An Introduction to Microscopy and Digital Imaging

Part 1.2: Introduction to Digital Imaging Ethics

\[ d = \frac{A}{2 \sin \alpha} \]
Twiggy’s UK Olay add

Twiggy’s Photoshopped add banned in England

Regulatory agency that oversees advertisement in England ruled that Twiggy’s perfect skin was due to Photoshop, and not to Olay, as the add claimed. The add was banned.
Abraham Lincoln (Not!) portrait

~ 1860

http://www.cs.dartmouth.edu/farid/research/digitaltampering/
University of Wisconsin recruiting add

http://www.cs.dartmouth.edu/farid/research/digitaltampering/
Womb with a view?

All is not as it seems in a television programme on the life of a fetus.

Martin Kemp

We tend to believe what we see, provided that the image obeys certain rules of internal consistency. Although we have plenty of evidence to reject the old adage that the camera never lies, particularly in this era of digital manipulation, we are perceptually prone to trust a representation that exudes an air of the ‘real thing’, especially if it has a photographic look. Illustrators therefore have an ethical imperative to use their skills in the service of a contract of trust with the viewer. With recent advances in computer graphics, these issues of trust have assumed a heightened urgency.

Film-makers have access to techniques that can render in compelling detail interactive horde of warriors using just a few real actors. That’s entertainment, they say. But exploiting computer-generated (CG) imagery in public science broadcasting is quite another matter.

Visual images can now convey the unseeable in brilliant colours and with wondrous spatial conviction, whether they are great arrays in the cosmos or molecular engineering. Such images are clearly a good thing in the communication of science. However, the viewer is frequently not told about the status of the images. When they relate to matters of considerable emotional and social importance, the stakes in the contract of trust can be huge.

results were seductive, visually and emotionally. We felt that we were eye witnesses to a beauty and conscious life previously unseen.

But at no stage was it clear what we were seeing. The credits named the companies responsible, but did not explain how the images were generated, and they were all implicitly accorded the same level of ‘visual truth’.

Only on MillTV’s website is the process made clear: “After months of research, courtesy of 4D ultrasound scans, medical books and pictures of mummified fetuses,

MillTV developed anatomically accurate CG recreations of month-four and month-seven fetuses.”

Each elaborate and laborious animation involved such methods as “multi-layering” for “shadowing” depth. I should like to propose a law and a consequent rule. The law is that the greater the skill available for making utterly convincing and seductive images,

The meeting that never happened...
More examples and discussion at:

http://www.cs.dartmouth.edu/farid/research/digitaltampering/
This article has been retracted

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REPORTS

Cdx2 Gene Expression and Trophoderm Lineage Specification in Mouse Embryos

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Retraction

WE WISH TO RETRACT OUR REPORT “CDX2 GENE EXPRESSION AND TROPHECTODERM LINEAGE specification in mouse embryos” (1). Allegations of research misconduct were received by the University of Missouri-Columbia (MU) Provost, and an investigation found that the first author (K.D.) engaged in research misconduct by intentionally falsifying and fabricating digital images in the preparation of Figs. 4I; 4N; 4S; 2G; 3, J to L; S2, V to X; and S6, I to K accompanying the Science article. In addition, the original raw image files for the majority of the figures in the paper have not been located (the exceptions being the confocal scanning images in Figs. S1, S3, S4, S5, and S6), raising the possibility that the data they represent may also be suspect. We have decided to withdraw the article in its entirety in view of the fact that the paper was founded at least in part on falsified or fabricated images.

The corresponding author (R.M.R.) takes responsibility for placing excessive trust in his co-worker and for not assuring that a complete set of raw data existed at the time the questions first arose about the paper. We deeply regret any scientific misconceptions that have resulted from the publication of this article.

The first author resigned from MU shortly after the allegations of research misconduct were received and could not be found to sign the retraction.

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Reference

Editor’s Note: Science published an Editorial Expression of Concern (27 October 2006, p. 592) about this paper, which alerted readers to the then-ongoing investigation.
**Scientific misconduct** is the violation of the standard codes of scholarly research and ethical behavior in professional scientific research.

The consequences of scientific misconduct can be severe at a personal level for both perpetrators and any individual who exposes it. In addition there are public health implications attached to the promotion of medical or other interventions based on dubious research findings. *(Wikipedia)*

In the US, Scientific Misconduct is investigated by a Federal Agency, the Office for Research Integrity (ORI):

http://ori.dhhs.gov/
**Definition of Research Misconduct (ORI):**

Research misconduct means fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results.

(a) Fabrication is making up data or results and recording or reporting them.

(b) Falsification is manipulating research materials, equipment, or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.

(c) Plagiarism is the appropriation of another person's ideas, processes, results, or words without giving appropriate credit.

(d) Research misconduct does not include honest error or differences of opinion.
Forms of Scientific misconduct:

**Fabrication:**
- Obfuscation (hiding non-desired data)
- Fabrication (making up non-existing data)
- Falsification (modifying data)
- Unsubstantiated claims

**Plagiarism**
- Self-plagiarism
- Violation of ethical standards
- Ghost writing
- Misappropriation of data

Since around the year 2000, an increasing proportion of the investigations of misconduct involve suspicious images.

Most probably linked to widespread use (and abuse) of imaging software...
Surveys conducted by various journals have concluded that as many as one in five papers may contain at least one improperly manipulated image.
Photo manipulation (Image manipulation):

In 2006, the Journal of Cell Biology instituted tests to detect photo manipulation in submitted papers. Other Journals have since followed this trend, and routinely screen images to detect inappropriate manipulations.
Inappropriate manipulation of images may be intentional, but very often it is due to poor understanding of image processing techniques and software, or poor understanding of what is or is not acceptable.

In fact, most inappropriate modifications turn out not to be intentional.
In some cases, such images may lead to an investigation of scientific misconduct.
In a two-month period, *PLoS Biology* found problems with 5 images in 3 out of a total of 35 papers checked. Barbour says that they saw similar levels of problem pictures during the rest of the year. Over the whole year, *PLoS Medicine* also encountered 5 problem images in 3 papers, this time out of a total of 13 that they checked.

authors gave "satisfactory explanations" for all of the manipulations, and that none of the problem papers was rejected.

Barbour (the investigator) adds she was "shocked" at researchers' "appalling" systems for organizing and filing their data. The pilot study found that authors of 25% of the problem papers had difficulty finding their original data.

What's in a picture? The temptation of image manipulation

Mike Rossner¹ and Kenneth M. Yamada²

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² Editor, The Journal of Cell Biology, and the National Institute of Dental and Craniofacial Research, National Institutes of Health
Figure 1. **Gross manipulation of blots.** (A) Example of a band deleted from the original data (lane 3). (B) Example of a band added to the original data (lane 3).
Figure 2. **Gross manipulation of blots.** Example of a duplicated panel (arrows).
Figure 3. **Manipulation of blots: brightness and contrast adjustments.**

(A) Adjusting the intensity of a single band (arrow). B) Adjustments of contrast. Images 1, 2, and 3 show sequentially more severe adjustments of contrast. Although the adjustment from 1 to 2 is acceptable because it does not obscure any of the bands, the adjustment from 2 to 3 is unacceptable because several bands are eliminated. Cutting out a strip of a blot with the contrast adjusted provides the false impression of a very clean result (image 4 was derived from a heavily adjusted version of the left lane of image 1). For a more detailed discussion of "gel slicing and dicing," see *Nature Cell Biology* editorial (2).
Figure 4. **Manipulation of blots: cleaning up background.** The Photoshop "Rubber Stamp" tool has been used in the manipulated image to clean up the background in the original data. Close inspection of the image reveals a repeating pattern in the left lane of the manipulated image, indicating that such a tool has been used.
Figure 5. **Misrepresentation of immunogold data.** The gold particles, which were actually present in the original (left), have been enhanced in the manipulated image (right). Note also that the background dot in the original data has been removed in the manipulated image.
Generally not acceptable:

• splicing together different images to represent a single experiment
• changing brightness and contrast of only a part of the image
• using clone tools to hide or add information
• creating composite images

• any change that conceals information, even when it is considered to be non-specific, which includes:
  • changing brightness and contrast to leave only the most intense signal
  • showing only a very small part of the photograph so that additional information is not visible ("representative cell")
> Acquire images in a manner that preserves the information content

(use histogram tool or under/over lookup tables to adjust imaging parameters)

> Use “authorized” image adjustments and processing methods, and report them
Always keep a copy of the original data

Use a sensible archival system (so that you can find data if needed)

Keep all acquisition info whenever possible (microscope, magnification, numerical aperture, scale, exposure time, etc...)

Understand and document any post-acquisition (image processing) steps
Learn more:


http://swehsc.pharmacy.arizona.edu/exppath/micro/digimage_ethics.php
