Sciences

What this handout is about

Nearly every element of style that is accepted and encouraged in general academic writing is also considered good practice in scientific writing. The major difference between science writing and writing in other academic fields is the relative importance placed on certain stylistic elements. This handout details the most critical aspects of scientific writing and provides some strategies for evaluating and improving your scientific prose.

What is scientific writing?

There are several different kinds of writing that fall under the umbrella of scientific writing, such as:

- Peer-reviewed journal articles (presenting primary research)
- Grant proposals (you can't do science without funding)
- Literature review articles (summarizing and synthesizing research that has already been carried out)
- Popular science articles (communicating scientific discoveries to a non-scientific audience)

As a student in the sciences, you are likely to spend some time writing lab reports, which often follow the format of peer-reviewed articles and literature reviews. Regardless of the genre, though, all scientific writing has the same goal: to present data and/or ideas with a level of detail that allows a reader to evaluate the validity of the results and conclusions based only on the facts presented. The reader should be able to easily follow both the methods used to generate the data (if it's a primary research paper) and the chain of logic used to draw conclusions from the data. Several key elements allow scientific writers to achieve these goals:

- Precision: ambiguities in writing cause confusion and may prevent a reader from grasping crucial aspects of the methodology and synthesis
- Clarity: concepts and methods in the sciences can often be complex; writing that is difficult to follow greatly amplifies any confusion on the part of the reader
- Objectivity: any claims that you make need to be based on facts, not intuition or emotion

How can I make my writing more precise?

Theories in the sciences are based upon precise mathematical models, specific empirical (primary) data sets, or some combination of the two. Therefore, scientists must use precise,

concrete language to evaluate and explain such theories, whether mathematical or conceptual. Here are a few strategies for avoiding ambiguous, imprecise writing:

Word and phrasing choice

Often several words may convey similar meaning, but usually only one word is most appropriate in a given context. Here's an example:

Word choice 1: "population density is positively correlated with disease transmission rate"

Word choice 2: "population density is positively related to disease transmission rate"

In some contexts, "correlated" and "related" have similar meanings. But in scientific writing, "correlated" conveys a precise statistical relationship between two variables. In scientific writing, it is typically not enough to simply point out that two variables are related: the reader will expect you to explain the precise nature of the relationship (note: when using "correlation," you must explain somewhere in the paper how the correlation was estimated). If you mean "correlated," then use the word "correlated"; avoid substituting a less precise term when a more precise term is available.

This same idea also applies to choice of phrasing. For example, the phrase "writing of an investigative nature" could refer to writing in the sciences, but might also refer to a police report. When presented with a choice, a more specific and less ambiguous phraseology is always preferable. This applies even when you must be repetitive to maintain precision: repetition is preferable to ambiguity. Although repetition of words or phrases often happens out of necessity, it can actually be beneficial by placing special emphasis on key concepts.

Figurative language

Figurative language can make for interesting and engaging casual reading but is by definition imprecise. Writing "experimental subjects were assaulted with a wall of sound" does not convey the precise meaning of "experimental subjects were presented with 20 second pulses of conspecific mating calls." It's difficult for a reader to objectively evaluate your research if details are left to the imagination, so exclude similes and metaphors from your scientific writing.

Level of detail

Include as much detail as is necessary, but exclude extraneous information. The reader should be able to easily follow your methodology, results, and logic without being distracted by irrelevant facts and descriptions. Ask yourself the following questions when you evaluate the level of detail in a paper:

1. Is the rationale for performing the experiment clear (i.e., have you shown that the question you are addressing is important and interesting)?
2. Are the materials and procedures used to generate the results described at a level of detail that would allow the experiment to be repeated?
3. Is the rationale behind the choice of experimental methods clear? Will the reader

understand why those particular methods are appropriate for answering the question your research is addressing?
4. Will the reader be able to follow the chain of logic used to draw conclusions from the data?

Any information that enhances the reader's understanding of the rationale, methodology, and logic should be included, but information in excess of this (or information that is redundant) will only confuse and distract the reader

Quantify

Whenever possible, use quantitative rather than qualitative descriptions. A phrase that uses definite quantities such as "development rate in the 30°C temperature treatment was ten percent faster than development rate in the 20°C temperature treatment" is much more precise than the more qualitative phrase "development rate was fastest in the higher temperature treatment."

How can I make my writing clearer?

When you're writing about complex ideas and concepts, it's easy to get sucked into complex writing. Distilling complicated ideas into simple explanations is challenging, but you'll need to acquire this valuable skill to be an effective communicator in the sciences. Complexities in language use and sentence structure are perhaps the most common issues specific to writing in the sciences.

Language use

When given a choice between a familiar and a technical or obscure term, the more familiar term is preferable if it doesn't reduce precision. Here are a just a few examples of complex words and their simple alternatives:

complex simple

efficacious effective

utilize use

elucidate explain

proximal close

In these examples, the term on the right conveys the same meaning as the word on the left but is more familiar and straightforward, and is often shorter as well.

There are some situations where the use of a technical or obscure term is justified. For example, in a paper comparing two different viral strains, the author might repeatedly use the word "enveloped" rather than the phrase "surrounded by a membrane." The key word here is "repeatedly": only choose the less familiar term if you'll be using it more than once. If you

choose to go with the technical term, however, make sure you clearly define it, as early in the paper as possible. You can use this same strategy to determine whether or not to use abbreviations, but again you must be careful to define the abbreviation early on.

Sentence structure

Science writing must be precise, and precision often requires a fine level of detail. Careful description of objects, forces, organisms, methodology, etc., can easily lead to complex sentences that express too many ideas without a break point. Here's an example:

The osmoregulatory organ, which is located at the base of the third dorsal spine on the outer margin of the terminal papillae and functions by expelling excess sodium ions, activates only under hypertonic conditions.

Several things make this sentence complex. First, the action of the sentence (activates) is far removed from the subject (the osmoregulatory organ) so that the reader has to wait a long time to get the main idea of the sentence. Second, the verbs "functions," "activates," and "expelling" are somewhat redundant. Consider this revision:

Located on the outer margin of the terminal papillae at the base of the third dorsal spine, the osmoregulatory organ expels excess sodium ions under hypertonic conditions.

This sentence is slightly shorter, conveys the same information, and is much easier to follow. The subject and the action are now close together, and the redundant verbs have been eliminated. You may have noticed that even the simpler version of this sentence contains two prepositional phrases strung together ("on the outer margin of Â…" and "at the base of Â…"). Prepositional phrases themselves are not a problem; in fact, they are usually required to achieve an adequate level of detail in science writing. However, long strings of prepositional phrases can cause sentences to wander. Here's an example of what not to do from Alley (1996):

"…to confirm the nature of electrical breakdown of nitrogen in uniform fields at relatively high pressures and interelectrode gaps that approach those obtained in engineering practice, prior to the determination of the processes that set the criterion for breakdown in the above-mentioned gases and mixtures in uniform and non-uniform fields of engineering significance."

The use of eleven (yes, eleven!) prepositional phrases in this sentence is excessive, and renders the sentence nearly unintelligible. Judging when a string of prepositional phrases is too long is somewhat subjective, but as a general rule of thumb, a single prepositional phrase is always preferable, and anything more than two strung together can be problematic.

Verbosity

Nearly every form of scientific communication is space-limited. Grant proposals, journal articles, and abstracts all have word or page limits, so there's a premium on concise writing. Furthermore, adding unnecessary words or phrases distracts rather than engages the reader.

Avoid generic phrases that contribute no novel information. Common phrases such as "the fact that," "it should be noted that," and "it is interesting that" are cumbersome and unnecessary. Your reader will decide whether or not your paper is interesting based on the content. In any case, if information is not interesting or noteworthy it should probably be excluded.

How can I make my writing more objective?

The objective tone used in conventional scientific writing reflects the philosophy of the scientific method: if results are not repeatable, then they are not valid. In other words, your results will only be considered valid if any researcher performing the same experimental tests and analyses that you describe would be able to produce the same results. Thus, scientific writers try to adopt a tone that removes the focus from the researcher and puts it only on the research itself. Here are several stylistic conventions that enhance objectivity:

Passive voice

You may have been told at some point in your academic career that the use of the passive voice is almost always bad, except in the sciences. The passive voice is a sentence structure where the subject who performs the action is ambiguous (e.g., "you may have been told," as seen in the first sentence of this paragraph; see our handout on the passive voice for a more complete discussion).

The rationale behind using the passive voice in scientific writing is that it enhances objectivity, taking the actor (i.e., the researcher) out of the action (i.e., the research). Unfortunately, the passive voice can also lead to awkward and confusing sentence structures and is generally considered less engaging (i.e., more boring) than the active voice. This is why most general style guides recommend only sparing use of the passive voice.

Currently, the active voice is preferred in most scientific fields, even when it necessitates the use of "I" or "we." It's perfectly reasonable (and more simple) to say "We performed a two-tailed t-test" rather than to say "a two-tailed t-test was performed," or "in this paper we present results" rather than "results are presented in this paper." Nearly every current edition of scientific style guides recommends the active voice, but different instructors (or journal editors) may have different opinions on this topic. If you are unsure, check with the instructor or editor who will review your paper to see whether or not to use the passive voice. If you choose to use the active voice with "I" or "we," there are a few guidelines to follow:

- Avoid starting sentences with "I" or "we": this pulls focus away from the scientific topic at hand.
- Avoid using "I" or "we" when you're making a conjecture, whether it's substantiated or not. Everything you say should follow from logic, not from personal bias or subjectivity. Never use any emotive words in conjunction with "I" or "we" (e.g., "I believe," "we feel," etc.).
- Never use "we" in a way that includes the reader (e.g., "here we see trait evolution in action"); the use of "we" in this context sets a condescending tone.

Acknowledging your limitations

Your conclusions should be directly supported by the data that you present. Avoid making sweeping conclusions that rest on assumptions that have not been substantiated by your or others' research. For example, if you discover a correlation between fur thickness and basal metabolic rate in rats and mice you would not necessarily conclude that fur thickness and basal metabolic rate are correlated in all mammals. You might draw this conclusion, however, if you cited evidence that correlations between fur thickness and basal metabolic rate are also found in twenty other mammalian species. Assess the generality of the available data before you commit to an overly general conclusion.

Works consulted

We consulted these works while writing the original version of this handout. This is not a comprehensive list of resources on the handout's topic, and we encourage you to do your own research to find the latest publications on this topic. Please do not use this list as a model for the format of your own reference list, as it may not match the citation style you are using. For guidance on formatting citations, please see the UNC Libraries citation tutorial.

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