

Cambridge University Press

978-1-107-69193-3 - Successful Scientific Writing: A Step-by-Step Guide for the Biological and Medical Sciences: Fourth Edition

Janice R. Matthews and Robert W. Matthews

Excerpt

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Find a subject you care about and which you in your heart feel others should care about.

It is this genuine caring, not your games with language, which will be the most compelling and seductive element in your style.

KURT VONNEGUT

Most of us were drawn to science because, like Vonnegut, we found a subject we feel deeply about, not just because we wanted to write about it. However, all scientists recognize that research must be made known if it is to have lasting value. This is how science moves forward, with the shared word illuminating each step of discovery for the sake of others that follow.

“Scientific writing” can be defined narrowly as the reporting of original research in peer-reviewed journals, or construed more broadly to encompass other ways that scientists share research information with one another, such as review articles, abstracts, case study reports, grant proposals and summaries, posters, and slide-based presentations. (The term “science writing” is often used for writing about science topics for the general public.) Whatever form it takes, successful scientific writing must answer basic questions and address problems raised during the dialogs that identify and define a given subject. It must be clear, concise, and follow established formats. In many ways, its language forms a dialect all its own.

What is the most efficient way to write a paper or presentation that successfully covers all this? This book exists to help you tackle the task, step by step. In this chapter, we suggest that you back up from actual writing, and start where your research does – with a question. Learn the most effective ways of compiling background information. For help defining, organizing, and planning the content, use techniques borrowed from problem-solving strategies. Choose a journal so that you have a goal and format. Take charge of the whole project by using the Process Approach.

Ask fundamental questions first

Although peer-reviewed formal research publication receives major emphasis in this book, it is only one of many ways scientific data can be shared. The methods by which scientists transmit their work to one another have

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changed and multiplied more in the past three decades than at any time since the first appearance of scholarly journals back in the late seventeenth century. Thus, choosing how your study will be disseminated should be your first step toward presenting it to the world.

Before going any further, a savvy scientific writer asks four questions:

- What message do I want to convey?
- Who will be interested in my message?
- What format is most appropriate for my message?
- Where should this paper be published?

You may be able to answer these questions by yourself, but for an extra margin of safety, discuss them with a more experienced colleague. All of us can suffer from the normal human failings of inflating the importance of a message and overestimating the size and nature of its potential audience.

What message do I want to convey?

By this point, you should be able to answer this question in some detail. What is my research question, and what is (or probably will be) my answer? This is not the same as asking the “purpose” of the research. That phrasing can lead to some tremendously circular and meaningless statements: The purpose of my research was to obtain data so I could publish them in order to get my degree so I could do more research and publish some more . . .

Who will be most interested in my message?

Most of us have pretty healthy egos. We think our writing will merit the attention of far more readers than it will in fact attract. This nearly universal failing can lead to poor choice of a potential journal, and this poor choice can lead to delays, requests for major revision, or outright rejection.

Two closely related, bluntly asked questions can help a writer find the most appropriate audience:

- *So what?* This question could be cast less abruptly in any of several ways. What effect will my message have on concepts or practices? Why should readers pay attention to it? Will it lead to widespread changes in the way we view the world?
- *Who cares?* One could also ask this question more mildly. Who will be the most interested in this information? Will it be the specialists in a small field? Most practitioners? The scientific world in general?

Be realistic. Don't get caught up in contemplating a vast potential audience that “needs” to know your information. (In this information-filled world, no one

should be expected to make brain-room for data simply because the facts are currently unknown to him or her.) The more accurately you can answer these questions, the more precise your journal publication options become. And the more precisely you can target a journal, the better the chances for publication.

Where can I most effectively communicate my message?

Most of us are justifiably interested in recognition for our work. The way in which a study is presented and published can determine the nature of that recognition, and in fact whether we receive any recognition at all. This is most clearly demonstrated in the case of the twin concepts of “valid publication” and “priority.” For a scientist to receive professional credit for being the first to discover something new, it is not sufficient just to be the first to perceive or detect it – he or she must be the first to publish the information “validly,” that is, in a very specific way. This distinction is most important in (but not restricted to) the taxonomic sciences, in which the naming of new organisms hinges on a strict system of priority of valid publication.

Valid scientific publication has several essential components. It is (1) the first publication of research results (2) in a form whereby peers can assess the observations, evaluate the intellectual processes, or repeat the experiment and test its conclusions, (3) appearing in a primary journal or other source document (4) that is readily available within the scientific community. In addition, (5) the scientific paper contains certain specified kinds of information that are (6) organized in a certain stylized manner, i.e., it has a certain format.

What is a “primary journal or other source document that is readily available within the scientific community”? Primary and secondary has nothing to do with quality or importance. Rather, a primary journal is merely one that details first-hand information reported by people directly involved with an action or event. A secondary journal presents information that does not come directly from people involved in the action or event. Rather, a person two or three steps removed from the source reports the information. Some of these secondary publications are significant sources of communication among scientists and the educated public, particularly now that the Internet provides increased accessibility to them.

Communication format: the message determines the medium

In 1964, Marshall McLuhan, a Canadian philosopher of communication theory, coined the phrase “the medium is the message” to help explain the ways people reacted to new media such as television. Our variation on that

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phrase is to underscore the reality that where scientific material appears is almost as important as what it says. Conversely, where it appears ideally should be determined by what it says.

Research articles and case histories

Though they may be designated by slightly different sets of names, research papers in the biological and medical sciences fall into four general categories – research articles, case histories, reviews, and case-series analyses – and shorter variants with such titles as research notes or brief communications. Each category is most appropriate for different sorts of messages. Because of the very specific nature of requirements for establishing priority of discovery, the first two of these categories form the usual avenue for “valid” publication of original results. This is not to imply that other publication is “invalid” for any other use than this very specialized purpose.

Articles that present original research and case histories are the presentations that usually come to mind when people hear the term “scientific paper.” Both types of papers are “primary” because they are based on a scientist’s own experiences. A research article generally presents new data obtained through experimentation or observation. A case history usually covers such subjects as a unique or previously unknown syndrome or disease, new information on an illness, an unsuspected causal relationship, or an unexpected outcome such as a possible therapeutic or adverse drug effect. The study may be retrospective (based on analysis of previously accumulated data) or prospective (with a design that pre-dates data collection).

Satisfying a requirement for valid publication, research articles and case histories have a specific set of defining characteristics. Both are structured with distinctive sections that parallel the sequence of a critical argument. They present a question (often formally stated as a hypothesis). They marshal evidence to support various possible answers to the question or tests of the hypothesis. Finally, they attempt to persuade the reader of the truth of a particular choice of answers.

Review articles and case-series analyses

Review articles and case-series analyses, on the other hand, cover principally other scientists’ discoveries rather than one’s own, so they are “secondary.” This is not to downplay their importance, nor to suggest that they are in any way second-rate. Reviews, such as those found in the “*Annual Review of . . .*” series, perform a valuable role by synthesizing the results of a search through literature or other records. Both reviews and case-series analyses may yield new insights, hypotheses, and understanding.

Reviews can be particularly valuable to someone entering a subject for the first time and for communication between scientists. By summarizing and synthesizing existing studies and technologies, they broaden readers' knowledge base. They can also introduce new ways of looking at a topic, and point out flaws or gaps in scientific understanding or in the published literature.

In the past, journals only published reviews that they had invited scientific authorities to write (and some still do). However, many journals now have come to realize that review articles increase the impact factor, visibility, and perceived value of a journal. In response, they have opened the authorship opportunities and broadened the variety of types and lengths of reviews they offer. Online publishing has also loosened previous restraints on the length of published papers, making it both possible and practical to publish longer, more comprehensive reviews when warranted.

Publishing a review article, case-series analysis and other summary research can be valuable to authors as well. Such a publication can benefit a new researcher in establishing credibility in his or her field, and can enable more established scientists to stake a claim in a field tangential to their primary research focus.

The structure and format of reviews and other summary analyses are less standardized than those of a research article. If there is a Methods section, it often states the manner and extent of the search. If a series of cases is being included, it often tells what records were accessed. The organizational sequence of these papers depends on the topic. Commonly, items are covered either in chronological order, from general to particular, or from frequent occurrence to rare. In most cases, the journal will offer quite specific guidance on the form and substance they want to see in a review.

Theses and dissertations

These important documents have a common purpose – serving as a gateway and rite of passage for the highest university degree – but almost no generally accepted rules for their structure or composition. They do, however, generally come in two varieties: compilations and monographs. Monographs are usually the preferred form for humanities, theology, and law. Compilations are increasingly common in medicine, technology, and the natural sciences.

Compilations are collections of research papers on various aspects of the main message of the dissertation. Students and professors alike appreciate this format because it offers a front-loaded solution to a common problem – the daunting post-degree task of repackaging one's lengthy and formal academic dissertation into shorter publishable papers. In the past, as newly minted Ph.D.s left academia and took on new job-related responsibilities,

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many theses and dissertations simply languished on the shelf and never entered into formal publication channels. Nowadays, about half of the four papers or articles included in a typical biomedical dissertation have already been published, and the other two are either in press, have been submitted, or are manuscripts in final draft form, ready to be submitted (Gustavii, 2008). In addition, compilations mean that some or all of the papers have been subject to peer review and scrutiny beyond that provided by a local departmental committee.

Because much research today results from collaborative work, the compiled articles generally have several authors. The doctoral student is generally listed as first author, but it is important to state which parts of the work were his or her own. (See Chapter 4 for more on authorship.)

Some compilation-based dissertations sandwich the journal articles between introductory and concluding chapters written by the student. Others append reprints of the published articles to a separately written document that provides an overview of the work. However, in either case, the guidelines described in this book generally apply to theses and dissertations.

Grant applications and other proposals

Competing for money is a nearly universal part of an academic research career. To be successful, scientists need money and finding it is generally their own responsibility. Not surprisingly, this can be a major source of stress, but avoiding common mistakes can help tip the balance in one's favor.

The success of grant proposals depends on many factors (Table 1.1). Of these, only a few are really under your direct control: the perceived innovative nature or critical importance of your proposed project, your skill in building a compelling case, and the care with which you write your proposal. The first two of these are up to you and your imagination. Hopefully, the guidelines in this book will help you with the third. For advice on other aspects such as choosing the most appropriate funding source and interacting with potential funders, see sources such as Friedland and Folt (2009), Hofmann (2010), and Schimel (2012). Many online resources are also available that contain profiles, articles, and links related to specific funders.

Writing for a more general audience

Popular books and articles – the name given to secondary accounts designed to entertain as well as to inform – may or may not adhere to the rigorous standards of regular scientific articles. They typically offer only a condensed overview of the methodology used and a summary of the major findings, without presenting actual data. For these reasons, such articles do not

Table 1.1 Some major factors that determine funding success (modified from Hofmann, 2010)

Factor	Ways to influence chances of success
The sponsoring organization	Research the most appropriate potential sponsor; ensure an appropriate match; cultivate relationships; write letter of inquiry and/or pre-proposal.
The innovative nature or critical importance of the proposed project	Be realistic when listing aims, and do not make them too interdependent. Summarize impact as broadly as possible.
The competition level	When possible, research this.
The skills of the grant writer in building a compelling case	Make sure both experts and generalists can clearly follow your well-written text.
The care with which the proposal is developed	Obtain and strictly follow proposal guidelines. Make sure the first page (executive summary or abstract, etc.) is perfect. Provide a feasible experimental plan. Draft a realistic time line. Present a well-reasoned budget.
Good luck	Not too much you can do about this one!
Good timing (in terms of whether the funder and/or society is ready for the idea or approach)	Pay attention to indicators.

generally constitute “valid” publication in the narrow sense of scientific publication. Often, they are called “science” writing, as opposed to “scientific” writing.

Because science writing is intended to be entertaining enough to capture the continued interest of potential readers, its style is much less somber than the usual scientific writing. The use of slang, puns, and other word plays on the English language are accepted and even encouraged. (The book you hold in your hands straddles the divide between science writing and scientific writing. With apologies to those English learners for whom translating humor in another language sometimes may be problematic, we have consciously decided to strive for a light touch on what otherwise could tend to be a very somber subject.)

Distinguishing between science writing and scientific writing is reasonable – they have different purposes and a different audience. However, one would be ill advised to use the term “science writing” or “popular writing” in a disparaging way. Writing (or providing consultation for others who are writing)

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popularized accounts based on scientific research should be an important part of every scientist's outreach activities. The wider community is essential to adequate support for scientific endeavors. Scientists and non-scientists alike distrust and fail to appreciate studies that seem esoteric or secretive, but will defend and assist research that they have come to understand and value.

Other publication formats

In recent years, the lag time between acceptance and appearance in primary publication has grown. A gap of 1–3 years now sometimes exists. For work in highly competitive leading edge areas, this is no small consideration. Research notes, short communications, and research briefs have arisen to address the need for quicker, but less comprehensive transmission of results.

Writing variants such as abstracts, transactions, conference proceedings, local bulletins, posters, newsletters, websites, and other such outlets are often viewed as commanding less prestige than classic journal articles. Admittedly, they are not peer-reviewed, and they can be ephemeral in nature. However, they offer much more immediate communication with fellow specialists, and can be particularly valuable in helping one stake an intellectual claim in a rapidly changing field of study.

For practice with message, format, and audience, go to Exercise 1.

So, where *should* this paper be published?

Even after all these considerations have been examined, a lot of choice remains. There are tens of thousands of refereed scientific journals in current publication. Within a single specialized area, they differ in such vital aspects as topic coverage, format, interval and backlog of publication, acceptance rate,



"I'M SORRY, BUT THERE ARE NOW 16,000 MEDICAL JOURNALS, AND I NO LONGER HAVE TIME TO SEE ANY PATIENTS."

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page charges, and presumed prestige. Their readership varies as well. For the greatest efficiency and the best chance of acceptance and prompt publication, search early and well for the best match of topic, journal, and audience you can possibly achieve. Some surveys suggest that 80–90% of papers that are rejected from the author's first journal choice will eventually find a home somewhere if the author perseveres. Nonetheless, one can only imagine how many hours are consumed during this rewriting/re-submission process.

Very often, the most appropriate journal is the one you already most often read, or the one that contains a majority of the references you have identified. Did your literature search indicate that one or more journals were the principal sources of reports related to your research? If so, start there. Refer to those abstracting services or indexes that you used to begin a literature search, and use them to help identify potential avenues for publication.

After you have identified a few promising possibilities, go to the library or Internet and scan some recent issues. Check the table of contents. Look inside the front or back cover of a printed journal, and on the home page or directory of an online one. When you have uncovered some promising possibilities, seek answers to some fundamental questions:

- What type of journal is it?
- What categories of papers appear in the journal?

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- Is the general topic of my proposed paper within the journal's scope?
- Is my topic represented in the journal frequently or only rarely?
- What is the journal's acceptance/rejection rate?
- How long does this journal take to publish papers? (How much is editing phase? How much is production phase?)
- What do rankings such as *Journal Citation Reports* indicate about this journal?
- What potential costs or other constraints need to be considered?

Nearly all journals will have two items of special interest – a statement of the journal's scope, and a variably titled set of editorial guidelines we've chosen to call *Instructions to Authors* or *ITAs*. Some printed journals publish these in every issue, others only annually (usually in the first issue of the year). Increasingly, they will appear on the journal's website. Do the scope and guidelines seem appropriate for the topic and type of paper you will be writing? Generally, if a journal is regularly publishing a number of papers on topics similar to yours, you stand a better chance of acceptance than if very few papers related to your topic have appeared. However, stay open to considering journals outside your field. Editors today increasingly seem to be accepting papers on the basis of their importance to the journal's audience, rather than on the basis of narrowly defined academic fields.

Read through the rest of the *ITA*. Note that some journals with scientific society sponsorship may require that an author or coauthor be a society member. Additional factors that might influence your journal choice include costs such as page charges and Internet access fees. These vary widely.

Consider impact factors and related indices

So you have a tentative journal choice . . . Will your colleagues see your paper if you publish it there? One way to determine whether scientists in your field are reading a journal is to examine journal citation reports through various databases such as ISI Web of Knowledge or *Journal Citation Reports*. These reports indicate how often the average article of a journal appeared in citations in other journals during a calendar year. Thus, they can provide a rough indication as to which journals within a given field are being more widely read.

Do they also provide a way to assess the relative importance of a journal? This claim is subject to continuing debate. There is little doubt that the scientific community views journals as having various degrees of status. However, like beauty, much of this may lie in the eye of the beholder. Despite repeated efforts, prestige has been a difficult matter to assess reliably. Relative intellectual influence certainly is not simply a matter of circulation – some