

Scientific Writing

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*(based on the booklet by Marc. E. Tischler, Ph.D., University of
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General Guidelines

- A scientific paper is a written report describing research results.
- The format of a scientific paper has been defined by centuries of developing tradition, editorial practice, scientific ethics and the interplay with printing and publishing services.
- A scientific paper should have, in proper order, a **Title, Abstract, Introduction, Materials and Methods, Results, and Discussion.**

Title

- A title should be the **fewest possible words** that accurately describe the content of the paper.
- Omit all waste words such as “A study of ...”, “Investigations of ...”, “Observations on ...”, etc.
- Indexing and abstracting services depend on the accuracy of the title, extracting from it keywords useful in cross-referencing and computer searching.
- An improperly titled paper may never reach the audience for which it was intended, so be specific.
- If the study is of a particular algorithm, architecture, method, etc. name it in the title.

Abstract

- A well prepared abstract should enable the reader to identify the basic content of a document quickly and accurately, to determine its relevance to the reader's interests, and thus to decide whether to read the document in its entirety.
- The abstract should succinctly state the principal objectives and scope of the investigation when these are not obvious from the title. More importantly, the abstract should concisely summarize the results and principal conclusions.
- The abstract should not include details of the methods employed unless the study is methodological, i.e. primarily concerned with methods.
- The abstract must be brief, not exceeding 250 words or as otherwise defined by the journal.

Abstract (cont.)

- If the essential details of the paper can be conveyed in 100 words, do not use 200. Do not repeat information contained in the title.
- The abstract, together with the title, must be self-contained as it is often published separately from the paper in abstracting services.
- Omit all references to the literature and to tables or figures and omit obscure abbreviations and acronyms even though they may be defined in main body of the paper.

Rules for Scientific Writing

- Interest, inform, and persuade the reader.
- Write for your reader and write clearly.
- Eliminate unnecessary redundancy.
- Avoid digressions.
- Do not over explain and avoid overstatement.
- Avoid unnecessary qualifiers.
- Use consistent tenses.
- Use the precise word.
- Simpler words are preferred over complex words and use concrete words and examples.

Rules for Scientific Writing (cont.)

- Simpler sentences are preferred over more complicated sentences
- Use the active voice (except generally in methods)
- Make sure the *subject* and *verb* agree
- Use *affirmative* rather than negative constructions
- Avoid use of the indefinite “this”
- Cite sources as well as findings
- Proofread your paper carefully; spell check does not catch everything; *there* is spelled correctly but not if you meant *their*

Rules for Scientific Writing (cont.)

- In general, the best writing is simple and direct. Writing that is simple and direct is most easily understood.
- It also tends to be the most forceful and memorable. Use no more words than necessary and never use a complicated word if a simpler one will do just as well.
- Many people seem to feel that writing in a complicated way makes one sound serious, scholarly and authoritative.
- While this type of writing may sound serious, it is no more authoritative than writing that is simple and direct. Certainly, it is more difficult to understand. Adopt a style that is simple and direct.

Using An Outline To Prepare Your Paper

An outline is:

- A logical, general description
- A schematic summary
- An organizational pattern
- A visual and conceptual design of your writing
- An outline reflects logical thinking and clear classification.

Value of the Outline

- Aids in the process of writing
- Helps to organize your ideas
- Provides a snapshot of each section of the paper will flow
- Presents your material in a logical form
- Shows the relationships among ideas in your writing
- Constructs an ordered overview of your writing
- Defines boundaries and groups

Developing the Outline

Before you begin:

- Determine the purpose of your paper
- Determine the audience you are writing for
- Develop the thesis of your paper

Then:

- Brainstorm: List all the ideas that you want to include in your paper
- Summarize the question(s)/problem(s)
- List the key points/elements pertaining to the question(s)/problem(s)
- Organize: Group related ideas together

Developing the Outline (cont.)

- Order: Arrange material in subsections from general to specific or from abstract to concrete.
- Make sure the organizing scheme is clear and well-structured.
- Identify the important details that contribute to each key point/element.
- Label: Create main and sub headings.

Word Usage In Scientific Writing

- Any glossary of word usage assumes that what is acceptable for some uses may not be for others.
- Some terms and expressions are worn-out clichés and have outlived their usefulness; other expressions and terms, though not incorrect, are not precise.
- In reporting and recording research, try to be as accurate and precise in describing it as in doing it. Avoid the ambiguous and “faddish”.

Word Usage In Scientific Writing (cont.)

- Use an English spelling checker and a thesaurus.
- Make sure you use words according to the precise meaning understood by the average person.
- Ideally, you would check whether every word could be deleted or replaced by a better one.

Word Usage In Scientific Writing (cont.)

Aim for economy:

- *because* instead of (based on the fact that);
- *for* or *to* instead of (for the purpose of).
- (there were) several subjects (who) completed;
- (it is suggested that) a relationship may exist;
- (both) alike; (one and) the same;
- (a total of) n subjects;
- four (different) groups;
- (absolutely) essential;
- found (previously);

Aim for economy: (cont.)

- small (in size);
- in (close) proximity;
- (very) close to zero;
- (much) better;
- (period of) time;
- summarize (briefly);
- (the reason is) because;
- (also) included;
- except (for).

Aim for precision:

- *Patient* (instead of “subject”);
- *Concentration* or *frequency* (instead of “level”).
- Do not generalize unnecessarily. For example, do not say “some” if you know of only one instance.
- “This” on its own is an ambiguous antecedent. Use instead *this system*, *this problem* or *this architecture*.
- Avoid hype (hyperbole). Words like “very” and “extremely” are usually unnecessary.
- Note these singular and plural forms: *criterion*, *criteria*; *datum*, *data*; *medium*, *media*; *phenomenon*, *phenomena*.

Aim for precision: (cont.)

- Don't use “however” or its synonyms twice in one paragraph, because changing the direction of an argument twice in one paragraph may annoy readers.
- Don't use “however” more than once every 10 paragraphs. Try a thesaurus for synonyms.
- Avoid the so-called non-human agent. For example, use the *authors concluded that* rather than “the study concluded that”.
- Avoid colloquialisms, such as “clear of”.

Aim for precision: (cont.)

- Avoid “as such”.

Poor: *The SCAT is a reliable test of state anxiety. As such, it is suitable for experimental studies.*

Better: *The SCAT is a reliable test of state anxiety; it is therefore suitable for experimental studies.*

- Avoid “her”, “his” and any other sexist language, even if the subjects are clearly of one gender.
- Above (the above method, mentioned above etc.) – Often, you are referring to something preceding, but not necessarily above. Be specific. You know exactly what and where, but your readers may have to search (sometimes through much preceding material).

Aim for precision: (cont.)

- Affect, effect – *Affect* is a verb and means to influence. *Effect*, as a verb, means to bring about, result; as a noun, effect means result.
- All of, both of – Just *all* or *both* will serve in most instances.
- Alternate, alternative – *Alternate* as a noun and an adjective means to substitute; as a verb means to take turns, change back and forth
Alternative is an adjective and means other, different
- *And* (to begin a sentence) – Quite proper. You have been told not to do this in grade school. But teacher's purpose was to keep you from using fragmentary sentences; either *and* or *but* may be used to begin complete sentences. And both are useful transitional words between related or contrasting statements.

Aim for precision: (cont.)

- *Apparently (apparent)* – means obviously, clearly, plainly evident, but also means seemingly or observably. You know the meaning that you intend, but readers may not. Ambiguity results.

Use *obvious(ly)*, *clear(ly)*, *seeming(ly)*, *evident(ly)*, *observable* or *observably*, to remove doubt.

- *Appear, appears* – Seem(s)

He always appears on the scene, but never seems to know what to do.

Marley's ghost appeared but seemed harmless.

Aim for precision: (cont.)

- *As* – Do not use *as* to mean “because” or “inasmuch as”.
- At the present time, at this point in time – Say *at present* or *now* if necessary at all.
- Below – See comment about *above*.
- *But (to begin a sentence)* – Go right ahead (see *And*).
- By means of – Most often, just *by* will serve and save words.

Aim for precision: (cont.)

- *Case* – Can be ambiguous or misleading because of different connotations:

In the case of Scotch whiskey,...

For “in this case” try *in this instance*.

- Compare with, compare to – *Compare with* means to examine differences and similarities; *compare to* means to represent as similar.

*One may conclude that the music of Brahms compares **to** that of Beethoven, but to do that, one must first compare the music of Brahms **with** that of Beethoven.*

Aim for precision: (cont.)

- Comprise – Before misuse, “comprise” meant to contain, include, or encompass (not to constitute or compose) and still does, despite two now opposite meanings. Use and meanings now are so confused and mixed that “comprise” is best avoided altogether.
- Correlated with, correlated to
Although things may be related to one another, things are correlated with one another.
- Different from, different than –
Different from! Also, one thing differs from another, although you may differ with your colleagues.

Aim for precision: (cont.)

- Due to – Make sure that you don't mean “because of”. “Due” is an adjective modifier and must be directly related to a noun, not to a concept or series of ideas gleaned from the rest of a statement. “Due to the fact that...” is an attempt to weasel out.
- “During the course of”, in the course of – Just use *during* or *in*.

Aim for precision: (cont.)

- Either...or, neither...nor – Apply to no more than two items or categories. Similarly, former and latter refer only to the first and second of only two items or categories.
- Experience(d) – To experience something is sensory; inanimate, unsensing things (lakes, soils, enzymes, streambeds, farm fields, etc.) do not experience anything.
- Following – “After” is more precise if “after” is the meaning intended.

After [not following] the procession, the leader announced that the ceremony was over.

Aim for precision: (cont.)

- High(er), low(er) – Much too often used, frequently ambiguously or imprecisely, for other words such as greater, lesser, larger, smaller, more, fewer; e.g.
“Occurrences of higher concentrations were lower at higher levels of effluent outflow.”
- *However* – Place it more often within a sentence or major element rather than at the beginning or end.
- *But* serves better at the beginning.

Aim for precision (cont.)

- Hyphenating of compound or unit modifiers – Often needed to clarify what is modifying what:

a small-grain harvest (harvest of small grain)

a small grain harvest (small harvest of all grain).

Grammatically, adjectives are noun modifiers, and the problem is when adjectives and nouns are used to modify other adjectives and nouns.

Adverbs (usually with “ly” endings), however, are adjective modifiers.

Aim for precision: (cont.)

- In order to – For brevity, just use *to*.
- Irregardless – No, *regardless*. But *irrespective* might do.
- It should be mentioned, noted, pointed out, emphasized, etc. – Such preambles often add nothing but words. Just go ahead and say what is to be said.
- It was found, determined, decided, felt etc. – Are you being evasive? Why not put it frankly and directly? (And how about that subjective “felt”?)

Aim for precision: (cont.)

- Less(er), few(er) – “Less” refers to quantity; “fewer” to number.
- Majority, vast majority – See if *most* will do as well or better.
- Myself – Not a substitute for me. “This paper has been reviewed by Dr. Smith and myself” and “The report enclosed was prepared by Dr. Jones and myself” are incorrect; *me* would have been correct in all instances. (Use of “I” also would have been wrong in those examples.) Some correct uses of “myself”:

I found the error myself.

I myself saw it happen.

I am not myself today.

I cannot convince myself.

I locked myself out of the car.

Aim for precision: (cont.)

- Partially, partly – Compare the meanings (see also impartially). *Partly* is the better, simpler, and more precise word when partly is meant.
- Percent, percentage – Not the same; use *percent* only with a number.
- Predominate, predominant – *Predominate* is a verb. *Predominant* is the adjective; as an adverb, *predominantly* (not “predominately”).

Aim for precision: (cont.)

- Prefixes – (mid, non, pre, pro, re, semi, un, etc.) – Usually not hyphenated in U.S. usage except before a proper name *pro-Iowa* or numerals *mid-60s* or when lack of a hyphen makes a word ambiguous or awkward.

Recover a fumble, but perhaps *re-cover a sofa*.

Preengineered is better hyphenated as *pre-engineered*

Breaking pairs such as predoctoral and postdoctoral into *pre-* and *post-doctoral* “forces” hyphenating of both otherwise unhyphenated words.

Aim for precision: (cont.)

- Principle, principal – They're different; make sure which you mean.

The principal rivers of Brazil.

The first principle of geometry.

I agree with you in principle.

- Prior to, previous to – Use before, preceding, or ahead of. There are prior and subsequent events that occur before or after something else.

On a previous occasion.

The house was sold prior to auction.

- Proven – Although a proven adjective, stick to proved for the past participle.

A proven guilty person must first have been proved guilty in court.

Aim for precision: (cont.)

- Provided, providing – Provided (usually followed by *that*).
I will come provided that he stays away.
You may come providing that you pay for yourself.
- Reason why – Omit “why” if reason is used as a noun.
The reason is...
The reason is that...
- Since – has a time connotation; use *because* or *inasmuch as* when either is the intended meaning.
She hasn't been home since her marriage.
- Small in size, rectangular in shape, blue in color, tenuous in nature, etc. – Redundant.

Aim for precision: (cont.)

- That and which – Two words that can help, when needed, to make intended meanings and relationships unmistakable, which is important in reporting scientific information. If the clause can be omitted without leaving the modified noun incomplete, use “which” and enclose the clause within commas or parentheses; otherwise, use “that”.

The lawn mower, which is broken, is in the garage.

The lawn mower that is broken is in the garage.

Aim for precision: (cont.)

- To be – Frequently unnecessary.
The differences were [found] [to be] significant.
- Varying – Be careful to distinguish from various or differing. In saying that you used *varying amounts* or *varying conditions*, you are implying individually changing amounts or conditions rather than a selection of various or different ones.
- Where – Use when you mean *where*, but not for *in which*, *for which* etc.

Aim for precision: (cont.)

- Which is, that were, who are etc. – Often not needed.
The data that were related to age were analyzed first
the data related to age were analyzed first.
- Similarly, *the site, which is located near Arno*
the site, located near Arno
the site, near Arno.
- Rather than *all persons who were present voted*
all persons present voted.
- Instead of *a survey, which was conducted in 1974*
a survey conducted in 1974
a 1974 survey.
- While – Preferably not if, while writing, you mean “and”, “but”, “although”, or “whereas.”

Grammar

- Make sure you write well-formed sentences, and keep their structure simple.
- Use the first person
I or we tested six runners rather than the passive voice (“Six runners were tested”).
- Say *Smith reported* instead of “reported by Smith.”
- With comparatives (more than, less than), the *than* may need to be
than that of
than with
than by
to clarify the meaning.

Grammar: (cont.)

- Similarly, “similar to” may need to be *similar to that of*. *The measure was more valid than that of Smith et al. (1994).*
We experienced fewer problems with the revised instrument than with the published version. The method was similar to that of an earlier study.
- Don’t use a long string of qualifiers in front of a noun:
a modified test of cognitive function
a modified cognitive-function test.
- Avoid grammatically questionable formal clichés, such as: “Based on these results”, “it is concluded that” and “The results showed that.”

Grammar (cont.)

- Use the past tense to report results (yours or others). Use the present tense to discuss them.

We have found that”.

Smith (1989) reported a similar result.

A simple explanation of these findings is that

- Avoid so-called misplaced modifiers:

“When sedentary, protein supplementation resulted in”;

- The next two examples are marginal:

Using stable tracers, it is possible to measure...

Given the importance of body mass, there has been little study of its effects.

Grammar (cont.)

- Note that a noun was verbed to verb something.

An experiment was performed to test this hypothesis

is also technically incorrect but is used so widely that it has to be accepted.

- A noun was verbed (by) verbing is also acceptable.

An experiment was performed by testing....

The active voice would avoid these awkward expressions.

- Put “only”, “partly” and “mainly” next to the word they modify:

The test consists only of new items.

Grammar (cont.)

- Which or that? Simple rule: “Which” always follows a comma (and a pause), but “that” never does.

This study, which cost \$10,000, was a success

The study that cost \$10,000 was a success.

- Owing to or due to? Simple rule: “Owing to” always has a comma, “due to” never does.

The data were lost, owing to computer malfunction.

The loss of data was due to computer malfunction.

Grammar (cont.)

- An adverb is placed usually after the verb. Placing it before the verb creates a split infinitive:
to boldly go (is acceptable if emphasizing go);
to go boldly is better (if the emphasis is on boldly).

Active versus Passive Voice

- In the active voice, the grammatical subject is the doer of the action, and the sentence tells, “who’s doing what.”
- The passive voice tells what is done to the subject of the sentence. The person or thing doing the action may or may not be mentioned but is always implied.
- Verbs are also said to be either active (*The executive committee approved the new policy*) or passive (*The new policy was approved by the executive committee*).
- In the active voice, the subject and verb relationship is straightforward: the grammatical subject is the doer of the action, and the sentence tells “who’s doing what”.

Active versus Passive Voice (cont.)

- The passive voice tells what is done to the subject of the sentence. The subject of the sentence is acted upon by some other agent or by something unnamed (*The new policy was approved*).
- Computerized grammar checkers can pick out a passive voice construction from miles away and ask you to revise it to a more active construction.
- There is nothing inherently wrong with the passive voice, but if you can say the same thing in the active mode, do so (see exceptions below).

Active versus Passive Voice (cont.)

- We find an overabundance of the passive voice in sentences created by people who use the passive voice to avoid responsibility for actions taken.
- *Cigarette ads were designed to appeal especially to children* places the burden on the ads — as opposed to *We designed the cigarette ads to appeal especially to children*, in which “we” accepts responsibility.

Active versus Passive Voice (cont.)

- *The President was advised that certain members of Congress were being audited rather than The Head of the Internal Revenue service advised the President that her agency was auditing certain members of Congress, because the passive construction avoids responsibility for advising and for auditing.*
- We should not mix active and passive constructions in the same sentence: *The executive committee approved the new policy, and the calendar for next year's meetings was revised should be The executive committee approved the new policy and revised the calendar for next year's meeting.*

When to use Active Voice

- In general, writing should be composed in the active voice because of the sense of immediacy and conciseness conveyed when the subject of the sentence carries out the action.
- In addition, fewer words are usually required for the active voice, it is more efficient, and it takes the reader from point A to point B in a “straight line.”

When to use Passive Voice

- When it is more important to draw our attention to the person or thing acted upon: *The unidentified victim was apparently struck during the early morning hours.*
- When the actor in the situation is not important: *The aurora borealis can be observed in the early morning hours.*

When to use Passive Voice (cont.)

- Specially helpful in scientific or technical writing or lab reports, where the actor is not really important but the process or principle being described is of ultimate importance. Instead of writing *I poured 20 cc of acid into the beaker*, we would write *Twenty cc of acid is/was poured into the beaker*.
- When describing, a mechanical process in which the details of process are much more important than anyone's taking responsibility for the action: *The first coat of primer paint is applied immediately after the acid rinse*.

When to use Passive Voice (cont.)

- You can recognize passive-voice expressions because the verb phrase will always include a form of be, such as am, is, was, were, are, or been.
- The presence of a be-verb, however, does not necessarily mean that the sentence is in passive voice. Another way to recognize passive-voice sentences is that they may include a “by the...” phrase after the verb.
- The active voice enhances the authority of the writer, while the passive voice can obscure it. Passive voice: *It is understood by students that good writing is essential in college.* Active voice: *Students understand that good writing is essential in college.*

Examples

1. The report was read by Betty.
 2. Betty read the report.
1. A decision was made to stop the project.
 2. We decided to stop the project.
1. The passive voice should be avoided.
 2. Avoid the passive voice.
1. Scientists conduct experiments to test hypotheses.
 2. Experiments are conducted by scientists to test hypotheses.
1. Watching a reaction boil over through shielding reminds me to be careful.
 2. I am reminded to be careful by watching a reaction boil over through shielding.

Exercises

1. Before the semester was over, the new nursing program had been approved by the Curriculum Committee and the Board of Trustees.
2. With five seconds left in the game, an illegal time-out was called by one of the players.
3. The major points of the lesson were quickly learned by the class, but they were also quickly forgotten by them.
4. For several years, Chauncey was raised by his elderly grandmother.

5. An unexpected tornado smashed several homes and uprooted trees in a suburb of Knoxville.
6. I was surprised by the teacher's lack of sympathy.
7. Tall buildings and mountain roads were avoided by Raoul because he had such a fear of heights.

Answers

1. Before the semester was over, the Curriculum Committee and the Board of Trustees approved the new nursing program.
2. With five seconds left in the game, one of the players called an illegal time-out.
3. The class quickly learned, but then quickly forgot, the lesson's major points.
4. Chauncey's elderly grandmother raised him for several years.
(NOTE: In the original version the emphasis was more on Chauncey and there is nothing really wrong with that.)

5. An unexpected tornado smashed several homes and uprooted trees in a suburb of Knoxville. (NOTE: The original was already active.)
6. The teacher's lack of sympathy surprised me. (NOTE: If the intent is to emphasize your surprise rather than the source then the original version is fine.)
7. Raoul avoided tall buildings and mountain roads because he had such a fear of heights.