Article

Image Manipulation and the Editor: Tools to Prevent Unacceptable Alterations

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As staff of scientific and technical journals, our goal is to publish the most accurate, precise, and original information for our readers. Growing technical advances in electronic communication and digital imaging software make this goal increasingly challenging to meet. Programs such as Adobe Photoshop make it easy to perform any of a wide variety of alterations to an image such as add, delete, color, copy, stamp, paste, or clone. Whether unintentional or deliberate, authors may be tempted to use imaging software to 'touch-up' figures to make them look more attractive, cleaner, simpler, or to better reflect the desired result of an experiment. These actions pose a problem to editors dealing with raw scientific and technical data. Alterations made to images can be considered inappropriate manipulation of the original data and may be classified as research misconduct, especially if it falsifies the results of an experiment or study. Below are some general guidelines and tools editorial staff can use to help prevent image manipulation and ensure the accuracy and honesty of the data they publish.

The Journal of Cell Biology has pioneered this subject and initiated a dialogue among the scientific community. They have developed the following guidelines, which have been adopted by numerous science journals:

- "No specific feature within an image may be enhanced, obscured, moved, removed, or introduced.

- Adjustments of brightness, contrast, or color balance are acceptable if they are applied to the whole image, and as long as they do not obscure or eliminate any information present in the original.

- The grouping of images from different parts of the same gel, or from different gels, fields, or exposures must be made explicit by arrangement of the figure (i.e., using dividing lines) and in the text of the figure legend.

- If the original data cannot be supplied by the author upon request, the acceptance of the manuscript may be revoked."[1]

These guidelines are easily communicated to the journal's community through the 'Instructions to Authors' and can serve as a basis for the journal's image policy. It is important to draw the line between appropriate and inappropriate alterations because slight alterations are acceptable (for example, light contrast adjustments made to the whole image). Journals should recommend any alterations be specified in the figure legends. The editors can then decide whether these statements are needed at the time of publication. The Rockefeller University Press has outlined two types of

1. Rossner, M., & Kenneth M. Yamada. "What's in a picture? The temptation of image manipulation." *The Journal of Cell Biology,* Volume 166, Number 1, July 5, 2004 11-15.

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digital image manipulation: inappropriate and fraudulent. Inappropriate manipulation is defined as alterations to an image that violate the journal's guidelines but do not affect an author's results. One example is adjusting the contrast levels so the background of a gel or micrograph disappears. Fraudulent manipulation refers to alterations that affect the interpretation of the author's data. An example would be deleting a blot or adding a band from a different gel.[2] Mike Rossner's article, "What's in a picture? The temptation of image manipulation" provides useful examples and illustrations of appropriate and inappropriate alterations of data. Actively screening figures in accepted manuscripts for possible signs of manipulation is an effective step in the production process to ensure accurate, publishable data. No special tools are needed to screen figures besides basic imaging software, such as Adobe Photoshop. It is also a quick process that takes just a few minutes. After receiving an author's figures in the office, it is difficult to work backwards to see how the image was created. However, altered images often have inconsistencies that can serve as red flags for those screening for manipulations. John Krueger at the Office of Research Integrity explains that you should ask whether an image is 'inauthentic' or 'inconsistent' with how the experiment was purportedly done. The goal is to then identify the inconsistencies and address the possibility of an alteration.[3]

Journals should ask that figures have a high resolution and minimal compression so the detail is not compromised and artifacts are not introduced. It is also helpful if the images have good detail and a full range of grayscales.[3] It is especially necessary to screen gels, blots, and micrographs for signs of manipulation. You should look at the overall figure and note if anything looks selectively smudged, spliced, erased, or faint. If you are screening blots, note if any of the lanes inexplicably differ in width from the one next to it. 'Orphaned' groupings of bands inserted in different lanes or different rows should be explained.[3] It is a good idea to magnify the image you are checking, then if necessary, further magnify a particular area if it looks questionable. Begin by adjusting the contrast and brightness levels (found under Image -> Adjustments -> Brightness/Contrast in Photoshop). These levels show the most detail when the contrast is raised and the brightness is lowered. The 'Curves' routine is a particularly revealing way to change contrast (Image -> Adjustments -> Curves).[3] While adjusting these levels, look for inconsistencies in both the data and the background, such as areas that may have been smudged or erased. Also look for any areas of the image, which may be repeating, especially in the background. Watch for sharp edges, circular patterns (thumbprints are OK) or discontinuities.

For color images such as fluorescent confocal microscope images and for

2. The Council of Science Editors. CSE's White Paper on Promoting Integrity in Scientific Journal Publications. Identifying Research Misconduct and Guidelines for Action. 3.4 Digital Images and Misconduct. http://www.councilscienceeditors.org/editorial_policies/whitepaper/3-4_digital.cfm.

3. John Krueger. Scientist-Investigator, Division of Investigative Oversight. Office of Research Integrity. Personal Communication, March 13, 2008 and June 9, 2008.

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zymography gels, where the blots appear white and the background is black, you should use the 'Levels' slide (found under Image ->Adjustments->Levels) or Equalize (Image -> Adjustments -> Equalize) to check for inconsistencies.

The Gradient Map (Image->Adjustments->Gradient Map) is also a useful tool in checking for manipulation. The Gradient Map shows the most dynamic range of intensities and maps the shadows, midtones, and highlights of an image using a variety of colors and selectively enhances areas of weak contrast. Make sure to explore the different gradients and color patterns available in the Gradient Map to utilize its full potential.[3]

Note if an image does not have background. It may be hard to detect background in an initial viewing; however, after magnifying the figure and adjusting the contrast levels, the background should have different tones. Blots should have a grainy, random, amorphous background.[1,3] While it is acceptable to adjust the brightness or contrast of the whole image, an adjustment that makes the background fade or drop out completely is unacceptable, since this trick may be used to hide signs of splicing. Although some authors are not concerned about the data in the background and state it does not affect their results, it is still a concern to editorial staff. Readers may be interested in different parts of the figure, not just the highlighted data. The background of an image must also be free of empty, washed out spaces or inconsistencies. Inconsistencies in the background may also point to intentional manipulation of the author's presented data, such as a repeating gel.

Photo-editing has also been used to falsify physiological traces and scatter grams of flow cytometry (FACS) data. The random nature of the noise in the recordings or positions of the points in FACS data should never be the same in two separate measurements.[3]

If an author's figures are questionable, it is suggested the editors request the original data from the authors and compare it with the previously submitted figures. The Journal of Cell Biology reports since they have initiated the screening of accepted images in 2002, about 25% of all accepted manuscripts have had one or more illustrations that have violated the journal's guidelines. Most cases were resolved when the author presented the original data. In 1% of cases the authors may have engaged in fraud.[4] These screening methods only detect inconsistencies, they cannot verify the authenticity of an image. It is crucial the authors retain their original work and can present it if questioned. Only the original data can authenticate a figure if a question about images arises, even if the manipulation was well intentioned.[3]

New software is being developed that detects alterations made to scientific images. There are currently at least two commercial programs that detect image manipulation, but they have not been refined and can only detect manipulation under ideal circumstances. The sophistication of imaging technology will surely increase; however, manipulations will always be constrained by the clues left behind after an alteration is made.[3] Editors should take a proactive approach to address the possibility of image manipulation in their journals.

4. Wade, Nicholas. "It May Look Authentic; Here's How to Tell It Isn't." New York Times. January 26, 2006.

Article

Image Manipulation *continued*

As more editorial staff become aware of this issue and are educated on the tools used to prevent manipulation, the scientific community can continue to ensure the accuracy and honesty of the data it publishes.

Further reading:

Rossner, Mike and Kenneth M. Yamada. "What's in a picture? The temptation of image manipulation." The Journal of Cell Biology, Volume 166, Number 1, July 5, 2004 11-15. http://www.jcb.org/cgi/doi/10.1083/jcb.200406019.

The Office of Research Integrity. http://ori.dhhs.gov/.

The Council of Science Editors. CSE's White Paper on Promoting Integrity in Scientific Journal Publications. Identifying Research Misconduct and Guidelines for Action. 3.4 Digital Images and Misconduct. http://www.councilscienceeditors.org/editorial_policies/whitepaper/3-4_digital.cfm.

Young, Jefferey. "Journals Find Fakery in Many Images Submitted to Support Research." The Chronicle of Higher Education. May 29, 2008. http://chronicle.com/free/2008/05/3028n.htm.

President's Message *continued*

lucky if I get to personally visit with the people I work with even once a year. We e-mail and talk on the phone regularly, but it is not the same as having face-to-face contact. We are all in different time zones, going in different directions, and coming together only briefly at different times during the life of a manuscript. Isolation is a daily challenge.

Of course I also have absolutely no idea how other journals or publishers are operating. The virtual, distributed workflow world is not only isolated (and isolating), it is insular. Being ignorant to the goings-on and developments in our industry is dangerous because it means I am not fully tied into my industry and, therefore, probably not working at peak efficiency.

Thanks to ISMTE, though, professional isolation is becoming a thing of the past. Now I am part of a brand new and energized community of colleagues and like-minded individuals who face the same challenges as I do every day.

Case in point. At the inaugural ISMTE London and Baltimore conferences held in the spring, I was thrilled to meet more than 60 editorial professionals from a variety of backgrounds and publishers. I had no contact whatsoever with these people before—we were all operating in our own far-off islands of authors and reviewers, editors and publishers, manuscripts and page counts. Now, however, these are my new friends and colleagues with whom I can interact, learn from, and grow professionally. Eureka—I am not alone!

I am grateful that ISMTE has come along and is taking off so quickly. The timing could not have been better. My place in publishing has additional meaning and purpose thanks to ISMTE, and I look forward to growing professionally along with the Society.

Taylor

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