

# Interpreting Scientific Writing: Experimental Research

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## Introduction: The Purpose of Scientific Writing

Although one would hardly think so after many hours of struggling with a stack of research publications in preparation for a term paper, the primary function of scientific writing is to communicate by sharing ideas. Certainly the ponderous prose and the oblique language encountered in many papers seems to give this notion the lie, but the papers really are an attempt, at least, to clearly and succinctly present the author's case. Part of the problem is that there is a standard approach to writing in any discipline that makes it easier for the practitioners (the "in" set) to understand the message—and consequently makes it more difficult for outsiders to penetrate.

One of the most important aspects of scientific writing is its organization. Papers must present a compelling argument for the research, in the context of the understood discipline. This requires a review of the general bases for the study (the theory) and the relevant findings of other researchers to date. In a well-written paper, the ideas the researcher is interested in testing should be clear, and the statement of the hypothesis(es) to be tested make it explicitly clear what the author will test. The review of previous work should reveal a standard methodology (or methodologies) for testing ideas having to do with the question, and revealed the relative strengths and weaknesses of methods. In the *Methodology* section of the paper, the author describes exactly how the experiment will be conducted—and why the specific approach was chosen. *Results* outline what happened, usually using tables and charts, and the *Discussion* offers a summary of what the results mean.

## Experimental Research Articles

One type of scientific writing is the experimental research article. Experiment write-ups frequently follow a fairly prescriptive format, but in any case a good research article needs to include:

- A general description of the problem space for the research;
- A review of previous pertinent research;
- A description of the idea this author wants to test;
- The hypothesis tested;
- The methodology (how the experiment will be conducted);
- The results; and
- A discussion of the results.

Frequently an *Introduction* incorporates the first four items in this list, sometimes the hypothesis is presented as part of *Methodology*, and sometimes the four items are combined—or not—in various ways.

## A Contrived Example

Suppose the experiment in question involves cooking. The particular problem might be getting water to boil more quickly. In this case, the review of pertinent research should include summaries of previous efforts to speed the boiling of water, and why the people who conducted them thought they would work (the theoretical bases for the experiments). Based on some previous efforts, the author of this paper might want to test the effect of turning up the burner under the pot of water (I said it was a contrived

example). The hypothesis might be stated as “There will be an inverse correlation between the burner setting and the time it takes water to boil.” (In the past, it was customary to state hypotheses in an inverted style, such as “There will be no significant correlation between the burner setting and the boiling time.”)

### **Some Vocabulary**

In discussing the methodology and hypothesis (or hypotheses), the researcher will probably use some standard terminology. Even if these terms aren’t stated, understanding the research requires the reader to dig this information out of the article.

*Variables* are factors of interest in the research. For our contrived example, these would include water temperature, burner setting, amount of water, initial water temperature, time on heat—and more.

*Independent Variables* are the factors the researcher is manipulating in order to determine the effect they have on the outcome. For the example, the burner setting is the independent variable.

*Dependent Variables* are the factors the researcher measures to determine the outcome. For the example, the dependent variable would be the length of time it takes the water to boil.

*Other Variables* must be controlled (kept constant) to prevent them interfering. For instance, the volume of water for each trial must be the same, as must the initial water temperature. Failing to control these factors could prevent the researcher from determining the real effect of the factor of interest.

*Instruments* are the tools needed to measure the variables. In the example, the dial showing the burner setting would be one instrument, the timer used to determine the boil time would be another, and the thermometer used to check initial water temperature would be a third. In experiments using humans, the instruments might include various types of tests.

*Procedure* or methodology describes exactly what was done, including all measures to control extraneous variables. Generally experiments involve a number of trials using a *control* condition and a similar number of trials using a *treatment* condition. The only difference(s) between the control and treatment is(are) the change(s) the researcher introduces in the independent variable(s). There may in some cases be more than one treatment condition to allow for multiple values of the independent variable. For instance, our contrived example might include a control condition of having the burner off, and treatment cases with the burner at 3, 7, and 9.

*Results* are usually reported in the forms of tables and charts. Charts should be easy to understand. The researcher should also report whether the statistics reflect significant support for the hypothesis.

*Confidence Level* describes the percentage possibility that the results are the result of chance. In other words, if the specified confidence level is 0.05, there is a five percent chance that the results are due to something besides the controlled factors. Researchers choose the confidence level prior to conducting the research. In research involving human behavior, five percent is typical; for physical experiments it is much lower. The statistical tests must result in a number below the confidence level to yield support.

*Discussion* includes speculation on what might have been done differently, what sort of design flaws turned up. If the experiment did not yield expected results this is where the researcher might offer some tentative explanations, such as problems in the methodology that became clear during the execution of the experiment. In any case, suggestions for further research are usually included.

### **Interpreting a Research Article**

If an abstract is provided at the beginning of the article, it might be useful to read it. However, not all abstracts are well written. Read the background material (review of previous work) to try to develop a good sense of the problem the researcher is tackling, and why it's important.

Having developed whatever sense of the problem you can, read the rest of the paper, trying to identify the variables of interest and the instruments that are used to measure them. If you can do this, interpreting the experimental procedure, the results, and the discussion *should* be easy.

Some things to watch for:

- important variables the researcher hasn't dealt with, such as the size of the pot used in our example
- approaches to assigning which case (treatment versus control) for an instance that might include bias (first 10 trials will be treatment, next 10 control)
- insufficient number of trials (a minimum of 20 for tests involving human—and that's a pretty small number)
- claims of "proof." Experienced researchers don't use the word "prove."
- unreasonable confidence levels, or claims of "extreme significance" or "near significance."

When you read an experimental write-up, it may prove useful to remember that the author is trying to provide as strong a case as possible. This is the reason that so many other works are cited and other research is described in such detail. The idea of scientific writing is to convince the reader that the research question is really warranted, and that it isn't trivial and hasn't already been answered. The author must also demonstrate that whatever notion he or she is testing makes sense given previous work. All the added information can make a scientific paper difficult to read (although some writers develop a talent for making the information flow very well). However, research papers that appear incomplete, fail to deal with contradictory evidence, or in general don't stand up as a comprehensive argument, are likely to be dismissed. Part of the game of science is to read new research critically—to make sure that the authors have done their homework.

### **Conclusion**

Experimental scientific papers are an effort to clearly communicate, in precise terms, the result of some work performed by a researcher, based on a theoretical basis and in the context of other earlier work. To be convincing to the researcher's peers, the article must incorporate a large amount of information, since the previous work that provides the context may include many publications, and these may present more than one point of view. Consequently, scientific writing must be well-organized to allow for easier

interpretation. Even well-organized papers may seem daunting to readers outside the discipline. Knowledge of how papers are organized and the vocabulary used in scientific writing are necessary for successful interpretation of scientific publications.