

## SCIENTIFIC WRITING AND EDITING

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### Introduction

No scientific research is completed until it has been written up so that its results can be communicated to others. Much of this research will be written up for publication in scientific journals and will make its debut on the world scene in this form. Articles in scientific journals will also be given notice by one or more secondary documentation services and thus be brought to the notice of a wider audience than the readership of the journal in which the article was published.

Scientists may be called on to prepare many different types of scientific writing. These may include theses and dissertations, conventional scientific articles, monographs, books, reports, research proposal and applications for research grants, extension literature, practical manuals and technical specifications, popular and semi-popular articles. The range is wide, but the same basic principles of production and presentation apply to all.

The involvement of information officers and scientific administrators in scientific writing may take any of the following forms:

1. They may themselves have to write up scientific material for presentation in summaries, reports (e.g. departmental or annual reports), and for publication in popular or semi-popular form.
2. They may be called on to edit scientific writings and referee them for sense and grammar, advise on editorial matters and see articles, book, etc. through the press.
3. They may be asked to provide instruction in scientific writing and publication.

The principal and most representative type of scientific writing is the scientific article published in a primary journal. It is to this type of publication that what follows is mainly directed.

For many scientists almost the hardest part of a research project is to write up the results. It can be very difficult to make a beginning and some scientists may need a lot of tactful prodding and help to start them on their way.

Effective scientific writing calls for many qualities of logic and precision and depends on the ability of the writer to develop his arguments logically and express his results clearly.

### Scientific content

The scientific paper should report significant theoretical, experimental or observational extensions to knowledge or significant advances in the practical application of known principles.

The temptation to rush into print prematurely should be resisted. Only when the writer has something important to say and has a substantial body of original research results to back his conclusions should he publish.

### Organization of material

Various ways of presenting the contents of research papers can be adopted, but the following three basic structures are most common.

1. Introduction  
Materials and methods  
Results  
Discussion
2. Introduction  
Theoretical analysis  
Application  
Conclusions
3. (For description of new methods)  
Introduction  
Description of procedure  
Tests of the method  
Discussion

As a first step, it is useful to assemble all the material to be used in preparing the article and then devise a working title. This title should be as short as possible, but long enough to indicate the main purpose and scope of the research and should contain only one topic. In addition, a brief summary of the contents of the article and its conclusions should be written. These exercises help clarify and concentrate thought. At this stage the decision as to where to submit the article can also be taken.

### Where to submit scientific papers

In many instances the answer to this question is relatively self-evident and rests with the research worker who will generally know the journals in his subject field and can also get the advice of colleagues. Wherever possible, research should be written up with a specific journal in mind, rather than being written up first in the hope that a journal that will take it can later be found.

Having selected a target journal, it is then extremely important to read any instructions to Authors it may carry. Editorial practices and conventions differ among journals in such matters as the way they require illustrations, figures, bibliographic references, etc. to be given, length of articles, presentation and style, abbreviations, etc.

Many organizations similarly have their own editorial conventions for their staff which generally include instructions on such matters as page size, layout, abbreviations, units of measure and general in-house editorial procedures to be followed for the various types of publication prepared by the organization. Many of these conventions will also apply to material for publication outside the organization and, when used in conjunction with an effective in-house editorial board or panel to vet publications for scientific standards, etc., can be a very valuable means of ensuring a high standard of scientific publication.

### Drafting and revising

O'Connor and Woodford (1976) recommended first drawing up an outline of the text to be written. This should be in the form of a topic outline defining the subject to be discussed in each paragraph, and a sentence outline setting out the main points it is wished to make about each topic. Having done this, the first draft should be written as rapidly as possible, preferably at a single sitting and without special regard to style or grammar. In this way the draft will read as a single unit and can then provide a basic draft that can be corrected and refined for structure and style.

Assuming that the structure follows the first example given on page 7.1, the various sections should be drawn up with the following contents in mind:

Introductory section This should be brief, indicate the purpose and scope of the paper and show how the research reported follows on from previous work.

Materials and methods section The experimental design and approach should be described and the choice of method (including statistical methods) justified if there are alternatives. The exposition should be logical and given enough details to enable others to repeat the experiments.

If commercial equipment, drugs or chemicals with registered trade names are used, suppliers, names and addresses should be given. Pesticides, pharmaceuticals, etc. with both trade and established common names should be referred to by their common names only. If pesticides, etc. have no known common names, then use the trade name followed in brackets by the chemical name, where known, on the first occasion the name is used. There are various reference books which can be consulted. Where plants or other organisms are used, the genus, species, race,

cultivar, variety, etc. should be given, with authority for nomenclature as required. Particulars of sources of supply of organisms may also be important. In experiments with humans or animals, it may be necessary to ensure that ethical considerations and safeguards have been taken into account and details have been given.

Results section Results should be presented in logical order, giving only those details that are most important and relevant and are not given elsewhere, e.g. in tables. Statistical operations and significance should be shown.

Discussion section This section is sometimes run together with the results section in shorter articles. Its purpose is to assess the significance of the results, compare them with previous work and assess their importance for future studies.

Acknowledgements Any substantial help or advice received from individuals or organizations should be briefly acknowledged. It is wise to ensure that all acknowledgements are beforehand agreed with the persons or organizations named. This section should normally go at the end of the text and before the references section.

The abstract The abstract, usually placed at the head of an article, is now a most invariable component of scientific articles. It informs readers rapidly of the main contents of the article and thus helps them decide whether they need to refer to the article itself. Also, it will almost certainly be used by one or other documentation and information service as a means of alerting users of the service to the existence and contents of the article. The abstract may also be used as a source of index entries by secondary services.

Where scientific articles report original research results they should be informative. Generally, they should state the aims of the research (though not if this is already clear from the title of the article), indicate the methods used, give the main results obtained (with more important factual or numerical data) and the conclusions reached. Abstracts should be kept as short as possible consistent with acceptable information content and should not generally exceed 250 words.

So-called indicative abstracts are generally used for research reviews and similar articles. They will be short and need contain only a general description of the subjects dealt with or other relevant comment.

#### Tables and illustrations

Good guidance on the presentation of tables and illustrations is given by O'Connor and Woodford (1976) and it is not proposed here to do more than bring together the main points to be borne in mind.

Tables These should follow the style used in the target journal. Titles, column headings and notes should be such as to make the table comprehensible without having to refer to the text. Titles should be kept as short as possible and no table that is not strictly essential should be left in.

Numbers should be arranged from small to large where possible. Units that keep numbers as small as possible should be chosen. Statistical information is important and the test of significance used should be stated, with P values, standard deviations or standard errors of means.

1. The number of observations on which the values given are based should always be stated.
2. Remove explanatory notes to the foot of tables in small type; in order to refer to them, use small superscript letters in the body of the table.
3. Tables should be designed to fit into the column or page width of the target journal.
4. Tables stretching over two or more pages are greatly disliked, and every effort should be made to split overlarge ones. Similarly, tables should not be overstuffed with numerical data.

Illustrations The two main kinds of illustrations are line drawings (e.g. diagrams, graphs, histograms) and photographs from which half-tone illustrations can be made. Photographs of line drawings are difficult to correct and will cause problems if changes are needed. Reprographed versions of illustrations are rarely accepted. In all cases, instructions given by the target journal should be followed implicitly. All illustrations should carry legends and any necessary explanation of symbols, lettering etc.; like tables, they should be comprehensible without reference to the text.

With line drawings, graphs or histograms can be used to show several relationships simultaneously, but too much should not be crowded into a single illustration. In representing numerical results, it is a common habit to show them in terms of a plotted curve, which implies that the line joining two sets of values is a continuum. In such cases a histogram may be a more accurate representation. Lines should never be extrapolated without indicating to the reader that it is an extrapolation.

It may be necessary to abandon some types of photograph, e.g. chromatograms, autoradiographs, etc., which may be better represented by line drawings; similarly a diagram may be better than a photograph for describing equipment

Illustrations should be prepared with the column or page size and shape in mind.

1. Block-making may entail reduction in size, which may make any lettering or symbols hard to read.
2. Lettering should not be in thick, bold type, which looks very dark when printed.
3. Lettering and symbols should be at least 1.5 mm high after reduction.
4. A scale bar should be included in all micrographs, maps, etc.
5. Graph lines should not be drawn too thin or they may be scaled down to hair thickness on reduction. To produce broken lines it is best to draw the line solid, then ink the breaks in with white ink.
6. Use of Letraset or other pre-printed lettering may be very useful for diagram work.
7. Zeros should be placed before decimal points.
8. The symbols and units used should be those specified by the target journal.
9. Graph axes should carry lower-case, not capital lettering.
10. Lettering should be horizontal, not vertical.
11. Never draw letters freehand if it can possibly be avoided and use the same style of lettering in all illustrations and figures.

#### Bibliographic references and copyright

Any tables, illustrations or prose passages (verbatim or paraphrased) taken from other persons' published or unpublished work should be acknowledged. Permission to use such material may be needed and it is the author's responsibility to get it. In principle, up to 10 percent of a copyright text can be quoted without violating the copyright, but exact definitions are unclear. It is safest, as well as professionally courteous, to ask for permission to use anything more than 2-3 lines of text.

It should be made clear in the text by use of quotation marks (single quotes) where passages have been taken verbatim from other authors' articles. Where passages have been altered in the interests of brevity or selection, they can be referred to as: "Based on Smith, 1962" or "Adapted from Smith, 1962", with full bibliographic details given in the References section. Permission should always be sought to use unpublished material or private communications.

In compiling the list of references, most journals require the name and date system. Some may ask for references to be given as footnotes and others, especially review publications, may ask for a numbered system. The name and date system will take the general form "Smith, 1974" or "Smith (1974) has reported that ...". (See also The Royal Society, 1974). Where more than one paper by the same author, published in the same year is quoted, this should take the form "Smith, 1974a" or "Smith (1974a,b) has stated that ...".

References to unpublished work or to private communications should appear only in the text, not the reference section.

References to journal articles will usually take the following form:

- Names and initials of all authors
- Year of publication
- Title of article
- Journal title (either abbreviated or not abbreviated as required)
- Volume number
- First and last page number

References to books or book chapters:

- Names and initials of all authors
- Year of publication
- Title
- Names and initials of Editors
- First and last pages of chapter or section
- Publisher's name
- City or town of publication

These are the two most common types of references and include the full set of bibliographical components required for readers of articles to be able to identify and locate them should they wish to consult them themselves. Methods for arranging bibliographic components may be specified in the target journal. Other guidance is given in the British Standards Institution (1950).

Abbreviations for journals titles are now covered by two main systems. The first is the International List system based on British Standard Institution (1970) and American National Standard Z39.5-1969. A useful source for these abbreviations has been prepared by BIOSIS (1974). Another source is the UNISIST/ICSU-AB list (1970). The other authority is the World List of Scientific Periodicals, which has now perhaps rather less authority than the first.

#### Units of measure, acronyms, etc.

The Instructions to Authors should be checked for details of permitted units of measure and other editorial conventions. Generally speaking, abbreviations and acronyms should be

kept to a minimum; internationally established ones can stand by themselves, but others should be spelt out in full or defined the first time they are used.

With numbers, all measured amounts should be given as figures and not spelt out. Figures should be used for all numbers of 10 or over, except where they come at the beginning of a sentence.

When wishing to indicate use of Italics for species names, etc., underline the words in question, but otherwise avoid underlining except where necessary. Use marginal notes (in pencil) to draw attention to any similar points over which confusion could arise, such as letter 'L' for figure 1, capital 'O' for figure '0'. Use of proof correction symbols in the margin can often clarify such points. Symbols and units of measurement used should preferably follow international SI practice, as will be required by most journals (see British Standards Institution (1969)). Useful guides to editorial conventions, etc. are given by Collins (1956) and The Royal Society (1974).

## Style

Within the limits of this Workshop it is not possible to deal in any comprehensive way with matters of style. The foundation of effective presentation is to have good research to report and logically arranged, well organized material to write up. Scientific writing differs from other writing in reflecting the intellectual discipline of science itself. Hypotheses have to be expressed clearly. Statements made must be coherent, unambiguous and be able to stand up to the critical scrutiny of other scientists. A good deal of scientific research is of interest only to other scientists and it is all too easy to drop into stereotyped turns of phrase and jargon understandable only to other initiates.

Guidance on style and writing is given in various texts, among which the following can be recommended: Tichy (1966), Strunk and White (1972), Council of Biology Editors (1972), Gowers (1973), O'Connor and Woodford (1976), Woodford (1968), Darbyshire (1970), Turner (1974).

It is worth stressing that scientific writing in English greatly benefits from the use of short sentences and short rather than long words. All too much scientific writing suffers from inflated language, especially where use of abstract nouns rather than verbs has become a habit (e.g. "The conclusion reached was . . ." rather than "I conclude that . . ."). Authors should be pressed to shorten, simplify and prune all wordage that cannot earn its keep.

## Final drafting for press

In the final draft, the title should be written in terms as short, concise and informative as possible. The final

copy should preferably be typed up on A4 size paper, using ample margins on both sides and double line spacing, in as many copies as are required by the journal editor.

The copy will normally be arranged as follows:

1. Title, authors' names and addresses (with any changes of address as footnotes)
2. Abstract
3. Text
4. Appendices (if any)
5. Acknowledgements
6. References
7. Tables (each on a separate page)
8. Legends for illustrations

Before submitting a paper to a journal editor

1. check that all pages, tables and illustrations are numbered consecutively
2. see that the margin is marked to indicate where tables and illustrations should be placed
3. see that all bibliographic references, footnotes, tables and illustrations have their appropriate references in the text
4. make sure the final draft has met all the requirements of the target journal
5. make sure that copies of the final draft have been retained for authors' files
6. make out and keep a file record of all relevant dates and notes relating to publication (e.g. dates of draft typing, submission to referees and return, submission to journals, referees' comments, receipt and return of proofs, etc.)

### Proof corrections

Assuming that an article has been accepted for publication, the next stage is the receipt of galley proofs (unpaginated long sheets) or page proofs (sheets carrying the pagination in which they will be published). Photo-offset proofs may take the form of text with a transparent overlay on which corrections can be made.

Proofs should be read at least twice. It is helpful to read through once for sense and grammar and then again to check numerical data, spellings, authors' names, etc.

Substantial additions or deletions to printed text are difficult to make and may involve rearrangement of whole blocks of print. If the printer has pried the text, the onus is on him to put it right.

However, if an author has second thoughts about what he has written journal editors are unlikely to agree to any but minor alterations, and certainly not merely for stylistic improvement. Any corrections that have to be made should result in the minimum change in spacing - this can often be done by removing, adding or altering words to offset the change.

### Marking corrections

All corrections should be marked in ink both in the text and in the margins of proofs, using standard proof correction markings. Journals may also ask for different coloured inks to be used to distinguish between author's and printer's corrections.

Details of symbols for proof corrections are given in British Standards Institution (1958) and (1973). They are of most importance to editors, but authors should also know how to use them.

## References

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- Royal Society (1974) General notes on the preparation of scientific papers. The Royal Society, London.
- Strunk, W and White, E B (1972) The elements of style. 2nd Edition. Macmillan, Riverside, NJ; Collier-Macmillan, London.
- Tichy, H J (1967) Effective writing for engineers, managers, scientists. Wiley, New York and London.
- Turner, B (1974) Effective technical writing and speaking. Business Books Ltd., London.
- UNISIST/ICSU-AB (1970) International list of periodical title word abbreviations. Prepared for the UNISIST/ICSU-AB Working Group on Bibliographic Descriptions. ICSU-AB Secretariat, Paris; Chemical Abstracts Service, Columbus, Ohio.
- Woodford, F P (1968) Scientific writing for graduate students. A manual on the teaching of scientific writing. Rockefeller University Press, New York; Macmillan, London.

Table of Proof Correction Media

Marginal mark	Meaning	Corresponding mark in text
∕	Delete (take out)	∕
∕]	Delete and close up	∕ above and below letters to be taken out
#	Delete and leave space	∕
stet	Leave as printed	... under letters or words to remain
caps	Change to capital letters	≡ under letters or words to be altered
s.c.	Change to small capitals	≡ under letters or words to be altered
caps. + s.c.	Use capital letters for initial letters and small capitals for the rest of words	≡ under initial letters and ≡ under the rest of the words
l.c.	Change to lower case	Encircle letters to be altered
bold.	Change to bold type	⚡ under letters or words to be altered
ital.	Change to italics	— under letters or words to be altered
rom.	Change to roman type	Encircle words to be altered
w.f.	(wrong fount) Replace by letter of correct fount	Encircle letter to be altered
9	Invert type	Encircle letter to be altered
x	Replace by similar but undamaged character	Encircle letter to be altered
)	Close-up - delete space between letters	) linking words or letters
#	Insert space	^
eq. #	Make spacing equal	L between words
less #	Reduce space	L between words
ts.	Transpose	↯ between letters or words, numbered when necessary
n.p.	Begin a new paragraph	[ before first word of new paragraph
run on	No fresh paragraph here	↶ between paragraphs
(/)	Insert parentheses	^ ^
[/]	Insert (square) brackets	^ ^
⊖	Insert hyphen	^
ʹ	Insert apostrophe	^
“”	Insert single quotation marks	^ ^
“”	Insert double quotation marks	^ ^

[Proof]

The same corrected

1. S.C.

Results

Most of the experiments in the present investigation were carried out with cocaine; and the results to be described ~~below were~~ obtained with this unless special mention is made.

Most of the experiments in the present investigation were carried out with cocaine, and the results to be described below were obtained with this unless special mention is made.

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*Magnitude of action potential.*

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Smith (194)) stated, 'The following

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general equation may be used

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$a = ka_0$

$a = ka_0$

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$\left[ \frac{p+q}{(r+s)^2} \right]$

## Meaning of marks

1. *Change to small capitals.*
2. *Invert letter.*
3. *Close up.*
4. *Substitute comma. (Similarly for semicolon.)*
5. *Replace by word in margin.*
6. *Wrong fount. Replace by letter of correct fount.*
7. *Insert space.*
8. *Change to italics.*
9. *Delete (take out).*
10. *Insert hyphen.*
11. *Insert full stop. (Similarly for colon.)*
12. *Change to roman type.*
13. 14. *Transpose. When several words are badly mixed up they may be numbered, the mark 'trs' being written in the margin.*
15. *Straighten lines.*
16. *Replace by word in margin.*
17. *Insert word or letters in margin.*
18. *Change to lower case.*
19. *No fresh paragraph here.*
20. *Change to capital letters.*
21. *Reduce space.*
22. *Leave as printed.*
23. *Replace by similar but undamaged character.*
24. *Begin a new paragraph.*
25. *Insert single quotation mark.*
26. *Symbols over which this sign is placed to be 'inferiors' (subscripts).*
27. *Symbols under which this sign is placed to be inserted as 'superiors' (superscripts, indices).*
28. *Note to printer to explain an unusual character or expression.*