

## READING SCIENTIFIC LITERATURE: A GUIDE

### 1. Determine WHY you are reading this paper

Before you read the paper, consider what you want to get from. Is this essential background material? Are you most interested in the dataset or model setup? Do you want to apply the method to your research? Are the results important to compare to yours or a starting point for your research? This will help you to focus when reading the paper.

### 2. Skim the article and identify its structure

Most journals use a conventional IMRD structure: An abstract followed by Introduction, Methods, Results, and Discussion. Each of these sections normally contains easily recognized conventional features, and if you read with an anticipation of these features, you will read an article more quickly and comprehend more.

#### Features of Abstracts

Abstracts usually contain four kinds of information:

- purpose or rationale of study (why they did it)
- methodology (how they did it)
- results (what they found)
- conclusion (what it means)

Most scientists read the abstract first and note the four kinds of information outlined above.

#### Features of Introductions

Introductions serve two purposes: creating readers' interest in the subject and providing them with enough information to understand the article. Generally, introductions accomplish this by leading readers from broad information (what is known about the topic) to more specific information (what is not known) to a focal point (what question the authors asked and answered). Thus, authors describe previous work that led to current understanding of the topic (the broad) and then situate their work (the specific) within the field.

#### Features of Methods

The Methods section tells the reader what was done to answer the question stated in the Introduction. Methods are often difficult to read, especially for students, because of technical language and a level of detail sufficient for another trained scientist to repeat the experiments. However, you can more fully understand the design of the experiments and evaluate their validity by reading the Methods section carefully.

### Features of Results and Discussion

The Results section contains results—statements of what was found, and reference to the data shown in visuals (figures and tables). Normally, authors do not include information that would need to be referenced, such as comparison to others' results. Instead, that material is placed in the Discussion—placing the work in context of the broader field. The Discussion also functions to provide a clear answer to the question posed in the Introduction and to explain how the results support that conclusion.

### Atypical Structure

Some articles you read will deviate from the conventional content of IMRD sections. For instance, Letters to Nature appear to begin with an abstract, followed by the body of the article. Upon reading, however, you will see that the “abstract” is a summary of the work filled with extensive introduction (for the purpose of catching the attention of a wide audience), and the next paragraph begins a description of the experiments.

Therefore, when you begin to read an article for the first time, skim the article to analyze the document as a whole. Are the sections labeled with headings that identify the structure? If not, note what the structure is. Decide which sections contain the material most essential to your understanding of the article. Then decide the order in which you will read the sections.

### **3. Distinguish main points**

Because articles contain so much information, it may be difficult to distinguish the main points of an article from the subordinate points. When we first start reading papers we have the tendency to think every point is important and end up with a document that is covered in highlighter. Fortunately, there are many indicators of the author's main points:

Document level

- Title
- Abstract
- Keywords
- visuals (especially figure and table titles)
- first sentence or the last 1-2 sentences of the Introduction

Paragraph level: words or phrases to look for

- in contrast with previous work
- has seldom been addressed
- surprising
- unexpected
- we hypothesize that
- we develop
- we propose

- the data suggest
- we introduce

#### **4. Generate questions and be aware of your understanding**

Reading is an active task. Before and during your reading, ask yourself these questions:

- Who are these authors? What journal is this? Might I question the credibility of the work?
- Have I taken the time to understand all the terminology?
- Have I gone back to read an article or review that would help me understand this work better?
- Am I spending too much time reading the less important parts of this article?
- Is there someone I can talk to about confusing parts of this article?

After reading, ask yourself these questions:

- What specific problem does this research address? Why is it important?
- Is the method used a good one? The best one?
- What are the specific findings? Am I able to summarize them in one or two sentences?
- Are the findings supported by persuasive evidence?
- Is there an alternative interpretation of the data that the author did not address?
- How are the findings unique/new/unusual or supportive of other work in the field?
- How do these results relate to the work I'm interested in? To other work I've read about?
- What are some of the specific applications of the ideas presented here? What are some further experiments that would answer remaining questions?

#### **5. What do you do when there is something you don't understand?**

You will not understand everything in every paper. Realize that some papers are the result of years of work by dozens of scientists. Expecting to digest and understand everything in it in one afternoon is a far-fetched idea! Remember - science is about asking questions and finding answers. Some tips when you don't understand parts of a paper:

- \* Jot down what you don't understand as you read
- \* Sometimes, you can just read through a paper and any terms you're not familiar with will become clearer by the end.
- \* If it is very heavy going, then stopping and seeking additional information is usually the way to go. Google search words, jargon, themes, methods. Be careful about going down a rabbit hole that is not relevant to your purpose (see Section 1).
- \* Often you may need to read an article multiple times.
- \* Ask your mentor or advisor for help
- \* It depends on how much the non-understandable bits prevent me from following the main ideas. Do you really need to understand this part for your purpose (see Section 1)?
- \* Remember: confusion is not a threat; it is an opportunity!
- \* Break it down into chunks and read it over the course of a few days.

## 6. Draw inferences

Not everything that you learn from an article is stated explicitly. As you read, rely on your prior knowledge and world experience, as well as the background provided in the article, to draw inferences from the material. Research has shown that readers who actively draw inferences are better able to understand and recall information.

As an example, in the box below is an excerpt from the Introduction of an article in *Climate Dynamics* (Hunt 2015). The comments in italics are questions and inferences that might be drawn by a reader.

Megadroughts in the USA are a recurring feature of its climatology (Woodhouse and Overpeck 1998). *Comment: what is a megadrought? do they happen in other parts of the world?* They report that a decadal length drought occurred about every 500 years. *Comment: does this vary in different parts of the USA? What else happens every 500 years?* Systematic studies of the causes of such droughts have been made using atmospheric climatic models forced with observed sea surface temperature (SST) anomalies. *Comment: Forcing models in this way means there is no feedback with the ocean, is this important for drought? Is it only SST that causes megadroughts?* Thus, Schubert et al. (2004a, b) were able to replicate the major features of the famous Dust Bowl region drought, 1932 to 1939. *Comment: what about other droughts, can they replicate them?* They conducted a number of idealised experiments which identified that tropical (primarily ENSO-related) SST anomalies were the principal cause of this Dust Bowl megadrought. *Comment: Would this be true for other megadroughts in other parts of the USA or world? How does SST that varies every 2-6 years produce a decade long drought?* Seager et al. (2005) similarly used an atmospheric model to investigate the causes of North American droughts between 1856 and 2000. *Comment: But earlier you said that a decadal length drought occurred about every 500 years? Is this a long enough period to examine?* They also noted the dominance of tropical Pacific SST anomalies associated with La Niña events in generating such droughts, but also found that SST variations outside of the tropical Pacific Ocean strengthened such droughts. *Comment: How do these SST drive droughts, why is the tropical pacific the most important region, does it vary across the USA? What deficiencies exist in the models that could impact the results?*

## 7. Take notes as you read

Effective readers take notes—it improves recall and comprehension. You may think you'll remember everything you read in researching class assignments, professional papers, proposals, or your thesis, but details will slip away. Develop a template for recording notes on articles you read, or adapt the attached template for use. As you accumulate a large collection of articles, this template will help you distinguish articles and quickly locate the correct reference for your own writing. The time spent filling out the form will save you hours of rereading when you write a Background, Related Work, or a Literature Review section.

## **8. What to do next?**

After you have completed your research article summary a useful next step can be reading some of the articles cited in the paper, if you have not already read them. Whilst it is important to read and understand the most current literature, a historical perspective is also essential. Also, check what papers have cited this article - they may have progressed the research further and answer some of the questions you had when reading the paper.

You should regularly be checking the “early online releases” or “papers in press” to see the newest and most cutting edge research that is being published.

**Template for Taking Notes on Research Articles: Easy access for later use**

Whenever you read an article, book chapter, or research on the web, use the following format (or something similar) to make an electronic record of your notes for later easy access. Put quotation marks around any exact wording you write down so that you can avoid accidental plagiarism.

**Complete citation.** Author(s), Date of publication, Title (book or article), Journal, Volume #, Issue #, pages:

**If web access:** url; date accessed:

**Key Words:**

**General subject:**

**Specific subject:**

**Hypothesis/Outstanding problem to solve:**

**Methodology:**

**Result(s):**

**Summary of key points:**

**Context** (how this article relates to other work in the field; how it ties in with key issues and findings by others, including yourself):

**Significance** (to the field; in relation to your own work):

**Important Figures and/or Tables** (brief description; page number):



**1. SKIM**

Get the “big picture” by reading the title, key words and abstract carefully; this will tell you the major findings and why they matter

- Quickly scan the article without taking notes; focus on headings and subheadings
- Note the publishing date; current research is more relevant
- Note any terms and parts you don't understand for further reading

**2. RE-READ**

Read the article again, asking yourself questions such as:

- What problem is the study trying to solve?
- Are the findings well supported by evidence? Were assumptions made?
- Are the findings unique and supported by other work in the field?
- Is the study repeatable?
- What factors might affect the results?
- What questions are still unanswered? What were the limitations?
- Draw influences based on your own experience and knowledge.

If you are unfamiliar with key concepts, look for them in the literature

**3. INTERPRET**

- Examine figures and tables carefully
- Try to interpret data first before looking at captions
- When reading the discussion and results, look for key issues and new findings
- Make sure you have distinguished the main points. If not, go over the text again.

**4. SUMMARISE**

- Take notes on the key findings, methods and issues; it improves reading comprehension, helps you remember key points and prepares you for thesis/dissertation/paper writing
- If you have a printed version, highlight key point and write on the article. If it's on screen, make use of markers and comments. Do this AFTER reading and interpreting the article.