DATA Nuggets

How to Read a Scientific Paper

As your scientific career begins to blossom, you will need to incorporate an understanding of the scientific literature into your lab report. Academic sources are considered to be reputable because they go through an extensive peer-review process to determine whether there is scientific merit and proper methodology to support the claims of the study. Wikipedia does not have this extensive process, which is why it is not acceptable to cite this source in your lab reports.

A scientific paper is ranked in importance based on the number of times it is cited, meaning how many other papers reference it within their own text. Papers that are cited hundreds of times are considered to be foundational papers in the field. Papers that are cited only once or twice will tend to be very specific or were published recently. You may need to rely on both foundational papers and more recent works to write a lab report.

Understanding Articles

It can be really intimidating to read primary literature. Scientists like to use a lot of jargon that is specific to their field and bring up theories you may not be familiar with. But, once you slow down and take the time to really dig into the article, you can find a lot of useful information and inspiration as well as additional relevant papers to read. When you really concentrate on an article, it should take you at least an hour to read. Think of each journal article as a textbook chapter. Even though an article may be only 12 pages long, it will have a lot of information to sort through.

When I read a journal article, I keep a notebook close by to write down my thoughts, define terms, and record key findings. This way I have a record of papers I've read and I can quickly go back and find out what that paper was about. Here is my methodology for reading a journal article.

Going Through a Scientific Paper

Abstract

Articles include an abstract for a reason. Abstracts give a quick overview of the paper's topic, methods, and findings. However, it is not a great idea to solely read abstracts in place of the entire paper. You'll find more information, and gain a better understanding of how scientists think and convey their findings, by reading the entire paper. Besides, if you never practice reading articles, it will never get easier.

> **Question 1:** While reading the abstract, see if you can determine what the author's hypothesis/hypotheses are.
> **Question 2:** Identify the general findings. These are important to keep in mind as you delve into the paper.

Introduction

The introduction of the paper should have an overview of the general principles, hypotheses, or theories, tested in the study. It should also explain why they are using the particular organism or system of study. Lastly, it should include the hypotheses tested.

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In addition to introducing key concepts to frame the rest of the paper, the introduction will have lots of terminology used throughout the article. If there are any terms you do not understand, look them up now as you will probably see them again. It will save you lots of strife and increase your vocabulary.

The introduction is also a great place to find additional sources. Because introductions introduce key theories and study systems, they can be great resources for finding both more general and more specific information.

> **Question 3:** While reading the introduction, identify general theory explanations, study systems, hypotheses and/or predictions.
> **Question 4:** Define any terms you do not already know.
> **Question 5:** Highlight two additional sources you would look up for more information.

Methods

The methods section should cover locations, dates, details of experimental design, and statistical analyses used. Scientific studies generally fall into two camps: observational or manipulative studies. Observational studies do not manipulate any variables; they rely on existing natural variation to find relationships between variables. Experimental studies use controlled manipulations to determine relationships between the independent and dependent variables. The methods section will also outline statistical analyses used to determine these relationships. Do not be scared by the statistics! Just realize that these are tests the author uses to find whether the relationship between the independent and dependent variable is statistically real or if it is a function of random chance.

> **Question 6:** Highlight where and when the experiment was conducted.
> **Question 7:** Determine the type of study. Is it observational or manipulative? Does this determine the experimental design used?

Results

The results section is what you have been waiting for! This section shows the results of the study through the statistical analyses. Note that there are no interpretations of the data. The results section should simply report the data. The author will describe the results of the statistical analyses by reporting the test statistic (a number calculated from the data to determine the p-value; it varies between statistical tests), the number of independent data points (degrees of freedom or df), and the p-value (significance value). P-values of less than 0.05 are considered to be significant.

Additionally, take a look at the figures. The figures will be a graphical representation of the data. You may already be familiar with a few types of common graphs. A scatter plot will show the relationship between a continuous independent variable and a continuous dependent variable; continuous variables have variable limits, like the temperature outside. Scatter plots with a best-fit line are common with regression statistical analyses.

Another graph you are probably familiar with is the bar graph. Bar graphs show the relationship between a categorical independent variable and a continuous dependent variable; categorical variables are those where data points are grouped. For example, different treatment groups, like fertilized or non-fertilized, would be categorical while plant measurements, like number of leaves or plant height, would be continuous. Statistical tests that commonly use bar graphs to report data are the t-test and ANalyses Of VAriance (ANOVA).

> **Question 8:** Determine the statistical tests reported in the results. Does this match with those from the methods section?
> **Question 9:** Look at the figures. Determine the independent and dependent variables. Are they continuous or categorical? How can you tell?

Question 10: Find each figure citation (e.g. Fig. 1) in the text of the results section. Does the text match what the figure shows?

Discussion

The discussion section will interpret the results of the data and place them in the greater context of the research done in this field. You can think of the discussion section as a joining of the introduction section and the results section. The discussion should mention whether the results support or do not support the hypotheses. If the data does support the hypotheses, the authors should delve into why this is important, how it relates to other studies, and the implications of the findings. Note that the authors will refer back to figures and tables from the results section to support their claims. If the data does not support the hypotheses, the authors will delve into why this is important, how it relates to other studies, and the implications of the findings. Even if the data do not support the original hypotheses, it is still important and interesting!

Question 11: Determine whether the hypothesis was supported or refuted.
Question 12: Look at the references back to the results section. Do the figures support the claims and interpretations of the authors?
Question 13: Think all the way back to the abstract. After reading the entire article, does the abstract give an accurate picture of the entire study?

Think About It

Once you have a pretty clear idea about the main points of the article, look at other papers that cite the article. You can scan the new article to find the original article citation and double-check your interpretation.

- Think About It Tip 1: Did the citing authors reach the same conclusions you did? If not, what did they find most important?
- Think About It Tip 2: Do you agree with their interpretation?
- Think About It Tip 3: Think about your own study. How will this article help you support your hypotheses or your results?