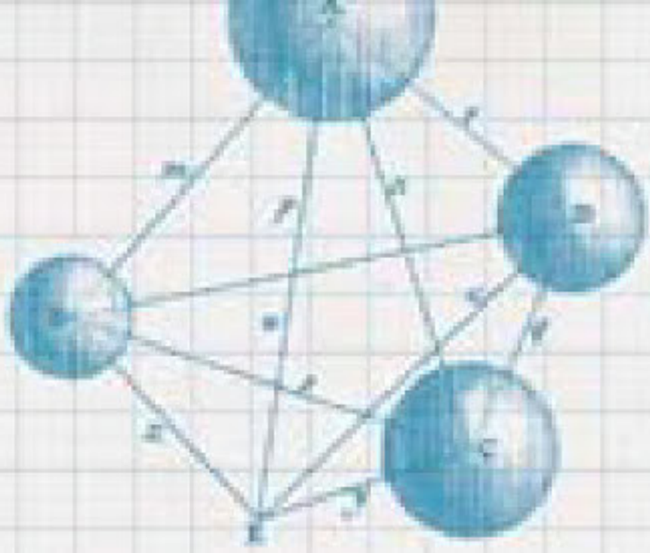
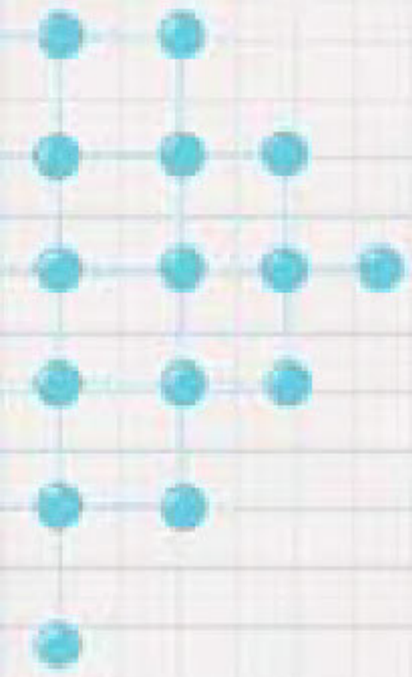
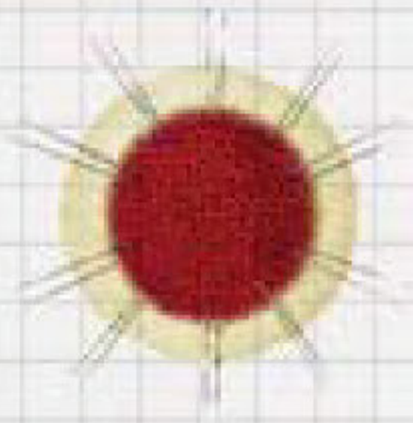
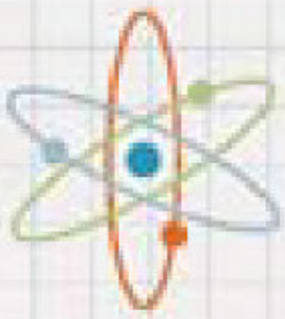


WRITING *SCIENCE* IN PLAIN ENGLISH

ANNE E. GREENE







Writing Science in Plain English

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Contents

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CHAPTER 1 Why Write Science in Plain English?

"Do you dread reading the scientific literature?" I ask on the first day of my scientific writing class. My students, mostly honors undergraduates majoring in biology, roll their eyes and nod their heads. They all agree—reading science papers is hard. When I ask why, the responses are telling: "Reading papers puts me to sleep," or, "I have to read them three or four times before they make sense," or, "They make me feel stupid." Why should intelligent, motivated students have difficulty reading the scientific literature? The answer is because most of it is poorly written.

If you are an undergraduate student, perhaps you have the same problem with your assigned readings. If you are a graduate student, a postdoctoral fellow, or an established scientist, perhaps you have heard similar complaints from your students, or had these thoughts yourself.

The truth is, many journal editors and senior scientists believe that unclear scientific writing is a serious problem. Peter Woodford, former president of the Council of Science Editors, described the poor writing he saw in journals as "appalling."[1] Leslie Sage, senior editor of physical sciences at *Nature*, wrote, "It is a sad commentary . . . that many of the 'crank' papers submitted to *Nature* are actually better written—from a purely stylistic point of view—than many of the professional papers."[2] Harold Heatwole, editor of *Integrative and Comparative Biology*, concluded, "The standard of writing in current scientific journals has reached an all-time low, in terms of both poor grammar and imprecise communication."[3] Many senior scientists who have written on the subject agree with David Porush that scientific writing is "unnecessarily dry, difficult to read, obscure, and ambiguous."[4] They urge scientists to write more clearly, with more directness and precision,[5–8] in a style Anthony Wilson calls "plain, simple English."[9]

Yet scientific writing, while exploding in quantity, is not improving in quality.[10] In a survey of 22 journals on atmospheric science, a measure of clarity of the articles was either holding steady or declining.[11] As

recently as December 2011, the chief scientific editor of *Science Signaling* described the computational results in many manuscripts as "obscure, convoluted, jargonistic, or impenetrable."[12]

Why does this epidemic of poor scientific writing matter? One reason is it hinders the flow of ideas across disciplines. As science becomes more specialized and the writing more complex, specialists in different fields struggle to understand one another.[13] Poor writing also makes it more difficult to apply discoveries from one field to another, a cross-fertilization that has advanced scientific discovery in the past.[11,14] One scientist recently suggested that unclear writing hinders the scientific process itself.[12]

In addition, poor scientific writing is partly to blame for the decline in science literacy in the United States and the long-standing communication gap between scientists and the general public.[4,9,15–17] If we are to solve the profound problems facing our nation and the world, decisions must be shaped by science-literate citizens and lawmakers.[18] But in a recent poll conducted by the Pew Research Center for the People and the Press, 85% of scientists surveyed say public ignorance of science is a major problem. About half the Americans surveyed disagreed that human activities are causing global climate change, and almost a third don't believe in human evolution.[19] To help close the rift, the president of the American Association for the Advancement of Science (AAAS), Peter Agre, urged "every scientist and engineer to make their work both beneficial and understandable" to the general public.[18]

Younger scientists may be our best hope. In their book *Unscientific America*, Chris Mooney and Sheril Kirshenbaum describe a crisis in communication between scientists and "everyone else" that could be improved by training "Renaissance scientists" who can communicate more effectively.[20] Similarly, the CEO of the AAAS and executive publisher of the journal *Science*, Alan Leshner, believes that young scientists should be trained in "public communication," and that scientists who share their research with a broad audience should be rewarded.[21]

But poor writing sets a bad example for young scientists. If you are a newcomer to the field, you probably imitate the writing you read in professional journals, a common enough practice in any profession,

but one that guarantees that poor writing persists.[4,8,22] Even if you are an established scientist, your writing style was probably influenced by your major professors or advisors, few of whom were trained to write clearly or to instruct others to do so.[7,17] One consequence of this is the feedback most science students receive on their writing varies enormously.

The good news is you can write science in plain English by applying a relatively short list of principles developed for professional writers by Joseph Williams in his book *Style: Toward Clarity and Grace*.[22] These principles are based on linguistic theory about what readers look for when they read complex, unfamiliar information. The list is surprisingly simple: readers look for a story about characters and actions; for strong verbs close to their subjects; for old information at the beginnings of sentences and new information at the ends; and for specific kinds of information in predictable places in paragraphs and documents.

Williams's principles and their linguistic history are at the heart of this book. Most other books on scientific writing focus on *what* scientists write; they describe how to prepare a thesis, a grant proposal, a research paper, and a review article; many include instructions on data presentation, formatting, and citation styles; some cover how to give an oral presentation and how to prepare a poster.[5,8,23,24] They don't concentrate on *why* scientific writing is so hard to understand or *how* to improve it.

This book dispenses with information about what scientists write and focuses entirely on how to write clearly and comprehensibly. The principles it describes will help improve everything you write, whether it is a lab report, a grant proposal, a research paper, or a press release. At what stage in the writing process you use the principles is up to you. You might use them to revise a first draft, or once you are familiar with them, you might incorporate the principles as you write. Just remember that at some stage you must adjust your writing so that it gives your readers what they need to understand you.

Before you begin to write, you must choose your audience, register, and tone. These topics are discussed in Chapter 2. The remaining chapters describe the principles, using good and bad examples of real

scientific writing. Once you understand each principle, you can practice it by doing the exercises at the end of the chapter. Then compare your results with those in the Exercise Key in Appendix 2.

Throughout the book, I use some common grammatical terms that refer to parts of speech and basic sentence structure. If you are unsure of these terms or need a quick refresher on grammar, refer to Appendix 1. It's important that you understand the terms because I use them to explain how the principles work, and they will help you apply the principles to your own writing.

Because many problems with scientific writing are common to all disciplines and at all levels, these principles will help whether you are a geologist, chemist, physicist, biologist, or social scientist, and whether you are a first- or fourth-year undergraduate, a graduate student, a postdoctoral fellow, or a professor.

Certainly, the merit of your scientific writing rests as much on content as on style. Equally important are the questions, hypotheses, experimental designs, and interpretations you describe. However, if you cannot clearly communicate these things to your readers, what is the point?

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CHAPTER 2 Before You Write

It's usually a good idea to plan ahead, and with writing, planning ahead can make the difference between success and failure. Before you write, decide who you are writing for, how formal you should be, and the attitude you want to project. These decisions will help determine if your writing is clear and interesting. Often, scientists reflexively favor a dry, abstract, and unvarying style, but we can do better by considering our audience, register, and tone before we write.

Audience

The most important first step is to envision your audience. Who will read your report, paper, thesis, or textbook? Your audiences could include family or friends, interested nonscientists, or other scientists who may or may not share your discipline. Most likely, some of your readers will know less about the subject than you do, so put yourself in their shoes. They are trying to understand you, *but don't know what you know*. Help them by making your writing as clear as possible. If you are unsure of your audience, err on the conservative side. Write for the reader who may be least informed. By doing so, you won't confuse anyone, and you will reach more readers.

As a student, you usually have an audience of one—your professor. However, in the real world, you will be writing for many different audiences, and your success will often depend on whether you communicate clearly to each of them. So when you write a paper or a lab report, envision a larger audience—one that is not as well informed as you are—and write for them. Writing about your subject clearly and simply will also show your professor that you understand the course concepts.

Writing with your audience in mind informs the principles in the rest of the book. It also determines two other qualities of your writing: your register and your tone.