(Getting the most out of) Reading a scientific paper

Why do any of us in the scientific community write and read papers? A research article (or report) is the "legal tender" of scientific knowledge – it is the currency in which we have agreed to deal, to share our findings, and to communicate with each other. If a group of researchers makes a discovery that, in their opinion, adds to the universe of understanding and knowledge around that topic, then they write up the story of their discovery in the form of a research article (an introduction, methods employed, materials used, results of specific experiments done, interpretation of those results and a conclusion) that is then submitted to the editorial staff of an appropriate journal.

The editors send it out for "peer review" – to other scientists working in the field who (almost always as an act of professional service) review the article, make criticisms and suggestions, (frequently) ask for a set of revisions, sometimes ask for additional experiments to be done as a condition of acceptance, or even more frequently simply reject it as not of sufficient quality or interest to their journal's readers. The resubmission-revision cycles continue until the paper is accepted (by this time, additional experiments may have been done, the story may have shifted, the writing has been revised multiple times) and published in a journal. At this point, other researchers may access the study and use it to inspire or refine their own experiments, to learn about something new, or sometimes to include in their "review" of a field i.e. their attempt to get a sense of the big picture of understanding in a certain field.

This brings us to the second kind of article you will typically encounter – the review article. This is not a first-hand report of someone's research findings. Instead, it summarizes and synthesizes (often with implicit and/or explicit critique included) mostly dozens (or, more rarely, hundreds) of research articles and attempts to build a larger meta-narrative based on the sum of individual stories of discovery.

You will read many primary research reports and review articles in this course. Review articles are not too different from a highly detailed textbook chapter, though it is usually more technical. Similar to a good reference text, it leads you to sources (primary research reports) that are summarized and cited in the body of the review.

When you are looking up these papers on Pubmed (which should always be your first stop on a search for biomedical literature of any kind), you will find an abstract. "Abstract" literally means to "draw from" or "separate" and the authors do just that – package the punchline of the lengthy story into a short, handy synopsis of their story. What you find in an abstract is a summary of the story that can be used to determine whether a paper will be useful to you to read, whether you might flag it as something interesting for you to check out later or, on the other hand put aside as not quite what you are interested in reading about. An abstract alone should never be used as the basis for the mention and citation of a paper in your writing. You simply do not know whether you will agree with the conclusion that the authors came to, and don't have sufficient details of the particular experimental context of the findings they report to be able to cite their study fairly and appropriately.

To use or cite a paper, you must read the paper with a strong focus on

1. the question(s) asked
2. experimental design and methods used
3. the results (and interpretations of them) that are actually supported by the data presented

The approach and guidelines were originally developed by Devavani Chatterjea in collaboration with Dr. David Matthes in 2006-2007 and have been adapted by Elena Tonc.

When delving into a paper, you can avoid the abstract and discussion sections until you've completed your reading of the other sections. These two sections represent the interpretations and conclusions of the authors and should be referred to only after you have formed your own understanding of the study in question. This is a "data-first" approach and one fun way to practice this is to sometimes look only at the figures and methods to figure out what the study was about (we will do this in class together at least once).

Usually, though, to appreciate and most effectively understand/critique a study, we need some context. The introduction of a paper offers this but in a very compact paragraph or two that can be difficult to unpack. In this class, I will offer you a review article together with each assigned paper. If you are reading a paper you have found or been assigned and it is in an area you are not too familiar with, you must find a review article or two on your own that fills you in on the context. Try finding one very recent one (published in the last year or two) and one from 10+ years ago; reading the two side-by-side can give you a sense of movement/direction within the field.

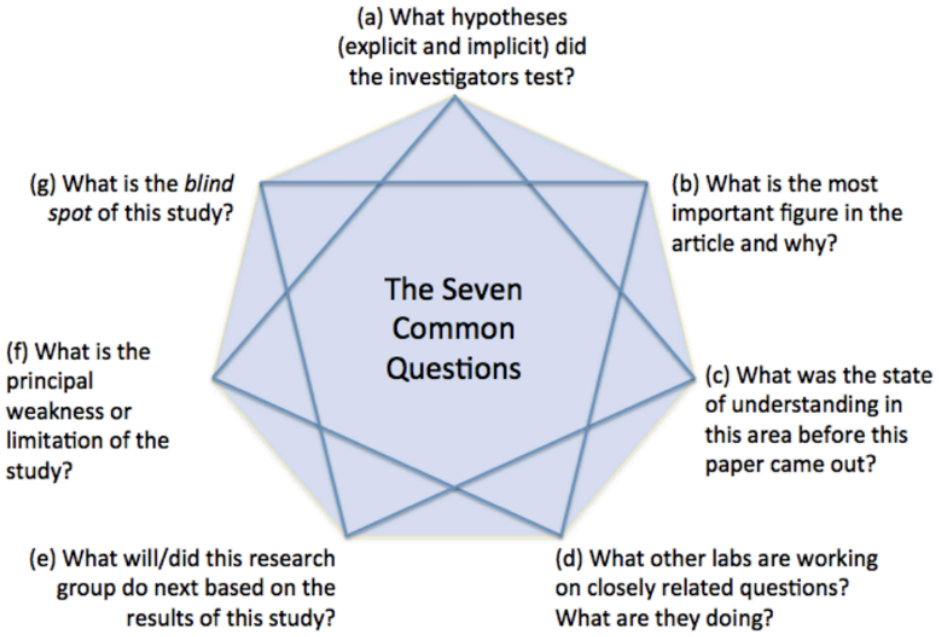
Probably the most important skills you will need to effectively read primary research papers and review articles in an area you are not familiar with are:

1. **Acknowledging** that you will come upon hitherto unknown terms, techniques and concepts with astonishing frequency

2. **Looking up** these terms before moving on with the rest of the article – use Google, Wikipedia, other articles, textbooks (print or online)

3. **Annotating** the article with a brief definition or explanation/visual cue so that when you read it again, you will have the information handy (you may want to print out papers single-sided so that you have space to make notes and write down definitions

As you read the paper, it is useful to have a frame of inquiry (specific questions) that you use to guide your reading. Following are seven questions that provide such a framework. One effective way to use them is to write down answers to these questions as you read. You will find that thinking through these questions in order will help you complete the reading response, preparation for facilitation, as well as your preparation for class discussion. The pre-class reading responses that you will complete most weeks were created based on these seven fundamental questions.



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In order to answer (b) you will need to tackle the figures in the paper - either pictorial representations of numerical data (in the form of line/bar graphs, scatter or intensity plits etc.) or images of cells/organs/organisms. For each figure, I recommend that you challenge yourself to "read" the figure from left to right/top to bottom as you would a piece of text, that is you don't leave any "real estate" in the figure that you have not thoroughly explored. I have found it useful to use the following as framing questions for each image:

1. What was measured?
2. For example, what does each axes on a graph depict?
3. What methods were used to obtain these measurements?
4. What do these measurements tell us? What is the "story" of this figure?

Finally, last but not least, the important eighth set of questions – what questions do you have after reading the paper? Is there information that would have helped you better understand this paper? Did you look for this information and not find it? Where did you look? Is there something you found but really could not understand? What specifically tripped you up? Is there a burning question, concern, disagreement, wild whoop of enthusiasm you find in yourself after you read this paper? How might you communicate that?

I hope that these general strategies and specific questions will help you get the most out of each paper you read as well as prepare yourself to lead or participate in a vibrant and productive discussion of the paper in class. Good luck!

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