Scientific Writing Workshop

leadership sculptor
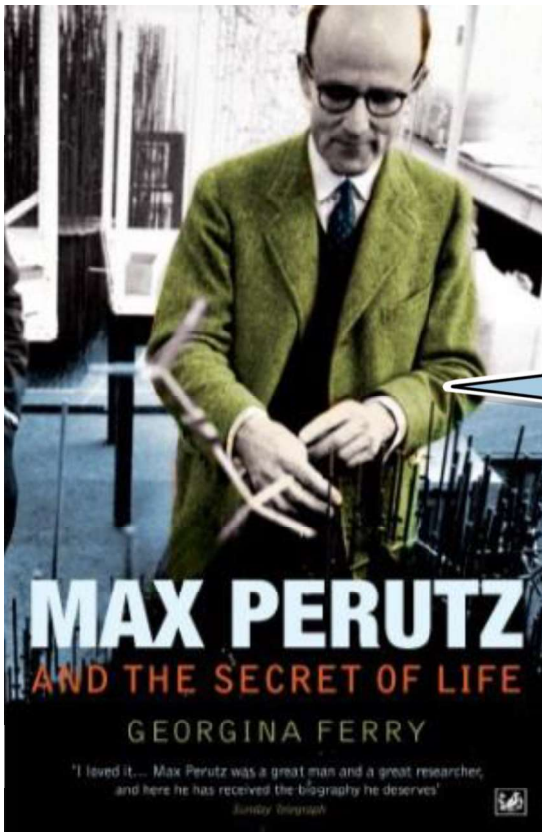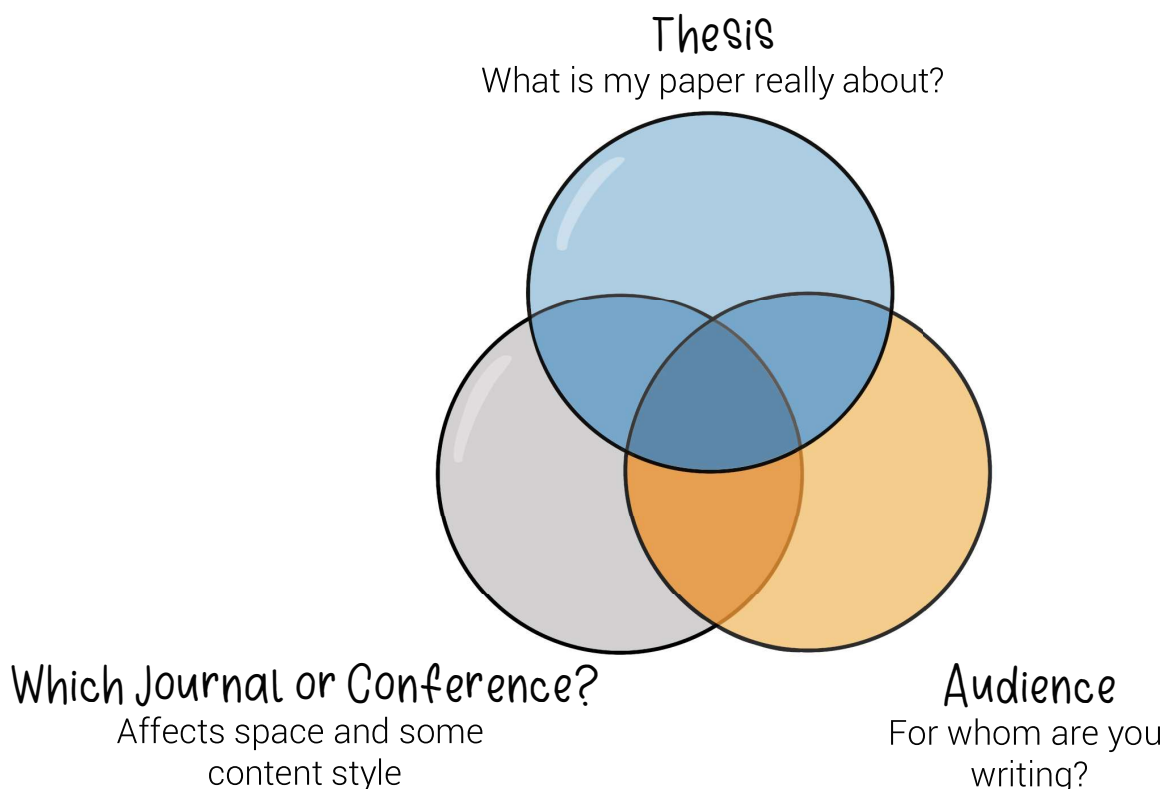
"I have become more interested in writing as such; the presentation of a scientific discovery is, or at least should be, a work of art. Scientific papers ought to be written so that they grip the interested reader, to be so clear that you don't have to read each sentence twice, and to explain to the reader not only what you have done but also why."
– Max Perutz, quoted on *p.262*

MAX PERUTZ
AND THE SECRET OF LIFE
GEORGINA FERRY

'I loved it.... Max Perutz was a great man and a great researcher, and here he has received the biography he deserves'
Sunday Telegraph

How To Decide What to Put in the Paper

A Decision Mechanism For Content

Thesis
What is my paper really about?

Which Journal or Conference?
Affects space and some content style

Audience
For whom are you writing?

Audience – 1

- First, identify your audience. Then identify what you want to tell them.
  - Why does the audience need or want this report?
  - What is the audience's technical background (knowledge, training, first-hand experience)?
  - What is the report's purpose?
  - Answers to these questions set boundaries on what you need to put in the paper.
  - They help you identify what sort of examples to include (and how many)
- What information do you need to give them so that they can understand?
  - This helps to identify what sort of information and how much of it needs to go into the paper
- How should the information in the report be presented?
  - What are the main steps towards your result?
  - This provides a logical sequence for the information
  - You can use this to identify the main sections in the paper

Audience – 2

- For whom is the paper intended?
  - Expert
  - Technician
  - Executive
  - Non-specialist
  - Lay person
- Analyse your audience
  - what background information can you expect them to know?
    How much detail is needed?
  - what needs and interests have they?
    What will they do with your paper?
  - Are there important demographic factors?
    This can influence the choice of examples and analogies

Thesis Statement

- A declarative sentence that gives the central message of the paper.
- It states what the paper shows.
- It is the key to all good writing.
  - In fiction, authors may take liberties in order to prove their thesis, since they define their world.
  - In scientific writing, writers must respect scientific knowledge and not take short cuts with their data.
- It helps you decide what needs to go in the paper and what can stay out.

Example

"Solving boundary layer problems efficiently requires singularly perturbed methods"

- The author must explain something about boundary layer problems,
- Show why and when standard methods are insufficient and
- Demonstrate that the sing. pert. methods work
- Other results from the author belong in another paper

Where to Publish

- Considerations
  - Amount of space
  - Writing style
  - Formality
  - Check the publisher's requirements

- Types of outlet
  - Journal
  - Conference abstract
  - Conference paper
  - Poster
  - Book chapter
  - Book
  - Technical report
  - Documentation
  - Magazine article
  - Grant application
  - Ph.D. thesis
  - Lecture notes

Revision Techniques – Content

- The first step in revising a draft is to check if the paper contains the right information

- Common mistakes in deciding content
  - information is missing are all key terms defined or standard
  - information is inadequate take enough space to explain key ideas
  - information is at the wrong level you have included "beginner" explanations for a specialist audience

Example

Explaining objects and object-oriented in a general IT paper

- Checklist for types of content
  - Definition all technical terms defined in sufficient detail?
  - Description are there objects or mechanisms that need to be described?
  - Process discussion algorithm/process
  - Comparison would a comparison help?
  - Division into categories is the classification criterion clear?
  - Location within a category is the classification consistent?
  - Causal discussion
  - Examples can you show your method is better
  - Analogy is your comparison too abstract / technical
  - (Historical) background what would help the reader to understand
  - Instructions could they apply or implement your idea?
  - Narrative does some special event need to be discussed?
  - Compare with typical papers see what form good papers in your area take

Structure of a Paper

Standard Structure

- The acronym IMRAD describes the standard structure:
  - Introduction – what is the problem
  - Methods – how was it studied
  - Results – what was found
  - And
  - Discussion – what does that mean
- Some journals prefer IRDAM (e.g. *Cell*)

Title

- A good title is clear, concise and meaningful
- It does not overstate your proposal
- It avoids jargon
- Be careful with buzzwords: they have a short "shelf life" and can put off reviewers
- "Cute" or informal titles can be off-putting: not everyone shares your sense of humour
- What do you think about the following titles?
  - Mechanisms of Cell Division and Differentiation
  - Mathematical Modelling of Nonlinear Systems
  - Molecular Mechanisms and Regulation of Metal Ion Uptake in Eukaryotic Cells
  - Does Tectonic Activity Cause Global Extinctions?
  - Temperature and Moisture: Controls on Global Carbon Cycles
  - Analysis of Pesticide Transport Pathways and Degradation in Natural Wetlands
  - The Role of Plant Transcriptional Adaptors in Heat Shock-Regulated Gene Expression

Abstract

- The abstract should
  - State the principal objectives and scope of the investigation
  - Describe the methods employed
  - Summarise the results, and
  - State the principal conclusions
- It should never give information that is not included in the main paper
- References to the literature do not need to be given (unless you are modifying a published result)
- It is usually written in the past tense, since it refers to work completed.

Structure of an Abstract

- Context for the research, incl. topic or question.
- State-of-the-art: what is the current knowledge in the area?
- The challenge:
  - what is the delta?
  - Where are the gaps?
  - What needs to be better understood?
- What is your proposed (partial-)solution?
  - This includes the approach or method
- What is the benefit
  - Summary of results and
  - Main conclusions

- The final point is the most important for reviewers and readers

The Introduction

- The purpose is to provide sufficient background information so that the reader can understand and evaluate the present results without having to read other papers first
- The introduction
  - presents clearly the nature and scope of the problem investigated (why this subject? Why is it important?)
  - reviews the pertinent literature to orient the reader
  - states the method of investigation. If necessary, the reasons for this choice should be stated
  - states the principal results obtained by the authors
  - states the principal conclusions
  - Outlines the structure of the paper
- Much of the introduction is written in the present tense, since it refers to the problem and pertinent established knowledge.

"Reading a scientific paper isn't the same as reading a detective story. We want to know from the start that the butler did it." – O.D. Ratnoff

Materials and Methods

- This section gives full details of the methods and materials used.
- There should be enough information so that a competent colleague could reproduce the results. (The principle of reproducibility)
- Methods are usually presented in chronological order; methods of the same type are grouped together.
- Results do not belong in this section; they appear later in the paper.
- It's a good idea to ask a colleague to check this section, to see if anything major has been omitted.
- Most of it is written in the past tense.

Results

- If you notice you have omitted a method, add it to the methods section, not to this section
- There is no need to repeat the experimental details from the methods section.
- Select representative data rather than showing all data.
- The results should be short and sweet.
- Strike a balance between commenting on tables and figures, and just stating the obvious.

Discussion

- Try to present principles, relationships and generalisations shown by the results. (Discuss, don't just recapitulate.)
- Point out exceptions or lack of correlation and define unsettled points. (Don't try to fudge data that doesn't "fit".)
- Show how your results and interpretations agree (or contrast) with previously published work.
- State your conclusions as clearly as possible.
- Summarise your evidence for each conclusion.
- Much of this section is in the present tense, since it includes previously established information.

Tense in Scientific Writing

- Rule of thumb: when you quote or refer to previously published work, use the present tense since you are referring to established knowledge.
  - Exception: "Smith (2004) showed ..."
- Refer to your own work in this paper the past tense. Once it has been published, it joins the body of established fact and can be referred to in the present tense in the next paper.
  - Exception: "Table 3 shows ..."
  - Exception: The results of calculations or statistical analyses are in the present tense – "These values are significantly greater ..."
  - Exception: Generally known truths are in the present: "water **was** added and the towels **became** damp, which proves again that water **is** wet."

Some Tips on Writing & Revising

Revision Techniques – Structure

There are two aspects to checking the structure:
- organisation (see next chart)
- depth

In the normal flow of writing, sentences either go to a deeper level of detail, or add detail at the same level
- this gives a simples means of checking the structure of paragraphs and sentences.
- It helps identify where some more detail might be useful in the paper

Revision Techniques – Organisation

Having checked that the paper contains the right information at the right level of detail, it is important to organise the information so that the reader can understand your message

A few tips on organising
- Describe the topic of each paragraph using a word or phrase
- Check if the sequence of topics makes logical sense (use the checklist as a guide)
- Within each paragraph use the checklist again to determine its organisation

Checklist for sequencing information
- General ➔ specific
- Simple / basic ➔ complex
- Thing-at-rest ➔ Thing-in-motion
- spatial movement
- Temporal movement
- Concept ➔ application of the concept / examples
- Data ➔ conclusions
- Problem / question ➔ solution / answer
- Simplified version ➔ technical version
- Most important ➔ least important
- Most convincing ➔ least convincing

Some Basics on Style

Fowler's Five Basic Rules of Writing

"Anyone who wishes to become a good writer should endeavour, before he allows himself to be tempted by more showy qualities, to be direct, simple, brief, vigorous and lucid.

This general principle may be translated into general rules in the domain of vocabulary as follows:

- Prefer the familiar word to the far-fetched.
- Prefer the concrete word to the abstract.
- Prefer the single word to the circumlocution.
- Prefer the short word to the long.
- Prefer the Saxon word to the Romance.

These rules are given in order of merit; the last is also the least."

Qualities of Good Writing

- Simple
  - Short sentences
  - Use subject – verb – object as the basic sentence structure
- Clear
  - Change from passive to active verbs, where possible
  - Use first person (singular or plural) where possible
  - Remove redundancy and repetition
- Readable
  - Switch from heavy use of abstract nouns to verbs, where possible, e.g. change "frustration" to "frustrate". and modify the sentence accordingly
  - Use pronouns and synonyms to avoid repeating the same word or phrase too often

Clear Thinking

- Clear thinking leads to clear writing
  - what do you want to say? Key messages
  - What is new in this paper? Answer this question before you start writing
  - to whom do you want to say it? Who is the audience
  - how do you want to say it? Thesis, journal, conference, web page, magazine, newspaper
  - how much space do you have? How much detail can you afford
- Start with a piece of paper
  - using the computer too quickly tends to result in unfinished thoughts landing on the page this annoys the reader
  - note the key ideas and structure them try out creativity techniques
  - investing a little bit of time here saves a lot of time later try it out for yourself!
- Make a summary of contents
  - this simplifies structuring the paper clear logic here makes the reader's life easier
  - quick identification if important information has been overlooked
  - helps in deciding what belongs where in the paper

Making Ideas Stick

- Checklist
  - Simple – What is the essential core of your idea? – In a simple sentence.
  - Unexpected – Use "opening gaps" to spark the reader's curiosity
  - Concrete – illustrate your ideas using concrete images
  - Credible – For what reasons are you the right person.
  - Emotional – People are (in general) more attracted by ideas with emotional content; this is useful for communicating science to lay people
  - Stories – An ideal format for making an idea memorable

- You can use the checklist on the left to test ideas that you have to communicate.
- The more of these properties the idea has, the more likely it is to be memorable.
- There is no need to force your idea to contain all of these.

Source: Made to Stick – Why some ideas survive and others die by Chip & Dan Heath

What's The Benefit?

- Many researchers suffer from "Bescheidenitis" – they're either modest about their results or expect the reviewer or reader to work it out for themselves
- Depending on the granting agency, it's important to think about different categories of benefit
  - Scientific: how big is the challenge, the advance?
  - Vista: what additional research areas or questions might become possible through achieving this result
  - Industrial: What impact on patents, jobs, economy?
  - Society: What implications has the discovery for society? Any ethical issues?

Some Writing Tools

Draw the Reader In

- The opening sentences need to be able to draw the reader in to your topic
- How far away from your topic you open, depends on the expertise of your readers
- It's important to be original or fresh in these sentences – not every paper will either cure cancer or solve all global warming issues
- Be specific in this start. A concrete example, relevant to the article, helps

Body of Knowledge

Research Topic
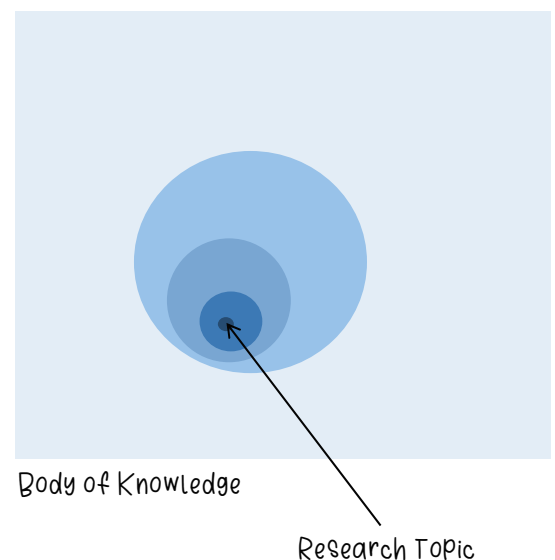
Sentence Length

- In technical writing it is easy to construct long sentences that are hard to read or understand.
  - A good guideline is 17-25 words per sentence.
  - If a sentence has more than 35 words, it needs to be broken up for one of two reasons:
    - You may no longer be clear about what you want to say, or
    - The reader will probably not pick up the message you intend.
  - An occasional short sentence (5-10 words) can be effective. However, too many of them lead to choppy or staccato writing.

Signposting

- Topic sentences and overviews offer a perspective on what's where: the topic, the subtopics, the purpose of the upcoming discussion, its relation to the previous section and to the document as a whole.
- A topic sentence is typically the opening sentence of a paragraph or set of paragraphs.
- An overview sentence provides orientation for a section or subsection; it may include the relationship of what is being discussed to the rest of the paper.

Five Editing Principles

1. Replace "to be" verbs (is, was, were, etc.) with strong active verbs.
   - Often this entails making your statement in active rather than passive voice.
   - In other situations, words ending with -tion are often verbs waiting to happen. For example, we can transform "frustration" into "frustrates," and "allocation" can become "allocates."
   - Also, collapsing compound verbs into a single verb ("are able to" into "can") rids your sentences of both dull verbs and a lot of clutter.

2. Eliminate strings of prepositions (often a symptom of passive voice).
   - Shakespeare's Hamlet is dominated by a sense of the main character's brooding over the nature of man in society.
     Notice all the prepositional phrases: *by a sense, of the main, over the nature, of man, in society*. We may not be able to eliminate them all, but we can tackle a few.
   - In Shakespeare's Hamlet, the main character constantly broods over man's place in society.

Five Editing Principles

3. Be concise.
   - Eliminate clutter, which often appears in the form of prepositional phrases, but also watch out for the senseless and the redundant moments.
   - Beware of pairs of words which create a nice rhythm to your prose but say the same thing: "With careless nonchalance, she threw the bag over her shoulder." Clearly, either "carelessly" or "nonchalantly" will serve our purposes, but we don't need both.
   - Expletives (there are, it is) often launch weak sentences: "There are many people who find success intimidating."

4. Vary the structure and length of your sentences.
   - Your prose becomes choppy (and dull) when every sentence begins with the main subject followed by a verb, and when sentences are of uniform length: "I stopped exercising. I gained 50 pounds."

Five Editing Principles

5. Use transitional words and phrases to show relationships between sentences.
   - Notice how, without any transitional words, we cannot be sure what the relationship is between "I stopped exercising" and "I gained 50 pounds." Did the speaker stop exercising because he had gained fifty pounds? Or did he gain fifty pounds because he stopped exercising? Did exercise or the lack thereof have anything to do with the speaker's weight gain? A revision should clarify this relationship.

Tables and Figures

Tips for Effective Tables

- Do not construct a table unless repetitive data must be presented
- Be suspicious of large numbers of 0s (or 100s, when %s are used)
- Only give significant figures. Non-significant figures may mislead the reader
- Omit unessential data
- Present the data in a table or in a figure or in the text – never in more than one way
- Data should be organised so that like elements read down (i.e. in columns)
  - Easier for the reader
  - Saves space
- Alignment:
  - Words: left
  - Numbers: right or by the decimal point
- Check the journal's submission guidelines

Tips for Effective Figures and Photos

- Same comments as for tables!
- Could it be written more effectively?
- Use a graph if the data shows interesting trends or features; tables are preferable for exact numbers
- Symbols and letters must be readable in journal size
- Graphs should be as simple as possible
- Place graphs "over and under" rather than "side by side"
- Do not extend the ordinate and abscissa beyond what the graph demands
- Use either different types of symbols, or different types of lines, but not both

- Photos: Crop the photo to focus on the area of interest, rather than show the entire photo and loose important detail

Some Tips on Punctuation

Punctuation '

When to use ´s

- To show possession for singular words not ending in s
- To show possession for singular words ending in s, add 's (usage varies on this, but this is a safe choice)
- To show possession for plural words not ending in s, add 's

When to use ´

- To show possession for plural words ending in s, add ' to the plural form of the word

When not to use ´ at all

- To show possession for possessive nouns
- The possessive form of "it" ("it´s" is short for "it is")

Examples

Java's usefulness   Linux's popularity

The departments' computers   James's paper

The department's computers   This algorithm is theirs

It's unfortunate that English has so many exceptions to its rules.

Punctuation ,

With adverbs or adverbial phrases used at the beginning of a sentence
Nevertheless, there is a need ...   In their absence, it is desirable ...

With adverbs or adverbial phrases used with a sentence
He, however, uses a different algorithm.

In a series of nouns and phrases
The department includes professors, lecturers, researchers, and support staff.   final comma
optional

Where a series of adjectives precedes a noun, it a matter of taste whether to use commas
A silly, verbose, pompous example

A commenting relative clause should be within commas, a defining one uses no commas.
Jones, who was here this morning, told me that ...   commenting
The man who was here this morning told me that ...   defining

Teenagers, who drive carelessly, should not be allowed to have a driving licence.   Note how commas
change the meaning!

Based on Sir Ernest Gowers *The Complete Plain Words*

Punctuation ,

1. **Commas for lists**
   ◦ The divide items in a list, and are not (necessarily) required before the and on the end, unless omitting the comma could introduce confusion
   ◦ In a list of adjectives you use a comma where an and would be appropriate – where the modifying words are all modifying the same thing to the same degree.

2. **Commas for joining**
   ◦ They are used when two complete sentences are joined together using a conjunction such as and, or, but, while and yet.

3. **Commas filling gaps**
   ◦ The comma implies some words have been omitted, e.g. the university bought three computers; the institute, one.

4. **Commas before direct speech**
   ◦ This is classical, and likely to die out soon.

5. **Commas setting off interjections**

6. **Commas that come in pairs**
   ◦ They are used for weak interruptions or pieces of additional information.
   ◦ The test is, does the sentence make sense if I omit the words between the commas.

Based on Lynne Truss Eats, Shoots & Leaves: The Zero Tolerance Approach to Punctuation

Example from Forbes.com on 16 February 2006

Garnett argues that Ingres' version of open source is better than MySQL's, because its code was built and updated by engineers inside an established corporation. "MySQL is not coming from the enterprise," says Garnett, "and with many open source products out there, it's unclear where the code came from. Our customers won't have to worry that they might get sued**,** because they're using software that was stolen."

Punctuation "

- "If you take hyphens seriously, you will surely go mad."
- When to use a hyphen
  - In a compound noun, e.g. hair-remover. If we add an adjective then we remove the hyphen it leaving it there could be misleading, e.g. superfluous hair remover
  - When you need to split a word. Then use the hyphen at the main break in the word, e.g. un-selfconscious is ok, unself-conscious is nonsense.
  - After a prefix to prevent the word being mistaken for another, e.g. re-form vs reform
  - In compound adjectives, e.g. a company-financed project
- When not to use a hyphen
  - There is no need to use a hyphen after –ly since the relationship is clear, e.g. carefully developed plan vs well-developed plan
  - Words which form parts of compound adjectives when they precede a noun may stand on their own two feet when performing another duty, e.g. a first-class compartment vs to travel first class.
- Avoid the practice of separating a pair of hyphenated words, leaving a hyphen in mid-air.
  - A hyphen's job is to join a word to its immediate neighbour

Punctuation . : ;

- **.** (full stop)
  - Denotes the end of a sentence.
  - Always use a full stop to separate two statements between which there is no true continuity of thought.
- **:** (colon)
  - Most commonly used to announce an explanation, a particularisation or a list.
  - Sometimes used to mark the antithesis between two statements.
- **;** (semicolon)
  - Used between two statements that are not close enough to use a conjunction and not far enough apart to warrant a full stop.
  - It may be used to separate phrases that contain their own comma.
  - It may be used to avoid dreary trailing participles.

Some Grammar Tips

Glossary

- **Grammar** refers to the rules and structure of language, the way words combine to form sentences. Example of a grammatical error: "He done gone."

- **Syntax** refers more specifically to the order of words within a sentence. Example of a syntactical error (as might be made by someone learning English as a second language): "I am here for the job to apply."

- **Usage** refers to the way words and phrases are used in writing and speaking. Often, a mistake is called a grammatical error when it's really an error of usage. Example of a usage error: the widespread misuse of *literally* when "*not* literally" is meant.

- **Style** refers to how something is expressed. Two writers might say the same thing in different ways. Neither is incorrect, but one style may be more suitable to the context than another. For instance, one could write either "the murky water" or, as Homer phrased the idea more poetically, "the wine-dark sea."

- **Rhetoric** refers to the use of language to achieve a goal, most often to persuade. Today, the word is often used pejoratively to describe bombastic or insincere verbiage, as in "The senator's speech was mere rhetoric." But the traditional meaning is valuable and should be preserved.

Source: Michael Masterson, author of the RFA newsletter

Grammar Tip – The Use of A, An, The

a = indefinite article (not a specific object, one of a number of the same objects) with consonants
She has a dog.   I work in a factory.

an = indefinite article (not a specific object, one of a number of the same objects) with vowels (a, e, i, o, u)
Can I have an apple?   She is an English teacher.

the = definite article (a specific object that both the person speaking and the listener know)
The car over there is fast.   The teacher is very good, isn't he?

The first time you speak of something use "a or an", the next time you repeat that object use "the".
I live in a house. The house is quite old and has four bedrooms.
I ate in a Chinese restaurant. The restaurant was very good.

DO NOT use an article with countries, states, counties or provinces, lakes and mountains except when the country is a collection of states such as "The United States".
He lives in Washington near Mount Rainier.   They live in northern British Columbia.

Use an article with bodies of water, oceans and seas.
My country borders on the Pacific Ocean

DO NOT use an article when you are speaking about things in general.
I like Russian tea.   She likes reading books.

DO NOT use an article when you are speaking about meals, places, and transport.
He has breakfast at home.   I go to university.   He comes work by taxi.

from esl.about.com

Which and That

- "On the whole it makes for smoothness of writing not to use the relative *which* where *that* would do as well, and not to use either if a sentence makes sense and runs pleasantly without." – Sir Ernest Gowers

- *That* cannot be used in a 'commenting' clause; the relative must be *which*. With a defining clause, either *which* or *that* is permissible.

This lemma should go in Section Three of the paper, which deals with theory.

      Commenting relative clause

The part of the paper that deals with theory is Section Three.

      Defining relative clause

Writer's Block

Writer's Block — Weak Strategies

- Trial and error
  - Working on phrasing in our head leads to rejecting the same phrases again and again
  - Jot down the variants and pick one
- Insisting on a perfect draft
  - A recipe for writer's block!
  - It is more efficient to go through several drafts focusing on different goals
- Waiting for inspiration
  - sometimes it works. Often we just sit there and get depressed
  - Try some of the powerful strategies to get some inspiration
- Words looking for an idea
  - Be wary of phrases like "due to the fact that" or "it is imperative that"
  - They give an illusion of progress, but it's easier to say something when you know what you want to say

Writer's Block — Powerful Strategies

Make notes as they occur to you
- Jot down ideas before you forget them!
- Use flow charts, diagrams, sketches, arrows, …

Freewriting
- Use this when you are stalled
- Write for 10 minutes without pausing
  - If you run out of things to write, write "blah, blah, blah, …"
  - If ideas away from your topic surface, write them too (they may be connected to the block!)

Brainstorming
- Decide on a topic and your goal for that topic
- Jot down ideas without censoring for usefulness or prose style

Piecework
- Once you know the rough outline of your article, start writing the section you know most about

- What I really mean is (WIRMI)
  - Use this phrase and then write down the idea the way you think it
  - Now you know what you need to rephrase!
- Satisficing (satisfy + suffice)
  - Take the first reasonable solution instead of searching for the perfect word or phrase
  - You can always revise afterwards

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