

Me write pretty one day: how to write a good scientific paper

The scientific literature is exploding in quantity even as it stands still in literary quality. In this brief guide, I suggest a few small steps that the individual can take to make his or her writing clear, straightforward, and digestible.

So...what was your point?

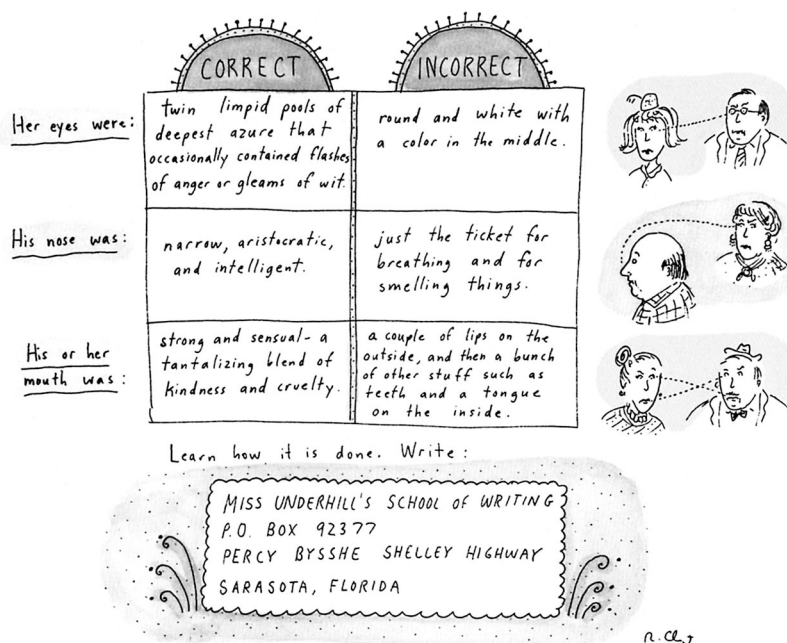
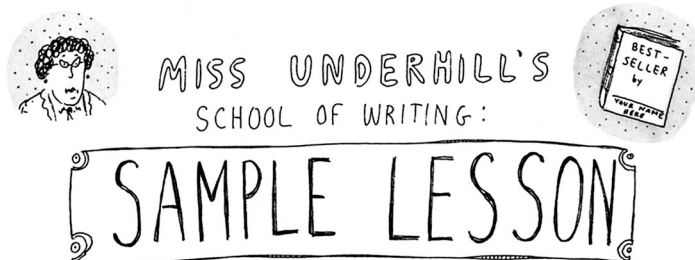
The first step with any manuscript is to define your bottom line. Be realistic about how much the average reader will take away from an article. Non-experts will retain at most a single message. Make sure you have one, and then repeat it over and over again—at the end of the Abstract, in the Introduction, in the Results, and in the Discussion. In contrast, everything but this single sentence belongs in one section (Introduction, Results, or Discussion) only.

To uncover your bottom line, ask some questions: What was the mystery that you wanted to answer at the start? Have you answered it? What first got you excited about this area of research? With any luck, it was more than the idea that proteins X and Y might bind to each other—there was probably a bigger idea that motivated and intrigued you. Make sure you convey that reason and that excitement.

What is new? Break up the story into “It was previously shown that...” and “Now it is shown that...”. Is there a significant difference between the two statements? Justify the interest of your work verbally to someone outside of your field. Your explanation should be compelling on a general, conceptual level, not grounded in minutiae with

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which your volunteer has no familiarity or interest.

Does the reader need help understanding the significance? If you think your discovery might (in the future) prove to be the explanation for mystery X, don't make the reader figure out the identity of mystery X. State it explicitly, make clear that the link is only speculation, and explain any basis for making the speculation. Remember that your readers are busy in their own field, and will not necessarily make the jumps in logic that are glaringly obvious to you. Make the jumps for them.

Show; don't tell. Not “Our results are exciting...” but “Our results double

the number of known penguin species...”. If your readers don't think that is exciting, they won't be convinced by you stating that it is.

Finally, include different levels at which your results are significant: e.g., (a) we have found a stem cell repressor, and (b) this may be one of many repressors for maintaining a generally dormant state in stem cells. This is particularly important for papers that you are trying to get into top-tier journals.

The anatomy of a paper

Now that you have your bottom line, you need a roadmap for writing the paper. Remember throughout that

everyone, even a scientist, thinks in narrative. Science is a story. Tell it.

To draft a paper, simply work out what the figures and tables would look like. Give each figure a simple, declarative title in the form of a sentence. Most of the content of the paper should be evident from reading these few sentences alone. When the sentences look as if they both tell a story and have a bottom line, it's time to start writing.

A good paper is not a random accumulation of facts. Give your paper a narrative structure that links from one finding to another. This can be the logical order of why one experiment was done in response to another, or you can describe from the beginning to the end of a pathway. Build up this structure by writing notes, in any order, and then rearranging them so that there are logical links.

Start by drafting a title that is strong, direct, and as "big picture" as the data can justify. But don't claim more than you have shown.

An *Abstract* can and must pack in many elements: background, a question, what was done, what was found, the conclusion/answer, and implications. Make it clear where the background ends and the new work begins.

Arrange *Results* either chronologically (as they unfolded in lab), or put the most important result first and secondary results later. The latter organization works best when organizing each paragraph.

Describe the data with only enough interpretation so that the reader can both see what logical path the writer is taking—how one experiment prompts the next—and understand what spin

the writer is trying to put on the data so that the reader can agree or disagree with this spin.

Start the *Discussion* with a very brief one-paragraph summary of the main results: first state the answer to the question, and then concisely add a broad-brush version of the supporting evidence. Organize subsequent topics from most to least important, i.e., start with topics most closely related to the answer. The first sentence of each paragraph should indicate the structure of the Discussion.

Do NOT just repeat the Results (or Introduction) section, but discuss how the results affect the field. Reveal any large areas that remain a complete mystery.

The *Introduction* sets up the background for what we are about to learn (the bottom line) and why it matters. Funnel from known (the big picture significance of the field) to unknown (the specific gaps in knowledge) to the specific question being asked by you. The Introduction is not a literature review but a means to set up the question.

How to write clearly

Now that the text is down in rough form, we can tackle style issues. Think about each element used to construct the paper. Sentences should have an active construction, address one thought at a time, and generally be kept short and to the point. Treat each paragraph as a thought, with a single, clear message.

More general style issues include signposts, flow, editing, and specificity. *Signposts* tell the reader where you're going with the argument that follows. Many authors mistakenly feel that they

have to build the entire case before telling us the conclusion. They list all their evidence before stating: "Thus, X = Y." But this leaves the reader scratching their head for sentence upon sentence. Put a preview first.

Flow comes about when the writer makes connections between the end of each sentence, paragraph, or section and the next. Make all transitions so there are no gaps in logic. Don't presume that the reader will do any work. Do the work for them.

The main route to clarity is to *cut, cut, cut*. Chop out everything from single words to entire thoughts. "In spite of the fact that..." becomes "Although...". Only after chopping out text will the average reader make it through your words without drowning.

Specificity means using only words with precise meanings. Replace lazy phrases such as "gives important insight into..." with words that actually mean something. Use the specific ("dog" not "animal") but simple ("girl" not "female child," "used" not "utilized") and necessary ("X was examined and found to vary" becomes "X varied").

Stuffy writing is frequently used to disguise intellectual fuzziness. Think about what you really want to say. Be exact.

Space precludes a full discussion of how to deal with journals, but there is one Golden Rule: be polite to editors, no matter how you are provoked. Editors are trying to do a good job, and screaming at them will not advance your cause, and could well damage it. Be forceful, but civil. And good luck!

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