

## A tiny guide to scientific writing - ten + one golden rules

Writing a scientific paper as a (PhD) student can feel challenging and complex, but is not a complicated process. In fact, it is just a way of communicating: you explain and share new findings with the community that is working on the same or a similar topic (for a regular article), or you provide an overview of your research activities to a general audience (for a review or student report). The common excuse that you feel no 'inspiration' or just 'first need this important result' is often just a way of postponing a writing process that can structure your thoughts and will give you satisfaction or even some fun if performed in a relaxed mood. My advise: just start writing, and afterwards discard/rewrite everything that turns out to be of no use (yet, the 'useless' parts will often turn out to be a very useful exercise for shaping your mind). This short guide contains a set of simple rules that help you making scientific writing more worthwhile.

Before I start with rules, it makes sense to sketch a general outline of a scientific manuscript. While the order & layout may vary with the type of manuscript (report, article, perspective, review or letter), the generic elements of a scientific manuscript are: **title and authors information, abstract, introduction, methods/sample preparation, results/discussion, conclusions, acknowledgement, references**. Also a table of contents (TOC) is often required (but later in the review procedure) in the form of text and/or graphics that summarises the manuscript.

Some useful suggestions:

- **Web of Science** (WoS, via the library) or Google is an efficient tool for performing a search in the existing literature via author names or keywords ([...] AND [...]) If you find a relevant paper of a certain group, it makes sense to check other publications of the corresponding author and/or references to that paper. Start your preparation stage by asking your supervisor for a list of key readings and competitors, and read a recent review paper on that list in detail. Since you are likely unfamiliar with the particular scientific field, it will inform you about its current status, provide significant keywords for more targeted searches in databases like WoS, and make you aware of the styles and standards in addressing the target readership.
- Write in **LaTeX** (.tex files). While Microsoft Word (.doc or .docx) is also popular, this format is not transferrable between different computer platforms. On **Surfdrive**, however, where most Dutch scientists store their shared data, one can edit .doc(x) files via a plugin.
- An online platform for tex-manuscripts is provided by **Overleaf** (<https://www.overleaf.com/>). Overleaf is an interactive platform for storing and compiling LaTeX files, and even allows you to submit to journals directly.
- Use productivity tools. **Github** allows for version control, including codes for analysis, raw plot data, and latex manuscripts. Some other productivity tools, for instance for project management (using Gantt charts) and time tracking, can also be useful.

The rules:

- I) **Start on time.** Structuring your mind, which is often what you do when you start putting ideas into words, takes time, and always more time than one anticipates. So, when you are gathering background material from the literature, to understand the 'knowns' and formulate your own research questions or 'unknowns', it is worthwhile to use this time efficiently. Annotate important reading materials by writing a few lines about their main goals and findings. Next, use these annotations to sketch an **Introduction** of the paper that you intend to write (using a blank file with the proper structure). Often, you can also already write the **Methods and/or Sample preparation** section, because you already know which (preparation) methods you intend to use. Update this manuscript regularly, and add key findings to the **Results** section as bullet points. Add all relevant literature that you find directly to a .bib file. Remember: the risk of starting (too) late is that you get stressed; consequently, your ideas do not reach their full potential. If the message/embedding is still somewhat unclear to you, it will certainly be unclear to your audience. So, start writing from day one.
- II) **Own your project I.** You are the owner of and the greatest expert in the research that you are carrying out, so take responsibility. Log all your key findings/settings (short descriptions of characteristics and images), as well as the location of the folder in your computer that contains key results, in a hand written logbook (to guarantee off-line accessibility). Your group

will have clean logbooks, ready for use. It will help you structure your research and gives you quick access to data when collecting images for the Figures in your publication. The **Results** section usually starts from these figures, as this section generally discusses results via these figures. So, if all the figures that you need to tell your story are ready, then the story is ready and a key part of your manuscript is ready. On the other hand, the figures will tell you when your story is incomplete and which part is still missing. If you are in a flow of writing the manuscript and do not have time to render the high-quality image that you need for a publication, a sketch will also do temporarily.

- III) Own your project II.** Although you are working on a project/topic that was proposed by someone else, you are responsible. Make sure that important data and/or findings are stored in a secure and shared location, and schedule an appointment with your supervisor when the time is ripe to discuss new results. Also in case you get stuck - remember that progress is slow in the beginning, and that getting stuck is part of a learning process, but that it should also ease up and speed up towards the end. So take action if you feel blocked for too long: stop, look, correct, take action! Manage your supervisor, who generally has to deal with many projects, by keeping her/him up to date and making sure that she/he owns all relevant information prior to discussion sessions. Take yourself serious. If part of your research is finished, ask your supervisor to schedule a talk in a small group for feedback. All these activities will help you overcoming doubts (only fools have no doubts whatsoever) and to understand the story. Stories are the essential ingredient of any writing process.
- IV) Read aloud and ask help.** Every scientist has experienced that the first steps on the path of science can be challenging. Particularly the scientific reporting part. So how do you deal with it? A useful ancient method is to read fresh writings to yourself out LOUD (make sure that you are alone; works better) in order to identify flaws, mistakes, missing words, strange sentences, and to see how your writing works in general. Ask friends and fellow students to read and help you; even when they are unfamiliar with the topic, they will be able to comment on your writings in general terms. You can offer to help them in return, and learn from their writings as well. Share important parts of your writings at an early stage with your supervisor, to get an informed opinion on the best way forward. Although you may find it scary, it will be efficient. The discussion will give you new insights and/or helps to structure your train of thinking. Feeling (too) shameful is not useful. After all, nothing is perfect!
- V) Be inspired.** We humans learn from the world that surrounds us, we are an echo chamber, so it is ok to be inspired by writings of the more experienced scientists. Yet, one cannot simply copy, except when one clarifies that that is exactly what one has done (by quoting and citing the original text). In practice, however, you might get away with copying (e.g. reusing complete equations bearing the same symbols without reference is common practice) in method sections, but introductory and result sections will be checked on plagiarism; any instance counts and may eventually become problematic. Your *rep* (reputation) is at stake! So, ask yourself the question: when I discuss [...], what do I want to say about it? Sit down without distractions (no TV, internet, mobile, newspaper, paper, book) and think, or go for a short walk (which is a good way of letting your creativity flow) and formulate what you want to say in your own words. Replace the yet unfamiliar English terminology by words in your native language, and translate afterwards. This will help you to feel relaxed and comfortable, and to be original. Forget the idea that 'work' is equivalent to sweating over a machine or in front of a computer: creativity is much better served by emptying your mind for a moment. At the end, it is the result that counts - nobody will know how you obtained it! Additional tip: start reading English literature/newspapers/magazines. This helps to increase your vocabulary.
- VI) Be fair and be honest.** Acknowledging the giants on which shoulders we are standing is a good thing; after all, now you personally experience the complexity of scientific practice. So be fair to them and cite! And be humble; be modest! The scientific community is increasingly incorporating the FAIR (Findability, Accessibility, Interoperability, Reusability) standards for data-storage, and also more and more journals are asking publications to include all information necessary for reproduction. Indeed, without it, published data is worthless. So be honest! Record and publish exactly what you did and how you did it. If you find something new that you cannot reproduce, and you are not entirely sure why, it is usually not worth mentioning in the manuscript. Yet, if you can reproduce something that contradicts your main

conclusions, check! Maybe something went wrong in the procedure - get to the bottom of things! If you cannot identify the cause of this discrepancy, you cannot publish your data. In particular, you might get away with publishing a few 'fake' results, but at the end colleagues will start whispering why they cannot reproduce your results, and it will show up in your *rep*. The same goes for not being able to explain results: the second best 'solution' is that you publish results and honestly admit that you don't fully understand them. The best solution, in my view, is to discuss such issues out in the open with trusted colleagues. Last, but certainly not least: **avoid bullshit at any cost!** Harry G. Frankfurt - the author of the essay 'On Bullshit!' - concluded that the work of a bullshitter is actually much more damaging than that of a liar, because the lie still relates to the truth that she/he is attempting to hide (knowing that it's a lie). The bullshitter does not care about truth; her/his sole interest is in *persuading* the listener or reader of a certain (false or true) opinion or viewpoint. This uncanny desire to bullshit someone who makes an effort to understand what you want to communicate is sadly rather common amongst lesser confident writers, and often expresses itself in an urge to bombard the poor readers with a diarrhoea of pompous but 'hollow' statements. While some of you can indeed make yourself poorly understood because you are living on mount Olympus of abstraction (or, alternatively, you are creative and use bullshit as a literary style figure) - in which case, chapeaux! - it often boils down to making an attempt of hiding that you don't yet (fully) grasp what you are writing about, or that you feel a desire to come across more knowledgeable than you actually are... in short: sprinkling sand into the eyes of the beholder. You should be aware that you may not fool all referees or readers! Sure, it may soften some experts that you are new to the game (how cute!) but more often it will annoy them (meaning trouble!). Even if you manage to fool most because they don't want to go the extra mile to debunk you, it will stain your *rep* as a newcomer simply because you have given written evidence of being capable of something worse than a lie. Remember that paper is patient, and that trust comes on foot and leaves on horseback (old man talking). So, control this urge and be honest, and stay away from bullshit as much as possible!

**VII) Outlet.** Before you consider I-VI), you need to select a provisional title (this says it all in one sentence, you may want to change it till the end) as well as your outlet of choice. Writing a manuscript for Physical Review Letters (PRL), a journal with stringent rules, is quite different from preparing one for Soft Matter. It will set the terminology! So, before selecting your outlet, you need to define to which outlet your work naturally belongs. Nature and Science, for instance, will turn down most of the submitted manuscripts, so submission is often a waste of time, and they usually publish somewhat speculative studies with 'sex-appeal'. PRL is for new developments (theory or experiments) in physics. So you need to think: i) how 'sexy' is my study? Am I contributing to a possible breakthrough in some important field?, and ii) who are my targeted readers? What journal does the community that I want to address actually read? Checking where the papers that you referred to were published will teach you something, but also reading the information about potential journals (on the journals webpage) does. In general: the citation index (CI) of a journal does not give it away. In particular, if your paper is published in a high-ranked journal but gets less citations than the average CI of that journal, it is considered a mistake. Highly-cited papers in a less cited journal (i.e. with a lower CI) sometimes stand out in the community. Yet, managers that count points (e.g. when you apply for a scientific position somewhere) don't care: they just see the CI of the outlet/journal. So, try to judge what is most important to your career and discuss this with your supervisor. Invest time to discuss who will end up on the authors list and on which position (position usually reflects input), and who will be corresponding author(s). One collects points for being first or last in the list, and for being a corresponding author (CA). Remember that also PhDs can be CA, albeit that often permanent staff is made principle CA because they are better tractable in the future. Don't go for alphabetic order if they use that weird argument on you.

**VIII) KISS (Keep it simple, stupid!).** Keep it basic; don't try to show off! Your great result, obtained by complicated derivations or based on highly developed technical skills and insight, may well be a true bore to the general reader, making her/him loose interest very quickly, so ask yourself if it is a necessity for the story to keep it in the body of the manuscript or whether it could go into the Supporting Information (SI). It is a good idea to keep the number of pages in the body of the work restricted to the minimum. In the past, journals were actually printed, so short articles were desired and also cheaper. More recent, it is becoming a sign of quality if you manage to convey your message in only a few pages: it means that you truly understand!

So if you had to deal with less relevant (technical) aspects, or measurements that need quite some explanation, it makes sense to put these details in the SI if possible. Be aware that SI is not checked by the editor, so you are to blame for any mistake.

- IX) Alternate.** Most scientist like to alternate their daily activities between different tasks to keep themselves awake/motivated, from administration to (informal) discussion, from writing to reading to active research. Please try to feel what works best for you! Apart from alternating tasks, you can also use different locations for individual tasks, especially in the current Covid crisis. In general: if you feel that your concentration is slipping away, change task. And switch back: make sure that you do not postpone the task that you find most difficult!
- X) Schedule.** Paint a plan at the beginning of your project. Make an inventory by writing down the list of tasks that you need to carry out to reach the finish line, and estimate how much time they will take individually. Draw a detailed timeline, and estimate an end date. Although these timelines are hardly ever kept in practice, they will help you (re)structuring your daily work. And, whatever you do, stick to the plan! It is always tempting to make side-steps, to use the new hammer in your hand for kicking all nails on the head, but stick to the plan! Life is too short for detours - instead, you make notes for future research when this project is finished! Update your schedule regularly to keep it up to date.
- XI) Kill your darlings.** One extra for the road, stressing the importance of keeping an open line with the outside world (colleagues, friends, supervisor, potential readers). In particular, it shows why keeping your supervisor involved and informed is always a good idea, and will save you some time in the long run. Eventually, it may even happen to more experienced writers that one polishes a paragraph or section over and over and over, to a shine that matches the grin on your face. You may come to think *'Boy oh boy, this section is amongst the best piece of writing that I ever produced; no letter may be shifted without compromising the entire structure'*. This may actually be true in sparse cases, but more often it is not. While some people can be a good judge of themselves when rereading manuscripts after some ageing, most of the time you will be saved by the standard procedure. After all, producing a publishable science paper is a tedious iterative process that involves many parties: often several authors (actually, the iterative nature of the process is why very few papers are published by a single author), and up to five referees and an editor after submission. Such an optimisation process intends to lead you to a bare minimum, which is the essence of your story. It may happen that the shiny armour that you have so meticulously put together during weeks of hard labor objectively does not add anything to the story that you want to convey. This observation is a matter of perspective, and somebody else may actually be more capable of observing it than you (can you imagine that?!). When this somebody puts her/his dirty finger onto the shine, it's tempting to dig your heels into the ground and utter 'my precious, my darling....' with a much nastier grin on your face. Yet, this is the ungrateful job that local 'editors' (=more experienced contributing authors) have to perform: making sure that everybody kills their own darlings in order to come to an article that will attract attention from fellow researchers in the field and can eventually stand the test of time. To **tackle** or preferably **avoid** such a standstill during the writing process, a good exercise for you is to simply explain what the story is about from time to time to a 'neutral' person. So ask someone to listen (e.g. your supervisor, but also friend or fellow students will do pretty well) and shortly explain the essence of your research; meanwhile, listen in to what you are telling this other person and tick all the relevant boxes! Is the shiny part one of them? It may well convince you that the criticism of the 'editor' is wrong (in that case, use this process to gather arguments against her/his opinion!), but more often you will sadly agree and decide to skip these magnificent but redundant parts. Note to always keep versions of your manuscript (in your local archive or on Github, Overleaf will only store changes) in order not to waste good parts for recycling purposes! But taking care of editing before submission will certainly clarify your story, and ease the reviewing and acceptance process.

Good luck publishing!

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