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Issues & Perspectives

Responsible Conduct of Research for Junior Researchers

In a case discussed at the **Online Ethics Center for Engineering and Research (http://www.onlineethics.org)** , an engineer doing graduate research at a major university left data out of his thesis that were at odds with his and others' previous conclusions. "Convinced of the soundness of his report and concerned that inclusion of the ambiguous data will detract from and distort the essential thrust of the report, Engineer A decides to omit references to the ambiguous data," reads **case No. 85-5 (http://www.onlineethics.org/Resources/Cases/ec85-5/nspe85-5.aspx)** . Based on the **Code of Ethics (http://www.nspe.org/Ethics/CodeofEthics/index.html)** of the **National Society of Professional Engineers (http://www.nspe.org/index.html)** , the NSPE Board of Ethical Review concluded that the engineer had behaved unethically.

When writing up your results, you should make sure that the resulting publication will "represent with veracity, with accuracy, [and] with truthfulness the data you have obtained." -- Adil Shamoo.

Every day, researchers make judgments about what data to include and what to leave out, balancing a desire to be forthcoming with the need to make a clear and simple argument. The case of the engineer shows just how difficult navigating such decisions can be for early-career researchers. And decisions about data aren't the only hazardous situations; judgments with ethical implications pervade scientific practice. "There are some situations that are very clear-cut, and that's when we talk about real misconduct. ... Everything else, every scientist needs to use their best judgment," says Kathleen Flint of the U.S. **National Postdoctoral Association (http://www.nationalpostdoc.org/)** in Washington, D.C., which has been **pushing (http://www.nationalpostdoc.org/publications/toolkits/rcr-toolkit)** to fill in a gap in training postdocs in the responsible conduct of research. Fortunately, sound ethical practice in science is very close to sound scientific practice: the key is to know what you're doing and to do it meticulously.

Acquiring sound data

Ways to be sloppy in the lab are limitless, and all can compromise your data. Sloppiness can take the form of not quite following the protocols for storing your samples, collecting just about (but perhaps not quite) enough data, or not running simultaneous controls. "Historical data are allowed, but it depends on what kind of historical data you have," says Adil Shamoo, a biochemistry professor at the University of Maryland School of Medicine in Baltimore who focuses on the responsible conduct of research.

Responsible Conduct of Research

Most researchers are determined to steer clear of the three cardinal sins in research -- defined by the U.S. Department of Health and Human Services **Office of Research Integrity (http://ori.dhhs.gov/)** (ORI) as **"fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results. (http://ori.hhs.gov/misconduct/definition_misconduct.shtml)** " ORI highlighted **nine key topics (http://ori.dhhs.gov/education/)** for training in the responsible conduct of research:

-Data Acquisition, Management, Sharing and Ownership

-Conflict of Interest and Commitment

-Human Subjects

-Animal Welfare

-Research Misconduct

-Publication Practices and Responsible Authorship

-Mentor / Trainee Responsibilities

-Peer Review

-Collaborative Science

"People are adding things all the time when they come up with their internal list for their institutions," says Daniel Vasgird, director of the **Research Integrity and Compliance Office (http://oric.research.wvu.edu/)** of West Virginia University in Morgantown. Some argue for adding financial responsibility and environmental health and safety, for example, he adds.

We are continuing to discuss these and other issues on *Science* Careers as part of our **rolling feature (http://sciencecareers.sciencemag.org.gate1.inist.fr/career_magazine/previous_issues/articles/2010_11_05/caredit.a1000108)** on research integrity.

Adil Shamoo Credit: (Courtesy, Adil Shamoo)

The pressure to cut corners can be high; in a 2002 **national survey (http://www.nature.com.gate1.inist.fr/nature/journal/v435/n7043/full/435737a.html)** of National Institutes of Health (NIH)–funded scientists, 23% **admitted (http://caliber.ucpress.net/doi/pdf/10.1525/jer.2006.1.1.43)** to "cutting corners in a hurry to complete a project." But cutting corners can be risky, says Melissa Anderson, a research-ethics researcher at the **University of Minnesota (http://www1.umn.edu/twincities/index.php)** , Twin Cities, and a co-author of that survey. Researchers who leave those last few essential tests until later "may forget that they skipped some steps, and then they present results as though they did them, or they may never have time to go back and make the changes." Or, once the project is funded, they get caught up in the moment and "they don't realize that their preliminary results weren't on quite as solid ground as they thought they were."

Record everything

One cornerstone of science is the necessity to keep thorough records so that you and others can go back and redo the work. Yet 27.5% of the respondents to Anderson's 2002 survey admitted to inadequate record keeping.

Good record keeping starts with the lab notebook. So what constitutes a good lab notebook? It may be a traditional, bound-and-numbered paper book, or it may be a manipulation-proof online notation system. But it always provides a comprehensible, well-organized, accurate, complete, day-by-day account of what you do in the lab. Others "should be able to step in and ... understand everything that happened and pick up the work from that point on," Anderson says. Early-career scientists need to understand the "appropriate standards of record keeping within their particular laboratory, within their institution, within their field," Vasgird says. Also, make sure you store your notebooks securely but accessibly and fully back them up.

Daniel Vasgird (Courtesy, Daniel Vasgird)

Use statistics properly

Another area where carelessness can have serious ethical consequences is in the use of statistics. Often, young scientists do not know enough about preparing their data for statistical analysis, or what test is appropriate under which conditions, Anderson says. "If you don't have a good enough statistical grounding, you'd better get some help from someone who does." Also, make sure you don't lose track of what you've done and what you're trying to achieve, she adds. Many young scientists produce hundreds of statistical runs "and they don't know what variables they've changed, and they don't know which run was supposed to do what, and they get all confused."

Represent your data truthfully

Fifteen point three percent of respondents to Anderson's survey admitted to "dropping observations or data points from analyses based on a gut feeling that they were inaccurate." It's wrong to "throw away information you don't like," Shamoo says. Sometimes it's appropriate to discard outliers but only "if it is, let's say, within 3 to 4 standard deviations of the mean. You say that, and you say what is the statistical reasoning" behind your decision, he continues.

Selecting data for publication is a particularly tough problem; you always run the risk of leaving out meaningful data. "You have so much latitude in that selection," Shamoo says, that it's sometimes difficult to assess what is just sloppy or plain unethical. You need to apply your best and most honest judgment, being aware of the standards in your discipline and asking colleagues if necessary. "What would be unethical ... is if the data you didn't include in the paper, for example, has direct bearing on the conclusion of the paper. What would be sloppy is, there are certain pieces of data" that are important "because it gives a different dimension to the outcome. It will not change the conclusion, [but it] was not published," Shamoo adds. "The safest approach is to note parenthetically or in a footnote that further analyses were done and that they are available upon request or on a Web site. The point is to be sure that neither the work nor the findings are misrepresented by omission," Anderson says.

Another gray area is how much you can alter images. "If you alter an image just to improve the clarity of what's there, without misrepresenting it in any way, that is acceptable. If you alter the image because you think that some of the data points were off and you don't have any good reason for thinking that, and you eliminate those data points, that's falsification," Anderson says. But "where you draw the line depends on the kind of work you're doing, the way the data were collected, and the norms of the discipline."

Write with fidelity

When writing up your results, you should make sure that the resulting publication will "represent with veracity, with accuracy, [and] with truthfulness the data you have obtained," Shamoo says. That means providing a complete account of all the steps you took. Nowadays, many journals offer extra space in appendices or on the journal's Web site; that lets you keep the core narrative clean and readable while documenting the work completely and publicly. "There is no excuse in this day and age not to have details of the experiments such that any graduate student anywhere in the world will be able to repeat it," Shamoo says. If you really lack space, "you could say simply, 'The details are not appropriate for this journal, please write to me' or 'Please go to my Web site.' "

Melissa Anderson (Courtesy, Melissa Anderson)

Also resist the temptation to over-interpret. Ask for feedback from your supervisor, who may have a broader view of the field and of what exactly can be claimed on the basis of the present findings, Anderson says. Feel free to make some educated guesses or speculations in your discussion, but clearly

identify them as such, Shamoo adds.

Treat animals and human subjects with care

However complex or cumbersome you may find the regulations governing research with animals and people, be extra careful to follow them fully and accurately. Start with training courses but don't end there. "You're in really big trouble if you're violating human-subjects protocols, so it can't just be something that you do pro forma," Anderson says. "It needs to be something you're really living by."

Among the requirements for human-subjects research, for example, are getting your proposal approved by an institutional review board and getting appropriate informed consent from all participants. "You have to provide sufficient, accurate information. There should be no undue influence ... on the subject, and you have to ensure that they have comprehension of what you're telling them." They must also be capable of sound judgment, Shamoo says.

Points of reference

Many professional societies, academic associations, and journals nowadays offer discipline- or issue-specific policies, guidelines, and codes of ethics. Become acquainted with the ones in your field. Institutions, too, have policies and regulations in place, so make sure to study them, Anderson says. **NIH (http://grants.nih.gov.gate1.inist.fr/grants/guide/notice-files/NOT-OD-10-019.html)** - and **National Science Foundation (http://www.nsf.gov/pubs/policydocs/pappguide/nsf10_1/aag_4.jsp#IVB)** –mandated courses on the responsible conduct of research are another place to learn.

Responsible conduct of research "is most dependent upon you being able to talk about these issues with people who are senior to you, and your own colleagues and peers," Vasgird says. This makes the choice of your institution and principal investigator (PI) important. Try to visit before you join and talk to people there to get a good sense of the working culture, Flint says. Have an upfront conversation about "how often do the individuals in that lab see the PI, how involved is the PI in reviewing the actual data or the analysis," and whether there is "joint responsibility for how the research is actually done," she adds. Once you've joined the lab, if there are question marks or anything that comes up, don't be scared to ask. "Really try to open up those lines of communication," Flint says.

Recognize your mistakes

As long as you try hard to do what's right, making a mistake is not unethical. But realizing that you made a mistake and not doing anything to fix it *is* unethical. Usually, you can fix mistakes before they cause problems, but "if what you did had consequences for the other people, ... then you've got to let them know," Anderson says. If the work is about to be or has already been published, never choose false, temporary success over integrity, Anderson adds. Admit to your mistake and redo the work. "It's short-term pain versus long-term disaster."

Above all, "research is not just about results. Research is also a process. ... If the process is corrupted, the results are going to be virtually meaningless," Vasgird says. To guarantee integrity, "you need to basically assume that you will be called to account for your work at any point," Anderson says. "Pretend you have the public or other scientists looking over your shoulder."

Kathleen Flint (Courtesy of Kathleen Flint)

Further reading

- The U.S. Department of Health and Human Services Office of Research Integrity's (ORI's) resources on **responsible conduct of research (http://ori.hhs.gov/)**

- The U.S. National Academies ***On Being a Scientist: A Guide to Responsible Conduct in Research*** **(http://www.nap.edu/catalog.php?record_id=12192)**

- The **Online Ethics Center for Engineering and Research (http://www.onlineethics.org/)**

- Adil Shamoo and David Resnik's textbook ***Responsible Conduct of Research*** **(http://www.amazon.com/Responsible-Conduct-Research-Adil-Shamoo/dp/019536824X)**

- **Online course (http://ori.dhhs.gov/education/products/columbia_wbt/index.html)** on responsible conduct of research produced by Columbia University (with input from Daniel Vasgird)

- ***Teaching the Responsible Conduct of Research in Humans*** **(http://ori.hhs.gov/education/products/ucla/default.htm)** by Stanley Korenman

- The National Postdoctoral Association's resources for **Data Acquisition, Management, Sharing and Ownership (http://www.nationalpostdoc.org/publications/rcr/119-rcr-toolkit-data)** and **Communication and Difficult Conversations (http://www.nationalpostdoc.org/publications/rcr/113-rcr-toolkit-difficult-communication)**

- ' **Guidelines for Responsible Data Management in Scientific Research (http://ori.hhs.gov/education/products/clinicaltools/data.pdf)** ' by Clinical Tools Inc.

- Tufts University's **Do's and Don'ts for Keeping Lab Notebooks (http://techtransfer.tufts.edu/?pid=20&c=37)** and **Do's and Don'ts for e-Lab Notebooks (http://techtransfer.tufts.edu/?pid=21&c=38)**

- ' **Plagiarism and self-plagiarism: What every author should know (http://www.biochemia-medica.com/content/plagiarism-and-self-plagiarism-what-every-author-should-know)** ' by Miguel Roig

- ' **What's in a picture? The temptation of image manipulation (http://www.ncbi.nlm.nih.gov.gate1.inist.fr/pmc/articles/PMC2172141/?tool=pubmed)** ' by *Journal of Cell Biology* editors Mike Rossner and Kenneth Yamada

- ' **Stop Misbehaving (http://www.jci.org/articles/view/28824/version/1)** !' by Ushma Neill, executive editor of *The Journal of Clinical Investigation*

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