

Tips on Reading a Scientific Paper

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A scientific paper is a specialized document whose purpose is to present some empirical evidence in favor of or against some hypothesis. Scientific papers often describe the methods and results of one or more experiments conducted by the author(s), and then spell out some of the possible theoretical implications of these experiments. Scientific papers follow specific genre conventions, and the ability to read, understand, and make use of them is a specialized skill. The purpose of this document is to give some beginning tips for how to begin developing this skill.

A Note on Non-Linear Reading

Normally when you read something—whether it is a novel or a piece of nonfiction—you read it in order, from start to finish. After all, the author has organized the text in that way for a reason. Reading it in the order they intended is part of how they intended you to experience their art. It would spoil many texts to read the end before the rest, and even if it would not give away any important surprises, it would normally make the reading experience more confusing and less enjoyable to read a text out of order.

An important part of what makes scientific papers distinctive is that they aren't like this. Your goal in reading a scientific paper is not to follow the a story or to have the aesthetic experience that the author intended. Rather, your goal is to efficiently extract a clear understanding of the paper's scientific upshots: the experiments it describes, the methods used, the results, their theoretical implications, and perhaps also their shortcomings. The best way to do this is usually not to just read the paper from start to finish a single time.

¹ This piece is heavily indebted to “Reading a scientific paper,” by Ann Nordmeyer & Michael C. Frank, which is available here: https://docs.google.com/document/d/12wim-iquugb-XoLepIG3RPNIfccDKxl_Z_3DvuttVPY/edit. This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/).

Rather, it is usually better to read through the paper multiple times in succession, each time with a somewhat different goal in mind. In order to “read like a scientist,” you would have to practice this reading method enough so that you can do it fast. This would allow you to absorb large amounts of information from the scientific literature quickly and efficiently. However, as a beginner, it is a good idea to take things more slowly at first

First Pass: Extract three key pieces of information

When you first look at a scientific paper, a good first thing to do is to do a quick first pass of the paper in order to answer these three questions:

1. What is the main question that the paper is trying to answer?
2. What is the paper’s main thesis? In other words: What is the authors’ answer to their main question?
3. How does the evidence presented in the paper support its main claim?

The most concise answers to these questions (at least, to the first two) will often (but not always) be in the paper’s abstract and conclusion, and so those would be good first things to read. However, you’ll probably need to look through the other sections in order to find proper answers, especially for the third question. For example, if the paper has “discussion” and “results” sections, you’ll want to at least skim those in search of your answers.

At the end of your first pass, you probably won’t be in a position to assess the strength of the authors’ evidence, or to explain the details of how their experiments worked. But you should be able to give clear and concise answers to these three questions. These are the major pieces of information you take away from the article. They are what you would summarize in a review, or recount to another person who wants to know about the paper.

Exercise 1: Answer the three questions

After doing a first-pass reading of a scientific paper, write down each of the three questions above, in one sentence each, without looking at the paper.

Are you happy with your answers? Which parts of your answers are you not confident about?

Exercise 2: Try again

Take five minutes to look again at the paper, now with the goal of improving your three answers. The purpose of this exercise is to hone your instinct for efficiently finding and extracting the information that you're looking for in a paper.

Exercise 3: Find the authors' own answers

For each of your three answers, find a single sentence in the paper that best matches what you said.

Exercise 4: Find the key data

Find the plot or data you'd point to in order to convey the primary finding of the paper. How would you describe this plot/data in a single sentence?

Second Pass: Assessing the Experiment

At this point, you have extracted the central question, claim, and data from the paper. Now it is time to give the paper a second, more in-depth reading, this time with the goal of understanding the experiment(s) well enough that you can assess them.

One part of your goal in the second pass is to make sure that you understand how the experiment actually worked. If the experiment was conducted on human subjects, you should make sure that you understand the details of the experiment well enough that you can imagine what it was like to be a subject in it. In particular, for controlled-trial experiments, it is important that you understand the difference between what it was like for subjects in the experimental conditions versus the control conditions. (The experimental condition is the version of an experiment in which the main stimulus is being tested. The control condition is the version that is the same in every other way, but in which the main stimulus is not present. The control condition is used to establish a baseline with which to measure the effects of the stimulus. Not all experiments have a control condition, but it's important to recognize when they do.)

Another goal of your second-pass reading is to begin to think critically about how well the paper's data supports its main claim. You should be able to

explain what the authors take to be the link between their data and their main claim. And you should be able to brainstorm some possible alternative explanations of their data. An alternative explanation is a way that the data could have been observed even if the paper's main claim is false. Note that there are always alternative explanations of any data, and this alone doesn't show that a paper hasn't been successful. Rather, a successful experiment is one that makes the paper's claim more likely than the various alternative explanations that would count as answers to its main question. In order to understand and assess a scientific paper, then, you have to be aware of which alternative explanations are available.

Exercise 5: Imagine being a subject

Put down the paper. Take 3 minutes to write a few lines about what was it like to be in an individual trial in the experiment. (Describe this in the second person, e.g. "you hear a sentence.") If there were multiple experimental conditions, or if there were control conditions, how was the experience different depending on which condition a subject was in?

Exercise 6: Alternative explanations

Write out an alternative explanation for the authors' data. If this alternative explanation were true, how would this affect the plausibility of the paper's main claim? Did the authors do anything to rule out this alternative explanation? If so, what did they do? Is the explanation as likely as the authors' explanation?



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