Elements of Scientific Writing

ENGR 361: Scientific Research Communication

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References

- Alred, G. J., Brusaw, C. T., & Oliu, W. E. (2009). *Handbook of technical writing*. Macmillan.

- Day, R. A., Sakaduski, N., & Day, N. (2011). *Scientific English: A guide for scientists and other professionals*. ABC-CLIO.

Assignment 4 – The Research Paper

SOURCE DATA ASSIGNMENT
▪ **You will need to specify what data source you plan to use for the report. Write a brief description of how the data was collected (~150 words) and reference work, submit an electronic document.** If you plan to use published data from the literature (a **meta-analysis**), attach copy of the publications containing the data you plan to use. Be careful to write the report in your own words; you may use data but nothing else from that published paper.

RESEARCH REPORT 1st, 2nd, and FINAL DRAFT
▪ The report should be pitched to a reader who has a good science background and is somewhat knowledgeable about the topic on which you're writing (not an expert in the field). The length of the final report should be about 2000 words. You will lose credit if your report is less than 1700 words or more than 2500 words. **Your research report should include the following sections: Title page, Abstract, Introduction, Methods, Results, Discussion, Conclusion, References, and Figures**.

▪ You must include references of **at least six** publications relative to the subject of the report. These would normally include an original publication of the methods being used as well as other references to the problem being studied. At least four of the references should cite original research literature.

Characteristics of Scientific Writing

- A main purpose of science writing: *explain*
  - *What did I do?*
  - *Why was it important?*
  - *How did I do it?*
  - *What did I find?*
  - *What does it mean?*

- Answering these simple questions will greatly aid your writing

Characteristics of Scientific Writing

What did I do?
Why was it important?
How did I do it? → **Essential structure of the research paper, abstract**
What did I find?
What does it mean?

Characteristics of Scientific Writing

- *Who is your Audience?*

> - **Level of expertise?**
> - **What information do they need?**

> - **Words and images you choose will depend on your reader**

Scientific Writing

- The audience that scientists primarily write for is fellow scientists: people who value precision and demand accuracy

- Scientific papers are read carefully!!
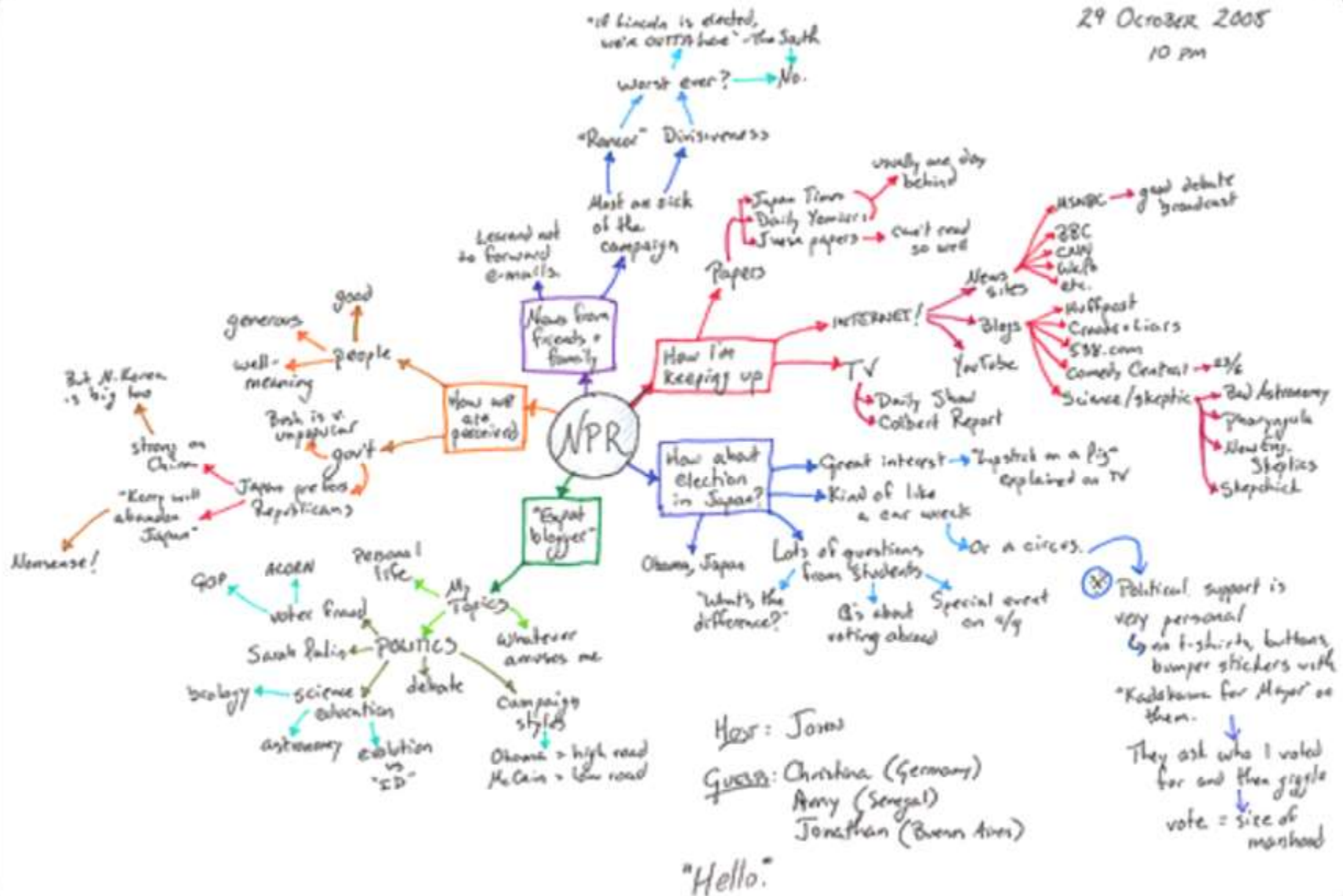
Scientific English. 3rd ed

Establish Purpose

- Establish the purpose
  - Determine the audience
  - List all the ideas to include
  - List the key points
  - Group related ideas together and arrange material in subsections from general to specific or from known to unknown

Organization

Outline

- Helps identify the most important aspects

- Guides the writing process

- Helps organize ideas

- Helps identify areas where more information is needed

Outline for Writing a Research Paper

I. Introduction- begin with Thesis Statement: In one clear sentence state the focus of your paper.
  A. Key points (have at least three, but no more than five)
    1. state each main point that you'll be making in the paper
    2. main point
    3. main point
    4. main point
    5. main point
II. Body of paper- outline the topic sentence and supporting research for each point you'll be covering in the paper, beginning with point #1 stated in the introduction.
  A. Point 1- topic sentence idea
    1. research concept
      a. supporting idea(s)
      b. connect to next concept
    2. research concept
      a. supporting idea(s)
      b. connect to next concept
    3. research concept
      a. supporting idea(s)
      b. connect to next topic idea
  B. Point 2- topic sentence idea
    1. research concept
      a. supporting idea(s)
      b. connect to next concept
    2. research concept CONTINUE FORMAT
    3. "   "
  C. Point 3- topic sentence idea and CONTINUE FORMAT
  D. Point 4- topic sentence idea and CONTINUE FORMAT
  E. Point 5- topic sentence idea and CONTINUE FORMAT
    1.
    2.
    3. after last point is made and supported, create a transition to summary and conclusion
III. Summary paragraph- create a key summary sentence that declares a wrap-up of concepts to begin this paragraph
  A. Follow the summary sentence with clear sentences that summarize each of the main ideas that have been discussed in the body of the paper
    1. summary of point 1
    2. summary of point 2
    3. summary of point 3
    4. summary of point 4
    5. summary of point 5
IV. Conclusion- transition to the ending of your paper and final thoughts in a paragraph
V. Reference page in alphabetical order by last name (see APA format online and note examples from Reference section in back of textbook, and remember to cite all of your references in the body of your text following a summary concept or quote)

Outline

- Shows relationship between ideas

- Provides a way to break larger topics into smaller sections

- Defines boundaries and groups

- Helps prevent digression & the inclusion of extraneous information

Outline for Writing a Research Paper

I. Introduction- begin with Thesis Statement: In one clear sentence state the focus of your paper.
  A. Key points (have at least three, but no more than five)
     1. state each main point that you'll be making in the paper
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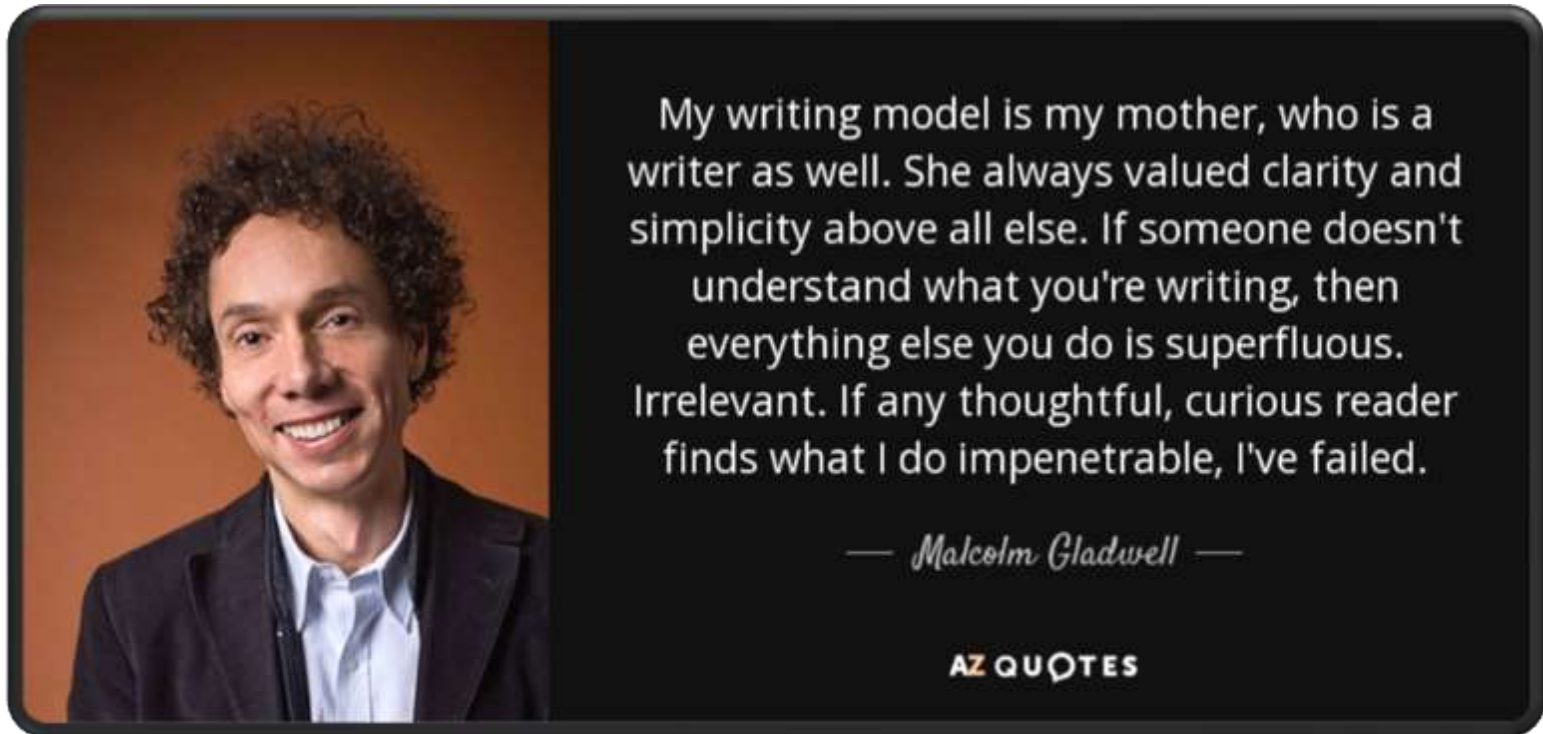**LONG BEACH**

The Scientific Voice

- The scientific voice requires **precise**, **consistent** vocabulary, **clear** sentences, and a **logical**, **sequential** approach to the subject matter

Finding Your Scientific Voice

Clarity

- Your writing must accurately communicate what you're trying to say

My writing model is my mother, who is a writer as well. She always valued clarity and simplicity above all else. If someone doesn't understand what you're writing, then everything else you do is superfluous. Irrelevant. If any thoughtful, curious reader finds what I do impenetrable, I've failed.

— Malcolm Gladwell —

AZ QUOTES

Clarity

- Your writing must accurately communicate what you're trying to say
    - What the reader understands is no more AND no less than what you're trying to say
    - Say what you mean
    - Avoid implying things you do not mean

Clarity

- Writing with Clarity …
  - Stems from clarity of thought
  - Requires language understood by reader

Are too many messages confusing your readers?
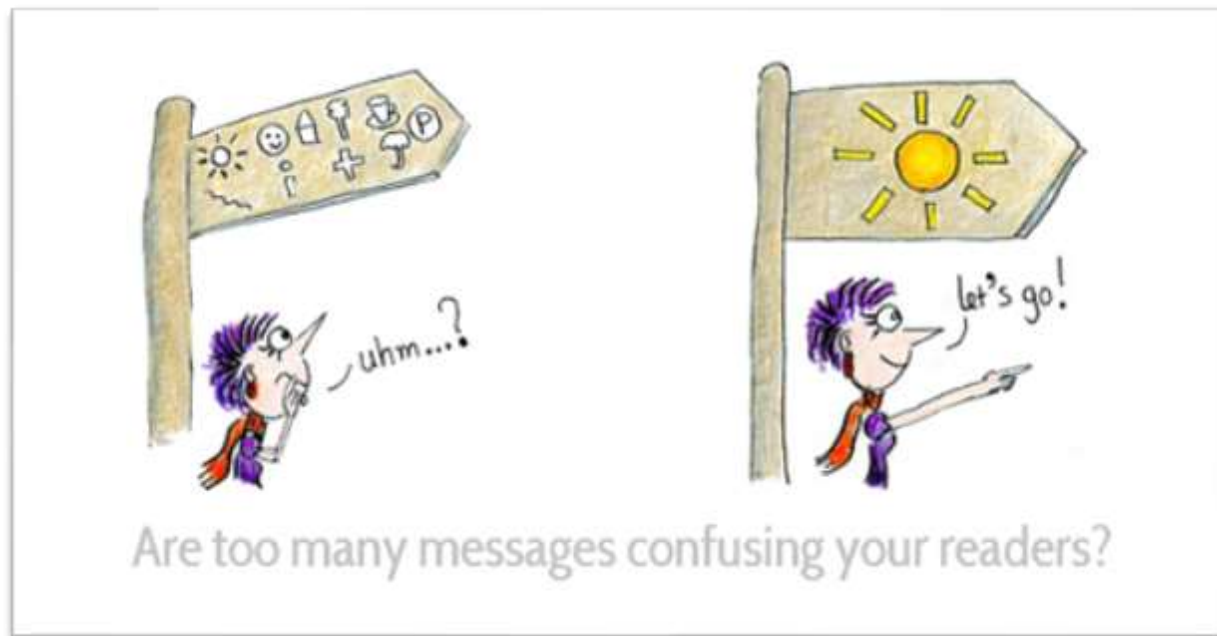
Completeness

- Treatment of Subject/Topic should be self contained comprehensive
  - Statements should be grammatically complete
  - Arguments should be followed to their logical conclusion
  - All aspects of an issue or argument should be considered appropriately
    - No Gaps!

Impartiality

- Indicate manner by which data were collected and limitations of methods
    - Possible sources of error
    - Limitations in conclusions
- Clarify assumptions and underlying arguments
   - Crucial for validity and strength of conclusions

Impartiality.

Impartiality

- Perform statistical analysis
- Evaluate results, conclusions in critical unbiased manner
- Do not "have a stake" in the outcome of an experiment
  - A major purpose of peer review

Impartiality.

Assumptions vs Evidence

- Conclusions must be based on data
- Assumptions, extrapolations, generalizations must be based on sufficient evidence
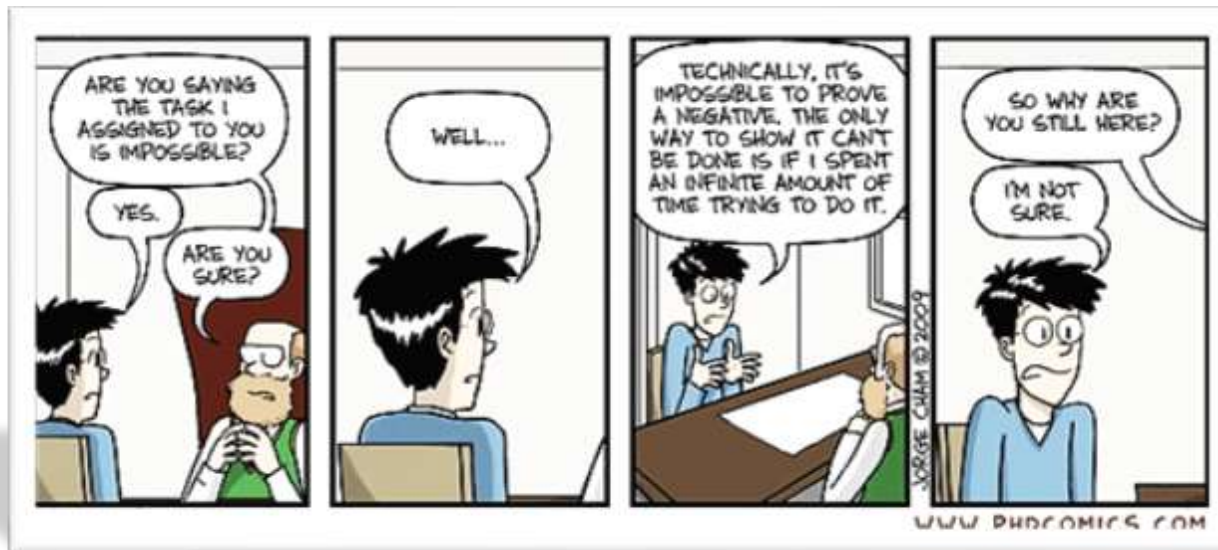
NO Replacement for Evidence

- Conclusions must be based on data

- Assumptions, conjectures are NOT evidence

- Do not confuse "data" with "facts"

- "Fact" statements are based on the weight of multiple lines of evidence

NO Replacement for Evidence

Weak Phrase	Actual Meaning
"It is evident that..."	"I think..."
"It is generally agreed that..."	"Some people think..."
"All thinking people agree that..."	"If you don't agree with me, you must be..."
"It is likely that..."	"I don't have enough evidence to say that..."
"So far as we know..."	"We could be wrong but..."
"As you know..."	(couldn't think of how to start the sentence)

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Summary So Far …

Scientific communication: *explaining* ➡️

- *What I did*
- *Why it's important*
- *How I did it*
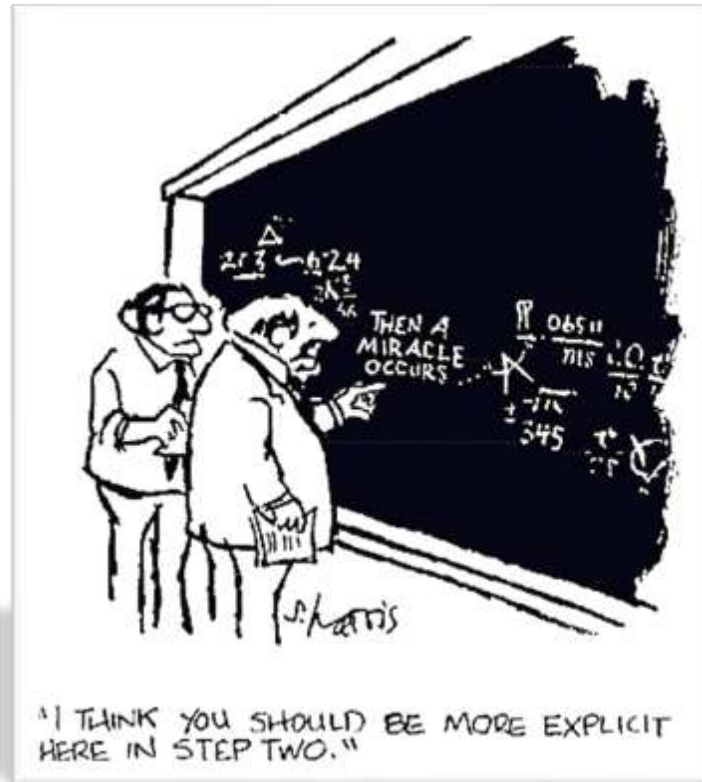- *What I found*
- *What it means*

Qualities of science writing: ➡️

- *Clarity*
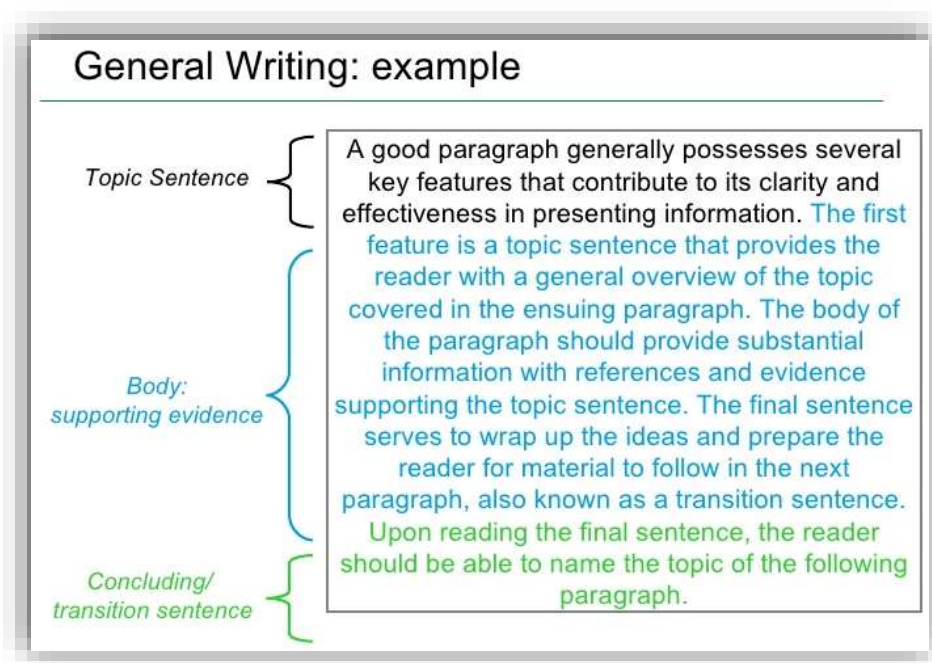- *Completeness*
- *Impartiality*
- *Evidence-based*

Order

- Good science writing has a logical order, makes sense to the reader

"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

Order

- Good science writing has a logical order, makes sense to the reader
- Hierarchy, sequence of the ideas, promote readability, understanding

General Writing: example

Topic Sentence ⎰ A good paragraph generally possesses several key features that contribute to its clarity and effectiveness in presenting information. The first feature is a topic sentence that provides the reader with a general overview of the topic covered in the ensuing paragraph. The body of the paragraph should provide substantial information with references and evidence supporting the topic sentence. The final sentence serves to wrap up the ideas and prepare the reader for material to follow in the next paragraph, also known as a transition sentence. Upon reading the final sentence, the reader should be able to name the topic of the following paragraph.

Body: supporting evidence

Concluding/ transition sentence

Order

- Good scientific writing is like constructing a building
  - Planning
  - Foundation
  - Care in execution
  - Attention to detail

Accuracy

- Good scientific writing reflects the care invested at all levels of the scientific process
    - Planning
    - Preparations
    - Execution of experiments
    - Observations
    - Data recording
    - Data analysis
- Every experiment is repeatable
- Every conclusion verifiable

Accuracy

- Scientific writing, like the practice of science, is an exercise in craftsmanship

- Reporting science requires the same level of devotion as doing science

Objectivity

- Scientific statements are based on evidence, not on unsupported opinion
  - Faithfulness to facts
- Freedom from personal biases
  - Avoid excessive qualification of scientific claims
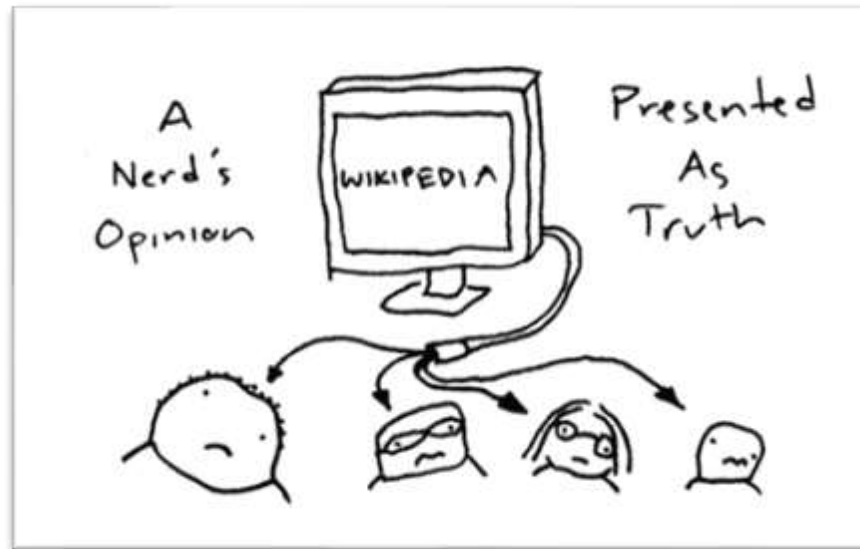
Objectivity

- Too many limitations, restrictions, or conditions on scientific conclusions cast doubt on their validity

- "Are more experiments needed?"

- Do NOT argue from a lack of evidence
  - Do NOT imply conclusions unsupported by data

Tips for Literature Review

- Review abstracts carefully

- Write down the searches you conduct in each database so that you may duplicate them if you need to later

- Use the references of research studies to locate other related work

- Ask your professor or a scholar in the field if you are missing any key works in the field

- Maintain careful notes to track your thought processes during the research process

Reviewing an Article

- What are the research problems/ questions?

- What is the hypothesis?

- Is the research important? Why/Why not?

Reviewing an Article

- Are the methods and instruments used appropriate?

- What are the samples used in this study?

- What type of research is this?

- How was the data analyzed?

Reviewing an Article

- What are the major findings?

- What are the conclusions?

Reviewing an Article

- Could it have been conducted more thoroughly?

- What further questions does it raise?

- Are there conflicting studies?

- Has this study been cited?

In-Class Activity - Analyzing a Paragraph

- Next Slide is the opening paragraph of a review article

  Consitt LA *et al.* (2009). Intramuscular lipid metabolism, insulin action, and obesity. IUBMB Life 61:47-55.

- Read through the paragraph and evaluate it as follows:

1. What is the paragraph's topic?
2. Where is the topic sentence?
3. Is the sentence sequence logical?
4. Does it contain superfluous sentences?
5. Based on this paragraph and the article title, what topics do you predict the article will contain?
6. Does the paragraph have impact?
7. Is the paragraph effective? How might it be improved?

Consitt LA *et al.* (2009). *Intramuscular lipid metabolism, insulin action, and obesity*. IUBMB Life 61:47-55.

The prevalence of obesity throughout the world has reached epidemic proportions. The World Health Organization classified at least 400 million people as obese (body mass index or BMI ≥ 30 kg/m^2) in 2005 and projected this number to reach 700 million by 2015. A number of comorbidities have been attributed to obesity including cardiovascular disease and type 2 diabetes ([1]). Based on the link between obesity and type 2 diabetes, it is not surprising that the rate of diabetes has also escalated. It is estimated that by the year 2010 over 220 million people world-wide will be affected by type 2 diabetes, an increase of 46% in the past decade ([2]). With the increased prevalence of obesity and insulin resistant disorders, research has attempted to elucidate the potential mechanisms behind these diseases, with the hope of ultimately providing effective interventions.
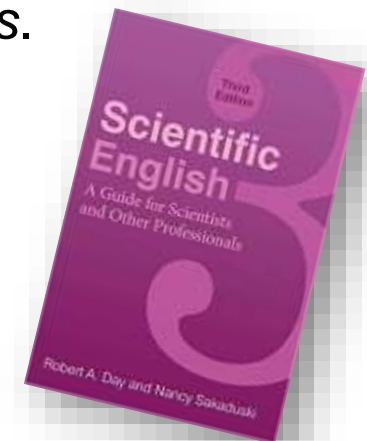
Elements of the Research Paper

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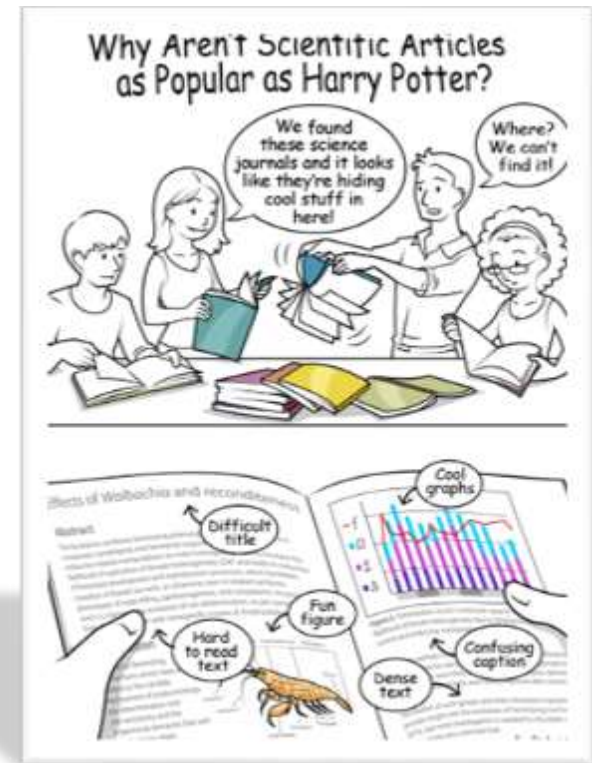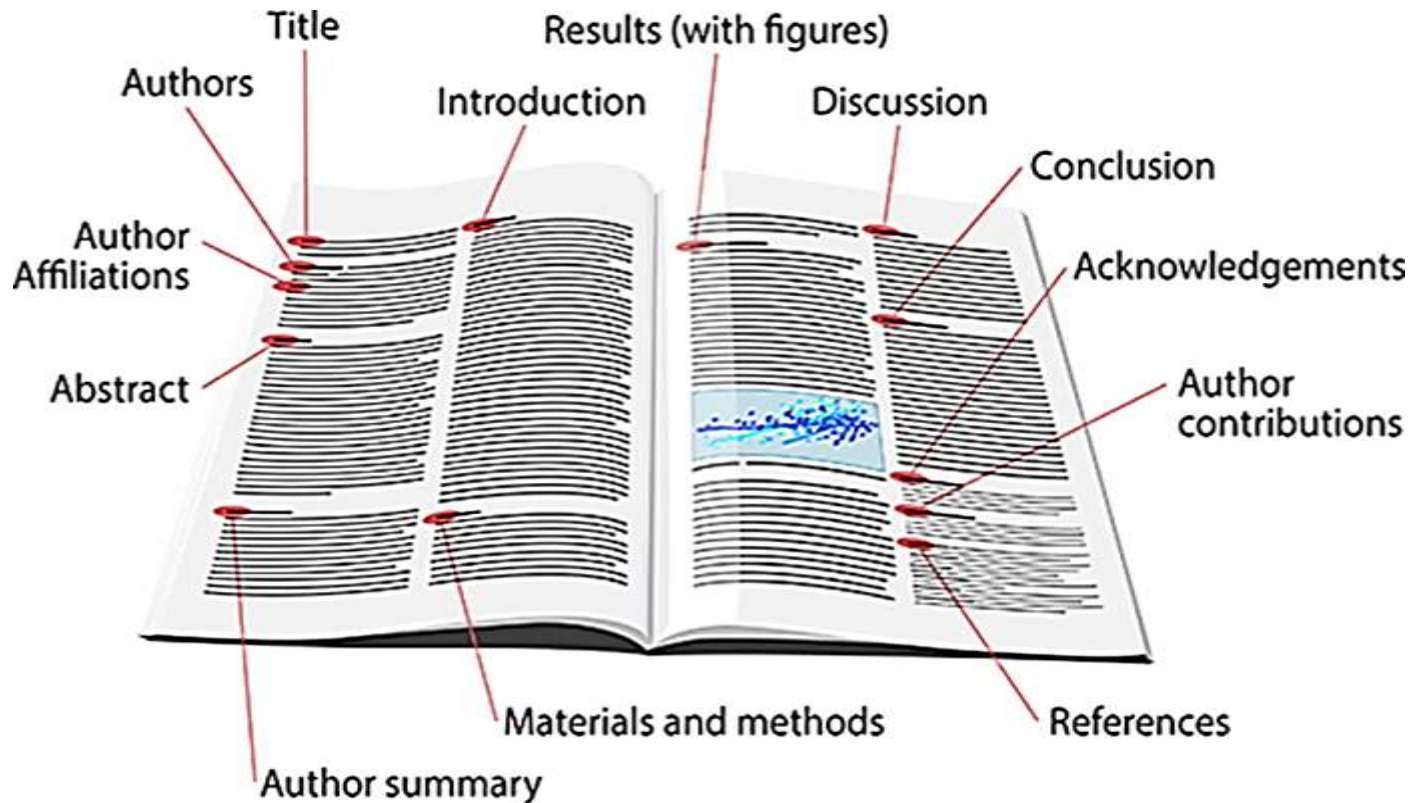
Writing the Scientific Paper

The Scientific Paper

- Primary method of presenting findings
- The Major sections of the Scientific Paper
  - Title
  - Abstract
  - Introduction/Background
  - Methods
  - Results
  - Discussion
  - Conclusion
  - References
  - Acknowledgements

The Scientific Paper

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The Scientific Paper

■ **Major Sections**

– Title

– Abstract

– Introduction

– Methods

– Results

– Discussion

– Conclusion

– Acknowledgments

■ **Addressing Specific ?'s**

– What's the problem?

– Why is the problem important?

– What approach did you take?

– What did you find?

– What do the results mean?

The Scientific Paper

Order of Sections
- Title
- Abstract
- Introduction
- Methods
- Results
- Discussion
- Conclusion

Order of Writing
- Methods
- Results
- Discussion
- Conclusion
- Introduction
- Abstract
- Title

Core

The Scientific Paper

Order of Writing

Write these while you're doing experiments. Easiest to write.

➡
- Methods
- Results

Arguably, the most difficult to write

➡
- Discussion
- Conclusion

With core completed, abstract easier to compose (coherent and Focused)
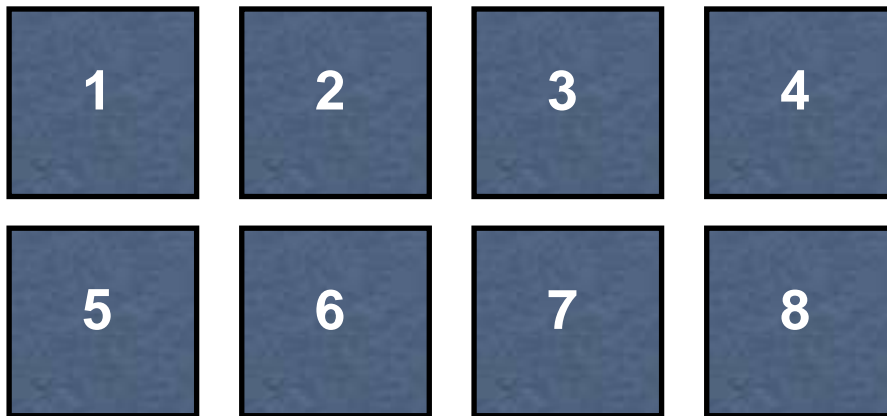
➡
- Introduction
- Abstract
- Title

Compiling a Results "Storyboard"

- Two Types of Experiments
  - Heuristic Experiments
    - "Discovery" trials ("Let's try it—see what happens!")
  - Algorithmic ("Show-and-tell") experiments
    - Keep a running file of these experiments

Organize the Results "Storyboard"

- Compile "show-and-tell" data

Sequence of experiments that effectively tells your "story"

- Check for connections, holes, patterns, the "storyline"

The Abstract

The Abstract

- Mini-version of the paper
  - Summarizes each section
  - 1 to 2 sentences for each section
  - Limited in length (<300 words typically)
  - Free-standing

- Abstract & Title used by digital search engines
  - Often the ONLY part of the paper people read

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Abstract Content

- Background

- Principal Objectives

- Methods

- Summarize Results

- Principal Conclusions

- Context of Study

- "We Ask whether…
  "We hypothesized that …
- Experimental approach, design variables
- Key results found (minimal raw data)
- Answers to question posed
  Essential implications of results

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Abstract: The Rules

- Single Paragraph
- Write in past tense
- Do Not cite references in the abstract
- Do NOT reference information not stated in the paper
- Except for long terms repeated multiple times, do not use abbreviations

(Robert Day)

Abstract: Critical Content

- Avoid inclusion of extraneous material

- Write a clear abstract - Crucial!

- Abstract is usually the first thing editor or reviewer reads

- Make the reviewer your advocate-don't lose or upset him/her

(Robert Day)

Abstract: Critical Content

- Examine EREVY WORD in the Abstract
- Be succinct as possible

- A good paper is usually followed by a good abstract

- A poor abstract is a sign…

(Robert Day)

Abstract

- One sentence background

- Purpose of the study and general approach

- Main results

- Results reflect methods implemented

- Primary conclusions

Lactoferrin binds to rat hepatic lectin 1 (RHL1), the major subunit of the asialoglyco-protein (ASGP) receptor, with high affinity by a galactose-independent mechanism. To better understand the molecular basis of this novel interaction, we compared the binding of lactoferrin and asialo-orosomucoid (ASOR) to isolated rat hepatocytes and to purified ASGP receptors as a function of pH, Ca^{2+}, and receptor acylation. Binding of ^{125}I-lactoferrin and ^{125}I-ASOR to isolated rat hepatocytes at 4 °C decreased sharply at pH < 6, following similar titration curves. Binding of ^{125}I-lactoferrin and ^{125}I-ASOR to hepatocytes was Ca^{2+}-dependent. Binding increased progressively at ≥ 300 µM $CaCl_2$, in the presence of 1 mM EDTA. Monensin treatment of hepatocytes, which causes hepatocytes to accumulate inactive ASGP receptors, reduced surface binding of ^{125}I-lactoferrin and ^{125}I-ASOR by 46 and 49%, respectively, with only a 16% loss of immunodetectable receptor protein from the cell surface. Finally, deacylation of purified ASGP receptors in $vitro$ with 1 M hydroxylamine abolished receptor lectin activity as reflected by the loss of ^{125}I-ASOR binding as well as the complete loss of specific ^{125}I-lactoferrin binding. Treatment with 1 M Tris had no effect on binding of either ligand. We conclude from these data that galactose-independent lactoferrin binding to the ASGP receptor requires the receptor's carbohydrate-recognition domain to be in an active configuration. An active configuration is promoted by neutral pH and Ca^{2+} and also requires the receptor subunits to be acylated.

Mcabee, D. D., Jiang, X., & WALSH, K. B. (2000). Lactoferrin binding to the rat asialoglycoprotein receptor requires the receptor's lectin properties. *Biochemical Journal*, *348*(1), 113-117.

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One-sentence background

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Purpose & General Approach

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Primary Conclusions

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What can be done to reduce unhealthy eating among adolescents? It was hypothesized that aligning healthy eating with important and widely shared adolescent values would produce the needed motivation. A double-blind, randomized, placebo-controlled experiment with eighth graders (total $n = 536$) evaluated the impact of a treatment that framed healthy eating as consistent with the adolescent values of autonomy from adult control and the pursuit of social justice. Healthy eating was suggested as a way to take a stand against manipulative and unfair practices of the food industry, such as engineering junk food to make it addictive and marketing it to young children. Compared with traditional health education materials or to a non–food-related control, this treatment led eighth graders to see healthy eating as more autonomy-assertive and social justice-oriented behavior and to forgo sugary snacks and drinks in favor of healthier options a day later in an unrelated context. Public health interventions for adolescents may be more effective when they harness the motivational power of that group's existing strongly held values.

Bryan, C. J., Yeager, D. S., Hinojosa, C. P., Chabot, A., Bergen, H., Kawamura, M., & Steubing, F. (2016). Harnessing adolescent values to motivate healthier eating. *Proceedings of the National Academy of Sciences*, *113*(39), 10830-10835.

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One-sentence background

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Purpose & General Approach

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Main Results

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Primary Conclusions

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Introduction/Background

- Provide sufficient contained background

- Provide rationale for study

- Outline of Introduction Section
  1. Present nature and scope of problem investigated
  2. Review pertinent literature to orient the reader
  3. Build the argument why this research needed to be done
  4. Sate the purpose and hypothesis leading the reader into the Methodology

(Robert Day)

Introduction/Background

- Tell a story
  - What is known?
  - What is unknown?
  - How is the problem tackled in this study?

Connect the dots
for the reader

1

2

3

4

(Robert Day)
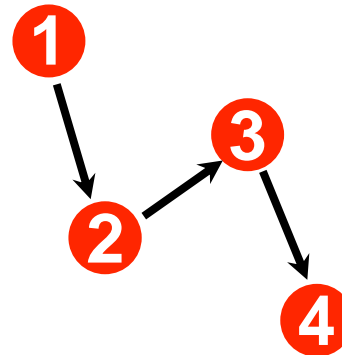
Introduction/Background

- Write Introduction in present tense
  - Stating what you propose to do
  - Stating already published findings

- Define specialized terms or abbreviations
  - Journals define standard abbreviations
  - Some journals require a footnote for definition of all non-standard abbreviations

(Robert Day)

Introduction/Background

- Collecting Background Information
  - Search literature databases: keywords, authors, structures, etc.
  - Where to start?
    - Review Literature
    - Advisor's Papers
    - Reference sections of papers

- Have an organizational system to keep track of information, papers, citations

Introduction/Background: Literature Review

- Summarize *current state of knowledge* focused on the area that relates *specifically* to your study

- Assume reader is generally knowledgeable about your area
- Do NOT provide historical review
- Avoid non-essential details

Introduction/Background: Literature Review

- Summarize previous findings without discussion of methods (unless other methods are an issue)

- Refer reader to general reviews of the topic

- Cite references of key work leading to this study

- Last paragraph states the purpose, aims, and hypotheses

- Stay focused: 400-1000 words (1-4 pages typed, doubled-spaced)

Assignment 4 – The Research Paper

__SOURCE DATA ASSIGNMENT__
- **You will need to specify what data source you plan to use for the report. Write a brief description of how the data was collected (~150 words) and reference work, submit an electronic document.** If you plan to use published data from the literature (a __meta-analysis__), attach copy of the publications containing the data you plan to use. Be careful to write the report in your own words; you may use data but nothing else from that published paper.

__RESEARCH REPORT 1st, 2nd, and FINAL DRAFT__
- The report should be pitched to a reader who has a good science background and is somewhat knowledgeable about the topic on which you're writing (not an expert in the field). The length of the final report should be about 2000 words. You will lose credit if your report is less than 1700 words or more than 2500 words. **Your research report should include the following sections: Title page, Abstract, Introduction, Methods, Results, Discussion, Conclusion, References, and Figures**.

- You must include references of __at least six__ publications relative to the subject of the report. These would normally include an original publication of the methods being used as well as other references to the problem being studied. At least four of the references should cite original research literature.

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