How to Read a Scientific Article

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Reading a scientific article is a complex task. The *worst* way to approach this task is to treat it like the reading of a textbook—reading from title to literature cited, digesting every word along the way without any reflection or criticism. Rather, you should begin by skimming the article to identify its structure and features. As you read, look for the author's main points. Generate questions before, during, and after reading. Draw inferences based on your own experiences and knowledge. And to really improve understanding and recall, take notes as you read. This handout discusses each of these strategies in more detail.

1. 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. Others—especially experts in the field—skip right from the title to the visuals because the visuals, in many cases, tell the reader what kinds of experiments were done and what results were obtained. You should probably begin reading a paper by reading the abstract carefully and noting the four kinds of information outlined above. Then move first to the visuals and then to the rest of the paper.

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 experiments were done to answer the question stated in the Introduction. Methods are often difficult to read, especially for graduate 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.

2. 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*. 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

- *surprising*
- *unexpected*
- *in contrast with previous work*
- *has seldom been addressed*

- *we hypothesize that*
- *we propose*
- *we introduce*
- *we develop*
- *the data suggest*

3. 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?

4. 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 the journal *Biochemistry (Ballestar et al., 2000).* The comments in italics are questions and inferences that might be drawn by a student reader.

Rett Syndrome is a childhood neurodevelopmental disorder and one of the most common causes of mental retardation in females *Comment: Hmmm...must be related to a gene on the X-chromosome*, with an incidence of 1 in 10000-15000. *Comment: How common is that? Not too likely to happen to me, but there must be several such children born in Houston every year.* Rett syndrome patients are characterized by a period of normal growth and development (6-18 months) followed by regression with loss of speech and purposeful hand use. *Comment: What happens? Something must be triggered or activated at late infancy.* Patients also develop seizures, autism, and ataxia. After initial

Some specific suggestions:

Phase I: Screening the article

1) Read the title once fast looking for key words. Read the title slowly until it makes sense.

2) Look through the authors to see if there is anyone whose name you recognize, whose work you know. This is an important process in trying to judge the quality of the data.

3) Look at the date. In molecular biology, where information is rapidly changing, the date may be all-important. With policy issues, the date is less important than the quality of thought. Bear in mind that there is a definite lag period between when the research gets done, when the article gets written and when it gets published. In addition to the publication date, many journals list the date when the article was received, and the date when the article was accepted. Interestingly, journals that are refereed (see below) are more likely to be delayed in their publication, but are less likely to contain inaccurate or frivolous articles.

4) Some articles have a brief list of key words. Although they are sometimes misleading (as anyone who has done a computer reference search knows) they are usually quite informative and should be looked at early on.

Phase II: Getting the punch line.

1) Read the abstract once fast looking for key words. Read the abstract slowly until it makes sense.

2) Read introduction. The introduction is often the easiest part of an article to read. In some cases, it is also the most informative - not so much in terms of presenting new information, but in consolidating background information. Some authors will also present the punch line of their research in a way that is easier to understand than the way it is presented in the abstract.

3) The introduction will often cite many of the references. This is an excellent time to begin looking at them. The references are particularly informative if they contain the titles of the articles being cited. You will want to go back to the reference page over and over again.

Phase III: Understanding the approach

1) Peruse the figures and tables. You will not understand them this first time through but this will help you know what to look for when you actually read the article.

2) Go to the discussion. Read the first few paragraphs and the last few paragraphs. If it is short and/or easy to understand, read the whole thing.

Phase IV: First reading

1) If you get this far you may wish to photocopy the article if you have not already done so. The monetary investment will surely be trivial in comparison to the investment of your time.

2) Skim the abstract and the introduction once again. At this point you should be able to have an adequate understanding of them.

3) Skim the methods section. The methods section will need to be studied carefully only if you intend to use some of the procedures in your research.

Certain parts of the methods, such as where the chemicals were purchased or whence the viral strains were obtained do not actually contribute to an understanding of the article and may be safely omitted. Other parts of the methods may remain obscure even after the rest of the article is fairly clear. For our purposes, the methods should be studied only in so far as they contribute to the understanding of the rest of article.

4) Read the results section.

5) Read the discussion.

6) Study the figures and tables.

Phase V: Increasing understanding

1) Reread the article in its entirety. You may wish to read several times.

2) Be sure to write on the article. Circle words you do not know. Check important points. Question things you do not understand or that do not appear to make sense. X-off things that are wrong. Jot down further ideas or questions.

3) Consult the references. Look up points that were not fully explained.

Consult textbook to clarify points of general biology. Look up words that are unfamiliar.

4) Before leaving the article, reread the abstract once again.