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Editor's Viewpoint

The Power of Scientific Writing and Publication

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In this editorial, I describe how scientific writing and publication contribute to the body of scientific knowledge. I include brief considerations regarding conceptual tendencies in the art of publication and scientific writing. After arguing that scientific publication plays a fundamental role in academic debates, I describe 8 primary ways to improve scientific writing skills.

Science is a strategy used by humans to solve practical or theoretical problems. This strategy relies on the production of reliable knowledge. In this task, the primary concern is to eliminate distortions that undermine the credibility of this knowledge. Although science does not aim to discover truths, it should be able to produce knowledge that is accepted for a time. From scientific knowledge, explanations and technologies that improve human well-being might arise.

Francis Bacon (1561-1626) was the first thinker credited with recognizing that knowledge would enable man to master nature and would lead to unimaginable advances in human progress. However, Bacon believed that the means to obtain this knowledge had not been sufficiently developed. Thus, he established a scientific method that closely resembles the modern scientific method. Bacon's method assumed that information is obtained through human sensory experience, a notion that forms the empirical basis of modern scientific practice. In a scientific text, the set of methodologies and new data as well as the data referenced from other empirical studies form the empirical basis of the study. This method is the primary tool for developing new technologies and addressing theoretical concerns. The scientific method lent crucial support to the Industrial Revolution, which began in mid-XVII-century Britain. Note that the first scientific journal appeared earlier in the middle of the XVII century (01/06/1665). Currently, the need for scientific knowledge to produce technological and theoretical solutions is imperative.

Despite this encouraging picture of scientific value, the concern with achieving reliable knowledge remains constant. In this sense, technical and epistemological instruments are utilized to minimize errors

in the construction of knowledge. The appropriateness of a technological tool (i.e., an apparatus or a set of ideas) is usually but not always used to validate the body of knowledge underlying this technology. If the data obtained in error are accepted as valid knowledge, new technologies or theoretical solutions may be precluded. Worse still, new solutions that prove to be disastrous in the medium or long term may be implemented (see examples of some medications or medical procedures).

Scientific writing is another tool for improving scientific knowledge. The need for scientists to publish their work goes far beyond curriculum-vitae vanity. Publication is more than the simple dissemination of knowledge; it is a way for knowledge to undergo criticism. Because scientific research is conducted by scientific experts, the first critiques should emerge precisely from this community before the findings are released to others. Editors and reviewers first critique the findings. If the manuscript is rejected, the author may approach other scientific journals and undergo a second critique. If the work is published, it becomes available on the Internet with nearly unrestricted access (notwithstanding certain limitations due to language barriers or financial constraints in a pay-to-access system). Currently, some electronic journal formats allow the general community to participate in the scientific discussion by publishing comments in response to the text (e.g., see the journal PLoS One). These recent electronic journals more closely resemble a discussion blog than a printed journal in PDF format.

A key aspect of this system is that the criticism is based exclusively on what readers glean from the published text. For this reason, scientific writing plays a key role in the construction of scientific knowledge. Strong scientific research converted into a weak text (or a weak publication) is an immeasurable waste. The task of converting the research into a strong text is not simple, but it is a priority for modern scientific researchers.

In Brazil, scientific findings focused on Brazilian issues (e.g., animal science, veterinary studies and public health) were isolated from the international debate for many decades. As a consequence,

methodological and epistemological gaps have emerged. These gaps have prevented the country from contributing to the global development of these scientific areas. I suggest that mistakes increased over the course of generations. However, areas of basic science were consistently immersed in the international scientific debate and were improved upon by scientists participating in a critical system that transcends linguistic and socio-cultural barriers. The degree of participation in the international scientific debate seems to lie at the root of the differences in the hard-science participation rates among the different areas of science in Brazil (although these differences may not be restricted to this country). In the late 1990s, when Brazil's system of graduate courses was first examined based on the international standards of scientific quality, these differences became more visible. This review process marked the beginning of the XXI century as a revolutionary phase for Brazilian scientific publications.

Our scientific findings need appropriate ways to reach an international audience quickly. Such means include deep cultural changes in scientific writing, especially in the areas for which the incorporation into an international discourse has been delayed. In this scenario, I offer the following recommendations to improve the quality of a scientific text to better reflect the science that it represents. These recommendations are intended to harmonize the key concepts of our different scientific areas. A crucial task for our scientific journals is to ensure high standards of quality because our authors learn from their experiences with these journals. In fact, we do not need more journals. Rather, we need researchers to submit stronger science to be published in the existing journals.

1) The scientific paper is directed at scientists. We use methodological and epistemological jargon (a hermetic language; e.g., statistics) that hinders people outside academia from critically approaching the text. If non-scientists accept the conclusions of a scientific text, they only do so as a matter of faith. However, once the article convinces its critics in the scientific community (as demonstrated by its acceptance in a recognized international journal), then its main contributions may be released to the non-scientific general media (e.g., *Ciência Hoje* and *Pesquisa Fapesp* in Brazil; *Scientific American*, abroad) through appropriate language, although all care must be taken to not distort the scientific information.

2) Write to non-specialist scientists. Readers in your paper's field are expected to read your text. However, scientists outside of your area of expertise may need your text. This assumption is a coherent one if we consider the need for interdisciplinary approaches to modern science. We never know how distant our readers are from our area of expertise. From my experience, two of my papers on fish behavior were used by scientists from the fields of Physics and Medicine to support their argument or to broaden the implications of their findings. Even if the topic is far removed from your subject area, general scientific language and knowledge should be used such that other

scientists can understand the basic argument of your text. As the vocabulary that you use becomes more specialized, the number of scientists who will read your text decreases. In this sense, a scientific writing style requires simplicity and clarity. For instance, instead of using "HPA axis activity" or "plasma cortisol level" in a title, select "stress", if applicable, because the latter is a more common term (readers will grasp the subject of your paper from the title). However, you do not need to explain what a "Student's t-test" is because a scientist is expected to know this information.

3) Your readers are international. The notion of a national science has no precedence in the history of science or philosophy. Every study was developed in a specific place. The difference is that some scientists elaborate upon particular data, whereas others focus only on the data. Science needs theoretical generalizations. Once the generalizations are established, particular facts are explained. The reverse is not true. I include the language of writing in this topic. Science is communicated in English, regardless of whether you agree with the reason behind this preference (you may find exceptions in some grammar studies, for instance). The more open your text is, the more scientists can reach it, and as a result, the more science will benefit.

4) The role of scientific journals. A scientific journal's editors and reviewers have the arduous and essential task of selecting texts for publication. Although some mistakes may occur, this scientific review aims to avoid disseminating errors to the community. Currently, information is published on the Internet nearly every second. Such an information overload does not help (for example, most people do not read beyond the first page of Google's search results, even though several pages are available). Therefore, the filtering role played by the review process seems more beneficial than detrimental. However, a journal must utilize high-quality editors and reviewers. Journals should guarantee four requirements for an international publication (1): a) the novelty of the conclusions; b) the strength of the techniques and methodology; c) the clarity of the results; and d) the quality of the presentation. In top international journals (e.g., *Nature* and *Science*), if the editor notices important new findings in a poorly written text, s/he can help to rewrite the text because the editor wants to publish the novel findings. However, a poor presentation may prevent the editor from noticing the novelty of the findings.

5) The way forward for scientific journals. It is imperative for a scientific journal to reach an international audience. Therefore, the journal must be published in English, on the Internet and in recognized international databases. The journal must obtain international recognition by publishing papers written by scientists from different countries and by being cited by scientists from different countries (see, for example, the index for measuring international recognition (2)). These requirements present a difficult challenge because of

social, intellectual and economical barriers, but this path is the way forward.

6) Scientific journals are an authority. The authority argument is not acceptable in scientific discourse. However, if a scientist reads a paper outside of his/her area of expertise, s/he may confidently accept the details that s/he is not able to understand because of the journal's authority. This strategy is valid for high-quality journals because the probability of publishing scientific errors is inversely correlated to the journal's quality. Good science is usually intended for publication in good journals, and high-ranking scientists can more easily contribute to the peer-review process. This situation is a real but undesirable one.

7) The scientific text is a discourse rather than data. In the empirical sciences, what is most essential is not the data but the conclusions based on the data (3). Theory without data is fantasy; data without theory is chaos (4). That is, science needs theory, but theory also needs data. Scientific writing must enrich the discourse linking data with theory such that the argument may not only be criticized but also withstand scrutiny. This goal is the real aim for good scientific writing: to provide readers with a clear argument for their consideration.

8) Do not “copy and paste”—your text is unique. Each paper is an argument used to validate a particular finding (3). Thus, information is presented as a premise to support the main conclusion. Because each text must present at least one original conclusion, its argumentation must be unique. The presentation of a result is primarily determined by its role in the text as well as by the general rules for the results. For instance, a table is appropriate in descriptive studies in which the values of exact numbers are needed, but it is not appropriate if you wish to compare numbers (treatments) to demonstrate an effect (here, the differences between the values are crucial and are better depicted in a graph than in a table). Consider your text as a way to develop your argument. Do not copy and paste other formats for presenting data.

In short, scientific writing and publication serve an essential role in the scientific method, which entails a fascinating journey that helps us understand our natural world. Publication brings visibility to ideas within a critical academic community. Good scientific writing presents a comprehensible, reliable, accurate and elegant discourse.

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