Writing and Publishing Scientific Papers

A Primer for the Non-English Speaker

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11. How to Write the Results

This section is a key part of any scientific article; indeed, it is, the very reason of for writing the paper: the presentation of significant, new facts. Because of this, everything hinges on your results. If you do not have good enough results, convincingly presented, no matter how well the other parts of the paper are written, the manuscript will not be accepted for publication by any reputable scientific journal. The results must be new, possibly significant, compellingly represented, and the claims well-supported by evidence. This is the part where the new information appears, and one has to be very careful in about how to present this new knowledge.

The results are not a simple presentation of the outcome of your measurements. They have to be organised and interpreted to ease the task of the readers, so that they can most easily understand the novelty and the nature of the new information. So, a perfect Results section does *not* read: "The results can be seen in Figure 1". Results — other than occasionally — do not speak for themselves. You have to organise the results into a sequence, possibly so that it is consistent with the problem statement, the starting hypotheses, and so on, in turn. You have to present:

a) the big picture, an overall description of the experiments. What did you manage to prove?

b) results that support the claim you make. How do they corroborate the claim you make under a)?

When writing, detail significant data, not insignificant ones. If a variable was ineffective, mention it, but do not give excessive detail. Not all data need a table. Also, be aware of the saying: "the absence of evidence is not evidence of absence"; detail what did you not find as well.

Here are a few things you should avoid.

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- Do not start with a forgotten method — include that in the appropriate place in the previous section.
- Do not present material as results. Obtaining your study material is necessary for your research, but this is not a result. It does not belong to the results section; for example, how many birds you captured for your study is not appropriate, only the outcome of the actual measurements. If you had to identify the material collected, then it becomes a result.
- Do not try to present all your data. The fact that you measured more data than anyone else will not increase your reputation. In effect, the opposite may be true: "the compulsion [...] not to leave anything out does not prove unlimited information; it proves lack of discrimination" (Day, 1998).
- There should be no double presentation of the data. Do not repeat your data in text *and* tables/figures. This does not mean that occasional values, presented in a figure or table, can never be mentioned. Precise values cannot be read from a figure, for example, so if a value, also present as a data point on a figure, is important, it can be mentioned in the text. In general, the most economical method should be used to present your data. For further discussion on how to decide on the most suitable form for presenting data, (text vs. figure vs. table), see Chapter 15 and Chapter 17.
- Do not leave the reader to find the meaning and analyse your data on her own. The reader will see your new data for the first time, and needs your help to quickly grasp their nature, meaning, and novelty. You are the best guide for her, and do not shy away from this responsibility.

When describing the results, follow the "from macro to micro" principle: first make a general claim or point, then illustrate or prove this by giving more detail. Present details, statistics, etc. that support your argument. Point to significant trends and facts among the numbers. This way you can direct reader's attention. There is no need to interpret the results — that should be done in the following section, the Discussion.

Do not yield to the temptation to combine results and discussion. Authors sometimes resort to this with a claim that "it is easier to understand the flow of the argument". Interestingly, however, most such authors do not seem to have a clear line of argument to present. On the contrary: the argument is often muddled, which is not made clearer by immediately mixing it with interpretation. Often, it is not easy to separate the authors' own work from that of others. However, it is very important, to make it especially clear what they measured or observed themselves, i.e. what is the empirical base, and what is the speculation or interpretation. This is extremely important for colleagues with a smaller publication record — it is to their advantage that the world can clearly see what they did (results) vs. how they argue (discussion).

The sequence of the presentation should also be consistent in the sense that, if there are several experiments carried out, the results should be presented in the same sequence as they were described in the previous sections, the Introduction and the Material and Methods.

Results contain new information, new facts. Every statement should be supported by facts: a figure, a table, a number, or a statistic. Most of the figures and tables contain results, and are to be placed in this section. All figures and tables should be integrated into the narrative. Do not simply claim that the results of one experiment can be seen in one or more figures/tables. For understanding, do not rely on the legends, either, even if figures and tables should be understandable without reference to the text. Link text statements and their evidence into one narrative.

Presenting Statistics

When a statement is supported by a statistic, the conventions are precise and rigid: give the name of the test, give the test statistic value, followed by the degrees of freedom, and the level of significance. For example: "XZ was significantly larger than FF (Student's t-test, $t = 5.43$, d.f. = 114, $p = 0.00014$)". In general, if your statistical significance was calculated using a program, the output should be a precise value of the probability of error, p. The notation $p<0.05$ indicates that the evaluation used a statistical table, where only levels can be assessed (i.e. $p <$ *or* $> 0.1, 0.05, 0.01, 0.001$, etc.). Beware of false precision: every measurement has a

sensitivity, and presenting the mean of measurements to five decimals implies a very high sensitivity (0.00001). Do not present more decimals than the sensitivity of your original measurement. Some allow that the number of decimals in means can exceed that of the original sensitivity by one: if the original measurements have a sensitivity of 0.1, the mean and the chosen measure of variability (s.d., s.e., confidence interval, etc.) can be given as x = xx.01.

Box 8. Presenting numbers

- Numbers <10 are usually written out in letters; if they are >10, Arabic numbers are used
- When the numbers represent measurements (they have a measurement unit), always write them as numbers, and never in words
- Sentence does not start with a number in Arabic. You cannot write "200 birds were captured...". If it is necessary to start a sentence with a number, always write it out in letters, irrespective of its magnitude: "Two hundred birds were captured..." or "One unicorn was captured...."
- Observe the writing of the number and its unit — sometimes there is, sometimes there is no space required between a number and its unit.
- Numbers smaller than 1 should always start with a zero, i.e. 0.123 and not ".123"
- When reporting a range of values, use the "to" rather than the mathematical symbol. The latter can be misinterpreted as the negative sign. Write "1988 to 1996" or "-23°C to 18°C". When writing page numbers in the reference section, though, use the "en-dash" symbol: Ecology, 24, 133--145.
- Use the official Système Internationale (SI) units only
- Be careful about mixing up scientific and everyday use of properties measured (e.g. weight vs. mass)
- Beware of exactness! Measurements always have a level of precision (to be indicated in the material and methods section). When one deals with measurements, the mathematical absurdity "1 ≠ 1.0 ≠ 1.00" is true. The last number (1.00) indicates a measurement sensitivity which is a hundred-fold higher than the first one (1).
- When presenting means and other numbers calculated from the original data, retain the sensitivity of the original measurement. If your measurement exactness was 0.1, do not give its mean as 0.13333. If your

sample size is n <50, give only whole numbers, i.e. 15%. When your sample size is n <20, give the actual numbers, and no percentages.

- Singular-plural may have different meaning:
  10 g was added — as a single dose/quantity
  10 g were added — a total of 10 g was added, but in several doses

Also, statistics must be meaningful, which is not the case in the following statement (from Day, 1998): "in 33.3% of mice, the treatment was effective; no change was observed in the condition of the other 33.3%; the third mouse escaped".

Grammar and Style

The Results section usually contains no references, because it describes your own, new work. Use the simple past tense. Here, your own results are being presented for the first time, and convention requires that they are not yet treated as established facts, and the use of the present tense is not appropriate. This section will certainly include numbers, for which special rules apply (Box 8). These may vary by journal — check the necessary format and follow the requirements.

Concerning style, there are overriding necessities: crystal clarity and simplicity. Precise language and clear, simple statements are not only highly appreciated stylistic values of the English language — precision and clarity make the understanding of new information easier. A common mistake is to write overlong, convoluted sentences that, also, sometimes contain infrequently used, foreign terms. Neither is optimal, nor is it necessary to the degree used. Ideally, one sentence should make one point or statement. Only occasionally can an interpretative clause be added. The simplicity of the coding principle is again invoked: this is the part that is new, and contains information that is known to no-one but you — at least before the article is published. The world at large will have an easier task to understand the magnificence of your new results if they do not also have to struggle with a convoluted style. Simple sentences indicate profundity of thought.