

## Image Manipulation

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Image manipulation. Sounds evil, doesn't it? In an unscrupulous author's hands, it can be, but an ethical author, illustrator, or editor may manipulate an image to improve communication. Other alterations may be inadvertently introduced. Some images, however, are intentionally falsified. Questioned images were involved in 2.5% of cases investigated by the Office of Research Integrity (ORI) in 1989-1990 but 44.1% in 2005-2006.

Computerized graphics have improved visual representations. We can now visualize structures too big (outer space) or too small (macromolecules) to see unaided. We can use data to create models (Visible Human Project: [www.nlm.nih.gov/research/visible/visible\\_human.html](http://www.nlm.nih.gov/research/visible/visible_human.html)). Adding CDs allows for three-dimensional models that can be rotated. Perhaps the largest stride is interactivity, such as Richard Schwartzstein and Michael Parker used

in *Respiratory Physiology* (Lippincott Williams & Wilkins; 2005). A Web site ([www.medicalexplorer.org/preview/main.asp](http://www.medicalexplorer.org/preview/main.asp)) accompanying the text lets readers interact with diagrams, changing factors to understand effects.

Such techniques are useful when undertaken by skilled, knowledgeable people. Unfortunately, authors are sometimes unfamiliar with graphics, including such concepts as resizing versus resampling, vector graphics versus continuous-tone images, CMYK versus RGB, file formats, and resolution. Authors may not understand what publishers need, so staff must bridge the chasm. Image-editing software was designed for graphics professionals, and learning these programs can be difficult for others. More image-editing options exist than ever before, but schools have been slow to offer training. Many authors cannot find a graphic artist or cannot afford one. Hence, authors are often self-taught and may unintentionally manipulate images. They know that some techniques are possible but not how to use them appropriately, often producing figures that look fine but that a journal cannot use.

To combat those problems, clear author guidelines are a must. Use terms authors know, and explain how to meet requirements. Remember that few authors read guidelines; those who do are seeking instructions about specific items. Encourage authors to check the guidelines, and notify authors (via e-mail or the journal's Web site) of changes. The *Proceedings of the National Academy of Sciences* guidelines ([www.pnas.org/misc/digitalart.pdf](http://www.pnas.org/misc/digitalart.pdf)) are an excellent example.

When interacting with an author, determine the author's skill level. Asking how the figure was produced can aid in determining how to fix it. Preparing FAQs for frequent problems saves everyone's time, as does keeping examples of good and poor images.

Above all, stay flexible. Editors both provide technical support and share the graphic artist's job with the author, so

it's important to know about various file formats (even those the journal doesn't accept), so that alternatives can be provided.

Digital technology facilitates the intentional falsification of images, because one person can handle the entire process. However, software used to alter images can be used just as easily to detect manipulation. Keys to detecting manipulated images include noticing when an image "just doesn't look right". Features may be duplicated and sometimes rotated to disguise their reuse. Areas of random "noise" in the background that should differ may appear the same.

Other ways to identify an invalid image include increasing visibility of details. A computer can amplify small grayscale differences that the eye cannot discern. Applying a "gradient map" can reveal selected alteration of the background or unusual features in components. Greatly expanding the contrast of light (underexposed) or dark (overexposed) images may reveal an altered background. If there is no background, inspecting morphologic features can expose questionable items.

Those techniques do not prove falsification, just that something "isn't right". It is not the journal's role to determine whether the image shows false data and, if so, whether it was intentional. Serious allegations should go to the research-integrity officer at the author's institution. ORI gives editors technical advice and on its Web site demonstrates ways to detect manipulated images ([ori.dhhs.gov/tools/data\\_imaging.shtml](http://ori.dhhs.gov/tools/data_imaging.shtml)). ORI has also identified appropriate institutional contacts for journals and can facilitate communication.

Two journals reported finding that about 1% of accepted manuscripts showed signs of dishonest manipulation of images and another 20% to 28% showed other questionable manipulation. Editors should consider what constitutes manipulation and how much manipulation is permissible. 🗨️