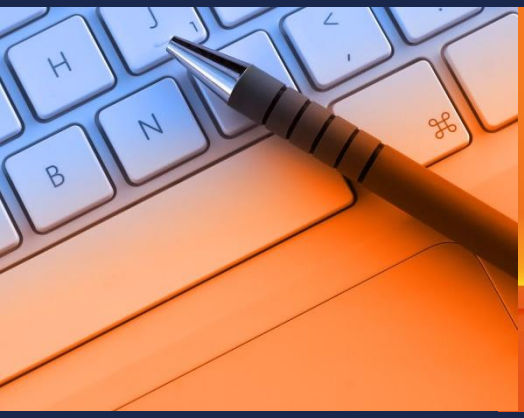
The Science of Scientific & Technical Writing: How to Achieve Greater Control of Reader Interpretations



Agenda

- Write with the Reader in Mind
- Reader Expectations for the Structure of Scientific Writing
- Subject-Verb Separation
- The Topic Position
- The Stress Position
- Avoid the No. 1 Problem in Scientific Writing
- How to Perceive Logical Gaps
- Locating the Action
- Writing and the Scientific Process

Write with the Reader in Mind

Write with the Reader in Mind

- People assume reading science is hard
- Readers do not simply read; they ***interpret***
- Readers must accurately perceive what the **author had in mind**
- We need to know *how* readers go about reading
- I will demonstrate rhetorical principles that produce clarity in communication without oversimplifying scientific concepts

Write with the Reader in Mind

- Any piece of text may have 10 (or more) different meanings to 10 different readers
- Readers make interpretive decisions based on clues they receive from the structure of text
- Let's look an example…

Write with the Reader in Mind

For example:

✗ **t(time)=15', T(temperature)=32º, t=0', T=25º; t=6', T=29º; t=3', T=27º; t=12', T=32º; t=9'; T=31º**

or

✓

time (min)	temperature(ºC)
0	25
3	27
6	29
9	31
12	32
15	32

Write with the Reader in Mind

- Info is interpreted more easily when in places where readers expect to find it
- The needs of the reader affect the interpretation not only of tables but also of the text itself
- Readers have fixed expectations about where in the structure of text they encounter items of substance
- You can therefore learn how to have better control over which data is emphasized

Write with the Reader in Mind

- Readers have certain expectations for each "unit of discourse"
- When these "units" are confused, readers are confused; readers search for info in certain places
- If these structural expectations are violated, readers are forced to divert energy to unraveling structure
- As the complexity of the context increases so does the possibility of misinterpretation

Reader Expectations for the Structure of Scientific Writing

Reader Expectations for the Structure of Scientific Writing

Here is our first example of scientific prose, in its original form:

✗ **"The smallest of the URF's (URFA6L), a 207-nucleotide (nt) reading frame overlapping out of phase the NH2-terminal portion of the adenosinetriphosphatase (ATPase) subunit 6 gene has been identified as the animal equivalent of the recently discovered yeast H+-ATPase subunit 8 gene. The functional significance of the other URF's has been, on the contrary, elusive. Recently, however, immunoprecipitation experiments with antibodies to purified, rotenone-sensitive NADH-ubiquinone oxido-reductase from bovine heart, as well as enzyme fractionation studies, have indicated that six human URF's (that is, URF1, URF2, URF3, and URF4, hereafter referred to as ND1, ND2, ND3, ND4) encode subunits of complex I. This is a large complex that also contains many subunits synthesized in the cytoplasm."**

Reader Expectations for the Structure of Scientific Writing

***Why* is this paragraph hard to read?**

The technical vocabulary?

Maybe it requires specialized background knowledge?

Knowing a little about the subject matter does NOT clear up all the confusion

The reader is hindered by MORE than just the scientific jargon

Here is how we can fix these problems…

Subject-Verb Separation

Subject-Verb Separation

- **Look again at the first sentence of the passage**

"The smallest of the URF's (URFA6L), a 207-nucleotide (nt) reading frame overlapping out of phase the NH2-terminal portion of the adenosinetriphosphatase (ATPase) subunit 6 gene has been identified as the animal equivalent of the recently discovered yeast H+-ATPase subunit 8 gene."

- **There are structural problems here; info is not presented where readers need and expect to find it.**

Subject-Verb Separation

Readers expect a grammatical **subject** to be followed immediately by the **verb.**

A stronger revision of our example text is: **"The smallest of the URF's (URFA6L) has been identified as the animal equivalent of the recently discovered yeast H+-ATPase subunit 8 gene."**

Anything of length that intervenes between subject and verb is read as an **interruption**, and therefore as something of *lesser* importance

The reader's expectation stems from a pressing need for syntactic resolution, fulfilled only by the arrival of the verb

Each **unit of discourse** is expected to serve a **single** function.

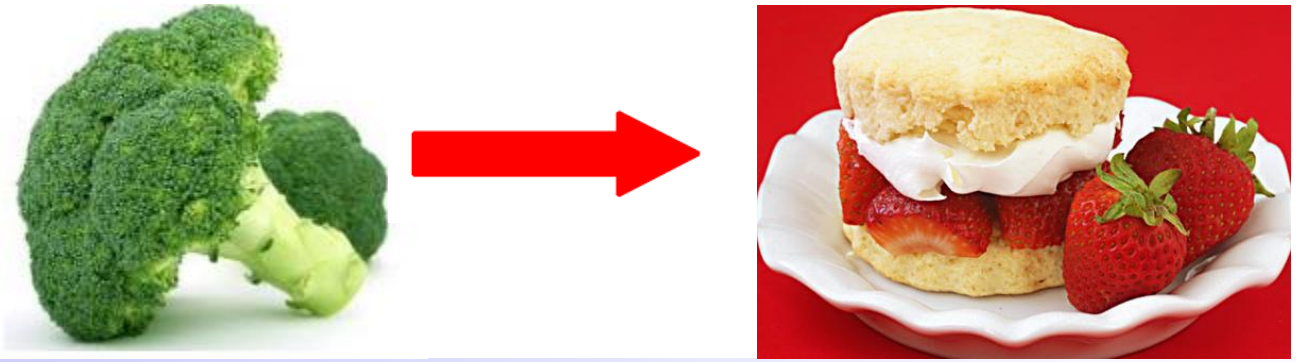
The Stress Position

The Stress Position

It is a linguistic commonplace that readers emphasize the material that arrives at the END of a sentence

Writers can take advantage of this. As a result, the chances greatly increase that reader and writer will perceive the same material as being worthy of primary emphasis

The structure of the sentence thus helps persuade the reader of the relative values of the sentence's contents

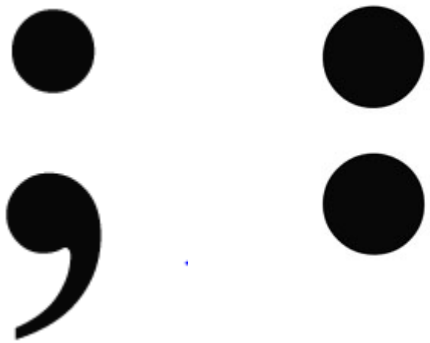


The Stress Position

Long sentences increase chances the reader won't interpret the text as the writer intended

The stress position should coincide with the moment of syntactic closure

Secondary stress positions can be formed using correct punctuation



Let's Review…

We have now discovered 3 rhetorical principles based on reader expectations:

- **First:** grammatical subjects should be followed as soon as possible by their verbs
- **Second:** every unit of discourse, no matter the size, should serve a single function or make a single point
- **Third:** info intended to be emphasized should appear at points of syntactic closure

Let's Review…

Note the subject-verb separation in the 62-word third sentence of the original passage:

✗ "Recently, however, immunoprecipitation experiments with antibodies to purified, rotenone-sensitive NADH-ubiquinone oxido-reductase [hereafter referred to as respiratory chain NADH dehydrogenase or complex I] from bovine heart, as well as enzyme fractionation studies, have indicated that six human URF's (that is, URF1, URF2, URF3, URF4, URF4L, and URF5, hereafter referred to as ND1, ND2, ND3, ND4, ND4L and ND5) encode subunits of complex I."

What's wrong here?

Let's Review…

When is a sentence too long?

A sentence is too long when it has more viable candidates for stress positions than there are stress positions available

No one should have to work hard to unearth the important content of a single passage!

The Topic Position

The Topic Position

In the stress position the reader needs and expects closure and fulfillment; in the topic position the reader needs and expects perspective and context

The information that begins a sentence establishes for the reader a perspective for viewing the sentence as a unit. The TP refers to the beginning of the sentence

"Bees disperse pollen" vs "Pollen is dispersed by bees“

The topic position provides linkages

The Topic Position

"Large earthquakes along a given fault segment do not occur at random intervals because it takes time to accumulate the strain energy for the rupture. The rates at
which tectonic plates move and accumulate strain at their boundaries are approximately uniform. Therefore, in first approximation, one may expect that large ruptures of the same fault segment will occur at approximately constant time intervals. If subsequent main shocks have different amounts of slip across the fault, then the recurrence time may vary, and the basic idea of periodic mainshocks must be modified. For great plate boundary ruptures the length and slip often vary by a factor of 2. Along the southern segment of the San Andreas fault the recurrence interval is 145 years with variations of several decades. The smaller the standard deviation of the average recurrence interval, the more specific could be the long-term prediction of a future mainshock."

The Topic Position

So what's wrong with this text?

Let's look closely at the information in each sentence's topic position:

Large earthquakes
The rates
Therefore...one
subsequent mainshocks
great plate boundary ruptures
the southern segment of the San Andreas fault
the smaller the standard deviation...

Writing that continually begins sentences w/ new information and ends w/ old information the end = bad

The Topic Position

Here is a revised version:

“Large earthquakes along a given fault segment do not occur at random intervals because it takes time to accumulate the strain energy for the rupture. The rates at which tectonic plates move and accumulate strain at their boundaries are roughly uniform. Therefore, nearly constant time intervals (at first approximation) would be expected between large ruptures of the same fault segment. [However], the recurrence time may vary; the basic idea of periodic mainshocks may need to be modified if subsequent mainshocks have different amounts of slip across the fault. [Indeed], the length and slip of great plate boundary ruptures often vary by a factor of 2. [For example], the recurrence intervals along the southern segment of the San Andreas fault is 145 years with variations of several decades. The smaller the standard deviation of the average recurrence interval, the more specific could be the long term prediction of a future mainshock.”

The Topic Position

Our revised version is *much* easier to read!

We can see that most of our difficulty was owing not to any deficiency in our reading skills but rather to the author's lack of comprehension of our structural needs as readers

Many authors rush to write down new ideas

They don’t revise their work; the structure becomes sloppy and they forget to consider *how* the reader processes info

Important Reminder

The No. 1 problem in professional writing today is the misplacement of old and new information

Important Reminder

Let's review…

In the topic position place the old information that links backward

In the stress position place the new information you want the reader to emphasize

How to Perceive Logical Gaps

Logical Gaps

When old information does not appear at all in a sentence readers are left to construct the logical linkage by themselves (not ideal!)

“The enthalpy of hydrogen bond formation between the nucleoside bases 2'deoxyguanosine (dG) and 2'deoxycytidine (dC) has been determined by direct measurement. dG and dC were derivatized at the 5' and 3' hydroxyls with triisopropylsilyl groups to obtain solubility of the nucleosides in non-aqueous solvents and to prevent the ribose hydroxyls from forming hydrogen bonds. From isoperibolic titration measurements, the enthalpy of dC:dG base pair formation is -6.65±0.32 kcal/mol.”

Each sentence *must* proceed logically from its predecessor!

Locating the Action

Locating the Action

So where do we start when making revisions?

Attending to any one structural problem eventually leads us to all the others

-Look at the topic sentences

-Make a list of the verbs in the paragraph

***-Remember:* The fewer the structural clues to interpretation given by the author, the more variable the resulting interpretations will tend to be**

As critical scientific readers, we need to concentrate our energy on whether the experiments prove the hypotheses

Writing & the Scientific Process

Writing & the Scientific Process

Remember the following structural principles:

1. Follow a grammatical subject as soon as possible w/ its verb.

2. Place “important information" in the stress position.

3. Place "old information" in the topic position for linkage backward and contextualization forward.

4. Provide context for your reader before asking that reader to consider anything new.

Writing & the Scientific Process

A few points to wrap up…

-Don't slavishly follow rules

-Rules can occasionally be broken…for a good reason! 

-Reverse bad habits that burden readers

The substance of science comprises more than the discovery and recording of data; it extends crucially to include the act of interpretation

Remember: The structure *influences* the reader

Think: *Does your writing help or hinder the reader?*

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