

# Designing Effective Figures

## 20.109 Communication Workshop 1

Please find your seat next to your partner(s) and get started on the individual **brainstorming activity**. Write down a few responses to the broad questions on the sheet.

Sean Clarke  
Communication Instructor  
with Diana Chien and the  Communication Lab  
[be.mit.edu/communicationlab](http://be.mit.edu/communicationlab)

### Why care about scientific communication?

What's your experience with the scientific communication you've encountered?  
When and where does scientific communication happen?

### When you think of successful scientific communication, what words/phrases come to mind?

What can you do after reading a good paper or viewing a good figure?

### What makes you feel that communication has been successful?

#### As a receiver?

Clear message, logic flows, you can find your way around, visual appeal

#### As a sender?

Reward (citation, grade, funding), good feedback: questions or criticism

### We often blame ourselves for struggling to understand talks or papers,

but poor communication is often the barrier, not your scientific understanding.

"I got stuck here. I feel like there was a huge logical leap I couldn't follow."

"There's way too much going on in this plot. What am I supposed to be looking at?"


In these workshops, we'll turn your instincts as a reader of science into tools for identifying...

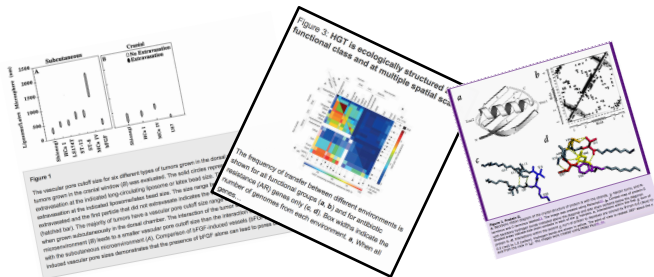
- WHEN scientific communication is confusing
- WHY it's confusing
- HOW to fix the problem

...and start applying these tools to your 20.109 communication tasks.

## How the workshops will go

1. Discuss an example from the field
2. Derive principles and strategies
3. Practice strategies
4. Go home with a checklist/rubric

Practice with a fellow at the  **Communication Lab !**



## Figures (and captions)

Why start here?

 **Journal of Bacteriology**

### This Article

Accepted manuscript posted online 6 August 2010, doi: 10.1128/JB.00524-10  
J. Bacteriol. October 2010 vol. 192 no. 19 5103-5114

Abstract **Free**  
» **Figures**  
Full Text  
PDF

Science 08 Feb 2009  
Vol. 323, Issue 5915, pp. 741-746  
DOI: 10.1126/science.1159398

**Science** MAGAZINE

Article **Figures & Data** Info & Metrics eLetters  PDF

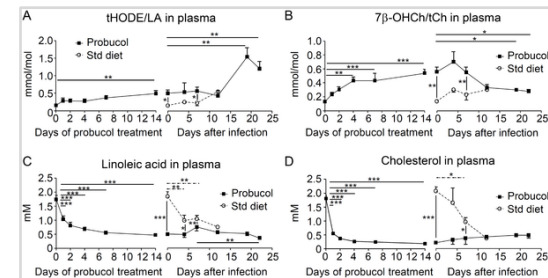
**PNAS**

Abstract Full Text Authors & Info **Figures** Metrics Related Content **PDF**

Figures must convince your audience of your data's impact and credibility.

- Expert audiences may ONLY READ your title, abstract, and FIGURES.
- Hold your "naked" data up to be judged.
- Help tell your story compellingly AND honestly.

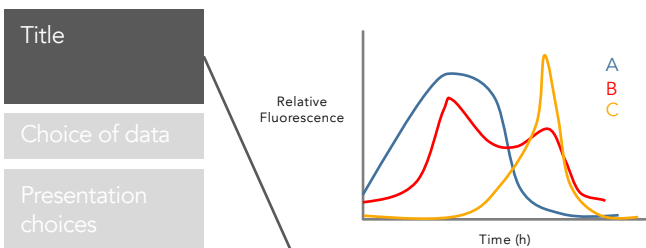
## Identify the basic figure components



**Fig 4. The ratios of lipid peroxidation products to parent lipids in plasma increased after probucol pre-treatment.** Six-week-old C57BL/6J mice were treated with 1% w/w probucol in the diet for 2 weeks and then infected with  $0.2 \text{ mL of } 1 \times 10^7$  erythrocytes/mL infected with *Plasmodium yoelii* XL-17. Plasma samples were obtained at day 0, 1, 2, 4, 7, and 14 after starting the probucol diet ( $n = 5$  per group) and at day 0, 4, 7, 12, 19, and 22 post-infection ( $n = 2$  to 7). The ratio of total hydroxyoctadecadienoic acid (HODE), a peroxidation product of linoleic acid (LA), to linoleic acid (tHODE/LA) in plasma (A) and the ratio of 7 $\beta$ -hydroxycholesterol (7 $\beta$ -OHCh), a peroxidation product of cholesterol, to total cholesterol (7 $\beta$ -OHCh/tCh) in plasma (B) were measured. The concentration of LA (C) and tCh (D) were measured by using gas chromatography-mass spectrometry (GC-MS). All data are expressed as mean  $\pm$  SE. Statistical analysis was carried out by analysis of variance (ANOVA). \* $p < 0.05$ , \*\* $p < 0.025$ , and \*\*\* $p < 0.001$ . The solid bars indicate the significant changes in probucol-treated groups and the dotted bars indicate the significant changes in standard (Std) diet-fed mice.

## Basic figure components

Figure = message + data



**Fig. 1: A, B, and C have different dynamics under Condition X.** A, B, and C were sampled using Method 1 and their fluorescence quantified with Method 2. Fluorescence data normalized to negative control.

Title

Choice of data

Presentation choices

Caption

## Basic figure components

Figure = message + data

Title

- Take-home **message** of the figure
- What conclusion should the reader evaluate when looking at the figure?

Choice of data

- Only data that are critical to the conclusion

Presentation choices

- Type of graph or display, legends & labeling, design choices
- Uncluttered
- Allow quick evaluation of conclusions, without referring to legend or caption.

Caption

- Descriptive, not explanatory/interpretive.
- Only enough methodological detail to make it clear how results were obtained.

All the figures you make need all of these components

Schematics  
Diagrams  
Photos

...count as figures too.

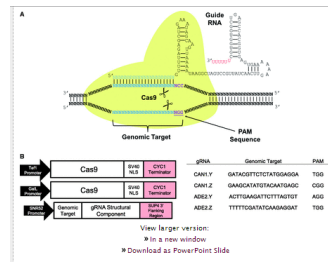
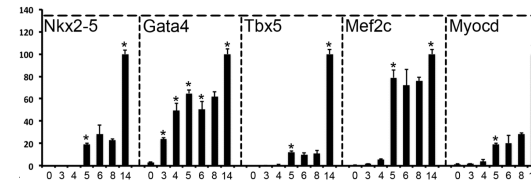


Figure 1. Diagram of Cas9 complex and schematic of genetic constructs. (A) Illustration of Cas9 protein interacting with CRISPR gRNA to direct endonuclease activity proximal to the PAM sequence. (B) Design of the Cas9 and gRNA constructs. Cas9 gene contained a SV40 nuclear localization signal and was expressed under the Gal-L inducible promoter in CAN1 experiments and the TEF1 constitutive promoter in ADE2 experiments. The gRNA was DiCarlo et al., 2013 Nuc. Acids. Res.

Use titles to state a figure's message, not the method



Gene expression analysis performed on differentiating mouse iPS cells

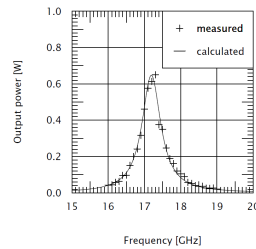


Expression of early cardiac transcription factors increases over time in differentiating mouse iPS cells

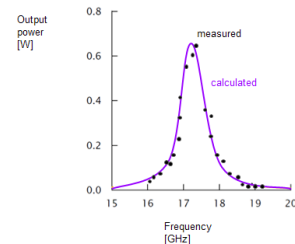
Christoforou N, et al. (2013) PLoS ONE 8(6): e65963. doi:10.1371/journal.pone.0065963

Maximize signal-to-noise:

State your message.  
Eliminate anything that distracts from it.



**Low signal-to-noise ratio**  
The background interferes with the data.

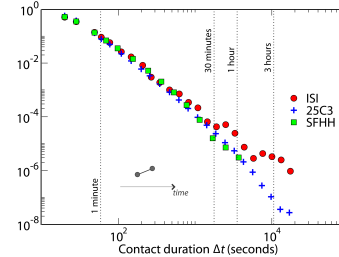


**High signal-to-noise ratio**  
Only the necessary information is shown.

Adapted from Jean-luc Doumont, Trees, Maps, and Theorems

Only show as much data as you need to convey your message.

Probability distribution of human interactions at 3 conferences

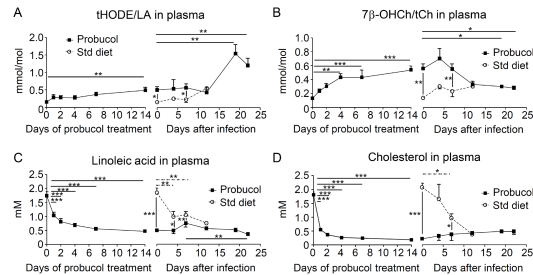


At a poster session, 50% of your audience walks away after 20 sec.

Time talking	Probability listening
0 sec	100%
20 sec	50%
1 min	10%
2 min	5%
5 min	<1%

Cattuto et al., 2010, PLoS ONE

## Activity: Improve this published figure



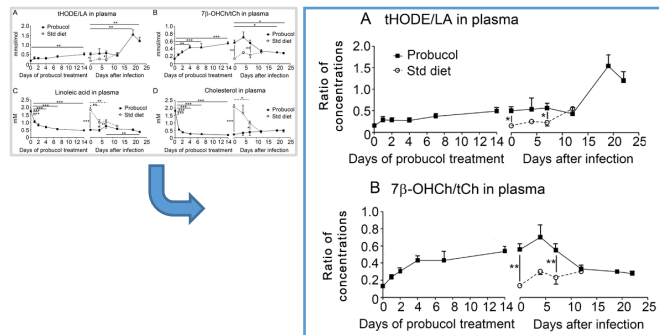
**Fig 4. The ratios of lipid peroxidation products to parent lipids in plasma increased after probucol pre-treatment.** Six-week-old C57BL/6J mice were treated with 1% w/w probucol in the diet for 2 weeks and then infected with 0.2 mL of  $1 \times 10^5$  erythrocytes/mL infected with *Plasmodium yoelii* XL-17. Plasma samples were obtained at day 0, 1, 2, 4, 7, and 14 after starting the probucol diet ( $n = 5$  per group) and at day 0, 4, 7, 12, 19, and 22 post-infection ( $n = 2$  to 7). The ratio of total hydroxyoctadecadienoic acid (tHODE), a peroxidation product of linoleic acid (LA), to linoleic acid (tHODE/LA) in plasma (A) and the ratio of 7 $\beta$ -hydroxycholesterol (7 $\beta$ -OHCh), a peroxidation product of cholesterol, to total cholesterol (7 $\beta$ -OHCh/tCh) in plasma (B) were measured. The concentration of LA (C) and tCh (D) were measured by using gas chromatography-mass spectrometry (GC-MS). All data are expressed as mean  $\pm$  SE. Statistical analysis was carried out by analysis of variance (ANOVA). \* $p < 0.05$ , \*\* $p < 0.025$ , and \*\*\* $p < 0.001$ . The solid bars indicate the significant changes in probucol-treated groups and the dotted bars indicate the significant changes in standard (Std) diet-fed mice.

Herbas MS et al (2015) *PLoS ONE* 10(8): e0136014.

## Evaluating figure choices

- Which data are irrelevant?
- Are there any data/labels missing?
- What could be done to better highlight the most important data?
- Is there a better way to present the data?
- Do the statistics actually add anything here?

Only include the minimum information necessary to draw a conclusion.



## Exercise: Turn real data into a figure.

- Don't get bogged down in the details.
- Approximations and sketches are perfect for this exercise.
- Try to draft all the parts we have talked about.

<b>Title</b>	Take-home message of the figure. What conclusion should reader evaluate when looking at the figure?
<b>Choice of data</b>	Only data that are critical to the conclusion.
<b>Presentation choices</b>	Type of graph or display, legends & labeling, design choices. Uncluttered; allow quick evaluation of conclusions, without referring to legend or caption.
<b>Caption</b>	Descriptive only, not explanatory/interpretive. Only enough methodological detail to make it clear how results were obtained.  "...include only the most relevant aspects of the methods, such as the names of the diagnostic enzymes, a clear description of any normalization or statistics done on the flow cytometry data, etc." (Mod. 1 Wiki)

## These are our next steps

- This presentation and rubric will be on the wiki for you to reference.
- Put these methods to work on your 109 figures
- Tell me: How can these workshops be better? saclarke@mit.edu
- In 2.5 weeks... Abstracts!

## A checklist to help you optimize your figure

### High-level questions

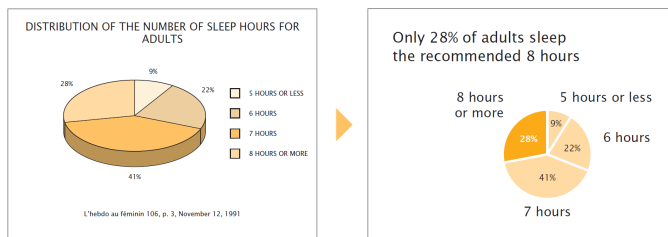
- *Strategic purpose:*
  - What do you want to convey?
  - How will you and/or your audience use this figure?
- *Organizational structure:*
  - Where does this figure fit into the communication?
  - Why?

### Checklist

- Choice of data
  - Can figure stand alone?
- Consistent layout
  - Fonts, spacing, colors
- Text amount and placement
- Scale, axes, tick marks
- Error analysis
- Ink-to-whitespace ratio

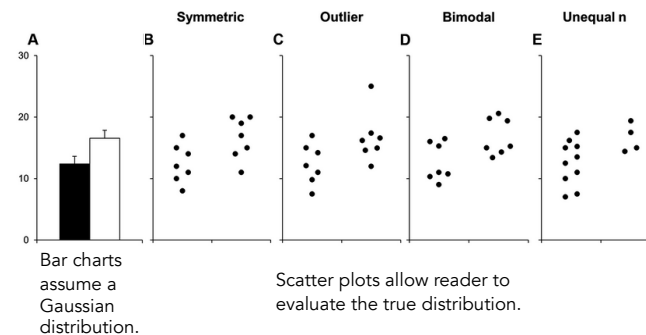
## Maximize signal-to-noise:

State your message.  
Eliminate anything that distracts from it.



Jean-luc Doumont, Trees, Maps, and Theorems

## Consider which plot type best allows the reader to evaluate your conclusion.



Weissgerber et al. (2015), Beyond Bar and Line Graphs: Time for a New Data Presentation Paradigm. *PLoS Biology*