How to write a scientific paper

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Several years ago, my long-time mate, colleague and co-director, Barry Brook, and I were lamenting how most of our neophyte PhD students were having a hard time putting together their first paper drafts. It's a common problem, and most supervisors probably get their collective paper-writing wisdom across in dribs and drabs over the course of their students' torment… errhm, PhD. And I know that every supervisor has a different style, emphasis, short-cut (or two) and focus when writing a paper, and students invariably pick at least some of these up.

But the fact that this knowledge isn't innate, nor is it in any way taught in probably most undergraduate programmes (I include Honours in that list), means that most supervisors must bleed heavily on those first drafts presented to them by their students. Bleeding is painful for both the supervisor and student who has to clean up the mess – there has to be a better way.

Yes, there are books on the issue (see, for example, Day & Castel 2011, Hofmann 2009, Schimel 2011), but how many starting PhDs sit down and read such books cover to cover? Hell, I can barely get them to read the basic statistics texts.

So as is classic for Barry, he came up with his own approach that I like to call 'La Méthode Brookoise' (a tribute to another clever *jeu de mots*). This short-cut guide to setting up a scientific paper is simple, effective and intuitive. Sure, it was designed with ecology in mind, but it should apply to most scientific disciplines. It appeals to most of our students, and we have both been asked for copies by other supervisors over the years. Our original intention was to write a paper about writing papers to flesh out the full *Méthode*, but that has yet to happen.

Therefore, for the benefit of the up-and-comings (and perhaps to a few of those longer in tooth), behold *La Méthode Brookoise* for writing papers:

STEPS

-1. Conduct your research in an adequate, well-planned and sufficiently replicated manner. Research methods are NOT the topic of the *Méthode*.

0. **Mind map** (jot thoughts down on a whiteboard or paper) and 'group plan' with collaborators (face-to-face or via email or video-conference). As first author, make notes, collate discussion. YOU are the one primarily responsible for deciding what goes into the paper and what doesn't.

Don't worry about self-censoring during this 'mind mapping' step.

1. Write down your **main message** in 25 words or less (adhere to this limit, 26 words are too many). You may have multiple lines of evidence in your paper, but you should have one main message. If you can't think of just one, you are either not focussing enough, or you have more than one paper to write.

2. Write a **working abstract**. It should answer the following, explicitly:

> Why are you doing this? [context and aim]
>
> What did you do? [methods]
>
> What did you find? [core results – say something useful – no motherhood statements or deference to the main text!]
>
> What does this mean? [interpretation in context]
>
> What is it good for? [application]

No one will bother to download and read your full paper (or cite it) if they are not interested by the abstract.

3. Based on your main message and working abstract, **write down your title**. Or perhaps 3 alternatives if you can't decide. A good title should lure the casual browser to read further. In most cases, especially for primary data papers, give your main result in your title – hence, a direct link to your main message. No one will bother to read your abstract if your title is boring or lacks relevance.

4. **Send** your main message, working abstract and proposed title(s) to your co-authors. After their feedback, revise them and send back. Iterate until everyone is happy (this is, of course, a relative emotion).

5. Decide on **display items**. Impose a strict **upper limit of 6** (any mix of figures and/or tables, multi-panel figures are acceptable if they relate to the same theme). If you have more than 6 items, rank in order of importance and move the lowest ranked ones to the online supplementary information. You may have fewer than 6.

6. **Create the figures and tables**, and write the legends for each. Ensure that each legend is **stand-alone** from the main text.

7. **Circulate** your choice of (up to) 6 display items with legends to your co-authors. Revise accordingly, iterate until everyone is happy with selection and presentation.

8. Plan the **paper's skeleton** (this requires careful thinking, and might take you up to a day to do properly – but believe us, it is time well spent!):

> Decide on length of main text. Our strong suggestion is to follow the criteria specified by *Proc R Soc Lond B*, *Ecol Lett* and *Ecology* (reports, not articles). That is, 20 double-spaced manuscript pages, or 6 printed pages (as it would appear in the journal). How long is this? Approximately 850 words of text per journal page, or 50 references, or 4 display items. So, roughly 3.5 pages of text, 1.5 pages of display items, and 1 page of references for an average primary data paper. That's $850 \times 3.5 = 3000$ words of main text. If you need to write more (e.g., detailed methods), it must go in the supplementary information.
>
> Work out the relative size of each section (Introduction, Methods, Results, Discussion,

Conclusion). A rule of thumb split is 600, 900, 500, 800, 200, but it varies depending on how much context setting is required, how many lines of evidence you are using, etc. Yet, despite this, it surprisingly often works out at roughly this ratio.

For each section, plan the paragraphs. Each paragraph should be about 50 to 250 words, but at this stage, do only this: write out each paragraph's main message in 15 words or less (similar to the concept of the paper's main message – remembering that each paragraph should be about only one thing). Then, play around with the arrangement of the paragraphs until you are satisfied with the logical flow.

If you wish, add to each paragraph some additional notes, key words, indications of reference to cite, display items to refer to, etc. Helps elaborate on the 15-word main message.

Circulate the skeleton to co-authors and invite critical feedback. Emphasise that this is the appropriate time to fix problems with flow, ideas/content, thrust towards main message, etc. Iterate the skeleton's revisions until co-authors are happy (or at least some consensus has been reached). Often you'll get no feedback except "that's fine". No problem – this indicates that you've planned well.

9. Write the paragraphs! You can do this in any order you like because you know your structure and flow are already established. This is a great advantage, because some parts of a paper are inevitably easier to write than others (and getting more and more final text down is a psychological boost). This also punches through writer's block, and also permits you to work on discrete units of your paper to avoid mental burn-out (don't try to spend all day writing – take a break with email, a walk, some analysis or coding, etc). DO try to set goals for a day (e.g., 5 paragraphs for a day, with an hour on each). Add the references (via Endnote or similar) as you go.

10. Revise the working abstract into a final draft form, based on the final structure and content of the paper. This now becomes your paper's abstract.

11. Circulate the finished draft ms to your co-authors and give them sufficient time (say 2 weeks) for feedback. You'll find they'll be happy to meet this time-frame, as they've already been embedded in the ms development project quite a bit (even if it's just to say "great!" at each juncture in which they're asked for feedback).

Some other points

It takes discipline to follow these 11 steps. But persist, even when you think "*Ahhh, stuff this, I'll just follow my nose, it'll come together!*". Don't give up. The structured method works and the unstructured method results in a lot more time wasting (and poorer-quality manuscripts) – we say this from hard-won experience.

Strategic repetition of your main message in the Intro, Results, Discussion and Conclusion is very important. Strategic repetition means saying the same things using different words (be clever and your readers won't even we aware that you're doing this).

Lead with your main points (a.k.a. you are not composing *Boléro*). This is especially important for the Results and Discussion. Your most important result should come first, your least important last. Your Discussion should start, in the first paragraph, with a strategic repetition of your main message.

You can be working on later steps whilst you await feedback from co-authors, but try to limit this to stuff you will do anyway (e.g., reference collation, reading, etc.). It may help to be working on more than one manuscript at a time, to avoid time wasting (not that any of you

should be doing that!).

Never *demand* feedback from your co-authors. Request it, and make the point that it's optional for any stage ~~except comments on the final draft~~. If they give none at a particular stage, it might just be that they're entirely happy with what you've done.

Avoid superfluous/tortured language and 'verbiage'.

Stick strictly to your overall main text word limit (3500 words for a primary research paper), try to limit to 50 references; NEVER more than 6 display items. Within the structure, some paragraphs may end up being longer or shorter than you'd planned, but don't make it a habit. If your finalised structure is good, you'll know what goes into each.

Feel free to ask questions – be sure to reply to all.

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