How to read and understand a scientific article

Dr. Jennifer Raff

To form a truly educated opinion on a scientific subject, you need to become familiar with current research in that field. And to be able to distinguish between good and bad interpretations of research, you have to be willing and able to read the primary research literature for yourself. Reading and understanding research papers is a skill that every single doctor and scientist has had to learn during graduate school. You can learn it too, but like any skill it takes patience and practice.

Reading a scientific paper is a completely different process from reading an article about science in a blog or newspaper. Not only do you read the sections in a different order than they're presented, but you also have to take notes, read it multiple times, and probably go look up other papers in order to understand some of the details. Reading a single paper may take you a very long time at first, but be patient with yourself. The process will go much faster as you gain experience.

The type of scientific paper I'm discussing here is referred to as a primary research article. It's a peer-reviewed report of new research on a specific question (or questions). Most articles will be divided into the following sections: abstract, introduction, methods, results, and conclusions/interpretations/discussion.

Before you begin reading, take note of the authors and their institutional affiliations. Some institutions (e.g. University of Texas) are well-respected; others (e.g. the Discovery Institute) may appear to be legitimate research institutions but are actually agenda-driven. *Tip: google "Discovery Institute" to see why you don't want to use it as a scientific authority on evolutionary theory.*

Also take note of the journal in which it's published. Be cautious of articles from questionable journals, or sites that might resemble peer-reviewed scientific journals but aren't (e.g. Natural News).

Step-by-Step Instructions for Reading a Primary Research Article

1. Begin by reading the introduction, not the abstract.
The abstract is that dense first paragraph at the very beginning of a paper. In fact, that's often the *only* part of a paper that many non-scientists read when they're trying to build a scientific argument. (This is a terrible practice. Don't do it.) I always read the abstract last, because it contains a succinct summary of the entire paper, and I'm concerned about inadvertently becoming biased by the authors' interpretation of the results.

2. Identify the *big* question.
Not "What is this paper about?" but "What problem is this entire field trying to solve?" This helps you focus on why this research is being done. Look closely for evidence of agenda-motivated research.

3. Summarize the background in five sentences or less.
What work has been done before in this field to answer the big question? What are the limitations of that work? What, according to the authors, needs to be done next? You need to be able to succinctly explain why this research has been done in order to understand it.

4. Identify the *specific* question(s).
What exactly are the authors trying to answer with their research? There may be multiple questions, or just one. Write them down. If it's the kind of research that tests one or more null hypotheses, identify it/them.

5. Identify the approach.
What are the authors going to do to answer the specific question(s)?

6. Read the methods section.
Draw a diagram for each experiment, showing exactly what the authors did. Include as much detail as you need to fully understand the work.

7. Read the results section.
Write one or more paragraphs to summarize the results for each experiment, each figure, and each table. Don't yet try to decide what the results *mean*; just write down what they *are*. You'll often find that results are summarized in the figures and tables. Pay careful attention to them! You may also need to go to supplementary online information files to find some of the results. Also pay attention to:

- The words "significant" and "non-significant." These have precise statistical meanings.
- Graphs. Do they have error bars on them? For certain types of studies, a lack of confidence intervals is a major red flag.
- The sample size. Has the study been conducted on 10 people, or 10,000 people? For some research purposes a sample size of 10 is sufficient, but for most studies larger is better.

8. Determine whether the results answer the specific question(s).
What do you think they mean? Don't move on until you have thought about this. It's OK to change your mind in light of the authors' interpretation -- in fact, you probably will if you're still a beginner at this kind of analysis -- but it's a really good habit to start forming your own interpretations before you read those of others.

9. Read the conclusion/discussion/interpretation section.
What do the authors think the results mean? Do you agree with them? Can you come up with any alternative way of interpreting them? Do the authors identify any weaknesses in their own study? Do you see any that the authors missed? (Don't assume they're infallible!) What do they propose to do as a next step? Do you agree with that?

10. Go back to the beginning and read the abstract.

Does it match what the authors said in the paper? Does it fit with your interpretation of the paper?

11. Find out what other researchers say about the paper.
Who are the (acknowledged or self-proclaimed) experts in this particular field? Do they have criticisms of the study that you haven't thought of, or do they generally support it? Don't neglect to do this! Here's a place where I do recommend you use Google! But do it last, so you are better prepared to think critically about what other people say.

A full-length version of this article originally appeared on the author's personal blog (www.violentmetaphors.com). She gratefully acknowledges Professors José Bonner (Indiana University) and Bill Saxton (UC Santa Cruz) for teaching her how to read scientific papers using this method.