In his 2000 book *Kitchen Confidential*, the late chef and travel host Anthony Bourdain identified three ingredients that make restaurant food different (better) than “your” food: garlic, shallots, and butter. That is, there are a relatively small number of ingredients characteristic of dishes prepared by professional chefs which are underutilized by home cooks. This tongue-in-cheek list obviously ignores the years required for true mastery of an art like cooking. Nevertheless, there is truth in Bourdain’s claim that it is possible to achieve some professional qualities by practicing a few simple rules.

One task that all scientists are expected to do without significant formal training is writing. Indeed, writing underlies most of our success (and failure) in teaching our results to the community and in attracting research funding. However, writing in a transparent style does not come naturally to most scientists. Moreover, most of the world’s scientists are made to write in journals in a language they do not speak natively. Thus, it is worth asking if there is an equivalent of “garlic, shallots, and butter” for scientific writing. That is, are there a small number of simple suggestions that can make the writing of a scientist closer in quality to that of a professional writer?

Library shelves are replete with style guides. The most famous of these books is *The Elements of Style*, by Strunk and White.2 Given its age, it is incredible how often it is recommended by PhD advisers to their students. The book contains little on how to teach one’s results, how to formulate an argument, and how to construct coherent paragraphs. Much of it consists of dated, idiosyncratic pet pees. Its saving grace is that it is short and thus likely to be read by busy grad students. The best corrective to Strunk and White is *The Sense of Style* by Harvard linguist Steven Pinker, whose arguments are informed by psychology.3 In particular, Pinker recognizes the disparity in knowledge between the writer and the reader. That is, it takes an effort to make one’s writing understandable to the reader, who—unlike in a seminar—does not get to ask questions during the coffee break. The main disadvantage of Pinker’s excellent book is that it is long, and only language nerds like myself are likely to finish it.

A short article written specifically for students and postdocs in chemistry and material science is the 2004 article in *Advanced Materials* by my PhD mentor, George Whitesides,4 from whom I learned a great deal about writing. This is still a very good article on the structure of a paper, including what should go in the abstract, introduction, results and discussion, and conclusion. Whitesides makes a strong case for the creation of an outline as early in the course of a project as possible and emphasizes the advantages of the iterative revision of drafts with one’s coauthors. However, there is some guidance with which I now find myself in mild disagreement. For example, outlining doesn’t work particularly well (at least for me) for projects with self-imposed or open-ended deadlines. I’ve found that I am likely to use outlining as an excuse to put off doing the hard work of constructing the prose. Writing prose after a long outlining process inevitably leads to a situation where tracts of text need to be moved around. Sometimes you don’t know where the argument is going until the prose is in place. There are also a few points of style, such as the popular (though dubious) guidance of putting two spaces after a period.5 (All of these extra spaces will be deleted by the copyeditor.) Another issue identified by Whitesides is the overuse of what Pinker would call “noun piles”—e.g., long strings of nouns as adjectives, as in “rubber buggy baby bumper”—in the prose of inexperienced writers. However, the examples of nouns-as-adjecitives given in the Whitesides paper would be OK to the eyes of most readers. That is, while heaping piles of nouns are usually undesirable (see suggestion #3, below), it is fine to use “reaction product” instead of “product of the reaction”. Attention to such minor points of style may actually reduce the cognitive calories available to the writer which are best devoted to other aspects of clear writing.

All style guides are idiosyncratic, and many are written in a commanding, righteous tone. There is no single way to write well. However, there is an effectively infinite number of ways to arrange words on a page, and thus there are a nearly equivalent number of ways to write badly. In the rest of this editorial, I have identified three aspects of scientific prose that deserve attention by inexperienced writers. Over the course of commenting on drafts of 100 peer-reviewed articles, I’ve found that the majority of my comments not related to the science could be placed in one of these categories.

1. **Write from the top down.** Writing from the top down means creating “buckets” in the minds of the readers and then developing ideas that can be placed in these buckets. In pedagogy, this is called “teaching from the top down”. It is the framework that gives us the broad content of General Chemistry as a first-year student, followed by courses in organic, inorganic, physical, and analytical chemistry. When reading a paper, readers need to know why they should care about something and should be given clues as to what to expect. The writer must anticipate the needs of the reader, and the writing must trigger their curiosity. Questions should be answered in the prose soon after they are triggered in the mind of the reader.

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In the best examples of papers with a top-down construction, the reader feels like they are running downhill, as opposed to trudging through a swamp. Each sentence should follow the one before it in a logical manner, just as each paragraph must answer questions and develop ideas introduced in the one before it. To accomplish this effect, it is helpful to start paragraphs with simple, declarative, topic sentences. Constructions like “There is/are [some number] of [reasons, elements, techniques] capable of [explaining, bonding, measuring] the [energy, heat, force, current]” are helpful in this regard. Similarly, it is useful to start each section with a paragraph that serves as a preamble: an introduction or justification of the argument that follows. Once inside the bulk of the paragraph, every sentence needs to be bonded conceptually to the ones immediately before and after it. Each must pick up where the last one left off. There should not be any orphaned concepts or ideas.

The quality of writing in which ideas flow naturally from paragraph to paragraph and from sentence to sentence is called coherence and is a hallmark of transparent prose. There are many tactics that can be used in the service of coherent writing. For example, words like “moreover”, “furthermore”, and “for example” are useful ways to elaborate on a concept introduced in the previous sentence or to make it more vivid. Additionally, ending each sentence with the most important word or idea is a good way to lead into the next sentence, as is ending a sentence with the most descriptive element of a list.

2. Use shorter sentences. One tendency of young (and not young) scientists is to try to sound smart. This tendency is natural for individuals who have accumulated sometimes multiple hard-won degrees, but it tends to generate turbid prose. I often receive drafts of papers and manuscripts to review that contain several sentences of 35 words or more. These long sentences often contain introductory clauses, multiple ideas, and out-of-place references to arguments made previously in the paper. Keeping so many ideas cached takes Olympian levels of concentration. After I write the first draft of something, my first round of revision usually has the sole purpose of breaking up these long sentences. A good tactic is to avoid the temptation to start a sentence with long preambulatory clauses. For example, starting a sentence with the word “while” is nearly always regrettable. Whenever I start a sentence this way, I end up with a disjointed collection of thoughts that cannot be wrapped up in less than 40 words. (“While it is true that the mechanical properties of organic semiconductors have their basis in the microstructure and the morphology of the polymer chains in the solid state, it is nevertheless the case that this microstructure and morphology is dictated by the choice of solvent, along with the thermal history.” Blech.) Another useful tactic in shortening is to omit needless words (thanks Strunk and White).2

3. Avoid noun piles. One of Whitesides’ points of style is to avoid using nouns as adjectives, or “noun piles.” Where I could be seen as departing from Whitesides is my sense of what constitutes a noun pile. To me, a noun pile is a grouping of words which the reader does not automatically chunk into a single word. For example, “flow rate” should be “flow rate”, not “rate of flow”. To cite a three-word example, “charge carrier mobility” is also fine, rather than “mobility of the carriers of charge”, which is absurd in its pedantry. However, there are examples of gratuitous noun piles used by inexperienced writers that are perhaps the result of an attempt to keep the word count low. When I point these noun piles out to students, the pushback I get comes from the fact that the constructions are indeed grammatical. The problem is that noun piles are easy to write but difficult to read. One reason is that the reader’s brain automatically transduces the action of a verb to the first word in the object. In a noun pile, the word most closely identified with the object is the last word. Thus, the verb appears to act on the first word in a series of nouns-used-as-adjetives. To illustrate the point that noun piles make prose difficult to read, I have excepted the published paragraph from one of my group’s papers in Chemistry of Materials: I have also rewritten the paragraph to maximize the number of noun piles. The original paragraph and the modified version are intentionally unlabeled.

Example 1. “The glass transition temperature (Tg) is a second-order phase transition that ultimately describes the thermally activated chain reorganization in the polymer specimen amorphous domains. A density vs temperature plot exhibits a slope change in the vicinity of Tg (Figure 6). Similarly, a heat flow vs temperature plot measured by differential scanning calorimetry (DSC) reveals a heat capacity increase. Below Tg, a polymer is said to be glassy; above the Tg, it is rubbery. In a purely amorphous sample (e.g., atactic polystyrene), the material flows readily above its Tg. A semicrystalline sample above its Tg, but below crystalline domain melting temperature (Tm), exists as an ordinary time scale solid and is said to be in its elastomeric state.”

Example 2. “The glass transition temperature (Tg) is a second-order phase transition that ultimately describes the thermally activated reorganization of chains in the amorphous domains of a polymer specimen. A plot of density vs temperature exhibits a change in slope in the vicinity of Tg (Figure 6). Similarly, a plot of heat flow vs temperature measured by differential scanning calorimetry (DSC) reveals an increase in heat capacity. Below Tg, a polymer is said to be glassy; above the Tg, it is rubbery. In a purely amorphous sample (e.g., atactic polystyrene), the material flows readily above its Tg. A semicrystalline sample above its Tg, but below the temperature at which its crystalline domains melt (Tm), exists as a solid at ordinary time scales and is said to be in its elastomeric state.”

Example 1 is the noun-piled version, and Example 2 is the original. It is true that the noun-piled paragraph is shorter, but it is not a bargain; there is no question as to which is easier to read.

Final thoughts. Any essay or style guide is necessarily idiosyncratic and incomplete. One of the wonderful aspects of writing is the freedom one has in constructing an argument and teaching the reader one’s results. Indeed, almost any reader would have another list of three suggestions to make one’s writing closer to that of a professional writer, that is, the garlic, shallots, and butter of transparent prose. The purpose of the suggestions in this editorial is not to be pedantic but rather to make it just a little bit easier for young scientists to teach their results to the research community.

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