



Digital images and the problem of inappropriate manipulation: Can you believe what you see?

by Irene Hames

Until relatively recently, images for publication were prepared and submitted as photographs. Altering these was difficult and required considerable technical skills and access to darkroom facilities. Readers could therefore feel fairly confident that what they were seeing was genuine. This has all changed. The general availability and affordability of digital cameras and image-processing and -editing software (such as Adobe Photoshop) means that it is now very easy for anyone with access to these to alter the images they have captured. Some of the changes made may be subtle—done, for example, to create the flawless complexions and perfect facial features we see in the advertisements in glossy fashion magazines. In other cases the changes may be drastic, and result in surreal and bizarre images. A look at the image manipulation and contest website Worth1000 (www.worth1000.com, so called after the saying ‘a picture is worth a thousand words’) will show the incredible range of images that users of the site come up with and submit to the various themed contests. Such image manipulation is fun and mostly harmless. But what happens when image manipulation isn’t appropriate, for example in the reporting of experimental data? How can we trust that what we’re seeing is a true representation of the results?

It is the responsibility of editors to ensure that the work they publish in their journals is sound and that the integrity of the scholarly record is maintained; that it is not contaminated with incorrect or fraudulent work. In today’s culture of easy image manipulation, it is critical that the images being submitted are a true representation of the results of the experimental work carried out. It has become clear, however, that this isn’t always the case. Unfortunately, although awareness of the problem of inappropriate image manipulation is increasing, many journals and editors still don’t know about the issue, or if they do, are not sure what they can do to deal with it.

Inappropriate image manipulation in scholarly reporting

The *Journal of Cell Biology* (*JCB*, www.jcb.org) was one of the first journals to recognise the potential problem of

inappropriate image manipulation and is at the forefront of the effort to educate the scientific community on what is and what is not appropriate manipulation in scientific reporting. The *JCB* created standards because the community had not done so, and is owed thanks for this. An excellent article on the topic was published in 2004, co-authored by the journal’s Managing Editor, Mike Rossner, and Editor, Kenneth Yamada [1]. It is very straightforward and readable, and just as relevant today as when it was first published. The issues are simply explained, and many examples of inappropriately altered images are provided. I encourage readers to take a look at this article, and also at the *JCB*’s guidelines to authors on image acquisition and manipulation (<http://www.jcb.org/misc/ifora.shtml>).

Why do researchers alter images before submitting them? Part of the explanation probably lies in the trend to ‘data beautification’ [2] and the desire, perhaps unconscious, to present perfect images because others are doing this. There is also likely the fear that anything less than perfect will be at a disadvantage. The ability to create an image that a researcher ‘knows’ is a true representation but just hasn’t been able to capture can lead down a dangerous and slippery slope, resulting in fraudulent behaviour. Witness the recent case of the award-winning photo in which the members of a herd of an endangered Tibetan antelope species (the chiru) were pictured running alongside a high-speed train on China’s new and controversial Qinghai-Tibet railway, seemingly unaffected by the noise of the train. There had been considerable protest from environmentalists during the construction of the line, with concerns expressed that the breeding grounds of the chiru would be threatened. The photographer who took the picture camped out on the

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Photograph of Qinghai-Tibet railway with rare Tibetan antelopes. Details of the story are available at http://online.wsj.com/public/article_print/SB120363429707884255.html [3].

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Tibetan plateau and waited for the antelope to run by at the same time as a passing train. When this situation didn't materialise, he decided to merge two separate images of the train and antelope using Photoshop. The resulting picture, supposedly taken in the summer of 2006 soon after the opening of the line, was published in many outlets worldwide before it was exposed as a fake early in 2008 [3].

What is the extent of the problem of inappropriate digital image manipulation in scholarly reporting? This is difficult to gauge because journals are only just beginning to start checking images, and relatively few currently do this. The Office of Research Integrity (ORI) in the USA has reported a growing incidence of cases of alleged scientific misconduct involving questioned images (i.e. those where there are suspicions of fabrication, falsification or plagiarism). In the two-year reporting period 1989-90 there were 3 cases opened, by 2003-04 this had risen to 21 cases [4]. The *JCB* has also carried out some analysis. During its first 3 ½ years of screening, 1% of the papers accepted for publication were found to contain fraudulent image manipulation, a worryingly high number. In addition, 25% had at least one figure that had to be redone because the manipulation carried out to create those figures violated the journal's guidelines [5]. It is clear, therefore, that there is a great need to educate researchers about what is and what is not acceptable. But because until recently there has been little awareness of the problem amongst journal editors and editorial staff, they haven't really been able to provide guidance to their communities. The situation has also been exacerbated because many senior researchers do not have the level of expertise with image-manipulation software that the junior members of their groups do. Based on personal experience, it is clear that some have missed that certain images presented to them by their students have not been true representations of the data obtained in their experiments. It is vital, therefore, that senior researchers always compare to the original unprocessed data every figure in every manuscript they submit for publication.

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What changes are allowed and which are not?

The two most basic rules when preparing digital images for publication are that:

Firstly, images should be prepared with as little processing as possible and they must be a true representation of the data at the time of acquisition.

Secondly, any digital effect should be applied to the whole image, and is only permissible if it doesn't result in any features being lost or selectively enhanced.

Putting this into practice:

1. Features must not be obscured, removed, or misrepresented, for example by adjustments in brightness and contrast in those areas, or as a result of applying a change across the whole image. Neither should features be added, for example by using cloning tools to duplicate existing ones, moved, or altered or enhanced with retouching or transforming tools.
2. It should be made clear when images have been obtained from different experiments or at different times or from different places. Such images should be separated by clear dividing lines or put into different boxes, and details given in the legend. They should not be spliced together into a composite that appears to be the result of a single experiment or to represent a single unaltered field of view.
3. The background must not be eliminated, either by excessive increases in contrast or brightness, or by using the clean-up tools available in image-editing software (such as the 'clone stamp' or 'healing brush' and other painting and retouching tools in Photoshop). There may be features in the background that might not only affect the current interpretation of the data, but whose significance might not be realised until some time in the future, when new discoveries are made and researchers revisit and re-examine earlier data presented in the literature.
4. All non-linear adjustments, such as changes in gamma settings, must be fully described, as here changes in colour and brightness do not end up being the same for every pixel in an image.

Any digital effect should be applied to the whole image, and should not result in any features being lost or selectively enhanced.

What are journals and editors doing to protect the integrity of the digital image record?

As mentioned previously, it is only recently that editors have started to become aware of the potential problems that might exist with the images authors are submitting to their journals. They are now beginning to address this issue, and authors should be aware that editors are acquiring the relevant knowledge and expertise. Image checking has become a possibility because many journals now have fully electronic submission and review workflows. However, it is time-consuming, especially as many images may be complex and contain a number of parts, and requires specially trained staff. Many journals aren't in the position of being able to devote the resources they would like to this, or that would be necessary to check every image submitted to them [6]. Some are therefore choosing instead to do random spot checks, perhaps on the images in one or two arti-

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cles in each issue, and to tell authors they are doing this, in the hope that this will act as a deterrent to intentional inappropriate manipulation. Some journals, however, most notably the *JCB*, have chosen to devote considerable resources to image checking and to look at every image in every accepted paper. There is also another consideration. Some editors feel that it is not the responsibility of journals to take on the role of ‘data police’ and that it is essential that a degree of trust must be maintained in the scientific community [6].

Image checking can be done using the same image-manipulation software packages that authors use to prepare images. Adjusting brightness and contrast can reveal background characteristics, make visible significant hidden features, and show if elements have been duplicated or brought together from different places—a patchwork effect is often revealed. Pixel irregularities on image magnification are another clue to suspect image preparation. Magnification can also highlight minute areas of similarity and so help identify duplications—some of which may have been reversed or rotated, perhaps to try to disguise the duplication. Examples of falsified images and how they were detected can be found in the article by John Krueger from the ORI based on a compilation of information from cases dealt with from 1990 to 2000 [7].

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Journals are starting to educate their communities and providing guidance on image preparation (see, for example, *Nature*, *Journal of Cell Science*, *Journal of Biological Chemistry*, *JAMA*). Most of the guidelines are based on those of the *JCB* (<http://www.jcb.org/misc/ifora.shtml>). Some journals are also asking authors to sign declarations that their images accurately represent their original, unprocessed data. If irregularities are found, an increasing number are requiring that authors provide the original data for examination. In these cases, journals then need to decide whether or not the manipulations made affect the interpretation of any of the data and advise authors as part of the review feedback. Guidance on how to detect and deal with image fraud is available from the ORI website (<http://ori.dhhs.gov>), which provides step-by-step instructions and forensic tools that can be used to screen digital images. Although it is not the role of journals to determine whether there has been intent to mislead and deceive, they need to decide what to do if the manipulations are serious and the explanations from the authors unsatisfactory. In such cases, editors may take the step of referring the matter to the author’s head of department, institute, or funding body for formal investigation. The Council of Science Editors provides some guidance on this, mentioning that “Although the ORI guidelines for editors indicate that cases of “suspected” misconduct should be reported either to the ORI or to an author’s institution, journal editors should attempt to resolve the

problem before a case is reported. This is because the vast majority of cases do not turn out to be fraudulent” [8].

What advice can be given to authors to help them avoid doing things to their images they shouldn’t?

Those working with authors to help prepare their work for publication are ideally placed to provide advice and guidance on how to avoid problems with images.

1. Authors should be aware of the issues surrounding digital image manipulation and what is and is not appropriate. Problems with images can cause considerable delays in a manuscript being sent out for review. If the review process has started, it may be put on hold until any suspected or alleged problems have been sorted out. If problems come to light after acceptance, publication may be delayed, or the original acceptance decision may even be revoked if issues can’t be resolved to the editor’s satisfaction.
2. Authors must take care how images are acquired, and that they are saved in the correct format and at the right resolution. They should be aware that increasing ‘resolution’ after image capture will effectively result in data being added because pixels that weren’t present in the original are added. The article by Rossner and O’Donnell [9] provides excellent and clear guidance on file formatting and image resolution, and advice on how to maximise image quality legitimately.
3. Authors should always keep their original, unprocessed data files. These may be requested by journals and if they can’t be produced, the decision to publish may be revoked.
4. Authors should keep a note of the equipment settings used to capture images and also of the various manipulations carried out to produce their final images. Journals are increasingly asking for this information to be provided on submission.
5. Authors should develop a good and systematic file archiving and labelling policy, one that all the members of their groups know and follow. In research, images may be filed and not accessed until the time comes to write up the work. This may be years later, so it is crucial that the images representing various samples, treatments, times, and so on can be readily identified. Archiving errors are one of the most common reasons authors give when discrepancies are found in images and editors request an explanation (Stop press! NB: <http://www.the-scientist.com/blog/display/55208/>).
6. Senior authors should always be aware of what the members of their groups are doing when producing images. They should view the original raw data, when first captured, not just the final images produced for publication, and feel satisfied that the latter are a true representation of the former. They should set standards and have guidelines in place to educate new members of their research teams.

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An extra tip to help authors increase the visibility of their work

It is always a good idea for authors to send a potential image or images for consideration for the cover of the journals where they submit their work if those journals feature images on their covers. Unless a journal gives specific instructions on when it would like to receive such images, this can be done at any stage of a manuscript's progress through a journal's workflow—from original submission to final acceptance. Many journals are very glad to receive images, especially good ones that have the potential to make stunning or beautiful covers, and will keep on file cover submissions until the time comes to make the choice for the issues in which those articles are scheduled to appear. A note of caution: authors should be careful not to send very large images by email—they can cause great problems and clog up email boxes, which won't endear an author to the editor. It is always best to send a low-resolution version and say that a high-resolution image can be provided if required. That can then often be uploaded to the journal's or publisher's ftp site. Cover submissions are one area where image manipulation is allowed (as long as data are not misrepresented and all manipulations are described) and can play an important role in creating images that have the level of impact editors like the covers of their journals to have. Artistic licence is not only allowed, it is encouraged!

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A public resource for sorting the hype from the evidence in science: Sense About Science

The Sense About Science website is the place to turn for a balanced view on scares and sensations in science reported by the general media. Sense About Science is an independent charitable trust based in the UK which receives input from a wide range of experts. With a motto of "promoting good science and evidence for the public" it has set itself the goal of responding to "the misrepresentation of science and scientific evidence on issues that matter to society". These issues cover a broad spectrum including alternative medicine, evidence-based medicine, GM and plant science, bird flu, MMR vaccines, stem cell research, and weather and climate. A series of briefing documents 'Making sense of...' can be downloaded from the site on such topics as health testing and—intriguing even if you don't happen to be one—there is a guide on science for celebrities. Medical writers might be particularly interested in a downloaded pamphlet on peer review with the appealing title 'I don't know what to believe...'

This site is easy to navigate and refreshingly readable. It's more than an excellent resource for anybody who falls short of being an expert on every aspect of science in the news—it's fascinating.

Sense about Science URL: <http://www.senseaboutscience.org>.

Themes of upcoming issues of TWS

The March 2009 issue will have a regulatory writing theme. This issue will be guest edited by Sam Hamilton (sam@samhamiltonmwservices.co.uk).

The June issue will have a writing style theme and the September 2009 issue, which will be guest edited by Adam Jacobs (ajacobs@dianthus.co.uk), will have a statistics theme.

Articles (up to 2500 words) and boxes (up to 1000 words) in line with these themes or on any topics of interest to medical writers or of interest to editors, translators, language teachers and linguists working in the medical field are very welcome.

Part III of Françoise Salager-Meyer's series 'Book reviews in the medical scholarly literature' will be published in the March 2009 issue of *TWS*.

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