Writing Science: What Makes Scientific Writing Hard and How to Make It Easier

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Introduction

Writing is an integral part of science at every stage; it is how we outline a project idea, communicate with collaborators, draft a grant application, synthesize our insights into a manuscript, and share science beyond academia. Yet, when training students to be scientists, we often focus exclusively on the scientific method and the work of data collection. We rarely talk about the equally important topic of writing about science (Reynolds and Thompson 2011, Turbek et al. 2016). When we do discuss writing with students, trainees, and peers, we emphasize the mechanics: how to structure a manuscript, the style conventions of scientific writing, and the submission process (Guilford 2001, Turbek et al. 2016). As a scientific community, we rarely discuss the actual act of scientific writing itself. Unfortunately, the writer's block that plagues most academics has nothing to do with manuscript structure or style conventions (Kwok 2020). Even when we have a detailed outline, know what we want to say, and have the citations bookmarked, we often struggle to turn the outline into a full draft. Indeed, advice columns in *Science* (Van Bavel and Gruber 2019), *Nature* (Kwok 2020), *Inside Higher Education* (Rockquemore 2015, 2016), and many scientific blogs are full of acknowledgments that the act of writing is hard.

Here, I discuss why the act of scientific writing is difficult and suggest simple strategies for developing the skill of scientific writing. By understanding why we find writing difficult, we can begin to test different practices that might increase our writing output. This process of understanding and overcoming obstacles to writing for academic scientists of all career levels can increase scholarly output, boost career prospects, and ultimately advance scientific knowledge.

Why is Academic Writing so Difficult?

Understanding why the act of writing is challenging can help overcome the dreaded writer's block. In particular, writing a manuscript or dissertation is hard because, most of the time, no one has ever before been where you are in the realm of knowledge (Fig. 1); hopefully, no one has ever explored these data in precisely this way. You and every other scientist are writing at the edge of our collective knowledge. That is generally the point of a research publication: to add new knowledge to what is already known (Might 2012, Heard 2015*a*). Similarly, when writing a grant proposal, you are trying to imagine what might lie beyond our knowledge boundary and determine a path to getting there without much knowledge of what lies ahead.

Simultaneously, what makes research exciting is the very thing that makes communicating research hard. The goal of a research publication is communicating what you have discovered, at the very limits

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of our collective knowledge, to those who were not with you on the journey. The point of a grant is to communicate what you plan to discover and how you plan to discover it, and convince readers why that knowledge is essential to advancing science or addressing societal challenges. Additionally, writing up your research findings for publication can be scary because it signifies the project's readiness to take the next step, to move from data collection and analysis to preparation for sharing with the wider community. Doing so opens you up to criticism by the scientific community and the possibility that you may need to return to the stage of data collection for additional information. Lastly, although manuscripts present the scientific process as linear, the reality is much more meandering, with many failed experiments and loops back to the start before conclusions are finally reached. Distilling the journey into a linear narrative for a manuscript can be challenging and adds layers to the difficulty of writing a manuscript specifically.

General Tips for Success in Practicing the Act of Writing

Those same advice columns have many suggestions for how to write more and publish faster (McCollum 2015, Rockquemore 2015, 2016, Van Bavel and Gruber 2019, Kwok 2020). However, one size does not fit all writers or scientists. Strategies that work for one person may not work for a different person or may need to be tweaked. The good news is that our training as scientists is exactly what we need to become more prolific and confident writers. In the process of doing science, we survey the literature for methodological options, test several methods, and settle on the ones that best generate the data we need to test our hypotheses.

Similarly, we should apply the scientific method to improving our writing practices. Collect advice from many sources, try different tactics, retain what works, and discard what doesn't to ultimately settle on the strategies that can best help you write (Rockquemore 2016, Kwok 2020). Here are a few suggestions you might try to improve your own writing practices.

1. Adopt a growth mindset and treat writing like any other skill.

A growth mindset is the belief that intelligence and ability are the product of hard work, grit, and determination (Dweck 2016), coupled with relevant training (see tip 8). The ability to write is not an innate talent, but rather a skill you develop and practice, just like any sport or hobby you want to master. Understanding that writing is a skill to be learned, rather than a talent possessed only by some, can increase motivation to write (Truax 2017). Let's compare becoming a prolific writer to becoming an endurance runner; unless you want to risk serious injury, you shouldn't order your first pair of running shoes today and attempt a half-marathon the day they arrive. Similarly, you can't sit down at a blank document for the first time and write a full scientific manuscript or dissertation chapter. However, just as you ensure that you own the proper clothing and shoes before you begin running, reading extensively and developing a decent outline or plan for the draft you need to write is a critical first step to starting to write. Next, as with running, following a consistent training plan is crucial to developing the skill of writing (see Single 2009 and Lee 2017 for suggestions for developing a writing training plan). This running metaphor also helps convey how important it is to write regularly; in fact, many prolific writers advise writing daily, a habit that is important to practice early on in your career as a writer. Furthermore, if you take a long break from your writing schedule, it will take time to reach your previous output level, just like you would need to ease back up to your previous mileage or speed if you took a hiatus from running.

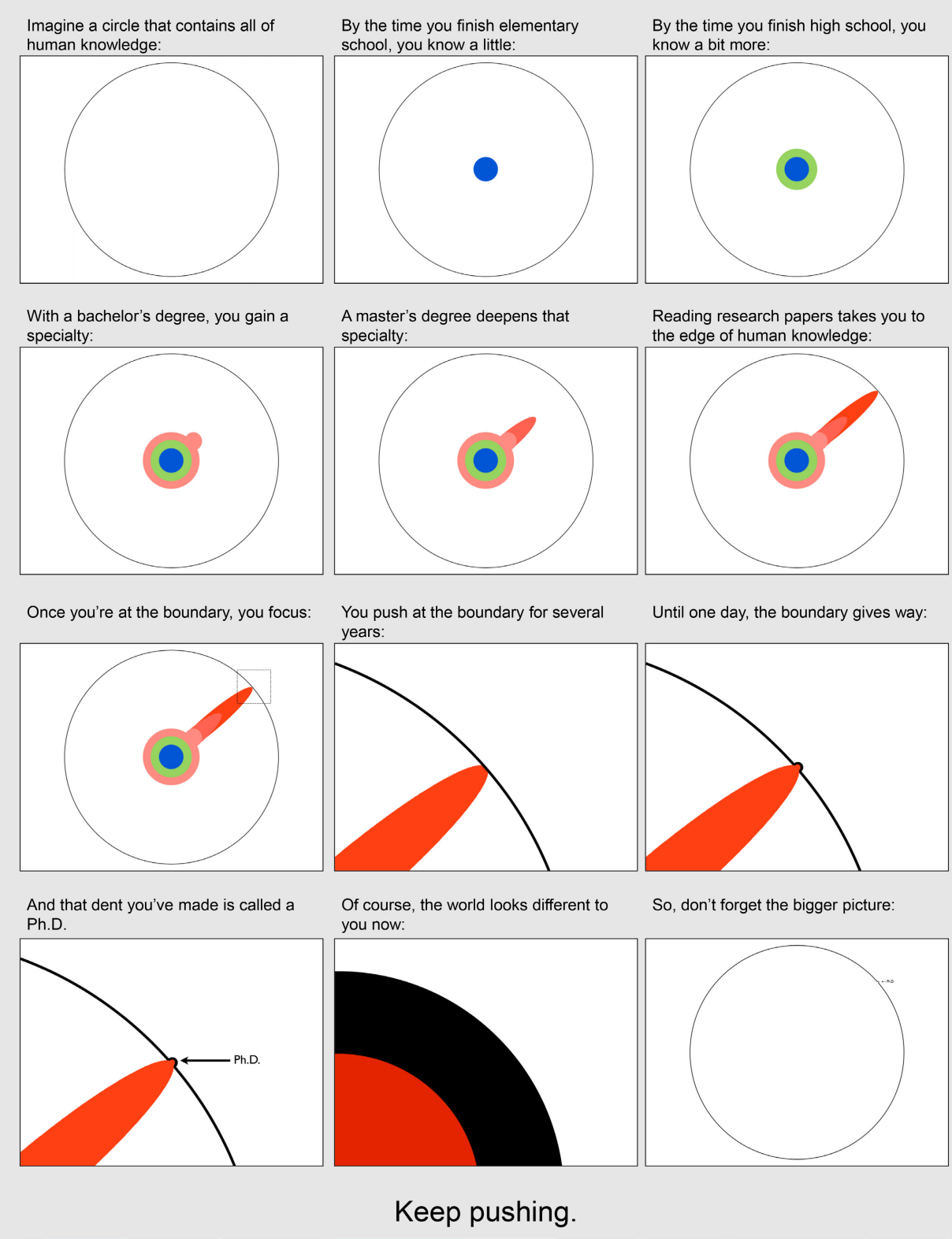

Fig. 1. The Illustrated Guide to the Ph.D., created by Matt Might (http://matt.might.net/articles/phd-school-in-pictures/; 2012) and shared under Creative Commons license BY-NC 2.5.

2. Generate content or copyedit, not both simultaneously.

Briefly, content generation is getting words on the page without worrying about word choice or flow, whereas copyediting is polishing the text you've written (Wilke 2013*a*). When you try to generate and edit content simultaneously, you end up in the "Perfect Sentence Vortex, a never ending cycle of incremental improvements that means you write excruciatingly slowly, and are never satisfied with what you write" (Firth 2013). Getting stuck in the perfect sentence vortex generates stress and feelings of failure. Instead, embrace the terrible first draft (Edblad 2016) and get into the mindset of strict content generation. After you review an outline of what you want to write, warming up with a free-write can be an excellent way to get words flowing without worrying about editing (Wilke 2013*b*). A free-write warm-up is a 5- to 10-minute "warm-up" before you begin working, in which the only rule is you cannot stop writing until the timer dings. This exercise is designed to accustom you to type your thoughts without worrying about editing. After you warm up, switch to your planned scientific writing task for the next hour.

For example, a one-minute free-write session for me looks like this:

> *I have no idea what to write but I'm so glad the dogs are sleeping right now which allows me to focus on editing this piece. Wow the number of spelling errors I'm having to correct as I free-write is pretty impressive. Maybe I should type slower but I don't really want to do that because this is free-write time which always makes me feel like I should be typing as fast as possible. I can't imagine doing this by hand. All my thoughts would be gone by the time I got halfway through a sentence.*

3. Avoid the rabbit hole of the "perfect" citation.

An easy way to derail your writing is to follow "a quick citation check" down the rabbit hole of literature searching. Suddenly, an hour or even two has passed with no writing progress but plenty of manuscript skimming. Writing and searching the literature are two aspects of the same skill, akin to running and managing a nutritious diet for a runner, respectively. Diet is your intake (the literature), while running is your output (the writing). At any given time, you focus on one or the other, not both simultaneously. You might bring a small amount of water or nutrition with you on a run, just like you might spend 1–2 minutes finding a quick citation while writing. The trick is to limit yourself to only that quick check without letting it lead you to a chain of papers you "have to check." Without that limit, you risk disrupting writing momentum. If the correct or best citation is not immediately at hand, insert a placeholder citation or note (e.g., INSERT CITATION HERE) and keep writing. Come back after you have accomplished your daily writing goal and dive down the literature search rabbit hole, just as you would eat a restorative meal after a run, not in the middle.

4. Don't stop in the Chasm of Despair.

Exercising your writing muscles is much easier when you feel like a good writer, which is dependent, in part, on where you stopped yesterday and why. If your last writing memory is positive, it's easier to sit down to the document again. Unfortunately, this use of positive association means you cannot stop writing when you're stuck, frustrated, or suffering from writer's block. This place is a familiar place

for writers, sometimes called the Chasm of Despair (Heard 2018). When in the Chasm, it seems much easier to stop for a break. But the problem is when you return, you're returning to the same problematic passage and will likely still be stuck and frustrated, at the bottom of the Chasm. The only way to cross the Chasm is to keep writing. When really stuck in the Chasm's morass, I make a deal with myself; if I write two to four more sentences (which I'll likely cut tomorrow) or edit one more paragraph, that counts as a win and I'm done for the day. If you finish in a place where you've made good progress, it is much easier to return the next day, eager and excited to write more.

5. Set concrete goals

When developing a new skill, it is common to set vague short- and long-term goals, like, "I will work on the introduction," "I'll write for a few hours," or "I'll write this manuscript this year." But these sorts of goals make it hard to know when you have fulfilled them, which, in turn, can drain motivation and reinforce a dislike of writing. If you are never done, you can never feel accomplished. To return to our fitness metaphor, habitual runners don't say "I'm just going to run for a bit," they have a discrete mileage or speed as a short-term goal. Similarly, runners training for a marathon or race have a deadline and work backward to develop a training schedule that gets them to their goal by a specific date. When writing, you should have concrete, accomplishable goals every time you sit down, like writing 500 words, editing four pages, or writing for 30 minutes. You should also have a long-term plan that works toward a concrete deadline.

For short-term goals, creating a S.M.A.R.T. writing plan is an excellent place to start (McCollum 2015). S.M.A.R.T. is an acronym that describes the attributes of clear and reachable goals and stands for specific, measurable, achievable, relevant, and time-bound. For example, generating 500 or 1,000 words a day is a S.M.A.R.T. goal. It is specific and measurable (500 words). It is time-bound (a day) and absolutely achievable, once you are actually putting words on paper. And lastly, it is relevant; most manuscripts are 4,000–7,000 words, which means you could have a terrible first draft after two weeks of completing this S.M.A.R.T. goal every day. Because achievable is an important component of setting S.M.A.R.T. goals, I find it helpful to set your goals lower than you would like, especially at first, so you are sure to finish it. For example, start with the S.M.A.R.T. goal of 250 words a day and build up to 500 or 1,000 a day. Completing the day's goal reinforces positive feelings about writing, which in turn makes it easier to return tomorrow. Don't limit yourself to only your goal if you feel motivated and inspired, but always remember to stop for the day feeling accomplished.

Using the Pomodoro technique can also be extremely helpful. Pomodoros are 25-minute working sessions followed by 5-minute breaks that you cycle through 2–4 times in a row per session (Cirillo 2006). This strategy helps to stay on track even in your daily, solitary writing sessions. Apps and websites exist which can set up a Pomodoro timer structure for you. Lastly, don't let yourself be side-tracked by more enjoyable or easier tasks like data analysis or literature searching (see tip 3). Accomplish your writing goals first and then track down that citation or double-check that *P* value.

For long-term goals, start with an external deadline. Even if there isn't one, ask a friend to help you stay accountable (see tip 6). Then, work backward to make a plan for hitting that goal, using the same S.M.A.R.T. techniques to set weekly goals that are both achievable and also accomplish your goal, while keeping in mind other deadlines or events that might take time in certain weeks.

6. Study your own best practices.

One of the most important things we can do as scientists is to study our work habits. Keep track of the external factors around your writing: Does the physical space you are in help or hinder? Do you write better in short blocks with breaks or one long block? How many hours can you reasonably write before you burn out for the day? Do you write better first thing in the morning, in the middle of the afternoon, or late at night? Are specific days better than others or does writing every single day work best for you? Use your scientific training to test different variables and find both your best practices and your limits. Working within them can help you maintain writing productivity over time, rather than working in bursts and busts.

7. Your network can help keep you accountable.

Many academics are struggling to write, but you can leverage this fact to everyone's benefit. In this case, peer pressure really is your friend. Accountability, even just to friends, can be much more motivating (and effective; see Gray 2015) than just being accountable to yourself. To help make writing a weekly or daily habit, organize a weekly #ShutUpAndWrite session (Mewburn 2013, Howard 2015), a 2–3 hour session, either virtual or in-person, in which everyone writes together using the Pomodoro technique to stay on track. You can also join a writing Slack group like Grad Write Slack or Academic Writing Support; there are almost always academics on Slack writing together virtually. For longer-term success, start a 12-week writing challenge with your friends, in which everyone commits to a modest weekly number of writing hours and shares their progress with the group (Howard 2015, Van Bavel and Gruber 2019, Scott et al. 2020). This strategy is the equivalent of a runner registering for a marathon in 12 weeks; once you've paid the registration fee or told your writing group your goals, you're much more committed to fulfilling your training plan and reaching your goal.

8. Don't try to do it all on your own.

Writing, and especially scientific writing, is not an innate talent. As a learned skill, training and mentorship are critical to successfully mastering writing. Hopefully, this training (provided by professors, advisors, reviewers, and peers) begins during undergraduate education, continues through graduate training, and persists throughout our careers. As a fledgling (or even fledged) writer, you can and should take ownership over obtaining this training. Take a class on science writing offered by your university, check out books on writing science from the library, and solicit feedback from peers and mentors (Heard 2015*b*). Because receiving and responding to feedback on your writing can be one of the hardest parts, you may feel reluctant to ask for it. But feedback is critical to improving your writing and will be a necessary and persistent presence throughout your career. Approaching the feedback with the right mindset, and practicing receiving feedback when the stakes are low, can help alleviate some of the sting and make asking easier the next time (Mewburn 2014, Ziter 2020). Iteratively receiving good, constructive feedback on your writing is one of the best and most efficient ways to improve and thus make writing easier.

Conclusion

The strategies suggested here range from mindfulness to concrete actions for putting words on a page to tactics for building accountability when a task lacks external deadlines. This list is not a panacea for writer's block; every scientist is different, and what works best for you might be the worst strategy for your colleague, friend, or trainee. However, by continually refining your writing practice, you can hone your writing muscles to the point where writing becomes an enjoyable part of being a scientist.

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