.7	0.3	1.8
CHEST PAIN	2.8	4.2	0.7	0.3	1.6
CHRONIC OBSTRUCTIVE AIRWAY	22.0	35.2	0.6	0.5	0.8
DYSPNEA	2.1	6.9	0.3	0.1	0.6

Why Not? Part 1

From GSK's experience…

- Regardless of therapy area, we found that **every group has one or a few "graphics gurus."**
  - **This is a key resource!**
  - Ensure they understand graphic design too

- … **making the right graph is key to answering the right question**. … Both [graphic design and clinical interpretation] are topics [that] improve communication about our medicines.

http://www.amstat.org/sections/sbiop/BiopharmReport/2012_Spring_BR.pdf

Why Not? Part 2

From GSK's experience…

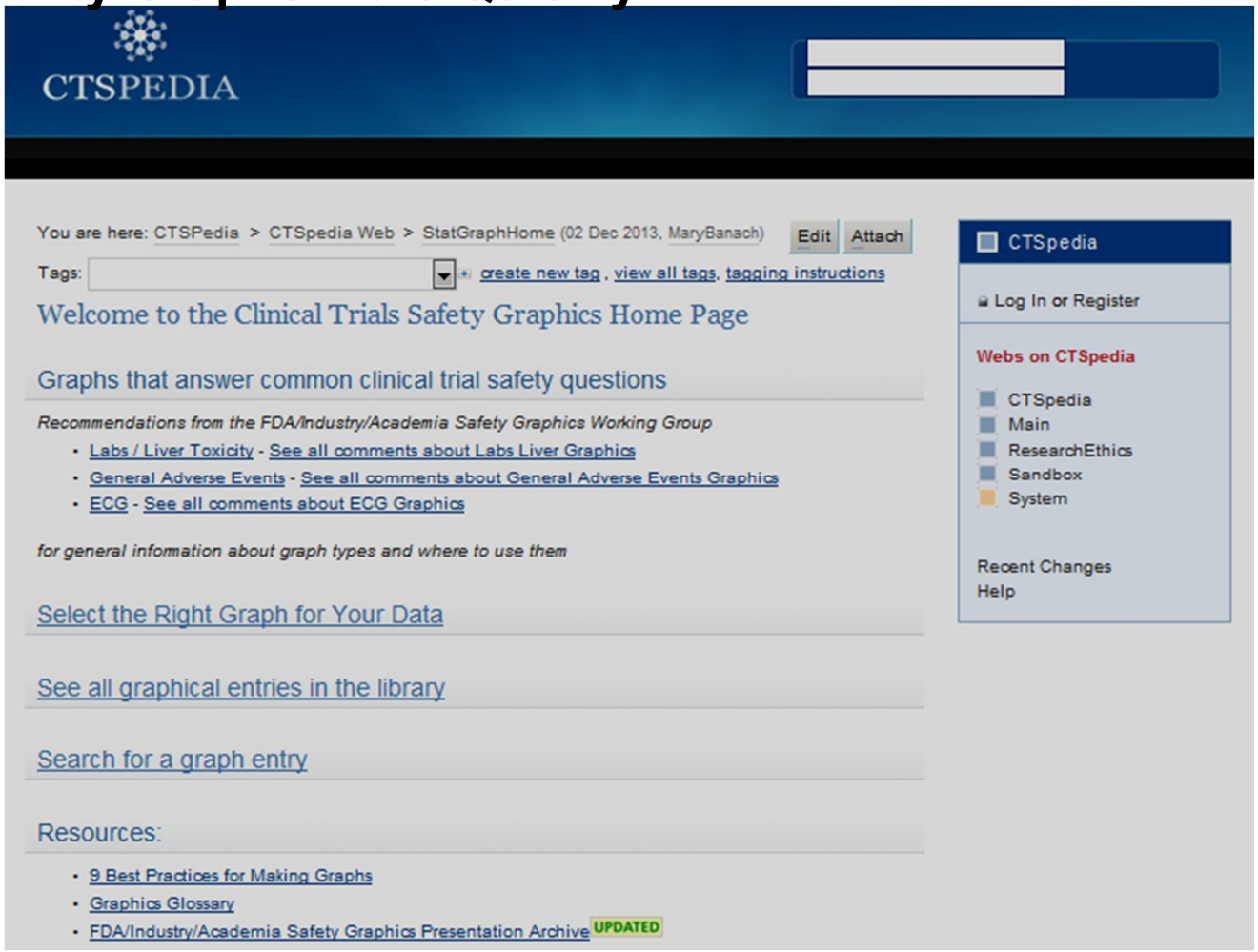
- **Software does matter.**
  - **A visual interface makes the graph come alive as it's constructed.**
    - We discovered by accident when we delivered both a graphical user interface (GUI) and some macros in our first deployment that users much preferred the GUI (and barely used the macros).
  - **Software that requires many iterations to create the desired graph is painful.**
    - For example, struggling with software to get appropriate device drivers takes longer and is more painful to use than software that has the right device drivers included by default.
  - **Standard graph templates** (and pre-processing macros to shape the data) **make it especially easy to answer commonly asked clinical trial questions with graphs.**

- http://www.amstat.org/sections/sbiop/BiopharmReport/2012_Spring_BR.pdf

Why Not? Part 3

How to Make Quality Graphs More Quickly?

- Use Standard Graphs for Common Safety Questions
- This wiki is available to everyone!
- Created by FDA/Industry/ Academia Working Group



http://www.ctspedia.org/do/view/CTSpedia/StatGraphHome

Thank you

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