Trust and the Future of Research

For many years, physicists were in denial that unethical conduct was a problem in their profession. But an erosion or neglect of trust and professional responsibility can threaten the research enterprise, often in subtle ways.

Caroline Whitbeck

Scientific research, like other cooperative endeavors, requires trust to flourish. The distinguished philosopher Annette Baier explains that trust is confident reliance.[1] Both elements, confidence and reliance, are vital.

If no alternatives are available, we may need to continue relying on people and things in which we have lost confidence. But reliance without confidence leads to a downward spiral of lowered expectations, defensive behavior, and reduced cooperation. That is the unfortunate situation in some areas of scientific research. For example, I know of investigators who have lost confidence in the fairness and honesty of peer reviewers. To fund their research and make known their accomplishments, those investigators must continue to rely on submitting their proposals and publishing in journals. However, because they fear that reviewers might try to steal their work, some have intentionally withheld information or even made misstatements in their submitted manuscripts. Their intention has been to wait for the final proofs of their articles before correcting the intentional misstatements. But such behaviors hamper the work of honorable reviewers and editors and create new risks to the research record, thereby making it less trustworthy.

The reliance ingredient in trust highlights the vulnerability inherent in trusting. We may be confident of all sorts of things, such as that a given newspaper will be published tomorrow. But unless we rely on that newspaper, unless we have something at stake in its publication, strictly speaking, we do not trust. The truster is at risk of being let down, disillusioned, or betrayed because the truster relies on the trusted. Disappointment and betrayal of research investigators' trust undermines future trust and, as we shall see, the future functioning of research.

As sociologist Niklas Luhmann observed,[2] trust simplifies life. It would be prohibitively time-consuming to consider all possible disappointments, defections, and betrayals by those on whom we rely, all possible consequences of those disappointments, and all mitigating actions we might take. Without trust, research will become ridden with defensive ploys. Blind trust, however, will not suffice. Such naive trust commonly leads to disappointment with the extra sting of shame at having been duped. It is *warranted* trust and trust*worthy* behavior that support enduring trust and cooperation.

Responsible professionals

One often hears that trust is necessary because the trusting party cannot control or monitor the trusted party's performance, but that fails to capture the need to trust professionals in modern society. It would do the layperson little good to have full prescience of all the events that went into the engineering of a bridge, or even to have the ability to guide the engineer's actions, unless the layperson also happened to be an engineer. The same holds true for scientific research. Although a typical person might be able to recognize some acts of gross negligence, she would not understand the implications of most of what she saw the researcher do and would have no idea how to improve the researcher's performance.

The trustworthiness or responsible behavior of a professional arises from a complex marriage of competence and concern. Being incompetent is not itself a moral failing, but it does not engender trust. A modern society devotes resources to its citizens' education, in part to enable members of various professions to master a body of knowledge and use their mastery and educated discretion to make good decisions in their areas of expertise. Thus, the moral concern required of professionals is not merely the concern to be careful and to mean well, but also the concern to marshal their expertise to achieve good outcomes in their special domain; society entrusts precisely that domain to a profession and its members. It may be a moral failing for research investigators to litter by negligently disposing of their lunch, but it is a failure in professional responsibility to be negligent about attributing research credit or about the accuracy of written reports. No good alternatives to having trustworthy professionals exist; both individuals and society need to be able to confidently rely on the judgment and discretion of the professional.

Investigators have another reason to be trustworthy if research is to thrive. As Baier has argued, morally decent trust should withstand the disclosure of the basis for that trust. For example, if a research supervisor's trust in his supervisee's honesty is based on the belief that the supervisee is too timid or unimaginative to fabricate data or experiments, disclosure of that belief will give the supervisee an incentive to cheat. Closer oversight of research

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might reduce dishonesty, but the moral climate of the scientific research will suffer if the surveillance only instills fear of detection. Oversight by supervisors and collaborators should serve two important ends: It should help investigators avoid self-deception that could lead them into desperate situations and tempt them to cheat; and it should foster a full understanding and appreciation of the values that contribute to good science.

In this article, I address only ethical questions about upholding values that contribute to defining good science. But a second category of ethical questions also exists: questions about the consequences of scientific work. When a funding agency asks that grant proposals address the ethical and societal ramifications of the scientific work being proposed, the agency is raising matters of this second type. Both are important matters of scientific responsibility, but they require fundamentally different sorts of considerations. Failure to uphold the responsibilities intrinsic to science puts the continuance of science and scientific research in question,

Box 1. Misconduct is not fraud

"**F**raud" is a misnomer for research misconduct for two reasons: First, the legal definition of fraud requires that some party be injured by the fraudulent action. In addition, the legal notion of fraud has three basic elements:

1. The perpetrator makes a false representation;

2. The perpetrator knows the representation is false or recklessly disregards whether it is true or false; and,

3. The perpetrator intends to deceive others into believing the representation.

Second, instances of misconduct commonly stem from an attempt to cut corners in order to confirm a result that the perpetrators deeply believe to be true, not something they believe to be false or whose truth-value they disregard. In such cases it is self-deception, recklessness, and perhaps arrogance, rather than the overt intent to deceive others, that is at work. I have discussed this point at length in chapter six of my book, *Ethics in Engineering Practice and Research* (Cambridge U. Press, 1998) and was gratified to see that the government-wide definition of research misconduct adopted in 2000 (see http://onlineethics.org/reseth/reference.html) was expanded to include reckless action as well as the deliberate intention to deceive.

Box 2. Millikan and his data

The 1986 edition of Sigma Xi's booklet *Honor in Science* (New Haven, CT) sharply criticized Robert Millikan for a statement in his 1913 paper on electron charge: "*It is to be remarked, too, that this is not a selected group of drops but represents all of the drops experimented on during 60 consecutive days.*"[5] The italics are in the original 1913 statement. As Gerald Holton first discussed, Millikan's notebooks (two pages of which are reproduced here) show that he had observed many other drops, whose behavior he judged to have been compromised. This drew some physical scientists into a controversy about how to interpret Millikan's statement. The discussion about Millikan, like many other discussions of research integrity in the 1980s, was very polarized. Parties either took the position that Millikan's statement was in no way objectionable—because by "all the drops" he meant something like "all the drops that did not behave oddly"—or they claimed that it constituted deliberate falsification, a species of research misconduct.

Millikan had been quite open in a 1910 paper about discarding data in ways that seem to have been acceptable in his day. He said such things as "Although all of these observations gave values of *e* within 2 percent of the final mean, the uncertainties of the observations were such that I would have discarded them had they not agreed with the results of the other observations, and consequently I felt obliged to discard them as it was." Such data selection would not be acceptable today, but in 1910, the editor and reviewers of the *Physical Review*, in which Millikan published that paper, seem to have had no objection. Therefore, what was wrong with his action was not his data selection—it was not falsification—but that he disguised his data selection in responding to changing standards.

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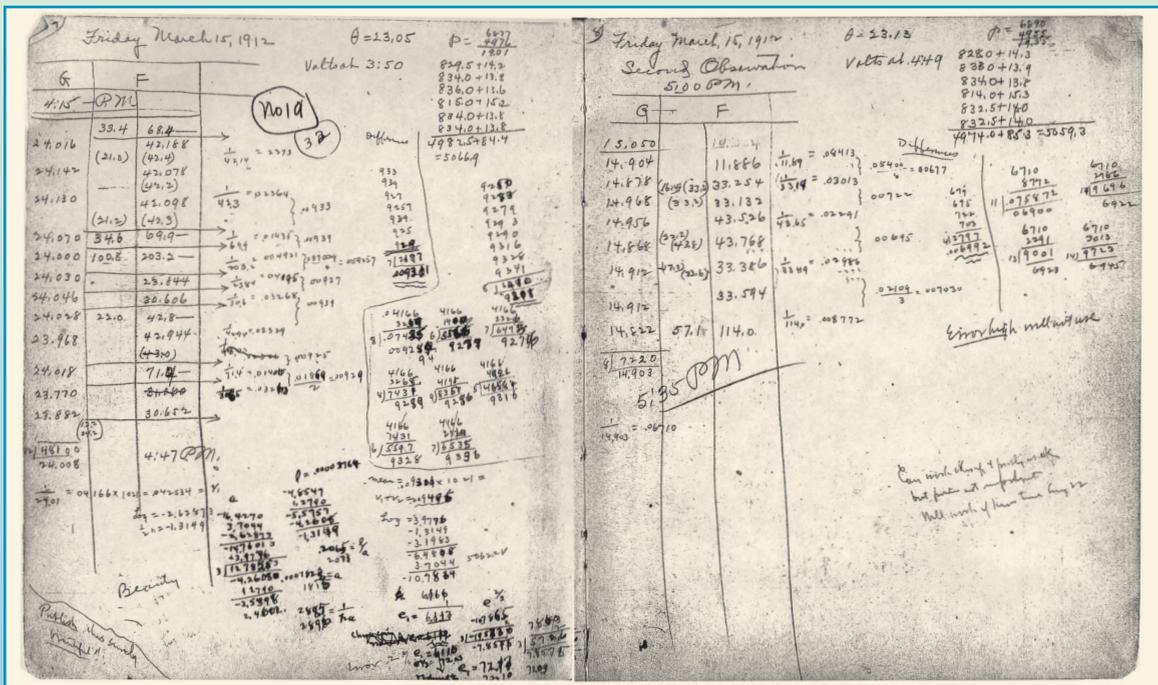
Pages from Millikan's notebook, showing both published and excluded data with his notations.

as the title of Kate Kirby and Frances Houle's article, "Ethics and the Welfare of the Physics Profession" on page 42 in this issue of PHYSICS TODAY clearly conveys. Failure to consider the ramifications of scientific work can threaten human well-being, a concern of obvious importance. Wayne Leys's article, "The Scientist's Code of Ethics," reprinted from half a century ago on page 55 of this issue, argues that scientists ought to not only uphold values of the first sort but also ensure that knowledge is used for the benefit of humankind.

Scientists should be concerned with being both good people (ethically concerned and involved citizens) and good scientific investigators (proficient investigators who do good science). Debate over the division of labor between scientists and nonscientists in influencing and deciding on the appropriate uses of science is likely to continue. However, deliberating on the importance in a person's life of scientific, artistic, or other accomplishments as compared to the value of benefiting others raises the question of what sort of life is worth living. That question will continue to be examined and discussed, and not just in the halls of academia. If Socrates was right, such examination is itself part of having a life worth living.

The maintenance of the values that contribute to good science, including the specifically ethical values of honesty and fairness, is less controversial. If we cannot confidently rely on the standards of research integrity being upheld, then the fabric of trust needed to support research—not to mention the public trust needed to sustain public funding of science—will be destroyed. Recently, the scientific community's understanding of the threats to the integrity of scientific research has changed. The findings of the American Physical Society (APS) ethics task force study reported in the article by Kirby and Houle further that understanding.

Lessons of history

The scientific community's understanding not only of responsible research conduct but also of the importance of professional responsibility in research has developed only recently. Indeed, although back in 1830 Charles Babbage decried what he saw as dishonesty in the science in England of his day,[3] the ethical standards for research conduct received little public discussion in the US or elsewhere until the 1980s. Then, the discussion began by focusing not on professional responsibility and trustworthiness, but on controlling research misconduct[4] (then commonly and mistakenly called "scientific fraud"; see box 1 on page 49). At that time, flagrant cases of "research misconduct"—in the technical sense of falsification, fabrication, or plagiarism—and the mishandling of those cases came to light. The quarter-century-long discussion of ethics in the conduct of scientific research contrasts with the much longer history discussing scientists' and engineers' other professional responsibilities. For example, engineers and chemists have discussed their professional responsibilities since at least the 1930s.

When research conduct became a subject of public discussion in the 1980s, some physicists took comfort in the fact that most of the misconduct cases had arisen in medicine and the life sciences. Physicists got involved in 1986, however, when Robert Millikan came under sharp criticism for a statement in his 1913 paper on electron charge (see box 2 on page 49).[5]

In the 1980s, a large number of scientists responded defensively to cases of flagrant misconduct and were reluctant to acknowledge a need for greater attention to research integrity. One can get a flavor of those times by reading the first edition (1989) of the National Academy of Sciences' *On Being a Scientist*.[6] It was an attempt by the NAS to contribute something about responsible research conduct to the education of young investigators. However, it neglected to address issues of how to interpret the actions of any established, successful scientist whose research conduct had been questioned. For example, that first edition contained a picture of a crucial page in Millikan's laboratory notebook that shows data points he dropped, although he explicitly denied having dropped any. But nowhere does the NAS publication discuss Millikan's controversial statement. In addition, it strongly promoted not merely standards of responsible research conduct, but "the scientific world view," presumably against the creationists, who were perceived as detractors of science.

The tone of the 1988 US congressional oversight hearings, chaired by Rep. John Dingell (D-MI), that investigated how research institutions were responding to misconduct allegations reinforced many scientists' view that both they and scientific research itself were under siege. Despite the embattled stance of many scientists, the scientific community had no choice but to acknowledge that allegations of research misconduct were clearly mishandled by many universities, as detailed in Allan Mazur's 1989 report.[7] For example, John Darsee, a cardiologist and clinical investigator, fabricated data in more than 10 research papers and at least 45 abstracts. He listed faculty members as coauthors on articles and abstracts without their knowledge or consent, but no effective action was taken against him. He moved from Emory University to Harvard, where he continued the same practices until he was finally caught fabricating data in 1981. Robert Slutsky, an extremely prolific investigator at the University of California, San Diego, wrote 160 papers in seven years. He too added coauthors to his papers without justification. After a reviewer questioned the duplication of data in two of his papers, he abruptly resigned. Only then was an investigation launched. It found that 12 of his published papers contained fabricated results and another 48 were questionable.

Whatever else happened, research institutions needed to develop better misconduct procedures. To continue to receive government research funding, especially NIH funding, most research universities at least began to establish or improve their procedures for handling allegations of misconduct. The common explanation for research misconduct in scientific circles at the time was that it was entirely due to a very few rogue investigators, most of whom were mentally ill.

In the early 1980s, Walter Stewart and Ned Feder documented lax behavior by many of Darsee's coauthors that allowed him to deceive the scientific community. But because some of those coauthors threatened to sue *Nature* if it published the exposé, publication was delayed until 1987.[4] Even then, the scientific community was not ready to absorb the lesson that broad lapses of professional responsibility by those who would themselves never commit research misconduct can nonetheless set the stage for misconduct by others.

In 1996, Francis Collins, the head of the National Institutes of Health's Human Genome Project, reported that a junior investigator in his NIH lab—indeed, his graduate student—had fabricated data in five papers coauthored with Collins. Many in the scientific community accepted Collins's explanation that he could not have prevented the fabrication or detected it earlier, except via the unacceptable alternative of double-checking everyone's work.[8] Such a quick dismissal of the responsibilities of coauthors, es-

pecially senior ones, contrasts with the much more nuanced judgment by the committee at Lucent Technologies' Bell Labs that investigated research misconduct by Hendrik Schön (see PHYSICS TODAY, November 2002, page 15). After absolving Schön's coauthors of any complicity, they went on to raise the difficult and much subtler issue of the professional responsibility of coauthors for work that bears their names.

The Schön case and the case of Victor Ninov at Lawrence Berkeley National Laboratory in the same year (see PHYSICS TODAY, September 2002, page 15) made physicists abruptly aware that the world of physics itself was vulnerable. Not merely trainees and mentally ill underlings, but rising stars could be tempted to misconduct in highly visible areas of research. The investigations of those cases did, however, prompt more discussion and reflection about the responsibilities of coauthors. Recent history can thus stimulate the difficult task of developing serviceable standards and guidelines, at least within particular disciplines and fields.

What compromises research integrity?

Various explanations have been offered for research misconduct. Some early writers, like William Broad and Nicholas Wade,[9] presented falsification and fabrication of results as a long-standing problem in science. But they were rightly criticized for failing in some cases to distinguish between dishonesty and the use of methods—such as the data selection by Robert Millikan—that would not admit to falsifying their lab reports.[12]

The explosive growth in the number of scientific investigators after World War II has made it difficult for new social controls to emerge rapidly enough to replace those that kept investigators honorable when everyone more-or-less knew each other. Other recent changes in the research environment—such as new forms of data, the increase in multiple-author articles and interdisciplinary collaborations, and the prospects of major financial gain for investigators in some fields—have required investigators to address new problems of fairness and research oversight.

A shift of emphasis

Scientists are beginning to recognize that detecting and punishing fabrication, falsification, and plagiarism are not enough. Over the past 10 years or so, the broader concern of fostering responsible conduct has been coming to the forefront. That general shift has several sources. As the 1992 report of the MIT committee on academic responsibility found,[13] charges of misconduct are prone to arise in settings where other instances of wrongdoing, abuse, or conflict have been left unresolved. The correlation between misconduct charges and poor or hostile research environments suggests that effective responses to subtle problems of research conduct can reduce the incidence of misconduct charges. And such a reduction is desirable, as anyone who has taken part in a misconduct investigation can readily aver.

> **Back when everyone knew each other, trust was easier to maintain. Nowadays, research conditions change too quickly. To keep and promote research integrity, we need to continually examine and update our standards of conduct.**

be acceptable by today's standards but were acceptable in earlier periods.

A 1994 US National Research Council study argued that cutbacks in research funding for the biological and biomedical sciences had disproportionately deprived young investigators of research funds.[10] The real threat of losing their careers placed able young investigators under exceptional pressure. A perceived dearth of jobs for PhDs in physics may create similar pressures to cut corners. Documented cases exist of graduate students who felt driven to falsification or fabrication by pressure, for example to experimentally confirm a research supervisor's theory.[11]

The number of graduate students per faculty research supervisor has grown dramatically in some fields, which raises serious questions about the quality of research supervision and mentoring for those students. The lack of faculty supervision is further complicated by the presence of postdocs in some fields: Sometimes postdocs are the primary recipients of faculty supervision, which leaves graduate students to depend on supervision by relatively inexperienced postdocs.

Some features of undergraduate education in science and engineering may inadvertently foster bad research conduct. Academic integrity surveys at research universities show that an alarming number of science and engineering students—the majority at some universities—

More fundamentally, trust is essential to the research enterprise. This latter point was articulated in the mid-1990s in several influential publications.[14] As the preface to the second edition of *On Being a Scientist* puts it: "The level of trust that has characterized science and its relationship with society has contributed to a period of unparalleled scientific productivity. But this trust will endure only if the scientific community devotes itself to exemplifying and transmitting the values associated with ethical scientific conduct."

A corollary is that a culture of suspicion and disappointment undermines confidence in the results on which one builds, clouds the joys of discovery, spoils the pleasures of teamwork, destroys other daily satisfactions of research investigation, and complicates research activities. The destruction of the existential pleasure of investigation receives surprisingly little attention, except tangentially in discussions of the high attrition or even suicide rates among trainees in some laboratories and departments.[15] People may certainly take pleasure in mastering the skills and acquiring the virtues needed to conduct research. Such pleasure, however, is eroded by evidence that others are exploiting one's trust to get a competitive advantage

in seeking external rewards, such as status and money. If the pleasure in doing research erodes, only the scarce external rewards will remain as incentives. Competition will become ever more cutthroat as the fear of detection becomes the only check on cutting corners in pursuit of those external rewards.

An interesting study[16] reported on the effects of two research climates. One climate emphasized the acquisition and exercise of mastery (mastery of a field, proficiency as an investigator), and the other emphasized getting research results. The study found that the mastery environments better supported the intellectual and professional development of trainees than did the results environments. That finding is fully consistent with the responses from junior APS members, quoted by Kirby and Houle elsewhere in this issue.

Fostering research integrity

As I stated earlier, if research is to continue to flourish, warranted trust and trustworthy behavior that support

Undoubtedly, abuse and exploitation exist. I have tried elsewhere to draw attention to the egregious practice of assigning overlapping dissertation topics to one's graduate students and thus creating a fierce competition in which the "loser" may have to start over on a new dissertation topic.[17] Some trainees are exploited as cheap, intelligent, skilled labor. Others are treated in some idiosyncratic and unreasonable fashion that mimics their supervisor's own treatment as a trainee.

Forward-looking universities and departments have instituted rules to prevent some past abuses from recurring. For example, some have rules against faculty members hiring their own thesis students to help in their consulting work; some require that every graduate student have a departmental adviser distinct from her research supervisor; others require faculty members to give written notice, a semester or more in advance, before cutting off a graduate student's funding. Some departments have created an office that functions as an advocate for graduate students, a mediator if tensions develop between supervi-

> **It's not easy to find effective responses to subtle problems of research misconduct. Members of the same department are often unaware that they have vastly different intuitions about a given situation.**

enduring cooperation are required. Although some research conduct is clearly wrong, good responses are not always obvious, especially in cases of multiple and potentially competing responsibilities. Decent people may act in ethically unacceptable ways when they consider only some aspects of a situation. For example, a person might notice the same text in articles authored by two different people and spread the word. People might then come to believe that the author who had published second had plagiarized the work of the one who published first. However, the underlying reality might be that the one who published second had written and circulated her manuscript first and the one who rushed to publication had plagiarized; or it might be that both writers were unconsciously using words that each had often heard from a common mentor.

It is precisely to protect all parties from harm that research misconduct inquiries and investigations are strictly confidential; but where the same strictures do not apply, mistaken impressions can lead to damaged reputations. Understanding the situation and knowing how to investigate it without doing other damage is not just a matter of learning rules and guidelines. At a minimum, it requires some experience or knowledge of how to draw on the experience of more seasoned investigators.

The concerns of recent PhD graduates in physics, reported by Kirby and Houle, are relevant here. The complaints of abuse and exploitation come as no surprise to those of us who have been following the issues about the relations between research supervisors and their trainees.

sor and trainee, and a broker to find the trainee a new supervisor if the relationship breaks down. Occasionally, the head of graduate studies fills this function. Sometimes, trainees know they can go to the dean of the graduate school or to a university ombudsperson for such help. Sometimes junior investigators contact us at the helpline of the online ethics center for engineering and science (OECES), http://onlineethics.org/helpline.

Another suggested measure is to require research supervisors and trainees to draw up an agreement before entering into their relationship. The quasi-legal connotations of such a measure offend many faculty members. But the motivation for drawing up such agreements is to prevent later misunderstandings by ensuring that supervisors are explicitly aware of their own expectations and make the expectations clear to their graduate students before engaging in any work.

The proposal for explicit agreements gets at some of the sources of students' perceptions of abuse and exploitation. Students often do not understand what they are getting into when they enter graduate programs, and departments often do not tell them. I have seen students enter graduate school with the mistaken impression that doctoral work will be just like undergraduate study, only harder and faster. They take a long while to catch on to the fact that they are being evaluated primarily on their maturity as research investigators, rather than just on course grades. Many trainees do not know how to interpret their experience and do not know where to get unbiased information.

In my experience, that uncertainty remains a common and often unrecognized problem. When trainees have no risk-free way of getting adequate explanations, they may draw the wrong conclusions about entirely innocent research conduct. They often share misinterpretations with

one another. Addressing trainee questions dispels cynicism about the actions and motives of investigators. Cynical expectations, carried into future research careers, may become self-fulfilling prophecies by further undermining the possibilities for trust and cooperation.

Some personal experience

My experience comes only in part from discussing helpline inquiries with the OECES team of engineers and scientists. Since 1990, I have been involved in developing and facilitating sessions on responsible research conduct for science and engineering departments and laboratories.[18] Because the sessions include both faculty members and trainees from a single department or laboratory, they reveal as much about senior investigators as about junior ones. At a typical session, the group discusses responses to ethically significant, commonly occurring problems in research. The group draws on the depth of experience of its members in interpreting the situation—which is usually open to several interpretations—and in formulating options. Explicit planning and structuring for the sessions is essential. The facilitator's role is to keep the group focused on figuring out good responses and to connect the group's proposals to various current ethical guidelines where relevant, rather than debating judgments about the characters in the problem statements. The role of facilitator can readily be taken over by an interested member of the department or laboratory.

Within the same department or laboratory, senior investigators often have widely differing intuitions—for example, on the career benefits one can legitimately reap from reviewing manuscripts, the factors that decide the order of authors on a paper, or the norms that should govern the supervisor–trainee relationship. Even more striking is that prior to the session, most investigators are unaware of the differences among them, which suggests that senior investigators who have known each other for decades have never discussed many elements of their research conduct. Often, but not always, the group comes to consensus on some new norms for handling problems that fall within the session topic. The departments and labs with which I have worked probably have better than average standards of research conduct, since their members are not afraid to participate in such discussions, but my experience is that discussing responsible ways of handling common problems can strengthen a group's understanding and ability to address problems.

Also evident from these sessions is that graduate students and other trainees appreciate the opportunity to raise questions about research conduct, questions they were otherwise reluctant to ask for seeming to challenge their research supervisor's practice. Trainees' concerns about the supervisor–trainee relationship are especially important to address. For all topics in my sessions, participants have the option of submitting problems that they would especially like the department to deal with. Trainees are especially likely to submit problems for the supervisor–trainee relationship sessions; they often ask for and receive anonymity. Most submissions become part of the permanent store of discussion problems available at http://onlineethics.org/reseth/mod/advis.html.

Because of variations between fields—for example, in data formats or journal practices—the ways that responsibilities are best met may also vary between fields. Therefore, even if procedures for handling allegations of research misconduct are best handled at an institutional level, norms for responsible behavior in everyday research situations need to be developed at the departmental and laboratory levels. Furthermore, senior investigators need to be apprised of current statements of norms that apply to their research practices. Their knowledge of current and emerging norms is sketchy and may even be behind that of the trainees they are expected to educate. If seasoned investigators have sound reasons for disagreeing with some statements of norms, they need to explain to trainees the reasons for those departures.

The APS survey results reported by Kirby and Houle show that some problems of research conduct are mishandled or misunderstood. It would be a mistake to assume that a better understanding of responsible research conduct can be acquired quickly and that everyone can then go back to just considering how to foster proficiency in research. As long as research continues to flourish, the conditions and collaborations necessary to further it will continue to change. Therefore, even those investigators who have been well advised and mentored by senior investigators of the preceding generation will face novel problems of research conduct that are ethically significant. Departments and laboratories need to be active as moral communities in developing and revising standards of conduct that will promote research integrity.

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