# A Style Guide for Scientific Research Papers

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## General Guidance

A general guiding principle that applies to any academic, technical, or other professional writing is to make your reader's job easy. Only submit clean, legible, proof-read manuscripts. Do not use fonts or typefaces that will strain your reader's eyes. Edit papers to ensure that careless spelling, grammatical, and usage errors are excised. Write clearly and fluently. Do not come across as pompous or boorish: this is an almost certain way to turn your reader against you, and when you are submitting a paper for a grade, a paper for peer review, or a grant application for evaluation, you really don't want your readers unsympathetic for reasons that are orthogonal to the quality of your research or the cogency of your argument. Vary your sentence structure and word choice. Format the paper in a way that makes reading easy. The reading of a scientific research paper is rarely a straightforward, start-to-finish process. Facilitate your reader's need to flip between the main text, any figures, tabular material, reference lists, appendices, etc. by providing page numbers, section headings, figure and table titles and legends, etc.

This may seem obvious, but you'd be surprised… Make sure you get the course title and instructor's name right. If you're writing a paper on a topic that was covered in lecture, and there was (primary literature) reading for the class on that subject, make sure to cite the reading material in your paper. Chances are, if it was assigned to cover that topic, it is important. In general, give the impression that you care about the course and have done your homework.

If your paper is a little short of the assigned page guideline, do not try to cover this up by using a big typeface or wide margins. Always remember, the people who read and grade your work (1) were not born yesterday, and (2) once were students themselves.

When in doubt regarding stylistic or usage questions, consult the *Chicago Manual of Style*, 16th ed. It is available in the reference section of most libraries and is a highly worthwhile investment for anyone pursuing an academic or other writing-intensive career. The University of Chicago Press also has a reference work, *Writing with Numbers*, which provides excellent advice on incorporating more technical material into papers. I also recommend William Cleveland's *Elements of Graphing Data* and Edward Tufte's *The Visual Presentation of Quantitative Information* for stylistic recommendations on the topics of data visualization and communication.

Imitation gets a bad name. In addition to being the sincerest form of flattery, it is an excellent way to improve your own style. Find a well-written scientific paper in the field that you are working in and imitate the style. Sometimes, it is also instructive to find a really badly written paper and analyze what is wrong with it.

## Researching Your Paper

Research papers should be based on primary scientific literature. In general, this means scholarly papers written in peer-reviewed scientific journals. You should avoid relying on articles from semi-popular scientific publications such as *Scientific American*, *Natural History*, or *New Scientist*. Such articles are designed to convey broad details to a generally scientifically literate audience. Articles in these publications do not typically report original

research nor have they undergone the scrutiny of peer-review. Furthermore, do not rely extensively on web pages from governmental (e.g., CDC) or non-governmental (e.g., WWF) organizations for your paper. Information pages from such organizations can be very useful for getting started, but if it is a good page, it will give references to the primary scientific literature. It is toward this literature that you should direct your research efforts.

Online databases provide a powerful and convenient research tool for finding primary scientific literature. Excellent databases for research in the biosocial sciences include:

ISI Web of Science
Medline
Ovid

Avoid databases such as Lexis-Nexis, which catalogue primarily journalistic articles.

Writing a good scientific research paper requires you to dive into the primary scientific literature. Do not rely on Google searches on your topic to provide sufficient background. The Internet is loaded with misinformation. If you find some potentially useful information on a web page, follow the citations it gives for the information it provides. Read those and use them instead. If there are none, don't use the web page as, it is not a reliable source. Never rely on Wikipedia (or any other encyclopedia, for that matter) for a scholarly paper.

The sheer volume of information available to us because of the Internet and related technologies means that we are probably more reliant than ever on the peer-review process. Note, though, that peer-review is itself no panacea. Always read and (more importantly) use your sources critically. Ask yourself the question, are there non-scientific agendas underlying the research you are reading?

If, for example, you are writing a paper on the impact of factory farming techniques on the rise of antibiotic resistant bacteria in the food supply, don't base your argument solely on information you obtain from the PETA website. This may be a viable starting point for your research, but follow-up on the references the site lists. Are they reliable? Are they taken from the scientific literature? Similarly, the Christian Coalition web page may not be the best place for accurate information on the safety of oral contraceptives. Critical thinking is a key skill in science and many other fields.

It might be old-fashioned, but there are still few better ways to find ideas for a research paper and get a general sense of the literature in your field than spending time in the library browsing the journals and stacks in the relevant area. Unfortunately, this typically takes some planning.

**Notes on Writing Style**

Do not be vague when you can be specific. Define your terms. If you suggest that "urban environments are bad for human health," what do you mean? What aspect of human health? What is "bad"? Increased mortality? Increased morbidity? When you write a scientific paper, it is particularly important to define terms that have generally recognized folk meanings. Watch out particularly for words like "stress" and "fitness," which have both colloquial and technical meanings. Do not confuse these.

Avoid extended quotes in scientific papers. Paraphrase (and cite appropriately!) material that you are using.

Avoid colloquialisms and trite neologisms. Do not use nouns as transitive verbs. Leave your soap box in the store room, your high horse in the stable, and squelch the sarcasm. Let the quality of your arguments, the coherence of your research design, and the elegance of your prose communicate whatever righteousness or criticism may be your just due. Your point will be made all the more powerfully.

Don't fall into the trap of parochialism or ethnocentrism. Think about the generalizability of your statements. If you write, "people work to save for their retirement," does that really apply to *people*, broadly construed? What about arid-country hunter-gatherers? Horticulturalists in the Amazon basin? Nomadic pastoralists on the Tibetan Plateau? In statistical parlance, ask yourself the question, what is the universe of entities to which my arguments apply? That said, don't overly particularlize your statements either. I am reasonably confident with the statement that people seek food when they are hungry and circumstances permit it. I don't feel the need to say something like, "As a Caucasian, middle-class man in my early forties speaking from this point in the early twenty-first century, I believe that hungry people seek food."

A research paper should have an argument; it should not read like a book report. Know what your argument is and also know what the counter-arguments are. This will help you define the kind of evidence you need to present to make your argument convincing. Argue with logic and from first-principles, not by citation. Argument by citation is only slightly better than appeals to higher authority, which have absolutely no place in a scientific paper.

The passive voice is to be avoided. A paper written with the author's voice removed does not sound more scientific, it just sounds old-fashioned and pompous. Some journals insist that all instances of "I" or "we" be excised, but this is becoming less common. That said, watch out for having your paper sound solipsistic – it should not read like a diary entry. Avoid, in particular, phrases like "I believe…" or "I think…" Clearly, you believe it if you are taking the trouble to write it.

Organize your paper with section headings and sub-headings if necessary. Such structure greatly facilitates readers' ability to follow the logical structure of a paper.

Edit your paper. As you read through it, see how many linking verbs ("to be" in particular) you can replace with active verbs. For example:

Replace: A high-fiber diet is healthy.
With: A high-fiber diet improves a variety of health indicators.

Use page numbers. The best position for page numbers is either centered in the footer or right-justified in the header.

Minimize the use footnotes. Use parenthetical citations and a full bibliography. See if you can find a way to include footnoted information parenthetically as well, while minimizing interruptions to the flow of your text.

**More Prosaic Stylistic Guidelines**

Spell out terms of phrases that you will abbreviate the first time you use them and provide the abbreviation in parentheses. For example: Hantavirus Pulmonary Syndrome (HPS), Adenosine Triphosphate (ATP), Evolutionary Stable Strategy (ESS).

Species names: Latin binomials take the form, Genus species. Genus is capitalized; species is not. For example: Homo sapiens, Anopholes gambiae, Aedes aegypti. Either underline or

italicize the binomial (underlining is probably better). After using the full binomial the first time, you can abbreviate the genus name with the capital of the name's first letter: H. sapiens. If this could cause confusion, use the first two letters of the genus (again, first letter capitalized): An. gambiae vs. Ae aegypti.

**Citations**

Use in-text citations in the "Harvard" style (Author Publication Date):

> The problem of the evolution of iteroparity lies at the heart of life history theory (Cole 1954).
>
> The evolution of iteroparity has been re-cast in more general terms as the evolution of optimal reproductive effort (Gadgil and Bossert 1970).
>
> Schaffer (1974) extended the analysis of the evolution of reproductive effort to variable environments.

For in-text citations of works with more than two authors, use the first author's name and substitute "et al." (short for "et alia," Latin for "and others") for the subsequent author list:

> A number of evolutionary biologists suggest that contemporary health and nutrition problems arise because of an evolutionary disequilibrium between what humans are designed to eat and what we actually do eat in modern, industrialized societies (Eaton et al. 1997).

While the in-text citation uses "et al.", the full citation in the bibliography lists all the authors' names.

While a variety of bibliography styles are appropriate, a certain minimum amount of information needs to be included in a reference: Author, year of publication, title of the work, and secondary title (e.g., the title of the journal or edited volume in which the reference appears). Journal articles should also contain the volume, issue (optional), and page numbers. D*o not abbreviate journal titles*. This is especially important to remember if you gathered your references from Medline, where journal titles are abbreviated. Chapters in edited volumes should contain the names of the volumes editor(s), the city in which the volume was published, and the publisher. Books should contain the city in which the book was published and the publisher. Also note if the book has a particular edition number. The best general-purpose citation style is Chicago 16 (which is also the form used by many of the University of Chicago journals like *Current Anthropology* and *American Naturalist*). This style is the basis for the Council of Biology Editors' bibliographic style recommendation.

**Bibliographic Entry Examples**

**Journal Articles:**

Winterhalder, B. 1993. Work, resources and population in foraging societies. *Man* 28 (2): 321-340.

Gadgil, M., and W. H. Bossert. 1970. Life historical consequences of natural selection. *American Naturalist* 104:1-24.

Garcia-Garcia, M. L., M. E. Jimenez-Corona, A. Ponce-de-Leon, A. Jimenez-Corona, M. Palacios-Martinez, S. Balandrano-Campos, L. Ferreyra-Reyes, L. Juarez-Sandino, J. Sifuentes-Osornio, H. Olivera-Diaz, J. L. Valdespino-Gomez, and P. M. Small. 2000. *Mycobacterium tuberculosis* drug resistance in a suburban community in Southern Mexico. *International Journal of Tuberculosis and Lung Disease* 4 (12):S168-S170.

**Book Chapters:**

Cashadan, E. 1992. Spatial organization and habitat use. In *Evolutionary Ecology and Human Behavior*, edited by E. A. Smith and B. Winterhalder. Hawthorne, NY: Aldine de Gruyter.

**Books:**

Sahlins, M. 1972. *Stone age economics*. Chicago: Aldine.

**Figures, Tables, etc.**

If you use figures, place them at the end of the paper, following the bibliography. Do not use your word-processor to insert the figures into the text, and never wrap your text around them to make the paper appear more magazine-like! Label your figures and provide each a brief legend explaining what the figure is.

Avoid including figures from other published sources, web pages, etc., particularly if that material is copyrighted! If you need figures, make them yourself. The one possible exception to this general rule is maps.

If you include tabular material in your paper, place your tables at the end of your paper (along with the figures), and keep the formatting to a minimum. Do not use borders or shading for cells within a table. A single line separating the column titles from the body of the table, and a single line at the end of the table works best. Tables should also be labeled, and should be accompanied by legends.

If you use mathematical equations, and I know you want to, offset complex equations between blocks of text. Define all variables, and render them in italic typeface. Mathematical formulae are typically set using a Roman font such as Times. Number equations to which you will refer in the text. For example:

> The Euler-Lotka equation defines the intrinsic rate of increase, *r*, as an implicit function of the age-specific schedules of survivorship and fertility,
>
> $$1 = \int_{\alpha}^{\beta} e^{-ra} l(a) m(a) da$$
>
> where α is age at first reproduction, β is age at last reproduction, *l(a)* is the fraction of the population surviving to exact age *a*, and *m(a)* is the fertility rate of age *a* individuals. Equation 1.1 represents Alfred Lotka's solution to the more general population renewal equation.

Making sure that your mathematical variables are rendered in the appropriate typeface (e.g., italic, bold) and font (e.g., Symbol) can become a huge hassle if you refer to the material

frequently. If your paper contains much mathematical material, consider using technical typesetting software (e.g., LaTeX). There is a learning curve associated with this software, but if you plan to continue writing technical papers, it is well worth the investment. You create LaTeX documents in a text editor, formatting equations and other formatted material using a mark-up language (not entirely unlike HTML). You then pass the plain text file to an interpreter which produces the typeset output, typically a postscript or portable document format (pdf) file. Word-processor-like software also exists (e.g., Scientific Workplace) to facilitate technical writing for people more comfortable with GUI-based word processors.

If you are planning to disseminate your work to a broader audience via electronic means, put it in a format that minimizes others' need to proprietary software or specific operating systems. An excellent choice for papers posted on web pages or distributed by email is pdf. Adobe Systems provides a free pdf reader for a wide range of operating systems. There are a variety of means for rendering pdf from some other original source, and they tend to be platform-specific. It is a trivial matter to render pdf from a word-processing application with MacOS 10.1 and higher. Simply choose the "Save As pdf…" option on the printer dialog, give the new file a name, and click "OK."

**On Becoming a Good Writer**

In many ways, being a good science writer is the same as being a good writer generally. If you want to be a good writer, write. Write, write, write, and then write some more. It turns out that if you are writing scientific research papers, this entails doing lots of science. This makes you both a better writer and a better scientist. Lather, rinse, repeat.

Writing is largely the art of re-writing. If you want an A-paper, peer-reviewed publication, or a successful grant, you should not expect to write it the night before the deadline. Get material down on paper (or, more likely, in electrons), and re-arrange and re-write again and again.

**References**

Cleveland, W. S. 1994. *Elements of Graphing Data*. Summit Hill, NJ: Hobart Press.

Tufte, E. R. 1983. *The visual display of quantitative information*. Cheshire, CT: Graphics Press.