The Baldwin Formula for scientific writing: writing papers and reviews

Ian T Baldwin, updated April 10, 2016

1. **Determine your audience:** Which journal do you want to submit your paper to? *Science* and certain other high impact journals (*Nature*, *Current Biology*, among others) that are tightly space limited (due to their antediluvian habit of still publishing in paper format) require a narrative format, and hence a different structure. What follows is a formula for all other journals that have the traditional Abstract, Intro, Results, Discussion type of organization. Knowing the editorial board and the types of papers and the scientific standards of the journal will be very helpful in selecting the right journal. Don't shoot too high (submitting a low impact paper to a high-impact journal), as the cycle of rejections will wear you down. Doing the opposite is tantamount to professional suicide. Know how many words, figures and tables are allowed for a particular type of submission before you start writing.
2. The most efficient way to write scientific papers is to **write while you are still conducting experiments**, for it is only when you put the conclusions that you want to draw from your experimental data on paper that you will be able to "see" the flaws in the argument, the missing controls, or realize, from placing your work in the context of the published literature, what a better experiment would have been. So **the process of writing should be viewed as being inexorably linked with the experimental process**. I consider writing as a type of scientific oral hygiene, something you should do every day, like brushing your teeth. And if you make this a habit, then the process becomes much less painful.
3. **The first step in writing a paper is to define the "red line"** of your paper. This is done by writing a rough draft of the **abstract** (for this version, don't worry about word limits---this version is to create the road map of the logic of the results and conclusions that you will be developing---and create rough drafts of your **figures** and **tables**. This is the heart of your paper and you shouldn't write anything else (other than the Materials and Methods, which you should have written while conducting the experiments) until you have thoroughly defined the logic of your thesis. Emotionally, it is very hard to throw away text that you have written and sweated over and if you start to write before the logic of your paper is clear, you will waste a lot of time and torture yourself. **The entire story of your paper should be comprehensible from this abstract and the figures and tables**…and these items are usually what reviewers read first to formulate their reject/accept decisions. In general, half of the total time that you spend writing a paper should be on this first step, because everything else will follow from this red line.
4. **Create the final versions of your figures, figure captions, tables and table legends**
    - Important points of your paper should be presented in a figure and not hidden in a table. **Each figure should illustrate at least one important take-home message of your paper and ideally be understandable in 30 seconds** to an uninformed scientific reader. If you can't hand a figure to a colleague who doesn't know your

story, and have them understand the point of the figure in 30 seconds, you need to reconsider your figure. All information required to understand the figure should be in axes of the figure and labels. Always label treatment groups directly on lines rather than relying on the legends that software packages provide, if possible. If the point of the figure is that there are significant differences, then provide appropriate statistical annotations. Use insets into figures to provide ancillary information, use axes breaks and rescaling to call attention to differences occurring at different scales among treatment groups. **A good figure is worth more than a 1000 words**.

- The content of figure captions differ a bit from journal to journal, but in general, the first sentence should summarizes the main point of the figure (and any abbreviation used in the figure should be defined here). A concise description of the data shown and the methods used should follow. Do not repeat sentences which describe the same methods in the next figure caption. Therefore, you should be sure that you know the order of your figures (and supplemental figures) before starting to write the figure captions. The statistical tests and symbolisms should be defined. Basically the entire figures should be fully comprehensible from the figure caption.

Table legends should include only a stand-alone first sentence (as for figure captions), which should come at the top the table (captions come at the bottom of the figure, and no matter what the journal rules are, I always recommend that the captions be fixed to the figure at submission time. This makes it much easier on reviewers). A key to any abbreviations in the table should come below the table.

- The abstract, figures and figure captions should be in their final, perfect shape before starting on the next step. If you have any doubts about the "red line" of your paper, **confront these doubts now** before proceeding. A poorly considered red line is the most common reason for frustrating paper writing efforts.

5. **Write the Results section**

- The results should follow the order of your figures and the red line delineated in the abstract. The **results section should present results**, and include only an absolute minimum of discussion. The Results section should highlight all of the conclusions that you can draw from your data with a minimum of discussion and inference: **your strong conclusions**. Your weaker conclusions should be covered so that they can be discussed in the Discussion section.

6. **Write the Methods section**

The Methods should have been written while you were conducting the experiments.

- The Methods should be concise, but sufficiently detailed so that a reader should be able to repeat your experiments from your descriptions. Some journals have very precisely defined information that they want from microarray data, for example, so be sure to consult the journal homepage in writing the methods. URLs are frequently the preferred means of providing information about companies, for example.
- **You want other scientists to be able to replicate your work**, so if you have developed a complicated procedure that is hard to capture in words, consider making a narrated video of the procedure. These can be published separately in one of the journals that specialize in protocols (ie *Bio-Protocol*), and loaded to your homepage.

7. **Write the Introduction**
    - **write the last paragraph of the Introduction first**; this should be an abbreviated road map of the question that you are addressing and the means by which you answered the question (not a summary of your Results and Conclusions).
    - Once you have written this last paragraph, circle all of the words and concepts that you used in this last paragraph that need to be introduced and elaborated on in preceding paragraphs of the Introduction. In this way, you **will be reverse engineering the entire Introduction from your last paragraph**. This is most efficient way of writing an Introduction that I know of.
    - A complete and thorough literature summary of these concepts should be presented in these paragraphs and each paragraph should end with transitions sentences that lead to the next concept. Introductions that are longer than 3 pages or 8 paragraphs are usually too long.
8. **Write the Discussion.**
    - The discussion should start with a paragraph which succinctly states your motivation, and the conclusions that you draw from your data that do not require discussion and ends with an introduction to the weaker conclusions that you would like to draw, but do require discussion. **This paragraph should not be a rehash of your results.**
    - The following paragraphs should discuss the conclusions that you would like to draw from your data, but require discussion because the inferences are indirect, or your data or the data in the literature are contradictory. The best way to neutralize the concerns of critical reviewers is to acknowledge the holes in your arguments, and propose experiments for future work which will place these arguments on stronger experimental footing. **Describing experimental tests which will falsify new hypotheses that you draw from your data is the most rigorous means of presenting a new hypothesis.**
    - The last paragraph should summarize all major conclusions from the discussion of your results and indicate future research directions.

9. **Write the references:** Make sure that every reference you cite is listed the reference section, and correct all formatting mistakes that can occur with EndNote or other reference manager software.

Tips for revising the manuscript:

1. **The key to becoming a good writer is learning to become a good editor** and to erase the memory of what you have written, so that you can "see" the grammatical mistakes and poorly constructed arguments in your writing. And **the best way to realize your critical potential is to erase your memory of what you have written. This memory is the single largest impediment to being self-critical, because you think that you know what you wrote, and this keeps you from seeing what you actually wrote.** So you want do what was done in the movie, ***Men in Black*** (https://en.wikipedia.org/wiki/Men_in_Black_%28film%29).
2. Tricks to erasing your memory include **printing out the text in a different font**, or some other format that breaks up your visual memory of the text. Another is **to have someone read the text aloud to you**, so that you are forced to "hear" the words, rather than see them, and thereby process the argument through a different sensory modality. **Edit different portions of the text that you haven't been working on recently**. Take a break to hit your "reset button"….Asking others to read your writing is very useful at early stages in your scientific career, but as you mature, the responsibility of producing coherent first drafts will rest with you, so you will need to find a system that works for you.
3. A great way to practice your editorial and critical skills is **to edit the words of others and when you get the opportunity to review manuscripts, you should jump at the chance.** If you are not given the chance, you should tell your supervisors that you want to do this. So here are some tips on writing reviews of manuscripts.

How to write a review

A good review has a number of key parts:

1) **A short summary** of the author's experiments and conclusions. This summary should not follow the abstract too closely and serves mainly as a means of gaining the respect of the authors, to show that you as a reviewer has fully understood what the authors did and how they arrived at their conclusions.

2) Then comes the critical part (if you are mainly critical) or the part where you praise the work, if you think that it should be published and it represents a real advance. A review is as much a dialogue with the editors as it is with the authors. If you are reviewing for eLife, a review is also a dialogue with the other reviewers.

A narrative which includes the following parts:

a. **How well the conclusions are supported by the data**. This is the most important part of a review and the most important thing to learn to do as a reviewer (and as a scientist): distill out the conclusions (sometimes these can be tricky to distill, and this is telling when this is the case) and evaluate how well the conclusions are supported by the data. The most important question to be asking is: are there alternative explanations/conclusions that can be drawn from the same data that the authors are missing.

b. If you think that the paper will need some PR in order for the editors to decide in favor of publishing the work, then a strategy that always works, is to **place the work in the context of the field**, highlighting how it represents an advance.

c. **Specific recommendations that could improve the manuscript if implemented**. In general, you shouldn't propose many new experiments, or rephrase or redirect the question that the authors were asking. It is the author's paper after all, and it's not the job of the reviewer to rewrite or redesign the experiments. What distinguishes the reviewing process at *eLife* from that of *Nature* and *Science*, is that we want to publish the paper that the authors wrote, not the paper that the reviewers wish the authors had written. So additional experiments are limited to those that can be accomplished in 2 months; if the paper requires more extensive experimentation, then to be fair to the authors, the manuscript should be rejected so that the authors are not held hostage in an interminable, career-killing review cycle.