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PRACTICAL MATTERS

Writing Your Paper from the Middle

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ABSTRACT

Communicating the results of research using concise, jargon-free language optimize its likelihood of being read and cited by other researchers. More than 3 decades of publishing scientific articles has convinced us that the most efficient approach to writing a scientific paper is one that starts in the middle and works outward. Such an approach means that the first items to finalize and polish are the actual tables and figures that will be included in the body of the paper (including supplemental tables and figures). This entails deciding on the order of these elements that, when viewed alone, should be able to tell the story of the paper. This first step is often the most difficult, requiring the most thought. However, once achieved, it is usually a straightforward process to write the Results section (that refer to these elements) followed by the Methods section. After these sections are proofed and polished, a quick review of the Methods, Results and associated figures and tables highlight the points that need to be made in the Discussion section. The last sections written should be the Introduction, to set up the entire Methods, Results and Discussion, and the Abstract, to summarize it all.

When this approach is combined with frequent proofreading of the article on some medium that is different from the one used to write it, experience has shown that the result will be a clear, uncluttered paper that is completed with a minimal number of drafts and that is most likely to be favorably reviewed and accepted for publication.

Good biomedical science requires good communication, and scientists who clearly and unambiguously communicate their observations, analyses, and conclusions in writing[1] are likely to reach a bigger audience. In our experience over the last 35 years, an approach to writing a paper that is adaptable to any topic, simple, reduces the number of drafts, and consistently results in a clear paper is one that starts in the middle and works outward.[2] Such an approach begins with the tables and figures of both the main paper and any appendix, continues with the Results, Methods, and Discussion, and ends with the Introduction and Abstract. Each of these steps is described below.

A: FIGURES AND TABLES

A paper generally includes figures and tables that clearly communicate the main message of the paper. Indeed, an approach to reading a scientific paper is to first read its title and Abstract and Conclusions sections and then flip to the figures and tables before deciding whether to read the full paper. Moreover, a paper's figures are often presented by other scientists when discussing their own work. It is for this reason that the creation of the figures and tables is an ideal place to start when writing a manuscript. This includes those that will be included in the main paper as well as in any supplement and that together will "tell the story" of the entire manuscript. As in any story, the order in which these elements are discussed needs to be carefully considered. Thus, before writing the Results section, it is best to decide the specific order of these elements (eg, Table 1, Table 2, Figure 1, Supplemental Table 1, Figure 2, Supplemental Figure 1, and then Table 3). Even if the author ultimately modifies this order, deciding on the initial order will facilitate writing the first draft of the Results section.

B: RESULTS SECTION

The Results section typically starts with a general description of the data that are analyzed, followed by the specifics of the analyses and findings with reference to the figures and tables. Brevity is a virtue for all parts of a scientific paper, and a succinct, clearly written Results section that tells the story that is shown in the tables and figures in a logical and uncluttered way will communicate the findings effectively. A supplement is the ideal spot for any information that does not directly address the study hypotheses.

C: METHODS SECTION

A clear set of figures and tables and a straightforward Results section facilitates drafting of a clear and concise

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Methods section. Although the amount of detail to include requires judgement, the guiding principle should be that it should be sufficient to describe what was done without confusing, irritating, or distracting the reader. Any other details can either be omitted or included in a supplement.

The Methods section, together with the Results, figures, and tables, represents the heart of the paper. Once it has been drafted, it is worth checking whether all the salient information, but no more, has been presented transparently. As with the any piece of writing,[3] we have repeatedly found that a good way to do this is to print a clean (unmarked) copy of the Methods, Results, tables, and figures as well as the supplement and review these sections as if they were written by someone else. Although one can never truly dissociate oneself from one's own writing, such an effort can help the writer identify confusing or distracting text that interferes with the flow of the written presentation of the information. It is also useful at this time to have a colleague read these sections before continuing, as it is not worth writing any more of the paper until these sections are polished.

D: DISCUSSION

The Discussion section of a paper presents an opportunity to contextualize the findings, show how they support or refute the hypothesis being tested, and show how they lead to new hypotheses or research. This is also the place where writers present their conclusions, which need to be consistent with the research design, the data quality, and the analytic approach used. For example, if a research finding is hypothesis generating, it is inappropriate to present it as hypothesis testing. In our experience, striving for clarity and brevity will reduce the likelihood of overstating the implications and relevance of a particular finding that happens to be consistent with a hypothesis and excusing or rationalizing an inconsistent finding.

The contents of the Discussion should directly flow from the Results section and should mainly focus on the findings that were observed. This can include citing other literature pertaining to these findings and suggesting possible explanations for the findings. Although every set of observations has limitations, a Discussion section that spends inordinate amounts of space on "explaining away" findings that do not support the investigators' hypotheses is usually unhelpful and distracting.

A simple structure for a Discussion section includes (a) restating the main findings, (b) a brief discussion of literature pertaining to these findings and how these findings advance an understanding of the hypothesis, (c) a possible explanation for these findings based on biologic mechanisms or methodology, (d) the strengths and limitations, and (e) the next steps and overall conclusion. It is important to note that a detailed literature review regarding the hypothesis best belongs in a review article, as such a review generally cannot be accommodated in the space available for the Discussion section.

E: INTRODUCTION

Perhaps the easiest section to write is the Introduction. The Introduction should state and briefly justify the hypothesis and its implications and generally foreshadow all the key points that are included in the Discussion section. A short 2-paragraph Introduction is ideal for many papers. As with the Discussion, the Introduction generally should include sufficient information to understand why the research was done. It should simply justify the reasons or motivation for doing the study, state the hypothesis in a few sentences, and provide a big picture as to what value this adds to science.

F: ABSTRACT

The Abstract of any paper should adhere closely to text written in the rest of the paper. Most biomedical journals have word limits for Abstracts ranging from 250 to 300 words. Generally, the most effective way to write the Abstract it is to summarize each of the other sections in 1 to 2 lines.

SUMMARY

Writing clearly is difficult and takes practice. This is as true for writing a scientific report as it is for writing a novel, play, technical document, or financial report. Regardless of what is being written, having a clear underlying structure that supports the document, and a systematic approach to building that document on that structure, can facilitate the process of writing a paper, ensure that the final product communicates clearly, and increase the likelihood that it will be used to further advance biomedical knowledge.

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