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Writing science that your colleagues can read☆

One of the most challenging tasks for both students of science and established scientists is to clearly communicate their ideas and findings in writing. Regardless of an individual's creativity, insights and intelligence, an inability to write clearly and effectively will dramatically reduce or eliminate any chance of success in acquiring funds, influencing colleagues or sharing ideas. Indeed, when established scientists are considering individuals for postdoctoral or faculty positions one of the first questions that is: "Can he or she write?"

Despite the foregoing, very few science programs train students in effective expository writing and most individuals learn to write through trial and error (i.e. as an apprentice). This means that what an individual learns is heavily dependent on who her mentor is. Much has been written about expository writing; however this literature is not accessed by most scientists, possibly because they do not deem it to be relevant. Indeed, there are few easily accessible resources to help guide either new or established authors.

This article is meant to provide some basic principles to facilitate the writing process (Table 1). It is based on the author's personal experience and his review of countless grant applications, graduate papers and peer reviewed articles.

Start writing early. Writing is an iterative process. It is not the transfer of information and ideas from one's brain to the paper. Writing represents a discussion between the author (as the writer) and the author (as a reader). The writing part is the putting down of ideas in sentence form; the reading part is the critical assessment of the ideas and the sentence and paragraph structure. As long as the reader is not happy, the draft is not complete. When the draft is complete, it is essentially a written record of the discussion that has gone on between the author and herself.

Warm up before writing. The best way to do this is to write the easy parts first. Not only will this reassure you that you are making progress, it will give you confidence and start your creative processes. For example, if writing a scientific paper, it is usually best to start with the methods section; this requires the least creativity and reminds you of all that was done, and helps your formulate the next (i.e. results) section.

Start with the basics. A solid foundation based on well-known principles will help orient the reader and provide a base upon which you can quickly build your case floor by floor. Even if the foundation represents widely known information, it is both useful and reassuring to the reader (regardless of her expertise) to be reminded of the basics and to see an argument built on that foundation.

Tell a story. Storytelling is perhaps the oldest of the social activities practiced by humans. The closer that your document is to a logical and easily remembered narrative the more effective it will be. It is important to get the facts right and to present them in a clear and uncluttered way, but concepts should get more space and attention than facts. Facts that are woven into the concept have a greater impact than isolated facts.

Use jargon sparingly. If a jargon term is truly required despite great amounts of soul searching, define it clearly and use it consistently throughout the document.

Minimize the use of abbreviations. If abbreviations must be used, define them in a glossary at the beginning of the document (sometimes abbreviations are defined in the first instance of use and then just used) and only use abbreviations for words that will be frequently used throughout the document so that the reader becomes familiar with them quickly.

Keep it short (i.e. less is more). Avoid including extraneous or distracting information and avoid parenthetic comments. A 3 course sit-down meal is much more effective than a smorgasbord of information and loosely related facts, observations or citations.

Keep the metaphors simple. If they are used to explain concepts (such as the one in the preceding paragraph), make sure that they are clear and internally consistent (i.e. don't mix metaphors).

Don't fall in love with your text. You may have written the most erudite and articulate paragraph in the world but if it does not communicate the message simply and effectively, or distracts from the message — cut it. Expository writing is as creative a process as fiction writing. The fact that much more text will be deleted than appears in the final document is not a measure of wasted time. Consider the deleted text a necessary part of the creative process in the same way that dismantled scaffolding and cranes are necessary parts of the process required to construct a high-rise building. Expect to write 10 or more drafts of any paper before you are satisfied with your final "first" draft.

Don't make the reader decipher your document. A well written document should be read easily and effortlessly and should be

Table 1
Principles of science writing.

Start writing early
Warm up before writing
Start with the basics
Tell a story
Use jargon sparingly
Minimize the use of abbreviations
Keep it short (i.e. less is more)
Keep the metaphors simple
Don't fall in love with your text
Don't make the reader decipher your document
Get the critical opinion of someone you respect
Only write when you have something important to say

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understood without much effort. Such a document will make readers feel good because: a) they can understand it easily; and b) it gets their own creative processes working. A document that requires deciphering by the readers first makes them question their own intelligence (and puts them in a bad mood) and then leads them to question whether you clearly understand the process (because they don't). As soon as you irritate the readers you have lost their interest. The goal is to make them finish the document in one read and feel excited and stimulated.

Get the critical opinion of someone you respect. No matter how good you think your document is, it can be improved. This is best done when you reach a point of diminishing returns (i.e. when you are satisfied). Critical opinions can be provided by your mentor, your colleagues and your students. Even better input can be provided by somebody who is a total non-expert in your area. At least 60%–70% of a well written document should be understandable by an intelligent and literate non-expert (e.g. spouse or sibling) regardless of their content expertise or even scientific knowledge. If they have no idea what you are talking about you may need to revise the document.

Finally, and most importantly, these principles will only be useful if you have something important to say. Otherwise, no matter how good the writing, a document that has nothing to say won't fool anyone. Assuming this is not the case, following this advice will increase the likelihood that your grant will be funded or that your paper will be accepted. After all, the only reason to write something is so that it will be read by somebody and the only reason for someone to read it is their (usually tacit) expectation that it will change them in some small or large way.

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