Writing tips for peer-reviewed journal articles

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This tutorial is designed to be a 30-minute refresher for anyone in the process of writing a peer-reviewed scientific article.

Getting Started • Brainstorming Your Paper • The IMRAD Format • • References & Resources

Getting Started

Writing and revising at the same time (commonly referred to as the "brain dump") does not work! A peer-reviewed journal article requires careful planning and thought.

Every piece of scientific writing is built on four elements: relevance, structure, style, and accuracy. Relevance and structure are most efficiently addressed while brainstorming your paper and developing an outline. Style and accuracy are best improved while revising your paper. Below are some very general tips.

1. Relevance

Think about the content first. What is relevant? Have you really thought about your results and discussed them with your co-authors? What is your hypothesis? How do your results add to the existing body of knowledge? What are the broader implications? See my brainstorming worksheet below.

Brainstorming is the key step to writing a good paper, as opposed to a mediocre report. The burden of proof lies with you, not with the reader. Simply disclosing all your results and methods in excruciating detail is not enough. Your "value-added benefit" lies in the conclusions you draw from your results. Journal editors will want to know what new knowledge your manuscript is bringing to the scientific field.

2. Structure

Start with an outline (usually following the IMRAD format below).

Do not mix up sections. For example, new results should not be introduced late in the discussion. Remaining scientific questions you forgot to mention in the discussion section should not appear in the conclusions.

Do not simply repeat information in different sections. For example, do not recapitulate results in the discussion – discuss the results themselves. Do not simply repeat the information in the figures and tables in the text.

Make sure one section leads logically to the next. Do not forget to use transition words and phrases to help the reader.

3. Style

Keep paragraphs reasonable. 1 Paragraph = 1 Idea! Start with a topic sentence, followed by sentences to support your topic.

Use simple sentences

- This minimizes the number of mistakes.
- Your ideas will not sound any less complex.
- Your international audience will understand you better and your paper will get cited.

Know your terminology

- Make a reference list for your specialized field.
- A misuse of terminology will surely call the rest of your results into question.

Remember to use the correct verb tense. Here are five easy rules to remember:

i. Use simple present to describe established scientific knowledge, in other words previously published findings.
ii. But use simple past to attribute scientific findings to a particular researcher or group.
iii. Use simple past to describe what you did.
iv. But use simple present to refer to tables, figures and data within the paper, and to derive equations.
v. Use simple future to describe what you will do.

4. Accuracy

In many cases you are the only one who can check the accuracy of your data. Always do this technical proofread with fresh, focused "eyes". You would be surprised how many people make these kinds of mistakes in their papers.

- Check your significant digits
- Check that all numbers in the text are correct – e.g., decimals and units are consistent
- Check that any statistics are correct and significant
- Check that all reactions are balanced

Brainstorming Your Paper

Ideally, you should bring all your co-authors together. Spread your data out on a big table. Borrow a huge white board. Make an enormous pot of coffee…Brainstorming your paper is what makes science fun.

Problem

⇓

Hypothesis

⇓

Results	*Conclusions*	*Points of Discussion*
Figure A Table B Observation C Rate D	Conclusion 1	Discuss why Conclusion 1 is valid. *Discuss possible errors, supporting evidence (previous research), outlying points: "Conclusion 1 is supported by previous research...)> "Conclusion 1 is valid even though there are outlying data points...')*
Table E Observation F Observation G	Conclusion 2	Discuss why Conclusion 2 is valid.
Figure H Figure I Observation J	Conclusion 3	Discuss why Conclusion 3 is valid.

⇓

Do your Conclusions answer the Hypothesis? How?

⇓

How does your research add to the existing body of knowledge? (Significance)

⇓

What are the Implications for the Problem or similar systems?

Notes:

1. Every paper should start with a discussion of a scientific problem or question. Otherwise, why read on? What is the knowledge gap in the literature? Why does it matter?

2. A clearly stated hypothesis shows you have followed the Scientific Method. Do not leave readers in the dark. This is not a novel; this is a scientific paper. Readers want to know from the beginning that the "butler did it".

3. Each result should be tied to a conclusion. This prevents you from presenting irrelevant (superfluous) data.

4. Each conclusion should then be discussed. Again, do not present irrelevant, extraneous material or

arguments. It only muddles your argument.

5. Ask yourself: do my conclusions answer my original hypothesis? This is the basis of your Conclusions section. Your paper should come full circle. Show the reader that the nagging questions you posed in the introduction have been answered. Your research was successful.

6. Not only was your research project successful, it was SIGNIFICANT. Discuss how your conclusions add to the existing body of knowledge, i.e., the literature. This should relate directly back to the literature review you presented in the Introduction.

7. Your paper should end with a discussion of the implications. Again, the implications should relate back to your version of the problem presented in the introduction. Avoid mundane statements such as "more research needs to be done on this problem."

Your ideas are taking shape. Now you are ready to insert these ideas into an outline.

The IMRAD Format: What goes where?
(IMRAD = Introduction, Methods, Research and Discussion)

Section	Purpose	Verb Tense	Elements
Abstract	Mini-version of the paper	Simple past - refers to work done	✓ Principal objectives ✓ Methods used ✓ Principal results ✓ Main conclusions
Introduction	Provides rationale for the study	Present — refers to established knowledge in the literature	✓ Nature and scope of problem ✓ Review of relevant literature ✓ Your hypothesis ✓ Your approach used in this study (& justification for this approach) ✓ Principal results ✓ Main conclusions
Methods & Materials	Describes what was done -- experiment, model, or field study	Simple past - refers to work done	✓ Description of materials ✓ Description of procedure in a logical order, e.g., chronological order or by experiment ✓ Sufficient detail so that procedure can be reproduced
Results	Presents the data, the facts -- what you found, calculated, discovered, observed	Simple past - refers to what was found, observed	✓ Your results ✓ Your observations during experiments/field work ✓ Your observations about the results (e.g., compare and contrast between experiments/model runs) ✓ Results of any calculations using the data, like rates or error
Discussion	• Shows the relationships among the facts • Puts your results in context of previous research	Present - emphasis on established knowledge, present results	✓ Trends, relationships, generalizations shown by the results ✓ Any exceptions, outlying data (and WHY) ✓ How your results agree/disagree with previous studies and WHY
Conclusions	Summarizes your principal findings	Present - emphasis on what should now be accepted as established knowledge	✓ Conclusions should relate back to the introduction, the hypothesis ✓ Summary of evidence supporting each conclusion ✓ Implications, the significance of your results or any practical applications

Once your outline is finished, it's simply a matter of turning your ideas into complete sentences.

References & Resources

1. References

Cutts, Martin. *Plain English Guide*. Oxford University Press, 1995.

Day, Robert A. *How to Write and Publish a Scientific Paper, 5th Edition*. Oryx Press, 1998.

Day, Robert A. *Scientific English: A Guide for Scientists and Other Professionals, 2nd Edition*. Oryx Press, 1995.

The ACS Style Guide: A Manual for Authors and Editors, 2nd Edition. Janet S. Dodd, Editor. American Chemical Society, 1997.

2. Suggested resources

a. A dictionary, preferably electronic -- I use Merriam-Webster's for American English
b. Roget's Thesaurus of English Words & Phrases
c. A style manual for your field, e.g. ACS Style Guide (see above)
d. A general writing guide: Plain English (see above) or Strunk & White's Elements of Style (available online)
e. Usage and Abusage: A Guide to Good English, 3rd Edition, or The New Fowler's Modern English Usage (effect vs. affect, compliment vs. complement, discreet vs. discrete)

Non-native English speakers may also want to look at

f. The Collins Cobuild English Dictionary for Advanced Learners. Definitions include examples and language tips.
g. Practical English Usage by Michael Swan. Oxford University Press, 2000. Teaches grammar using common mistakes made by advanced learners.

These books are available upon request for you to look at and copy.

3. Online resources:

Merriam-Webster Dictionary online: http://www.merriam-webster.com/

http://owl.english.purdue.edu/owl/ (http://owl.english.purdue.edu/handouts/general/gl_hocloc.html): Tutorials and handouts.

http://www.plainenglish.co.uk/guides.htm: Plain English guides and tutorials.

http://www.bgsa.gatech.edu/writing_sources.php: Georgia Tech's unofficial list of resources on the web. Check out the last link, "Writing Resources on the World Wide Web."

http://andromeda.rutgers.edu/~jlynch/Writing/links.html: More resources on the web. Includes a link to the classic *Elements of Style* by Strunk & White.