ONE

On Bacon, Hobbes, and Newton, and the Selfishness of Writing Well

The Invention of Clarity

In the European early modern period (c.1500–1750), everything was changing. The period saw the Protestant Reformation, the introduction of representative democracy, the secularization of political power, and the origins of the sovereign nation-state. It saw globalization of trade in goods and ideas, but also the subjugation of much of the world under European colonization.

Science was transforming itself right alongside religion, politics, and global economies. European curiosity cabinets (Figure 1.1) were bulging with specimens returned from overseas exploration and trade: stones, creatures, and artifacts begging to be explained by new ideas in natural science and anthropology. Chemistry took its first steps away from alchemy and toward systematic, rational discovery. Astronomy and physics were revolutionized by painstaking observations and new instruments, and by increasing openness of thought about the data these yielded. Finally, the invention and application of the calculus put mathematics at the center of all the sciences.

But while the content of human knowledge was exploding, another, more important change was taking place. The development of modern scientific methods, professional scientists, scientific societies, learned journals, and (in case you were wondering about the point of this historical excursion) modern-style scientific writing changed the way people acquired and communicated knowledge. In a sense, this was when scientists learned to write—or more particularly, to write with the explicit goal of making their ideas available to a broad scientific community.
Writing to communicate with the scientific community was a big change. Medieval “scientists” (alchemists, for instance) generally thought of themselves as solitary workers who would penetrate nature’s secrets for their own gain. Thus, if they wrote their findings down at all it was to claim priority or to make notes for their own use—and what they wrote was deliberately obscure, even written in code, cryptic symbols, or anagrams, to protect their secrets from their rivals. One of the first proponents of change was Francis Bacon, who criticized this secrecy and argued instead in his 1609 essay *De Sapientia Veterum* that “perfection of the sciences is to be looked for not from the swiftness or ability of any one inquirer, but from a succession.” In the posthumously published *New Atlantis* (1627), Bacon described a fictitious research institute—scientific society he called “Salomon’s House”—and he clearly intended his utopian novel to be a proposal for how science should work. In Salomon’s House research progressed because scientists communicated and collaborated with one another. (Bacon might well have been

Figure 1.1 Frontispiece to Ole Worm’s (1655) *Museum Wormianum*, a catalog of his curiosity cabinet.

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inspired by Islamic science of the 8th and 9th centuries, which flourished, collaboratively, under the Abbasid caliphs Harun al-Rashid and Abu al-Mamun [Lyons 2009].

Bacon’s concept of Salomon’s House inspired the creation of the Royal Society of London in 1660. Its founders extended his ideas about communication among collaborating scientists to communication with a broad scientific community and even with the curious public. One of those founders was Robert Boyle, who essentially invented a new form of writing: the scientific report, which described the methods and results of an experiment (Pérez-Ramos 1996). Another was Thomas Hobbes, who wrote in the preface to his 1655 work *De Corpore*, “I distinguish the most common notions by accurate definition, for the avoiding of confusion and obscurity” (xiii)—a goal that seems routine today, but would have been outrageously unconventional in Hobbes’s time. The founding of the Society brought with it the first modern scientific journal, *Philosophical Transactions of the Royal Society*, which printed scientific reports of the kind pioneered by Boyle, written in the clear language advocated by Hobbes. Just a dozen years later, Thomas Sprat described the organization’s rhetorical philosophy as

> a constant resolution, to reject all the amplifications, digressions, and swellings of style . . . a close, naked, natural way of speaking; positive expressions, clear sense, a native easiness: bringing all things as near the mathematical plainness1, as they can: and preferring the language of artisans, countrymen, and merchants, before that of wits, or scholars. (Sprat 1667, 113).

All this may seem obvious from our modern vantage point, but the transition from medieval secrecy through Bacon and Hobbes to the “clear sense [and] native easiness” of Sprat’s Royal Society was revolutionary. Without this tectonic shift in how science was reported, modern science couldn’t be done. The inventions of the calculus, the telescope, the microscope, and the inductive method (all between 1590 and 1630) were certainly important, but they’re all outweighed in im-

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1 This mention of “mathematical” plainness might be a shout-out to Euclid, whose *Elements* are admirably lucid. However, clarity and openness were not necessarily the rule among ancient Greek thinkers. Pythagorus, for example, bound his followers to secrecy, and his followers may have killed the philosopher Hippasus for divulging his discovery of the irrational numbers.
portance by the idea of describing one's scientific thinking clearly, for all to read.

Of course, no revolution lacks holdouts, and the revolution in scientific communication had a curious one: the famously cranky Isaac Newton, for whom publication remained largely about ensuring credit for his work. For example, he drafted his *On Analysis by Infinite Series* in 1669 in response to Nicholas Mercator’s *Logarithmotechnia*, which Newton worried would undermine his claim of first discovery for some key insights underlying the calculus. Despite pressure from colleagues, Newton allowed only limited circulation of the manuscript within the Royal Society; not until 1711 would he agree to open publication. More famously, he deliberately made his masterwork *Principia Mathematica*—and especially its third volume, *De mundi systemate*—difficult to read. Newton had originally written *De mundi systemate* in plain language to be accessible to readers (Westfall 1980, 459) but changed his mind and rewrote it as series of propositions, derivations, lemmas, and proofs comprehensible only to accomplished mathematicians. He left little doubt of his intent, telling his friend William Derham that “in order to avoid being baited by little smatterers in mathematics, he [Newton] designedly made his *Principia* abstruse” (Derham 1733). That is, he wrote to impede communication with other scientists, not to facilitate it! Of course, by then Newton was a superstar whose writing was likely to command from his readers whatever effort was needed to penetrate the fog. And readers could spare the effort, as the flow of published works competing for scientists’ attention was still little more than a trickle. This, too, would change.

Clarity and “Telepathy” in the Modern Era

Bacon, Hobbes, Sprat, and others of their time were taking the first steps toward what became, by the twentieth century, a consensus that the goal of most writing is clear communication. The best-known reflection of this is probably *The Elements of Style*, by William Strunk Jr. and E. B. White, first published in 1920. White described Strunk’s opinion that the typical reader was “floundering in a swamp” and that it was “the duty of anyone trying to write English to drain this swamp quickly and get
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[the reader] up on dry ground, or at least throw [down] a rope” (Strunk and White 1972, xii). However forceful Strunk’s pleading, though, the argument for clarity has its purest expression in Stephen King’s 2000 On Writing: A Memoir of the Craft. King’s chapter “What Writing Is” opens with the simple declaration: “Telepathy, of course” (King 2000, 95).

The word “telepathy” may seem chosen for humor, but in scientific writing your goal should always be communication so crystal clear that it feels to the reader like telepathy—like direct transmission to the reader’s brain from yours. You are writing because you have some information to transmit, and your goal should be for the reader to receive that information without even being aware of the process. As Nathaniel Hawthorne put it, “The greatest possible merit of style is . . . to make the words absolutely disappear into the thought” (letter to E. A. Duyckinck, 27 Apr. 1851, quoted in Van Doren [1949], 267). If the reader pauses to question your word choice or needs to squint to distinguish between two lines on a graph, then you have joined a battle you don’t want to be in: what you’re trying to say is fighting for the reader’s attention with the way you’re saying it.

At this point you might be a little skeptical. After all, popular wisdom holds that people who use big words and complicated sentences seem more intelligent. (A quick internet search will turn up dozens of lists of “Ten Words That Will Make You Sound Smarter.”) There is even some limited support for this idea: one study compared undergraduates reading texts printed in easier- and harder-to-read fonts (to vary reading difficulty independent of content) and found they scored the harder-to-read texts as better written (Galak and Nelson 2011). However, most research finds the opposite: that people ascribe higher intelligence to writers who (and higher quality to texts that) use clearer fonts, smaller words, and simpler sentences (e.g., Oppenheimer 2006). Even if difficult prose did make you seem smarter, this would only help if people actually read it—which brings me to my next point.

The Selfishness of Writing Well

Achieving telepathic writing is hard work (chapter 2). I have spent many hundreds of hours crafting pieces of writing that I hoped might achieve
crystal clarity, and in this book I will urge you to do the same. Those were hundreds of hours I could have spent doing more experiments, or drinking beer with friends, or even just walking along the water's edge skipping stones. So why invest the time and effort in writing well?

It might seem that working to make your writing clear is an act of selfless generosity toward the reader—this is the impression left by Strunk's metaphor of throwing the reader a rescue line. Or it might seem an act of generosity toward the progress of science. This was the argument made by Bacon, Sprat, and others in the 1600s; in this view, Newton was selfish in withholding his written work and writing for opacity. There's no question that writing well serves both the reader and the progress of science. But the evolution of science since Newton's time, and especially its spectacular growth, has changed the incentives for writing well.

In the 1680s, Newton had the luxury of writing a difficult book and knowing that every mathematician, physicist, and astronomer who mattered would invest whatever time was needed to grapple with his text. There just weren't many works of similar importance competing for their attention. But in our modern era, the deluge of published scientific work becomes greater every year. Just for the year 2012, for example, a Web of Science search returns more than sixty thousand records for oncology alone, fifty-one thousand for physical chemistry, and forty-five thousand for optics. By comparison, the mere nine thousand records for virology seem almost manageable—but even if you considered just ten percent of the virology literature relevant to your own work, keeping up with it would mean reading three papers every single day of the year. That might be possible for a while, but these numbers include only peer-reviewed papers in journals indexed by the WoS, not papers in more obscure journals, technical reports, books, book chapters, theses, grant proposals, or any of the other forms of scientific writing that form teetering piles in scientists' offices around the globe.

As a scientific writer, then, you are competing for attention with an incredible array of material your reader might prefer to your own. Your career and reputation, though, depend on having your work read. Hiring, promotion, and tenure committees and granting councils devour citation data for your publications. Grad-school admissions committees look for evidence of writing skill, and the best prospective graduate stu-
students search for supervisors by reading the literature to find someone whose ideas excite them. And, of course, journal editors and reviewers groan under the weight of submitted manuscripts, and can’t be depended on to see the jewel hidden in a manuscript that’s difficult to read. Readers have a lot to choose from. If your paper isn’t clear they will turn to another. When they do, it’s you as the writer who suffers most.

You can’t make your reader like your science simply by writing better—but you can make it easier for them to see why they should like it, or at least why they should read and cite it. Given all this, the biggest winner when you put in the effort to make your writing clear is not your reader, and not the progress of science: it’s you. And this is a victory you can shoot for, partly because there’s so much bad writing out there for you to outshine (glass half-empty) and partly because you can practice your craft and learn to write better and better (glass half-full). Newton clung to a world in which the selfish act was to write opaque, but in the modern world, scientists can do themselves no bigger favor than writing well.

The Transferability of Writing Skill

This book aims to help you improve your scientific writing. That you’re reading it suggests that you plan such writing in the near future (if you aren’t struggling with it now). But what if your career takes you away from academia and you never need to write a scientific paper again? Will the effort you put into improving your scientific writing be wasted?

In a word, no. Although I decorated my argument for the selfishness of writing well with details from the world of scientific writing, every bit of the argument holds for writing in other forms and other careers. Those who move away from scientific research may not write science after leaving the academy, but they will almost always write something else. Perhaps they’ll complete a graduate degree in geology but then work in industry or government and write progress and technical reports. Perhaps after earning an undergraduate mathematics degree a student will go to law school and draft case summaries, legal opinions, or even legislation. Perhaps a biologist, fifteen years on, will end up writing instruction manuals, sales brochures, or—who knows—children’s
fiction, popular histories, erotica, or even a book about writing. While
details vary, the basic tools you need to write well are remarkably trans-
ferable across fields. And the payoff to the work you put into improving
your writing can be even broader, because doing so inevitably sharpens
your logical thinking skills—and everyone uses those skills their entire
lives.

Chapter Summary

- The most important goal for scientific writers is to write clearly.
- Clear writing benefits the progress of science, the reader, and most of all,
  the writer.
- Writing that isn’t clear risks being unpublished, unread, or uncited.
- Writing skills learned to improve scientific writing are transferable to al-
  most any career.