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Roger A. Brumback, MD

Scholarly activity is what distinguishes the academic physician from the nonacademic physician. Because decisions concerning hiring, as well as academic promotion and tenure, are generally based on such scholarly activity, there is considerable cynicism expressed by physicians about the process: "the object of science is publication," "publish or perish," or "promotion committees can count but not read." The system of physician education is partly to blame for this situation. From entry into medical school, students are tasked with memorizing the vast knowledge base of biomedical sciences and are given little opportunity for creative scientific thinking. As clinical clerks, and then as house officers, their tasks are to follow protocols for obtaining the symptom history, doing the physical examination, and performing various procedures or surgery. More senior trainees acquire some experience in teaching their junior colleagues. Thus, by the completion of training programs, physicians are good at clinical service activities and have done some teaching, and therefore, are well-equipped to enter a nonacademic practice. However, those choosing an academic career find that scholarly activity is more prized than the clinical service and teaching activities. Too often, the new academic faculty physician receives no mentoring on scholarly activities and is basically in a "sink or swim" situation. Even more problematic is the fact that scholarly activity is generally equated with publication in scientific journals.

The need for the published documentation of scholarly activity has resulted in a proportional growth in scientific journals. Since the publication of the first widely-circulated scientific journal[1]—the *Philosophical Transactions of the Royal Society of London*—in 1665, the number of scientific/engineering journals published annually throughout the world has grown exponentially to about 40 000. More than half of these publications, approximately 25 000, are biomedical journals, and therefore, just about anything can (and probably will be) published somewhere. Of course, it is impossible for anyone to keep track of this much literature, which is where indexing services come into play.[1] Rather than indexing everything, the *Index Medicus* (produced by the United States National Library of Medicine) instituted a system of evaluating publication quality before including a journal in its database. Currently, the PubMed index (the internet-based successor of *Index Medicus* at http://www.pubmed.gov) includes only about 5000 publications. Publication in one of these indexed journals is highly desirable, because it assures the greatest visibility to the scientific community.

The publications selected for PubMed indexing generally perform some degree of quality review of submitted material prior to publication. This assessment of manuscript quality involves "peer review" by scientists or clinicians with presumed expertise in the field covered by the manuscript, and this peer review system is the gauntlet that an academic physician must navigate to get an article published in a PubMed quality journal. Although the system of peer review has often been criticized, no better alternatives have been developed. Many high profile academic journals can have rejection rates exceeding 90%, but rejection rates for the majority of peer review journals approach only 50%. Beginning academic physicians often find little success in running this peer review gauntlet and abandon the effort. This is unfortunate, because preparing an acceptable manuscript is no more complicated than activities associated with medical school and house officer training. However, some instruction is required for success in scholarly activity. Although numerous books and articles have been written about the techniques involved in scholarly endeavors culminating in manuscript preparation,[2-54] mentoring from successful academicians is far more useful in guaranteeing success.

It is vital to understand that the journal editor and reviewers probably do not know the article authors; thus, the submitted manuscript will provide them with their first impressions of the authors. This first impression is critical to success in the peer review process. Just as one

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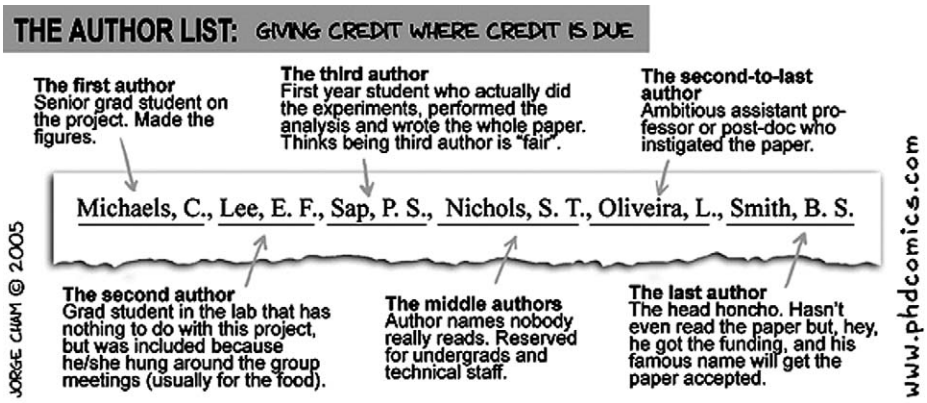

Figure 1. Satirical view of scientific authorship in a comic panel reproduced by permission from *Piled Higher and Deeper* created by Jorge Cham (http://www.phdcomics.com).

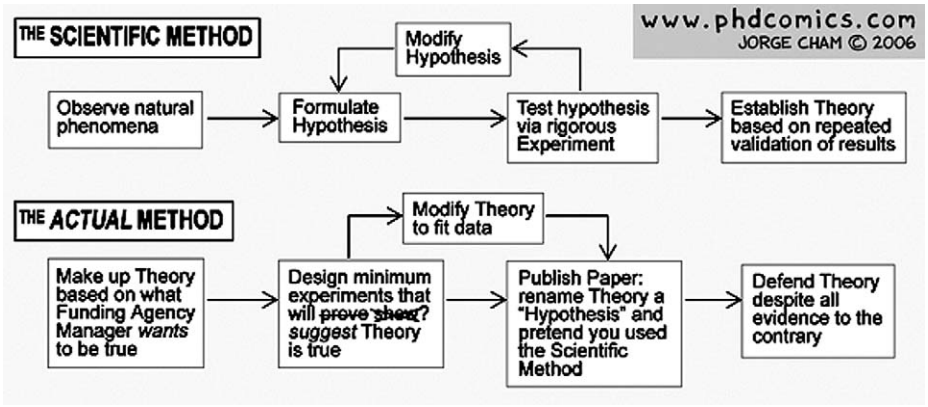

Figure 2. Satirical view of methodology in comic panel reproduced by permission from *Piled Higher and Deeper* by Jorge Cham (http://www.phdcomics.com).

would not appear unkempt for a first job interview, the submitted manuscript should be as perfect as possible to assure a good first impression; authors only have this 1 chance to make a good first impression on the editor and reviewers.

Before writing begins, one of the more important decisions is about authorship.[22] Editors find it disappointing to receive a note indicating that "we left off this author's name" or "Dr ___ wants his name removed as an author." These statements raise suspicions concerning controversy among the authors about the validity of the data. Authorship should be designated for those who contributed to the investigation or the writing of the manuscript (Figure 1), and some journals now require that each author describe his or her involvement in the work. Order of authorship also needs to be decided early—the first author is the most important and should be the major contributor to the work. Text quotations of an article generally only cite the first author followed by "et al," highlighting the importance of the first author position. In bibliographies, the names of just only the first 3 authors are usually listed followed by "et al," indicating that order of the names is of some importance when many authors are involved. The last author of an article is often considered to be the overall leader of the laboratory and sometimes that last author (rather than the first author) will serve as the corresponding author to handle all communications with the journal editor. Honorary authorship or authorship just for being the department chairman or institute director should be avoided.

Providing an answer to a specific question should be the focus of the scientific investigation, whether the answer is derived from laboratory (bench) research or clinical case review. This can be a difficult concept for many young academicians to understand (Figure 2). Formulating the scientific question to be addressed must be done

Figure 3. The incorrect way to begin a scientific manuscript as shown in comic panel reproduced by permission from *Piled Higher and Deeper* created by Jorge Cham (http://www.phdcomics.com).

early, preferably before starting the investigation, but certainly before any manuscript preparation is undertaken. This scientific question to be addressed should be the reason that the investigation or case study was undertaken and must be clearly stated. The answer to this scientific question should be the reason that the information in the article will be of use to other physicians or scientists and is why the article is submitted to a journal for addition to the worldwide medical/scientific literature. For example, the PubMed search tool lists over 11 000 articles about epilepsy—why then should another article concerning epilepsy be published? Just because a case is interesting enough for a hospital clinical conference or grand rounds does not mean an article about it deserves to appear in the medical literature. An author must identify that the material for publication addresses a specific scientific question that has thus far not been answered in the medical literature. It is also imperative to keep that scientific question in mind throughout the preparation of a manuscript.

From the beginning, the manuscript must be prepared in an organized format. The standard manuscript will include (in order) title page, abstract page, introduction, case summary/methodology section, results, discussion, conclusions, acknowledgments, bibliography (reference citations), table pages, and figure legends page. However, the manuscript should not be written in this order (Figure 3); instead the case summary/methodology section must be written first.

Because it is the first part of the work performed, the case summary/methodology section needs to be written before anything else. A clinician first evaluates the patient; therefore, the case summary should be prepared from the results of this patient interaction. The case summary should be thorough and biographical and should paint a complete word picture of the patient. The case summary description should be vivid enough for any reader (particularly someone who is unfamiliar with the scientific or medical field) to generate a clear mental image of the patient. Having a colleague unfamiliar with the patient proofread the case summary can help assure the completeness of the description. Including all details in the case summary is important, because information that seems trivial or unimportant now could prove critical for future investigators studying the same problem.

The methods are what the investigator employs to perform research studies and therefore the methodology should be written before the rest of the manuscript. The methodology section must be complete, including all steps in the process, and preparing the methods section while the investigation is ongoing will assure that no steps are omitted. The methods section should be thorough and must include overall design, detailed description of subjects and materials analyzed, all interventions, specifications of any equipment and supplies, exact measurement procedures, and the types of statistical analyses used. Do not assume that readers know the methodology used, even if the techniques have been widely applied by investigators. An analogy would be providing a recipe for chocolate chip cookies; if the recipe omitted the ingredient of chocolate chips, cookies prepared from that recipe might be very tasty, but would not be chocolate chip cookies. The inclusion of all steps in the method is important to assure that anyone else can duplicate the processes used and confirm the reported findings. The exact type of statistical analysis performed on the data must be specified, particularly because many journals nowadays use statisticians as peer reviewers.

The results section should be prepared second and should carefully detail the findings. Do not write the results section until after all information is available and all data collected and thoroughly analyzed. The description of findings needs to be clear and concise. Do not omit or "select" findings. Report all findings in an honest and straightforward manner. Organize the findings in a manner that facilitates reader understanding. Carefully construct tables, figures, and charts to help the reader

comprehend the results (see Appendix). These tables, figures, and charts should be able to "stand on their own" and be understandable without reading the text of the article. In the current era of computer projected presentations (using Microsoft PowerPoint), lecturers often include (in their slides) tables, charts, and figures excerpted from published articles; therefore, authors should strive to construct tables, charts, or figures that speakers will want to insert into presentation slides.

The discussion section should be prepared after completing the results section.[20,38] The discussion has to relate to the findings reported in the results section and should provide an answer to the scientific question that prompted the study. The discussion must demonstrate the importance of the work and how it will add to the worldwide medical/scientific literature. Too often, authors do not clearly describe the scientific question or hypothesis that prompted the work but instead expect that readers will somehow deduce the importance of the material; unfortunately, reviewers, and readers will not make the effort to do so (authors need to heed the saying: "if you don't tell us, we'll never know"). The discussion section should not just repeat the results section and should not offhandedly provide additional results (such as "we also did this additional study and it showed . . . ").

The discussion section should not be "one-sided" and must document all "pro" and "con" evidence from the literature. This requires the author to perform a thorough literature review (not just articles from recent years or those that are readily available online), documenting both supportive and contradictory reports. Authors must demonstrate how their article adds new information and why any contradictory reports were in error. All citation of previous literature must be accurate and derived from the original sources (not from the frequently incorrect citations or quotations by others). Authors need to be aware of the "Murphy's Law" for citations: the author of an improperly cited article will be one of the peer reviewers of the submitted manuscript. The end of the discussion section should contain a conclusion that summarizes the importance of the findings.

After completing the discussion, the introduction section should be written. For most biomedical literature, the introduction should be short and clearly state the scientific question addressed by the study (this is in contrast to articles in the psychosocial literature, which often have long introduction sections). The introduction section serves as a teaser to draw the reader, making the reader want to read the rest of the article.

The acknowledgement section should list all grants and commercial support and indicate any potential conflicts of interest (which should also be listed on the title page). Disclosing a conflict of interest does not automatically make an article unacceptable, because readers will be able to determine the extent of bias in the published material. However, concealing a conflict of interest almost always indicates significant bias that raises questions about the validity of any findings. The acknowledgment section should also be used to list individuals who assisted with the work but did not merit authorship. Some journals now require that each author's role in the work be detailed in the acknowledgment section.

The bibliography (reference citations) must be accurate and should be prepared from original sources. References in the bibliography need to match the citations noted in the manuscript text. Citation format should follow the style of the journal to which the manuscript will be submitted.

The abstract should be prepared last. Because the abstract is used in indexing databases (such as the PubMed database), it will be the initial information about the article available to most readers. A mistake often made by investigators is to copy a meeting abstract into the final manuscript. Often, however, additional analyses have been performed since that abstract was prepared and the abstract does not match the information reported in the manuscript. Thus, it is imperative that the abstract be a succinct and complete summary of the completed article.

The title of the article needs to be catchy and stand out to other investigators doing a literature search in any of the indexing databases (such as the PubMed database). The title can make or break an article and should indicate what is unique about the information provided in the article.

Authors must recognize that the journal editor has tremendous discretion regarding the fate of a submitted manuscript, making the editor's first impression critical to the success of any submitted material. Submitted material should never appear to be a draft. It must be polished and final and as nearly perfect as possible. Sloppiness in preparing and submitting the manuscript implies that the author is careless. A sure means of alienating an editor and guaranteeing failure is to submit a manuscript unmodified from a previous rejection by another journal. Editors and reviewers are generally shrewd enough to identify this and are not tolerant of such behavior.

An author should carefully review recent issues of the journal to determine appropriateness of the submitted material for that publication. Too often, authors select journals for submission based on high impact factor or reputation without determining whether the material would be consistent with articles generally published in that journal. Nowadays, the electronic online availability of most journals means that the published article will be widely available for viewing and citation even if published in a lesser known but more appropriate journal. Authors should follow all instructions for authors (including the uniform requirements of the International Committee of Medical Journal Editors: http://www.icmje.org/) and be

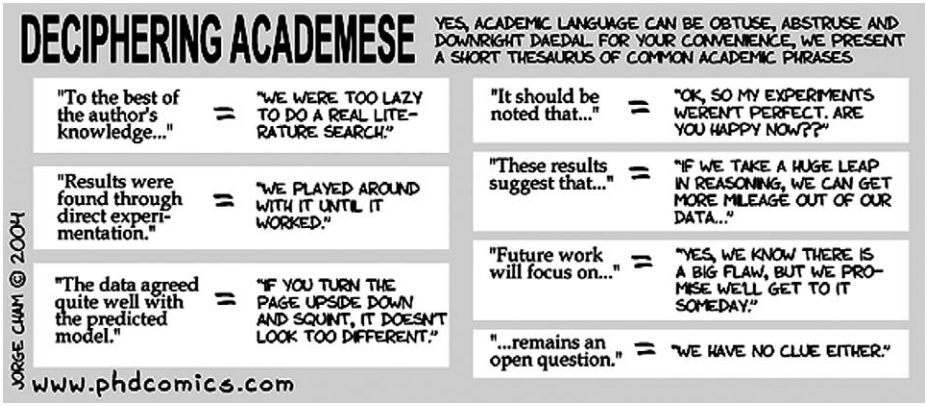

Figure 4. Satirical view of academic jargon in a comic panel reproduced by permission from *Piled Higher and Deeper* created by Jorge Cham (http://www.phdcomics.com).

certain that the article conforms to the format of articles recently published in that journal. A query can be sent to the journal editor if any of the instructions are unclear. Journal editors are often favorably impressed by a cover letter describing the importance of the information in the article and indicating why the submission is appropriate for the journal (for example, mentioning previously published related material or published articles in similar format).

During the second half of the 20th century, authors became increasingly enamored with the use of abbreviations (possibly in an attempt to save print space). Unfortunately, this use of abbreviations and acronyms has rendered many articles unintelligible by those not familiar with the particular abbreviations. Such jargon-saturated language suggests that the article is written for and only to be read by those in the same "clique" who speak in the same private foreign language of "abbreviobable."[23] Authors should write for the broadest possible audience among the medical/scientific community, something that is best accomplished by making the material understandable by everyone. Listing or identifying abbreviations used in the text does not make the text any more readable, because the reader must constantly interrupt the flow of reading to look up the identity of the abbreviation. Thus, abbreviations and acronyms should be avoided unless those abbreviations or acronyms have themselves become words (for example, DNA is now more familiar as a word than what it stands for—deoxyribonucleic acid).

Before submitting the manuscript, it is imperative that the author carefully proofread the text to confirm the proper use of English grammar. For nonnative English speakers, it is important to enlist the assistance of a native English speaker in this proofreading process to verify proper English usage and syntax.[54] Although spelling errors can be avoided through use of the "spell check" feature in most word processing software programs (an addin medical/scientific dictionary can greatly improve the procedure), careful proofreading is still necessary to avoid mistaken use of correctly spelled words (for example: "four" instead of "for"). Authors should take a cue from the Nobel Prize winning American author Ernest Hemingway (1899-1961), whose work is so clearly and simply written that it can be readily enjoyed by readers of all ages as well as those whose second language is English (Figure 4).

Authors need to realize that journal editors and reviewers volunteer their time and are usually not paid for the efforts. Thus, evaluating inappropriate or poorly prepared material wastes their valuable time. Often journal editors and reviewers will actually feel insulted by an author who submits an inappropriate manuscript, ignores journal instructions for authors, or otherwise prepares unacceptable material. Remember, a submitted manuscript is the author's introduction to the journal editor and reviewers.

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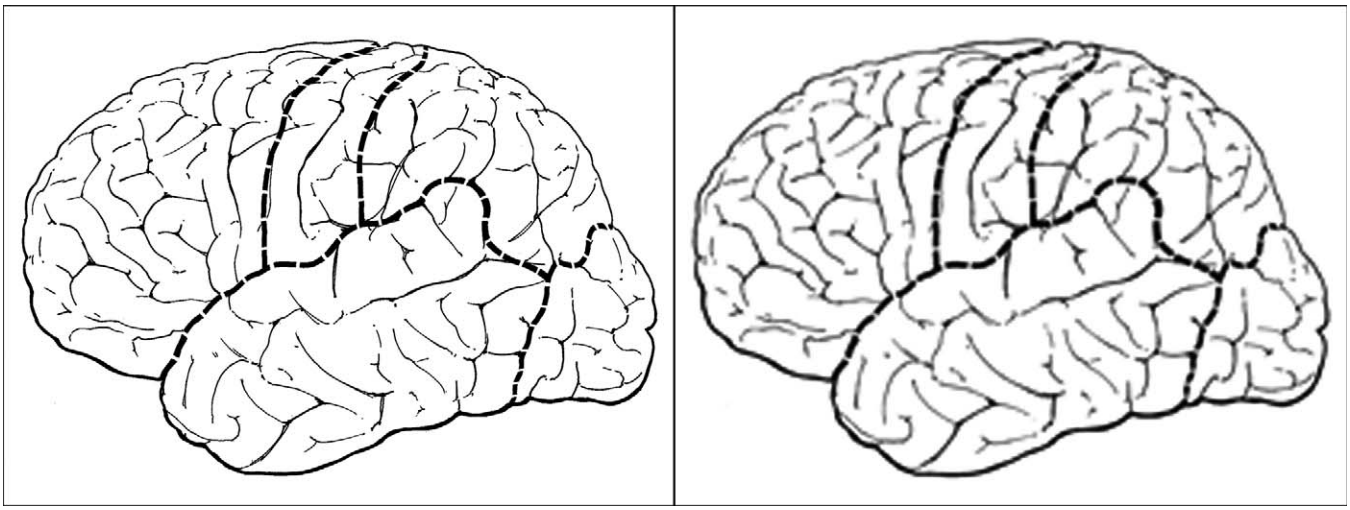
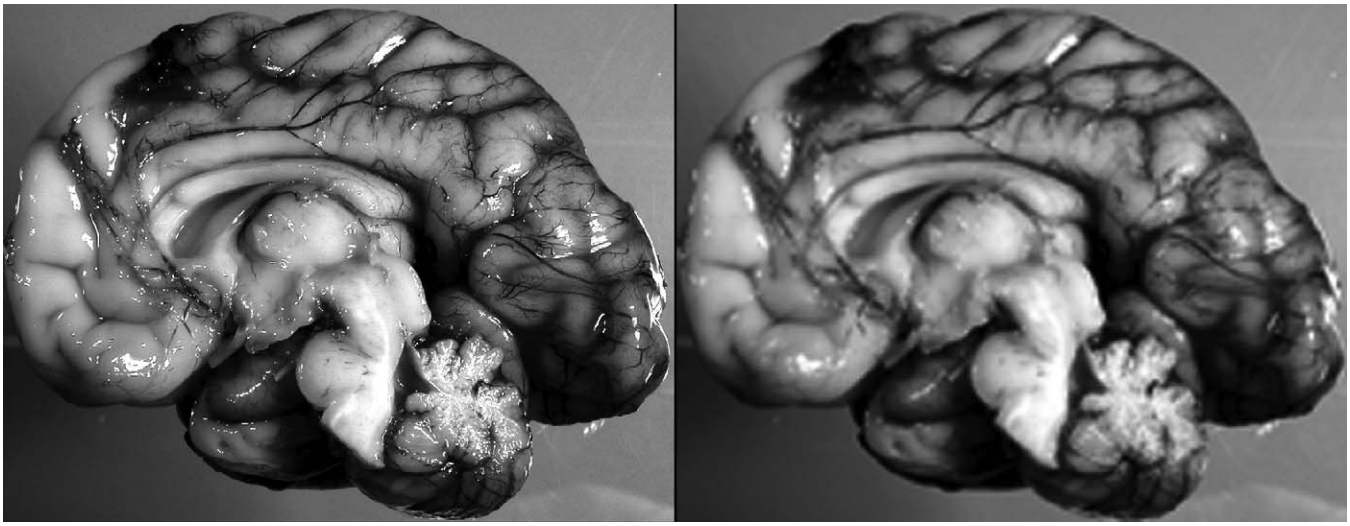


Appendix Figure 1. Line drawing of brain produced at printer resolution (left panel) and computer screen resolution (right panel). Note fuzziness in the printed version of the computer screen resolution image.

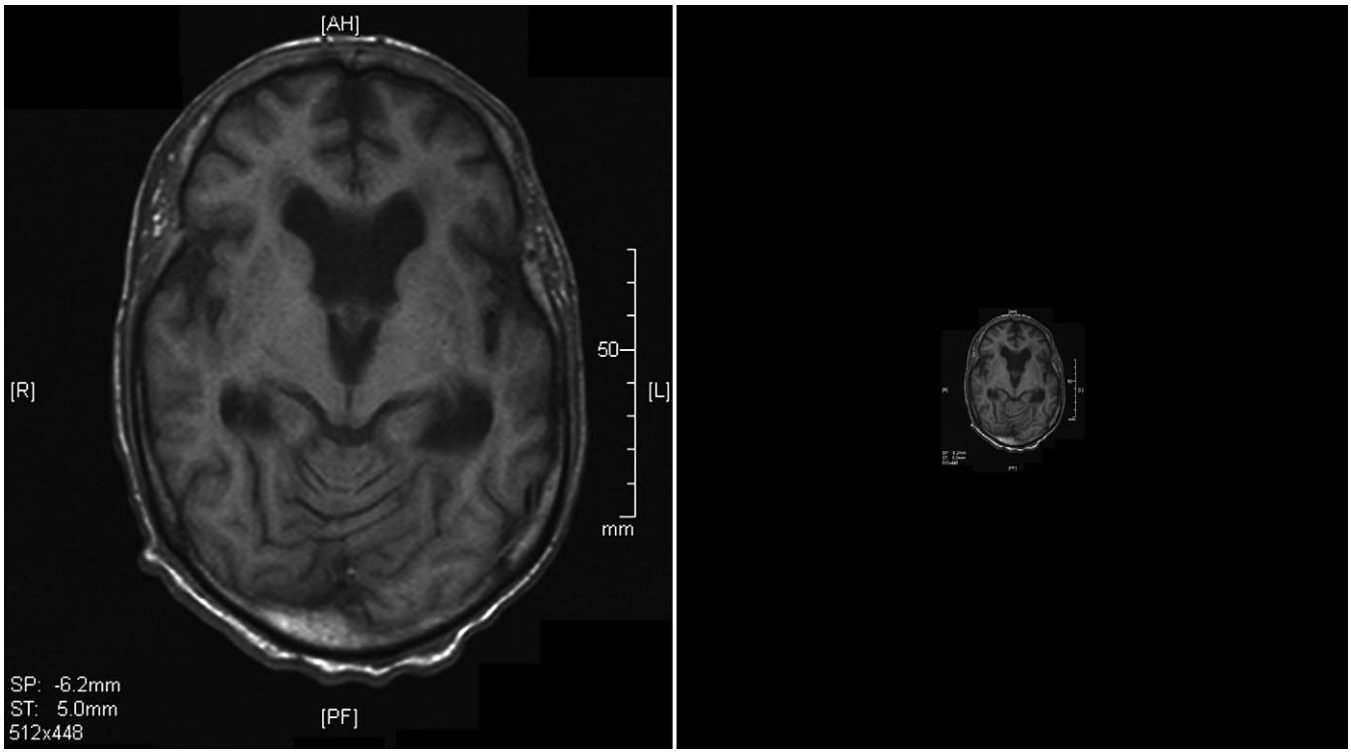


Appendix Figure 2. Sagittal view of neonatal brain produced at printer resolution (left panel) and computer screen resolution (right panel). Note fuzziness in the printed version of the computer screen resolution image.

Appendix

Figure Preparation

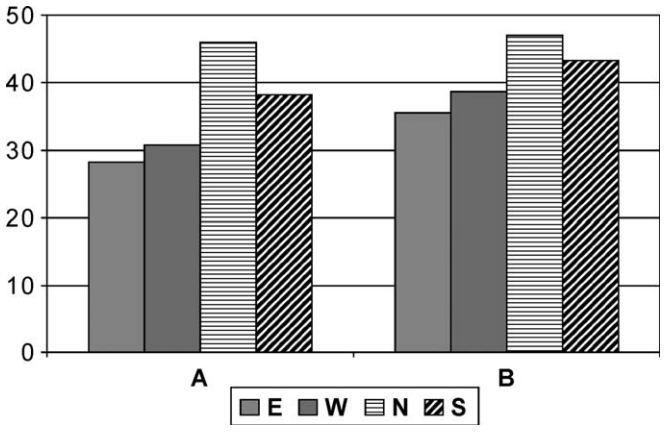
In the past, figures prepared for publication were photographed and printed before submission to a journal, allowing the author to view the images for clarity. Nowadays, figures are prepared on computer screens and submitted electronically, which creates problems in ensuring appropriate resolution for publication. Both computer screens and printers use the same technique of creating an image (and text) out of multiple closely spaced dots (viewing newspaper text with a magnifying lens demonstrates these dots). The major problem is that computer screens display images at a resolution of 72 dots (pixels) per inch (often abbreviated as "dpi" or "ppi"), while print resolution is 300 to 600 dots per inch. Thus, an image that appears large and sharp on a computer screen will be fuzzy if printed at the same size and would only be sharp if printed at postage stamp size (see Appendix Figures 1-3). On most modern computer screens, the display image is 1024 pixels in width and 768 pixels in height. An image filling that screen, if printed at a resolution of 300 dots per inch would be 3.4 inches wide and 2.5 inches high, but if



Appendix Figure 3. Magnetic resonance imaging (MRI) from a patient with septo-optic dysplasia. Original image size is 512 × 448 pixels (as noted in the left lower corner of the left image), which is fuzzy when enlarged to print size; the right panel shows the image size if reproduced at printer resolution.

printed at 600 dots per inch would be 1.7 inches wide and 1.3 inches high. Thus, what looks beautiful on a computer screen will not necessarily produce an appropriate image for publication. Publishers of high quality journals prefer images that will appear sharp when printed at a resolution of 600 dots per inch. Because journals generally have a single text column width of 3.5 inches (and a full text page width of 7 inches), a single column image should be a minimum of 2100 pixels in width (calculated by multiplying 600 dots per inch by 3.5 inches). Most commercial photo editing software programs identify the image size. (However, authors must avoid the temptation to "improve" images using photo editing software programs.[55-59]) Authors should always preview figures for clarity of detail by printing the image on a laser printer at the proposed size for journal publication.

Another consideration is the digital image file format used for the figure. Various computer software algorithms have been developed to reduce the image file size to conserve storage space. Although some of these algorithms provide faithful reduction of the image file with no loss in quality ("lossless compression"), other algorithms discard information causing potential loss of image quality ("lossy compression"). The 2 most commonly used algorithm formats are the tagged image file format (TIFF files with filename extensions ".tiff" or ".tif") and the joint photographic experts group (JPEG files with filename extensions ".jpeg" or ".jpg"). The JPEG file format is used in many digital cameras because it permits greater compression (smaller file size), but the compression algorithm



Appendix Figure 4. Graph comparing gray scale and line art. Note that the bars for "E" and "W" are difficult to distinguish even though the gray levels are different ("E" gray level of 147 and "W" gray level of 169), while the line pattern in bars "N" and "S" are readily differentiated.

produces lossy compression, which reduces quality and makes it less acceptable for scientific images. Files in the TIFF format are large but have no loss of quality (lossless compression) making them ideal for scientific images; additionally, the TIFF format is the standard in the printing industry. Figures should never be imported into document (text) files, as this greatly reduces their quality.

Authors must also choose whether to use color images. Many journals now accept color figures, but usually at an additional cost to the author, because color printing is more expensive and technically challenging than black and white printing. Color images must be carefully prepared to assure proper shading and balance of color when printed. Another drawback of color figures is that color blind readers (at least 1 in 20 men of European ancestry) will have difficulty interpreting the images. For most publications, black and white images are preferable and readily demonstrate necessary information. Two forms of black and white images are possible: grayscale and line art. Grayscale images have 256 levels of shading from black (level 0) through shades of gray to white (level 255). In contrast, line art has only 2 levels—black or white. Grayscale is useful for pictures with variable areas of light and dark (for example, patient photographs or computed tomography and magnetic resonance images). Because distinctions in the 256 gray scale levels are often difficult to discern in printed material (Appendix Figure 4), line art is preferable for graphs and charts (for example, electroencephalogram tracing or bar graph chart).