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BRITISH ECOLOGICAL SOCIETY

**The BES publications Short Guide to Scientific Writing**

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**NB: this guide is available online at:** bit.ly/BESGuidetowriting

A research paper is not only about presenting information - it's about communicating that research to others. We've collected tips on science writing from various sources to provide a quick-reference on good practice for presenting and structuring the information in manuscripts (and other forms of science writing). The advice uses the basic principles of good communication to get key messages across and make it easier for others to see the importance and novelty of a piece of research.

## 1) Know your audience

The central principle for scientific writing is exactly the same as for any other type of communication: ***know your audience***. When we start preparing a manuscript, we need to think about who will read it. In the first instance, this is probably a busy editor or reviewer, so we should make sure that we get our key messages across without making our readers work too hard. Ideally, we would like the reader to follow a clear line of reasoning and come to the 'right' conclusion - we want our readers to accurately see what we, the authors, had in mind.

There are a few general principles of how to get a message across and to make it stick in people's minds. These can be adapted to any form of communication, including science writing, and remembered with the acronym SUCCES (Heath & Heath 2007):

- **S**imple — keep it simple by finding the core or the main message and sticking to it.
- **U**nexpected - use the unexpected to grab the reader's attention e.g. a knowledge gap, unforeseen consequences, an unusual feedback, etc.
- **C**oncrete —the central concept should be easily grasped and remembered
- **C**redible — it must support interpretation and discussion with evidence
- **E**motional — the readers should *care* about the research by stimulating interest and highlighting the importance or relevance of the study.
- **S**tory — people enjoy and remember stories, so a good manuscript is a narrative about the research, with a logical train of thought.

Although we're constrained by scientific convention and the fixed format of most journals, we can still tell a simple, concrete and credible 'story' (non-fiction) about our research. We can use elements of the unexpected to show the novelty of the research and help the reader remember our paper by tapping into emotion (e.g. curiosity, amazement).

## 2) A different take on the main sections of a paper

**The title gets people reading the paper**.

The title should be brief and clear, summarising the main finding of the paper (think of a headline). It's wise to avoid questions, convoluted sentences, and too much detail. The title should be simple and concrete, and it can also incorporate something unexpected. The most important part of your title should come first (the second half may not appear in a list of search results).

**The abstract determines whether they read on**

The abstract should get the main messages across without drowning the reader in detail. It can be the hardest section to write because it needs to contain all the key information in an easily digestible form within a very strict word limit. The BES journal convention of numbering sections in the abstract or summary is useful for ensuring that it includes a brief background or justification, a broad description of the approach used, key findings, and a final statement (the *synthesis*) about the relevance of the study.

**The introduction sets the scene**

The introduction presents the background for the paper and shows the reader *why* they should be interested in the study. It should be a logical train of thought leading the reader to the conclusion that the study is novel, exciting and worth doing. It is tempting to do a mini-literature review but it is actually better to keep it simple and concrete by including only the information relevant to the immediate study subject and the reasons for doing the research. The introduction usually concludes with clear research aims or hypotheses to be addressed in the paper. At the end of the introduction, the reader should *want* to know what the outcome is.

**Methods: it's all about the detail**

It can be hard to get the level of detail right. The methods should provide enough information for the reader to 1) understand how the design of the study addresses the research aims or hypotheses and 2) judge whether the methodology and data analyses are appropriate. Details such as the number of plots, experimental treatments, frequency of data collection etc. are crucial, but we can usually omit details that have no influence on the measurements, results, or the way the data is collected. We may need to include more detail if we're writing a methods paper but even then, it's probably irrelevant whether the data were collected on a Tuesday rather than a Wednesday. We usually use a lot of conventions and jargon to keep the methods section concise but it should still be clear and comprehensible.

**Presenting the results: Logical vs. interesting**

Determining the order in which to report findings in the results and discussion sections is tricky. The 'logical order' gives basic results first, whereas the 'interesting order' highlights the novelty of the study by reporting the most exciting results first. The solution usually lies somewhere between the two. It is useful to refer back to the research aims or hypotheses (given in the introduction) to show how the results address them; this also helps get the most important findings across clearly.

A good way of thinking about this section is to decide which results are 'key results' and which ones are 'supporting results'. The key results are the novel findings that will be discussed, the 'supporting results' are there to lend weight or provide evidence for the interpretation of results and to support the conclusions.

**The discussion is our playground**

Of course the discussion should focus on the most interesting results but it is also the section where we are less constrained by convention and there is room for interpretation. There are at least four common types of discussion that really let an otherwise good paper down:

1. *The Saga*, where each result (no matter how trivial) is discussed separately in turn. This can produce a very long and unexciting discussion of peripheral results and bury the most interesting findings of the paper.
   We can avoid writing a saga by focusing the discussion on the most exciting or novel findings

and using the other results to interpret them and draw conclusions. It may sometimes be necessary (or wise) to reorder the results section to achieve this.

2. *The Whodunit*, where the reader is presented with various lines of evidence and the conclusion is drawn at the end. This leaves the reader guessing about the important facts while they wade through details.
   We can avoid a whodunit by giving the main finding upfront (topical sentences, see below) and subsequently explaining the line of reasoning with reference to 'supporting' results or other published studies. A concluding statement to round up the paragraph can emphasize the key message.
3. *The Report*, where the results are presented only in comparison to other studies, with little or no interpretation. This not only distracts from the study and highlights other people's work instead, but it is also a missed opportunity to show the relevance of the study and present new ideas.
4. *The Fairy Tale*, in which the discussion is sidetracked into lengthy sections on things that could have been important but were not measured or in which interpretation crosses the line into pure speculation that is not supported by the results.

A really interesting discussion brings together different lines of evidence based on the results of the study and other published work to make sound conclusions and/or propose new ideas and hypotheses to be tested in future.

**Conclude your paper with your actual conclusions!**

Your conclusions should be more than just a summary of the results (although some of the results can be given to support the conclusions). A good way to think about it is: What should the reader remember from the paper? What is the relevance of the results? Why should anyone care about this study? Are there any unanswered or new questions? ***The worst way to end a paper is to leave the reader thinking: "So what?"***

**3) Structure within structure**

When we read, our brain processes information in a certain way, and we can use this to our advantage by placing different types of information in 'strategic' locations within paragraphs and sentences to emphasize key messages. In general, the reader is most likely to remember the information at the end of sentences and in the first and last sentences of a paragraph.

***'Topical sentences' guide the reader.*** The first sentence of each paragraph should make it instantly clear what the paragraph is about - this is a 'topical sentence'.

- In the methods section, this is often the reason for making a measurement (e.g. "To determine the influence of X, we measured...").
- In the results section, it is usually the main finding of each analysis. If possible, we should avoid very general statements about things being 'significantly different' and instead describe the difference (e.g. "Parasite load in X was significantly reduced by 30%...").

The topical sentence is very important in the discussion because it highlights the main findings before discussing them in context. The main point(s) can be emphasized in the last sentence too, but the topical sentence will stop the paragraph from becoming a 'whodunit'.

A really good way to check for topical sentences is to write out or copy/paste the first sentence of each paragraph into a new document to see if it gives you a rough summary of the content.

***Use the 'stress position' to emphasize information.*** Readers naturally emphasize the material at the end of a sentence; this is referred to as a 'stress position' and can be used to the writer's advantage. By placing information at the end of a sentence, it appears at the moment when the reader will naturally give it the greatest reading emphasis. As a result, the reader is more likely to see the statement as being important (e.g. "We observed no effects of drought on arthropod abundance but there was a significant decline in the number of earthworms.")

We often need to report information that is not particularly interesting and may even distract from our key messages (e.g. non-significant results). The best place for this type of information is in the middle of the paragraph. Some of these 'supporting results' can also help plug logic gaps (see below).

**4) Improving the flow of information**

***Mind the logic gap!*** We can become so familiar with our research that we omit information that may seem unnecessary to us, but might not be obvious to others who are less familiar with the subject. Following a line of reasoning through to a conclusion is like climbing a ladder: each piece of information is a rung required to reach the next one; if there's a rung missing, the line of reasoning is broken and the reader will never reach the top. It's a good idea get feedback from someone who works outside the immediate research area before submitting your paper, as they are more likely to spot logic gaps. We are writing with the reader in mind, so if a reader or reviewer doesn't 'get it', then we probably haven't explained it clearly enough.

***Get straight to the point!*** If there's a lot of repetition in a section of text, then it probably needs restructuring. We are often constrained by word limits, so it is important to cut down on unnecessary detail or jargon. We should only include information that is relevant to the study and the interpretation of the results and drop the rest - no matter how interesting it is or how much hard work it was. Good science writing is not about using clever-sounding words and sentences, it's about getting the point across in such a way that readers can understand the research and reach the right conclusion (i.e. the one we want them to reach).

***Use figures and tables to your advantage.*** The best figures show the important result at a glance. They should also help cut down on lengthy explanations. Tables are useful for summary and 'auxiliary' data; as a general rule, if a text section reads like a list with lots of numbers, the information would probably be better off in a table. Unless the paper is actually about statistical methods, tables of statistics are best placed in an appendix.

***Use terms consistently and avoid too many abbreviations.*** It is tempting to use different terms for the same objects or variables to make the text less repetitive, but this can confuse readers who have less in-depth knowledge of the study. The reader may not be familiar with some of the abbreviations, so non-standard abbreviations should be logical (e.g. N+ for nitrogen addition treatments) and we should only use as many different abbreviations as is absolutely necessary.

**5) A little bit of grammar**

***Direct, active-voice sentences are clearer and more dynamic***

- We observed an increase in growth in the high-diversity plots. ✓
- An increase in growth was observed in the high-diversity plots. ✗

***Limit prepositional phrases***

- Arthropods accelerate decomposition by breaking down litter and providing greater surface area for microbial decomposers. ✓
- Arthropods are important for accelerating decomposition by breaking down the litter and providing greater surface area for microbial decomposers. ✗

***Avoid the passive tense (we did, not "this was done")***

Especially avoid: 'It has been shown to be', 'It has long been known', etc.

***Limit noun strings (nouns that modify nouns)***

- Governments should create effective mechanisms for scientists to explain how they spend taxpayers' money. ✓
- Community information feedback mechanisms are important if governments want scientists to explain how they spend taxpayers' money. ✗

***Put new and important information at the end of sentences***

- Although X had no effect, tree growth was significantly greater in Y. ✓
- Although tree growth was significantly greater in Y, X had no effect. ✗

***Use 'because' instead of the present continuous***

- Soil microbes are important because they are able to mineralise nutrients from organic matter ✓
- Soil microbes are important, being able to mineralise nutrients from organic matter. ✗

***Avoid 'useless' nominalisations (noun forms of verbs)*** - especially after verbs, 'there is' and other nominalisations

- We investigated the effect of... ✓
- We conducted an investigation into the effect of... ✗
- The floods considerably eroded the land✓
- There was considerable erosion of the land from the floods. ✗
- As the ground was unstable, we were unable to complete the field study. ✓
  The instability of the ground precluded the completion of the field study. ✗

*You can find other useful examples of nominalisations here: https://www.physics.ohio-state.edu/~wilkins/writing/Handouts/nominalization.html*

***Use the simple alternative for words and phrases ("Don't utilise 'utilise', use 'use' instead.")***

- 'near' or 'nearby' instead of 'in close proximity to'
- 'except' instead of 'with the exception of'
- 'in terms of' and 'with regard to' are usually completely unnecessary

***Finally, we can learn from the best*** by taking the time to analyse other people's writing style. We all read a lot of papers - some are a pleasure to read and others are confusing. It's worth trying to work out why one paper is so much easier to follow or so much more memorable than others. We

may think that something sounds good or important because we like a particular phrase or buzzword, but we only notice it because the author wants us to...

**Authorship and acknowledgements**

Written by Emma Sayer on behalf of *Functional Ecology*. We've collated tips and tricks borrowed from the references below but much of this guide is based on constructive criticism from supervisors, colleagues, co-authors, reviewers, and editors. We've also learned lots of lessons by scrutinizing particularly good and bad examples of scientific writing.

**References and further reading:**

Heath & Heath (2007) *Made to Stick,* Random House.

Schimel (2011) *Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded.* Oxford University Press.

Gopen & Swan (1990) The Science of Scientific Writing. American Scientist, Nov-Dec 1990.

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**Slim down wordiness with the Writer's Diet tool online: http://writersdiet.com/?page_id=4**