Research Ethics for Scientists

A Companion for Students

C. Neal Stewart Jr.

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Preface

My initial involvement with research ethics was quite accidental (to me) and commenced just as I began my own PhD programme as a student. I was selected by the Associate Dean of the graduate school to be the Chief Justice of my university's graduate honour system. To this day, I still don't understand how that all happened, but now I realise the huge affect it subsequently had on my career. Unbeknownst to me at that time, it paved the way for this book some 20 years later. As Chief Justice, my duties were to help investigate and hear cases of plagiarism, research misconduct, and cheating in courses by graduate students – my peers. I still recall my major professor's response when I asked him what he thought about my taking the job. "If you don't mind judging your fellow students. . ." In other words, I don't think he believed it was such a good idea. I wasn't altogether convinced about this new gig either – I thought it had the potential to be a significant diversion from the research I needed to do to graduate. Plus, truly, what scientist wants to judge the allegedly bad practices of his fellow peers in research? This, I find, is a common feeling among scientists. Few scientists are comfortable policing the conduct of other scientists.

The Graduate Honour System cases of alleged student misconduct were heard and decided by a panel of faculty members and graduate students. I simply presided over the proceedings and administered the system. If a guilty verdict was found, then a penalty would be prescribed, and I was the guy to tell the accused of their fates. These penalties ranged from probation to dismissal. After the hearings I walked downstairs from the hearing room and into the ersatz waiting room, personally delivered the good or bad news to the graduate student; always an anxious moment. This simple bearing of good or bad news showed me in a profound way that there is a face and heart behind every case of scientific misconduct.

Hearing these cases over three years opened my eyes to the world of bad behaviour in science (and most of the cases we heard were in fields of science or engineering) that I hadn't realised even existed. It also helped me understand some of the psychology and pressures that precipitated academic misconduct. That experience helped steer my own career clear of major potholes and fatal wrecks alike. Oh, I still made my share of mistakes, but none were fatal. I had simply been given the somewhat unique chance to learn from lots of other people's mistakes. And I think I could have steered clear of a few more of my wanderings had I read a book such as this one and/or sat through a one-hour graduate course on research ethics. I'll make my own confessions throughout the book, and we will examine real and fictional case studies that should be fuel for thought as scientists wind their way through their careers.

With my PhD in hand and the busy day-to-day tasks of running a lab and teaching, the days of my ethical "trials" were a distant memory. Real-life research integrity didn't hit home until just a few years ago when I was the "victim" of plagiarism. I vividly recall reading my own words from another person's paper and thinking, "this looks familiar – and the writing's not so hot." A student's plagiarism of my own work inspired me to pursue ethics anew in the form of co-teaching a graduate course on practical research integrity. This book then naturally arose from my teaching experiences, and from the fact that when my colleague and I searched for a book or material to help teach our graduate-level research ethics course, we learned there are a plethora of works on bioethics and many fewer that address research ethics. As a practicing biologist, I don't consider this book to be a scholarly treatise in ethics; it is written to practically address common problem issues in scientific research with narrative and case studies. I wrote it as a guidebook of sorts – both for undergraduate students contemplating a life in science and those graduate students and early career scientists who find themselves in the thick of it. In the end, the book turned out to be more autobiographical than I'd set out for it to be. That said, all opinions are my own and all names I use in the fabricated case studies are also fabricated. Any resemblance to real people is purely accidental.

I am thoroughly convinced that the best ethical practices lead to the best science. Granting agencies such as the National Institutes of Health (NIH) and the National Science Foundation in the US must agree as they require research integrity training to their awardees. I think it is simply a matter of time before all US funding agencies follow suit. I see more and more scientists now motivated to teach courses in research ethics to address these needs. Aside from mandates set by funding agencies, there seems to be a growing number of colloquia, informal meetings and workshops on research ethics being held. This is a welcome trend to proactively address real concerns in a complicated research world. Research integrity is for everybody!

Knoxville, TN, USA
March 2011

Acknowledgements and Dedication

Many people have shaped my life and career and have therefore shaped this book. I'm greatly indebted to my scientific mentors who took a chance on me as a trainee: Erik Nilsen and Wayne Parrott. For each I was unproven and a significant risk, but they saw past the risks to the potential. They are both superb mentors. I'm also indebted to my own trainees. My career was born and sustained because of these tireless and dedicated individuals who work the pipettors so I can attempt to make contributions in other ways. In addition, they and others have taught me innumerable and valuable lessons about best practices in science research.

I'm grateful to people who have joined me in teaching research ethics, especially Lannett Edwards who co-founded our course four years ago. Charlie Kwit and Lana Zivanovic joined me in teaching research ethics last year and graduate students H.S. Moon and Blake Joyce were teaching assistants and acted as peer teachers in the 2009 version of teaching ethics. In 2010, Mark Radosevich joined Lana in teaching the course and graduate students Charleson Poovaiah and Jonathan Willis have acted as teaching assistants. Without EPSN funding for partial graduate teaching assistantships for these four students, we'd all have been poorer without their input in our course. I'm also grateful for the help provided by graduate student Kim Nagle during the class. I've learned a lot about ethics from teaching with all of these capable individuals.

I include also Gary Comstock in this list of key people to thank. When I first got interested in teaching research ethics I was fortunate enough to call Gary to get his advice on the subject and attend one of his research ethics workshops. His vision and input was critical to what the course, and ultimately this book, became. He is a real professional in this field and is one of its leaders.

So many people helped on the book manuscript by rendering figures, organisation, proofreading, editing, and getting permissions, among other things. At the top of this list are our group's able administrative specialists, Michelle Hassler and Jennifer Young Hines, who did much of the administrative work (and there was lots of it!) for the book. Reggie Millwood, Blake Joyce, H.S. Moon, Mitra Mazarei, Virginia Sykes, Dave Mann, Muthukumar Balasubramaniam, Jonathan Willis, Jason Abercrombie and other people in my lab played critical roles in contributing and fine tuning the contributions.

Thanks to Bob Langer and Daniel Anderson for allowing me to interview them on mentorship. Bob, especially, has personally inspired me to become a better mentor. Unbeknownst to him, he was also the inspiration for me to allow my lab to continue its growth from my self-imposed and arbitrary cap.

Acknowledgements and Dedication

Thanks to Izzy Canning, Fiona Woods, Rachel Wade, and all the great people at Wiley-Blackwell in Chichester for the encouragement and guidance throughout this project. They were both kind and firm in their guidance, i.e., the perfect editorial staff. I also sincerely appreciate the time that the many peer-reviewers took to critique the various stages on the manuscript. I typically did not look forward to receiving the reviews, and then was not very happy with much of what they suggested, especially in the early stages, but in retrospect, their advice was critically important to the quality of the book. I owe a debt of gratitude to both the editorial team and reviewers.

This book is dedicated to my first and best mentor, Charles Neal Stewart, Sr. (1930–2010), who looked forward to seeing this book in print. I talked about this project with him on a regular basis during its development and he encouraged me to see it to completion. Thanks Dad.

To God be the glory.

Chapter 1

Research Ethics: The Best Ethical Practices Produce the Best Science

ABOUT THIS CHAPTER

- Research science is becoming increasingly complex and riddled with pitfalls and temptations.
- Global competition and cooperation will likely change the face of science in the future.
- Science is an iterative loop of ideas, funding, data, publication, in turn, leading back to more ideas.
- Ethics can be a guide toward best practices.
- Best scientific practices lead to the best science results and discoveries.
- Best practices and mentorship produce the best scientists.

It seems that it is increasingly difficult to be a research scientist. The number and complexity of rules, electronic forms, journals and publishing, and government and university regulations are ever-growing. The competition for funding is often ruthless, and the criteria exacted to warrant publication in good journals also seem to be on the rise. Indeed, not just the pressure to publish, but the pressure to publish the "right" papers in the "right" journals is also increasing. Nominally, the preparation of proposals and publications has been ostensibly made simpler by computer technology, yet the potential for real- and faux-research productivity has also been enabled by computers. Technology is a double-edged sword: enabling high levels of knowledge creation and dissemination, but also enabling research fraud and shoddy science. Thus, ethical dilemmas seem to be appearing at an increasingly rapid pace, with research misconduct regularly being the subject of news articles in *Science, Nature*, and *The Scientist.* I wouldn't be surprised when and if these scientific periodicals hire ethics reporters who will specialise in reporting misbehaviour. Even people who don't keep up with science news are familiar with the term "cold fusion" and the infamous stem cell cloning and data fabrication case from South Korea. While the most notorious cases of misconduct have occurred in higher-profile fields of science, such as physics and biomedicine, it is clear that no area of science is immune to unethical behaviour (Angell 2001; Judson 2004).

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We live in a "multiscience" world. Multitasking, multidisciplinary work and multi-authored works, to name a few, are ingrained in the fabric of science culture and certainly multi-multi is expected in order to succeed and move up the scientific ranks. The isolated small laboratory with the lone professor and few staff (see Weaver 1948 for a perspective) has given way to larger labs interacting in complex collaborations in interdisciplinary science. Complex relationships are accompanied with tough decisions regarding authorship, dicing the funding pie, and how to treat privileged data. And immense amounts of data at that, which are shared (or not) and curated in useful and meaningful ways (or not). In all this mix, the temptation to cheat, cut corners, and misbehave seems to be at its zenith for scientists wishing to compete at the highest levels of science, striving to get tenure and become rich and famous. Of course, one alternative to honest competition and competence, as seems to be the case for some scientists, is to con their way to the top. Cheating is front page news in business, politics and sports sections alike. Perhaps a bigger problem to outright fraud is cutting ethical corners. Thus, we have an apparent paradox – the antithesis of this chapter title – that the best (or highly rewarded) science is compromised with seemingly endless ethical issues. Whereas the lone professor and his or her graduate student worked in simpler and more linear paths in the past, modern science seems far too convoluted for its own good (Munck 1997). How can we win? How can sound science prevail in the face of all the obstacles?

If the situation is not complicated enough, it seems that there is growing concern about the abuse of graduate students and postdocs by their mentors. Some senior scientists feel that coercion, micromanagement and general overbearance of their trainees is an effective means to ensure high productivity. While research misconduct garners headlines, causing all sorts of angst upon university administrators, it might be the case that defective mentorship is actually a much weightier problem than outright cheating (Shamoo and Resnik 2003). But is it possible that these two problems could be interconnected (Anderson et al. 1997)? Mentorship is a current hot topic in science that has spawned cottage industries, self-help books and strategising among faculty members and university administrators alike. Everyone knows that finding good mentors is crucial for the young (and sometimes not-so-young) scientist wishing to be propelled into a sustainable career in the academic world of research and teaching or the private sector of research. Mentors share the unwritten rules of science. Mentors explain how these rules are intermeshed with research ethics and advise on best practices. Mentors help their students and postdoctoral trainees fulfil their dreams (should their dreams involve being a scientist). Bad mentors can shatter dreams and stagnate their trainees' careers. But perhaps even the best mentoring is not effective in deterring certain research misconduct.

Research misconduct is a major threat to science. As much as some scientists wish to point fingers at politicians and the public as the principal bad players responsible for the lack of appreciation and funding that science deserves, I think the real enemy is within our own ranks. Indeed, Brian Martin (1992) maintains that modern science, the "power structure of science," is to blame for much misrepresentation in research. Essentially scientists are not allowed to "tell it like it is" and must tell publishable stories; (he refers to the stories as "myths"). Research misconduct is insidiously damaging to the credibility of science and scientists in society since it erodes trust – not only trust in the individual researchers but in the system of science itself. Self-patrolling the profession from within is needed to reverse this damaging trend; the major pinch points for detecting research misconduct are at the levels of grant applications and manuscript review.

The ethical dilemmas in data collection, collaboration, publication and granting are likely to become even more complex and vexing in the future. More than ever, graduate students and postdocs must master more techniques, technologies and concepts in order to become and stay competitive in science. At the same time, young scientists must generate good ideas and raise increasingly scarce funds to make their research a reality. Global competition from scientists in developing countries, especially in Asia, is a new fact of life for the researchers in the West, who were formerly accustomed to the deck being stacked in their favour. At the same time, researchers in China, India, the Middle East, and other rapidly developing countries are enjoying increased levels of new funding. These new resources are coupled with even higher government and institutional expectations not only for results and publications, but groundbreaking results in publications in the most prestigious journals (e.g., Qiu 2010). From East to West, being a practicing scientist is certainly not getting any easier.

I don't wish to paint a picture of doom and gloom, however. Honestly, I can think of no more exciting time to be a scientific researcher than today with the booming innovations and opportunities to be found around every corner. We can also innovate and connect with other scientists and stakeholders across the globe in nearly instantaneous fashion these days. Certainly, the positive science news outweighs the negative news and its complications, but there is great consensus among scientists and others that the broken parts are in need of attention and fixing (Titus et al. 2008).

About four years ago, a colleague and I became convinced, for all of the above reasons (as well as others discussed later in this chapter) that a new course at my university needed to be taught on research ethics to graduate students, thus necessity spawned my new foray into ethics. After a couple of years teaching our new graduate course that met for one hour one day per week for 14 weeks, I decided that a book of this sort could be helpful to support the course (see Appendix for our syllabus), but also as a general help to young scientists just starting their research careers, and undergraduate students contemplating a career in scientific research. This book could be viewed as part guidebook, part virtual mentor, and part friendly polemic that should be helpful in addressing pragmatic problems that all research scientists experience. While virtual mentoring was part of my motivation, to substitute any book for finding a real mentor would be a mistake, which is one main reason a couple of chapters on mentorship are included. This book is on research ethics – a users' guide to success in science by following the rules that scientists largely agree are requisites for success. This book will not focus on greater issues of morality or bioethics – these are vastly different topics than the one we're embarking on here. In addition, many, if not all the chapters in this book, are subjects in their own right; the deep expertise of researchers in the social sciences, philosophy and education.

And with that, I'll state up front that I don't have all the answers. I think I do ask most of the pertinent questions, but like most things in life, asking the questions is a good bit easier than answering them. One of my main goals in asking the questions is to enable the readers to judge themselves with regards to best practices. When I started in science, I expected that there would be one right way to do experiments illuminated clearly, then analyse the data and write up the paper. It didn't take long to learn that this was not the case, and indeed, I judged myself then and ever-frequently now. Science is very creative and individualistic. There are many ways to answer scientific questions, and many ways also to go wrong. That is not to say that we can't learn from our mistakes and at least not doom ourselves in repeating the same mistakes over and over again.

So, I urge the reader to think about the questions and the answers and think about ideas expressed here, especially analysing the case studies for current and future action where applicable. Talk about these issues with your colleagues and mentors. If the topics in this book are discussed more widely in labs, hallways, and classrooms, then the best ethical practices will be advanced throughout fields of science. After I began teaching on research ethics, I found the new lively hallway discussions about various topics related to our course content was proof positive that our new effort towards promoting best practices was worthwhile.

Judge yourself

✓ Why are you interested in research ethics?
✓ What are your motivations for pursuing research?
✓ In what ways are these motivations synergistic or antagonistic with one another?

Morality vs ethics

What is the difference between morality and ethics? If morality is the foundation that ethics is built upon, research ethics is the top floor that is visible from the air. That moral foundation often has religious or spiritual ingredients and is engrained in substance that is far beyond the scope of this book. Ethics can be considered a sort of practical morality or professional morality that enables boundaries for the work of research to be played fairly. That is, if we think of problems not so much as in terms of right and wrong, but in terms of ought and ought not, then I think we understand how to parse morality vs. ethics. Many people are uncomfortable discussing morality, religion and politics. In contrast, most scientists are happy to share their opinions on ethics of their fields and science in general. It's ok if we don't all agree on the fine points of all the ethical considerations posed in this book. I worry more about the big picture.

One way to think about research ethics is in terms of best practices in conducting all aspects of research science – to maximise benefits and minimise harm. A very important ethics concept is non malfeasance – doing no harm (Barnbaum and Byron 2001). While the definitions and delineations on research ethics might seem a bit squishy, let's keep in mind that there is plenty of room for opinion. This book is about ethics much more than morality, and practical research ethics as opposed to theoretical ethics that would interest a philosopher. This book is for scientists. This book is about integrity in performing research. Summed up, this book is about scientific integrity.

Indeed, for our purposes here, this book is also about how to be a successful scientist. It can easily be argued that philosophers have thought about ethics for much longer, (e.g., Plato and other ancient Greek philosophers) than have scientists thought about science (a word not coined until the 1800s (Shamoo and Resnik 2003)). There are many viewpoints that philosophers have taken to conceptualise ethics. A few of these are utilitarianism, deontology and virtue ethics.

Utilitarianism is an example of teleological theory, which is based on outcomes rather than process. Utilitarianism seeks to do the most good for the most people; it is important to consider others and not just yourself. The utilitarian essentially does cost-benefit analysis to guide a person's path and decisions, and one that is widely implemented these days as a thought process (Barnbaum and Byron 2001).

Deontology is the ethics of duty. It strives to universalise rules that apply to everyone in guiding actions. One example here is the Golden Rule (or the rule of reciprocity), which is stated as, "Do unto others as you'd have them do unto you." "Morality as a public system" (Gert 1997 p. 24) applies to research ethics in that all scientists know the rules to be followed and is not irrational for the people who agree to participate in the system to follow the rules.

Virtue ethics focuses on living the good life. In this system, a person ought to decide to do what a virtuous person should do in all circumstances. Similar to the other two systems above, virtue ethics considers the potential for harm and avoids doing things to harm others, as this is what the virtuous person ought to do.

A last self-centred way to look at ethics is through the eyes of egoism (Comstock 2002). Egoism states that a person ought to do what is in his/her own self interests. If a scientist wants to have a long and fulfilling career, then he or she should follow the rules and perform the best science. It will also be in their own self-interest, especially in the long run, to care about others and tell the truth in science.

As a scientist, it is difficult for me to actually decide which of these various systems is most effective. To me, they all point in the same general direction to guide behaviour. If we mash them up, a virtuous scientist will seek the truth for the better good of humanity in following the rules that most scientists agree upon because it serves the self-interest of individual scientists. Scientists, by definition, should desire to maximise benefit and minimise harm (normative principles).

Inauspicious beginnings

Up until the past few years, I had no real interest in ethics as a topic of study (except a fleeting fling during my PhD training), much less in writing a book about ethics. I reasoned that everyone valued common sense ethics and there was no need to study or discuss it. When I decided to pursue science and move towards obtaining the masters, then the PhD after a stint of teaching in public schools, I was totally focused on science and research – no time for what I considered to be lollygagging in philosophical musings. In my mind, this singular focus on research was by necessity. I had found myself in so far over my head and out of my comfort zone in science, with a motivation to learn as much as I could as fast as I could. It seemed to take every drop of energy I could muster, especially in the early part of graduate training, to keep from drowning. Even then, at times, I felt I was floundering in my classes and research. I think I would have considered any training or discussion about ethics, best practices in science, or even how to *be* a scientist a real distraction from science itself. How wrong I was!

Let's imagine a fictitious mechanical engineer who is fascinated with cars. The engine design, drive train, tires, chassis, brakes, the whole thing, is an obsession. Now after studying the theory of everything automotive, our ambitious engineer designs and builds a fully functional 500 horsepower machine that's capable of going 0 to 60 mph in less than four seconds. And after all these years, our engineer will now finally drive his first car – ever – his first car being the one of his own design. Unfortunately, before taking the wheel, he never learnt the rules of the road. He doesn't know what that octagonal sign means, whether to drive on the right or left side, and let's not even consider motoring courtesies. No, our engineer considered all these things to be a distraction from what was really important – the car itself – the engineering. A disastrous crash and the destruction of the beautiful work of motoring machinery are highly likely without this key knowledge. Sad to say, the unpleasant result could have been avoided by a short course on how to drive while sharing the road with others.

While this might seem like a trivial example, it illustrates how many young scientists – myself included – approach learning science and being a scientist, seemingly by osmosis. One might argue that our automotive engineer would gradually learn the traffic laws and the accepted motoring behaviour over time, perhaps aided by a competent personalised driving instructor. But how much damage could be done in the meanwhile? As more and more students come into my lab and leave as budding scientists, I've become thoroughly convinced that learning best ethical practices earlier rather than later in a research career results in a big payout both to the scientist and the science itself. There is merit to having a driving course and a handbook.

How science works

The illustration below summarises the flow of science, at least how it is currently practiced, with all its necessary components. Science is actually a reiterative loop in which successes beget successes and failures cause the research loop to be broken. One of the primary drivers for success, as indicated by a completed and reiterative loop, or failure, as indicated by a broken loop, is scientists themselves. Having the best trained people who are eager to do research using best practices are at the heart of all successful science (Figure 1.1).

For the sake of discussion, we will designate a spot in the loop as the logical endpoint: publications. The end product of science is actually new knowledge, which must be canonised as peer-reviewed journal articles. Although there are other legitimate outlets for knowledge dissemination, such as presentations in professional meetings, books, book chapters, patents, and oral histories, the "gold standard" for credible science is peer-reviewed journal articles. This has largely been the case since 1660, when the first journal, the *Philosophical Transactions of the Royal Society*, was published.

In most cases, a science paper is built on data from well-designed experiments that test hypotheses. While professors might likely have a hand in designing

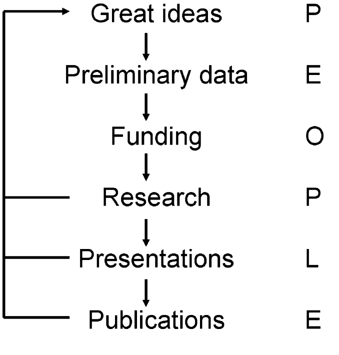

Figure 1.1 The flow of research, which starts with a great idea and background information and ends with the public distribution of new discoveries and information.

Source: C. Neal Stewart original