How to Read a Journal Article

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As you may have noticed, scientific publications have quite a different style than many other forms of writing. (Of course, it too has evolved over the years, and reading old articles from the '20s and '30s can be quite entertaining as well as educational.) As the primary focus is on relaying information, it is essential that the text describing that information be succinct, precise, and unambiguous — ideally, the authors will describe their data and methods well enough that someone else with the same data would be able to repeat their procedure (since repeatibility is one of the hallmarks of science). But at the same time, the reader must be able to a) read the paper without falling asleep or getting frustrated, and b) understand why the work was important to do and then write about in the first place. So a good publication will also have a decent amount of background information explaining where their project fits into the grand scheme of things and why it's critical to the field — it will "sell" the work.

Perhaps counter-intuitively, the best way to read a scientific journal article is *NOT* to sit and read from start to finish. The following will guide you through efficiently reading an article to get the most out of it without falling asleep.

Abstract

This small section is the first part of the paper and is usually only 1–2 paragraphs with at most a few hundred words. The point of the abstract is to catch the reader's attention, succinctly summarize what was done, and "give away the punch line" by stating the main conclusion of the paper right up front. This style is more useful to the reader and lets him/her know whether to invest their time reading more.

Questions you want to ask yourself after reading the abstract are:

1. What question or problem was the driving force behind the study?
2. What was the paper's main conclusion?
3. What are the "big picture " implications of the paper and how do the conclusions impact my project?
4. Is this paper related to my research? If so, how?

Introduction

After the abstract, the next important thing to read is the introduction. Here is where the authors will "set up" the problem — why their general area of research is important; what has previously been done in the field that they're building on, testing, or contradicting; new technologies or techniques that have changed the field; and why/how their particular project is well-suited to address the matter at hand. There will be several references to other papers here — this is the authors' main chance to give credit to relevant previous work and to tell the reader where to go look for a more in-depth coverage of facts/studies there aren't room for in this paper. Often (but not always) the introduction will end with a short outline of how the paper is laid out, so the reader knows what to expect. After reading this section, the reader should be able see how the paper is contributing to their field of study.

Questions you want to ask yourself after reading the introduction are:

1. What is the context of the paper? (I.e., what is the larger puzzle to which this "puzzle piece" paper belongs?)
2. Have previous studies of this problem been contradictory in the past?
3. Is this paper adding something completely new to the story?
4. Where in the paper should I look if I am only interested in the authors' *fill-in-the-blank* (e.g., model parameters, final speculations)?

Figures

Now, let's mix things up a bit. Remember — on the first time reading a paper, what we usually want is a quick overview of the results, followed by an explanation of those results and what they mean for us, the readers. So we're going to largely skip the sections dealing with data, simulation parameters, or instrument hardware for now, since we're not ready to get mired in details just yet. Thus, instead of diving right into the text, one of the best things to do next is look at all of the figures in order and read the captions. In a good paper, the figures will summarize all the important steps in the authors' investigation *and* present the results in sufficient detail for the reader to understand the paper's "story" without actually reading all of the text.
Some common figures seen in well-organized, informative papers are

- a figure or two showing the raw data or a visualization of the simulation (whether in the form of images, spectra, survey results, etc) — these just give the reader an idea of where the authors are starting from;
- one to several figures showing the data or results through various stages of processing — plots of information extracted directly from the models or raw data, various types of extracted information plotted against each other, and graphs/maps/charts of extrapolations made from the first-level results;
- comparison of results to previous studies' data, showing similarities or differences; and
- diagrams, plots, or maps showing the results' place in the "big picture" question set up in the introduction.

(Note that not all of these figure categories are relevant to all papers — for instance, some short papers may only have room to illustrate the results, simulation papers won't have raw data, and observation-based papers won't go into detail on the instruments used.)

Questions you want to ask yourself after reading the figures are:

1. What aspect of the project is Figure X related to? (data reduction, exploration of model parameter space, results, etc.)
2. Why did the authors include Figure X? (They obviously thought it was important.)
3. Do I understand what Figure X is all about? (If "no", you might consider finding the references to the figure in the text.)

Discussion/Conclusions

Now that we've skimmed the figures, it's often most helpful to read the authors' interpretation and conclusions. These are the sections where the authors go beyond "This is what the data say" to "This is what the data mean" (note that "data" is always a plural noun!). They will interpret correlations (e.g., "What does it say about physics, etc, that these two characteristics are proportional?") and propose and evaluate possible scenarios for things being they way they are. They may pull in data and results from other studies to back up their findings or show where there is an inconsistency that needs further investigation. These sections generally have more explanation of the "interpretations" than those found in the abstract. For example, they might recap interpretations of the results that were considered but ultimately rejected — something generally not seen in an abstract (unless the rejected interpretation had been widely accepted). In short, this is their chance to demonstrate what they claimed in the introduction — namely, that their results are important and worth paying attention to. Sometimes the discussion will be labeled *Analysis* or *Interpretations*, and it's the authors' preference to give it its own section or group it with the conclusions.

The conclusions often contain a summary of the procedure and results, a final sum-up of the interpretation(s), and possibly some more speculative guesses or predictions that the authors want to express but not tie themselves too strongly to without "further study." If they are separate from the discussion, it may actually be useful to read them first. These sections are where a lot of the forward motion of science comes from.

Questions you want to ask yourself after reading the conclusion/discussion are:

1. Are the results what one expected, based on past similar studies/predictions/prevailing wisdom?

2. Do the results make any explicit, testable predictions for future studies?

3. If contradictory to previous works, how can the new results be reconciled with the old?

4. Are there any implications of the results that currently cannot be satisfactorily explained?

5. What new studies or projects could help make the bigger picture clearer?

6. Do their results have any direct implications to my own work?

Other Sections

But wait, we skipped a third of the paper!...

Congratulations! You've finished a first reading of a scientific publication. (You've actually done as much as most people who read this paper will do.) By now, you should have potentially gotten a sense of "the point" of the paper four times (abstract, introduction, figures, and conclusions) despite the fact that you have not yet read the whole paper.

Now, if you want, it is time to go back and read the data collection, simulation parameters, or detailed analysis sections. This aspect of the reading is necessary if you want to be able to repeat what the authors did, or if you suspect they missed an important step in the analysis that, if done properly, would make their interesting results change or go away completely (or, of course, if you are simply interested in how they did it!). We will not go into a detailed guide on how to read these sections, simply because we cannot do it without making this a significantly more complex document — every paper will be slightly different, due to the type of paper (theory, observation, instrumentation, review) and the authors' personal style. Some general advice is to read slowly and carefully, make sure you understand *why* the authors did each step, make sure you understand any equation or approximation before adopting it for your own work, and don't hesitate to look up the studies they cite along the way — often, if a method is taken from another work, all the details necessary to understand that method will not be included, for brevity's sake.

The final section is a short paragraph or two acknowledging help from colleagues and funding agencies, and then the list of references used in the paper. You can skip both of these sections now, though of course the references list is essential if you need to look something up.