



Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology

HOW TO WRITE A SCIENTIFIC PAPER: A GENERAL GUIDE

Introduction

The task of writing a research paper can be daunting. You may have completed ground breaking research, but unless the paper is correctly written, at best publication will be delayed, at worse never published.

The purpose of this document is to try and give the reader an overview of how to write a well-structured research paper for publication. It is principally aimed at new authors and is generic enough to encompass all disciplines.

Do I need to write a research paper?

This might seem like an obvious question, but it is one worth asking yourself. Editors and reviewers are looking for original and innovative research that will add to the field of study. Ensure that you have enough numbers to justify sound statistical conclusions. If the research you are going to report upon relates to a larger study, perhaps it is better to produce one important research paper, rather than a number of average incremental papers.

In deciding where to send your paper, consider the reader. Does your paper address a question of international or mainly local interest? If the latter is true, it may be better placed in a national journal than in an international one.

The structure of a paper

Scientific writing follows a rigid structure; a format developed over hundreds of years and considered to be the most efficient means for communicating scientific findings to the broader research community. Moreover, the format has the advantage that it allows the paper to be read at several levels,

Section	Purpose
Title	Clearly describes contents
Authors	Ensures recognition for the writer/s
Abstract	Describes what was done
Key Words (some journals)	Ensures the article is correctly identified in abstracting and indexing services
Introduction	Explains the problem
Methods	Explains how the data were collected
Results	Describes what was discovered
Discussion	Discusses the implications of the findings
Acknowledgements	Ensures those who helped in the research are recognised
References	Ensures previously published work is recognised
Appendices (some journals)	Provides supplemental data for the expert reader

some people will refer to just the title, others may read only the title and abstract, while those who want a deeper understanding will read the majority, if not all, of the paper.

Most disciplines use the format: title, authors, abstract, key words, introduction, methods, results, discussion, acknowledgements, references and appendices. Though the headings are standard for most journals, there is some variation, so it is worth checking the guide for authors of the journal you intend to submit your paper to prior to writing.

Style and language

It is important to refer to the journal's author guide for notes on style. Some authors write their paper with a specific journal in mind, while others write the paper and then adapt it to fit the style of a journal they subsequently choose. Regardless of your preference, there are some fundamentals that remain true throughout the process of writing a scientific paper. The objective is to report your findings and conclusions clearly, and concisely as possible, try to avoid embellishment with unnecessary words or phrases. The use of the active voice will shorten sentence length. For example, "carbon dioxide was consumed by the plant.." is in the passive voice, by changing to the active voice it can be shortened to "the plant consumed carbon dioxide..". It is preferable to avoid using abbreviations in the text except for units of measure. The following shows how tenses are most often used in science writing:

For known facts and hypotheses the present tense should be used (eg, "There average life expectancy of a honey bee is 6 weeks ...").

When you refer to experiments you have conducted the past tense should be used (eg, "All the honey bees were maintained in an environment with a consistent temperature of 23°C...").

When you describe the results of an experiment, the past tense should be used (eg, "The average life span of bees in our contained environment was 8 weeks...").

Authors are encouraged to use American English spelling (eg, "color" instead of "colour," "organization" instead of "organisation").

If English is not your first language it is recommended that a native English speaker review the paper before you submit it for publication.

Authors

The listing of authors should only include those who have made an intellectual contribution to the research, who will publicly defend the data and conclusions, and who have approved the final version. The order in which the names of the authors appear can vary from discipline to discipline, in some fields the corresponding author's name appears first.

Title

A title should describe the paper's content clearly and precisely, and allow the reader to decide whether it would be appropriate to consult the paper further or not. The title is the advertisement for the article - a poorly titled paper may never reach its target audience, so be specific. It is advisable to omit unnecessary words such as "A study of . . .," "Investigations of . . .," "Observations on . . .," etc. Do not use abbreviations and jargon. It is also worth noting that indexing and abstracting services depend on the accuracy of the title, extracting keywords from it that are used in cross-referencing.

Keyword List

Some journals request a keyword list; this provides the opportunity to add important words, in addition to those already present in the title. Appropriate choice of keywords will increase the likelihood of your paper being located by other researchers, these words are utilised by the indexing and abstracting services.

Abstract

The abstract should briefly summarise, in one paragraph (which may vary from 50-300 words), the problem, the method, the results, and the conclusions. The Title is the simplest statement about the content of your article, in contrast the Abstract allows you to elaborate on each major section of the paper. The abstract should give sufficient detail so that the reader can decide whether or not to read the whole article. Together, the title and the abstract should stand on their own, as they are published in abstracting services. For this reason it is advisable not to include references to figures or tables in the abstract. Many authors write the abstract last so that it accurately reflects the content of the paper.

Introduction

The introduction should be brief, ideally one to two paragraphs long. It should clearly state the problem being investigated, the background that explains the problem, and the reasons for conducting the research. Summarize relevant research to provide context, state how your work differs from published work, importantly what questions you are answering. Explain what findings of others, if any, you are challenging or extending. Briefly describe your experiment, hypothesis (es), research question(s); general experimental design or method. Lengthy interpretations should be left until the Discussion.

Methods

("Materials and Methods" or "Experimental Methods"). The key purpose of this section is to provide the reader enough details so they can replicate your research. Explain how you studied the problem, identify the procedures you followed, and order these chronologically where possible. If your methods are new, they will need to be explained in detail, otherwise name the method and cite the previously published work, unless you have modified the method, in which case reference the original work and include the amendments. Identify the equipment and describe materials used, specify the source if there is variation in quality of materials. Include the frequency of observations, what type of data were recorded, be precise in describing measurements and include errors of measurement. Name any statistical tests used so that your numerical results can be validated. It is advisable to use the past tense, and avoid using the first person, though this will vary from journal to journal. When not using the first person, it may be necessary to use the passive

voice, for example, "The solution was heated to 100°C" instead of, "We heated the solution to 100°C."

Results

In this section you objectively present your findings, and explain in words what was found. This is where you show that your new results are contributing to the body of scientific knowledge, so it is important to be clear and lay them out in a logical sequence. Raw data are rarely included in a scientific paper; instead the data are analyzed and presented in the form of figures (graphs), tables, and/or descriptions of observations. It is important to clearly identify to the reader any important trends. The Results section should follow a logical sequence based on the Table and Figures that best presents the findings that answer the question or hypothesis being investigated. Tables and Figures are assigned numbers separately, and should be in the sequence that you will refer to them from the text. Figures should have a brief description (a legend), providing the reader sufficient information to know how the data were produced. It is important not to interpret your results - this should be done in the "Discussion" section.

Discussion

In this section you describe what your results mean, specifically in context of what was already known about the subject of the investigation. You should link back to the introduction by way of the question(s) or hypotheses posed. You should indicate how the results relate to expectations and to the literature previously cited, whether they support or contradict previous theories. Most significantly the Discussion should explain how the research has moved the body of scientific knowledge forward. It is important not to extend your conclusions beyond what is directly supported by your results, so avoid undue speculation. It is advisable to suggest practical applications of your results, and outline what would be the next steps in your study.

Acknowledgements

This section should be brief and include individuals who have assisted with your study, including, financial supporters, proofreaders, typists, suppliers who may have provided materials free of charge, etc.

References

Whenever you draw upon previously published work, you must acknowledge the source. Any information not from your experiment and not "common knowledge" should be recognised by a citation. How citations are presented varies considerably from discipline to discipline and you should refer to notes for authors for the specific journal. Quotes that appear in the article, if long, should have their own indented paragraph, otherwise if they are in the natural flow of the article should be within speech marks, and in both cases they should include a reference. Avoid references that are difficult to find, and/or refer to papers not written in the language of the journal to which you are submitting your paper.

The References section that appears at the end of the paper includes all references cited in your paper. This is in contrast to a bibliography, common in books, where works read but not necessarily cited in the text are listed. The order in which references are presented also varies from journal to journal and you should consult the journal's notes for authors.

Appendices

Typically raw data are not included in a scientific paper, however if you believe the data would be useful they can be included in an appendix. Increasingly this is becoming more common as journals move to an online environment and the cost of including supplemental information is lowered. Appendices can include raw data tables, video footage, photographs, or complex 3D models. If you have more than one set of materials to include, give each a separate number e.g. Appendix 1, Appendix 2, etc.

Further reading

- Davis, Martha (2005) "Scientific Papers and Presentations," 2nd Edition. Academic Press (ISBN 0-12-088424-0; available with a 20% discount via Elsevier)
- Grossman, Michael (2004) "Writing and Presenting Scientific Papers," 2nd edition, Nottingham University Press, (ISBN 1-897676-12-3).
- Clare, J & Hamilton, H (2003) "Writing research transforming Data into Text," Churchill Livingstone (ISBN 0443071829).