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# Demystifying the Academic Research Enterprise

## Becoming a Successful Scholar in a Complex and Competitive Environment

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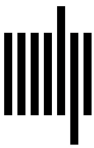

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# 7

# The Give-and-Take of Criticism: Subjecting Research to Scrutiny via Peer/Merit Review

## Chapter Overview and Learning Objectives

As is true for many aspects of our lives, research and creative activity are subject to scrutiny, particularly via the peer/merit review process.[1] By identifying not only problems or flaws but also new ideas and approaches, such review can aid in ensuring that rigor, quality, validity, significance, and originality are present in the work. This chapter describes the purpose and importance of peer/merit review as well as foundational principles and the steps involved in the processes. It also discusses strengths and weaknesses in review processes, variations arising from them, and methods for effectively using professional criticism. After reading this chapter, you should

- Understand the importance of and mechanisms for scrutinizing research proposals, methods and outcomes;
- Be able to define peer/merit review and describe the associated principles and processes for both publications and proposals;
- Be aware that principles of peer review are applicable to scholarly activities other than traditional publications, including performances, exhibits, and scores;
- Be able to explain the strengths and weaknesses of traditional peer/merit review and alternative methods being explored; and
- Understand the nature of professional critique and be able to apply it effectively to your work.

## 7.1 Importance, History, and Forms of Scrutinizing Research and Creative Activity

Throughout our lives, virtually everything we do is subject to scrutiny—that is, to critical evaluation for the purpose of learning, improving, and achieving

the highest standards of excellence. As children, our school work was scrutinized for errors, and we learned by receiving guidance and correction. Our performance in sports and in our jobs, our tax forms and bank accounts, and our posts on social media all come under scrutiny. Receiving criticism from scrutiny often is not enjoyable, nor is learning from it always easy. However, scrutiny is an essential and extremely valuable part of our lives, and research and creative activity are no exception.

In that context, scrutiny helps ensure that rigor, quality, validity, significance, and originality are present in research, and that the work performed meets the intended purpose. Scrutiny helps identify problems, flaws in concepts and approaches, and misconduct such as fraud and plagiarism (chapter 9). By its very nature in evaluating and challenging processes and outcomes, scrutiny sometimes leads researchers to identify new approaches and ideas, helps train researchers to improve over time, ensures public trust and confidence, and lends prestige to the entire enterprise. Never lose sight of the fact that someone is funding your research and creative activity, and wherever money is expended, high expectations and accountability understandably also are present!

However, we also must remember a very important point that argues strongly in favor of scrutiny—namely, that the stakes regarding research are extremely high. That is, our work as scholars is critically important to ensuring the health and vitality of all living beings, the sustainability of our environment, our personal as well as national security and prosperity, and the celebration and enrichment of our humanity. That is an enormous responsibility and is why we need to scrutinize the research process itself, along with grant proposals, journal articles, books, exhibits, performances, presentations, interviews, blog posts, and more.

Scrutiny of research and creative activity began long before today's process-oriented methods came into existence (chapter 4). Those who developed astrological, astronomical, and other bases of knowledge in prehistoric times no doubt debated one another's viewpoints, though we have little direct evidence given that the spoken word was at that time the only form of communication. Early Greek philosophers, who focused on understanding the natural world from non-supernatural viewpoints, probably marked the beginning of organized scrutiny of research—or as it was known then, natural philosophy.

Plato and Aristotle, who lived in the late fourth and early third centuries BC, respectively, are familiar names and are credited with systematizing inquiry into the natural world. In so doing, the scrutiny of one another's ideas and writings in their day became more formal. Because space does not permit a thorough examination here of the history of research scrutiny, several references

are provided (e.g., Moran 2010; Cohen and Lloyd 2014; Moore 2019; McElreavy et al. n.d.). However, we should not overlook the consequences of disagreement among scholars during the formative period of intellectual inquiry, with one of the most fascinating examples being the trial of Galileo in 1633. Galileo was accused by the pope of heresy for advocating heliocentrism, or that the earth revolves around the sun. Galileo ultimately spent the rest of his life under house arrest for his beliefs and writings, which like those of Copernicus, turned out to be correct!

In modern times, as research methods and academic disciplines became more formalized, scrutiny of research and creative activity likewise took on a more formal structure. Many forms of scrutiny now exist, including the review of progress reports by funders of research; congressional hearings on specific topics of interest to lawmakers; work by inspectors general at federal agencies to ensure appropriate laws and processes are being followed and that waste, fraud and abuse are not occurring in research; and the ability for the general public to comment on proposed government policies via the Federal Register.

The form of scrutiny that you, as a researcher, will encounter most often is known as peer review, which most trace to seventeenth-century Europe and the founding of the Royal Society of London in 1662 and the Academie Royale des Sciences of Paris in 1699. Both societies began publishing their own journals, and the first formal instance of peer review, in that context, is thought to be the *Philosophical Transactions of the Royal Society* and the French *Journal des Scavans*, more than three hundred years ago.

We will formally define and examine peer review in great detail in subsequent sections of this chapter, but for now, as the name implies, it is sufficient to know that peer review involves the evaluation, by peers, of grant proposals, journal and book manuscripts, performances, exhibits, data sets, and course materials. And of course, the book you are now reading! As you might imagine, peer review varies in its application across disciplines and circumstances, and also has its strengths as well as weaknesses—both of which we examine in subsequent sections. Yet, despite thoughtful efforts to improve peer review and even devise other strategies in place of it, peer review remains the global de facto form of scrutiny applied to research and creative activity.

## 7.2 Definition and Purpose of Peer/Merit Review

Scholarly peer review is the process by which research and creative activity are evaluated, according to specified criteria, principally by peer experts in the same or similar fields for the purpose of rendering some sort of decision. Note that merit is one criterion upon which review by peers can be based,

usually for grant or other types of proposals. Consequently, peer and merit review are different, with the latter being one possible component of the former. For simplicity, unless otherwise noted, henceforth I will use the term "peer review." Although the definition of peer review is seemingly straightforward, it is rich in content and worthy of being unpacked.

The first point to note is that peer review is a process, built upon a foundation of core principles (section 7.3), which involves proceeding through a series of steps that depend upon the particular situation at hand. For example, the peer review process applied to a grant proposal tends to be somewhat different than that applied to a journal or book manuscript, and varies across funding organizations and publishers, respectively. Issues such as conflicts of interest, confidentiality, and bias (chapter 8) are key considerations of the process, irrespective of where and how it is applied.

Second, the phrase "research and creative activity" in our definition can refer to a proposal, concept, or strategy, but also to an outcome or communication of results. The latter includes but is not limited to journal and book manuscripts, performances, exhibits, inventions, computer codes, data sets, processes, sculptures and other physical objects, course materials, and so on.

The third component of our definition concerns "evaluation according to specified criteria." The evaluation of research and creative activity is intended to emphasize a thorough assessment of motivation, questions or hypotheses put forward, methodological approach, information utilized, analyses conducted, and so on. And this evaluation is made relative to specific criteria, which can vary markedly among funding organizations, publishers, and disciplines and include the aforementioned items but also the fundamental intellectual merit of the activity; its potential impact on the scholarly field and/or society; the degree to which the work improves education and the engagement of others, especially those from traditionally underserved, underrepresented or marginalized populations; the creativity and innovativeness exhibited by the researchers; and the relevance of the work to the mission of the organization funding or publishing it.

Fourth is the notion of a "peer." Traditionally, this term referred to experts in the field or fields closely related to the research or creative activity being scrutinized. For example, cosmologists peer reviewing a journal manuscript on black holes, or a musical theorist reviewing an orchestral score. Today, the notion of a reviewer can be broader, sometimes including individuals in the general public who are knowledgeable about a topic but not formally degreed or credentialed (section 4.6).

The fifth and final component of our definition of peer review involves the "purpose of rendering of a decision." This is more complex than it sounds

because, embodied in this phrase are the words "purpose" and "rendering a decision." Although we already have defined peer review, its actual purpose, somewhat surprisingly, is a topic of debate. For the most part, in the context of making decisions such as selecting proposals for funding, papers and books for publication, and scripts for performance, peer review is intended to lead to the selection of the "best" among alternatives. But against what do we measure in defining "best," and would we always arrive as the same outcome if we used different peers?

Interestingly, peer review most frequently informs the decision being made but does not directly determine it. For example, a journal or publishing house uses editors to assess responses provided by peer reviewers of a particular submission, such as a journal or book manuscript. Quite often, the reviews exhibit widely varying views of the work and frequently require clarification and/or revision of the work by the researcher. Ultimately, the editor is responsible for considering all reviews, including his or her own, and rendering the final decision regarding acceptance for publication. The same holds true for federal agency program officers charged with selecting proposals for funding, though as noted previously, differences in process exist among funding organizations.

### 7.3 Principles and Processes of Peer/Merit Review

The process and components of peer review vary depending upon the circumstances in which they are applied. However, peer review is grounded in certain foundational principles that transcend the nuances of its application, though in a few cases, this is changing.

The first principle of peer review is *evaluation* by individuals other than those who produced or are proposing to conduct the work. The second principle is *objectivity*, guided by criteria utilized for the evaluation. The third principle is *impartiality* and absence of bias (chapters 8 and 9), which is managed by conflict of interest disclosure and other means. The fourth principle is *confidentiality* on the part of those reviewing and passing judgment on the work, though as we will see, in some situations, more open processes are now being tested. The fifth principle is *honesty and integrity*, with the peer review process free from political and other non-scholarly external influences. The sixth and final principle is *accountability*—to those funding the work, including but not limited to taxpayers, and to the research enterprise itself. Important to accountability are independent assessments of peer review itself, including how decisions based upon it are rendered, to ensure the processes are operating at the highest levels of professional integrity.

At the end of the day, as in so many aspects of our lives, the peer review process relies on trust—trust among reviewers, between author and editor, between researcher and agency program officer, and between the public and the research enterprise itself.

The best way to become familiar with the peer review process is to walk through the detailed steps involved in its application. Not surprisingly, each federal R&D funding agency, each nongovernmental funding organization (e.g., a private foundation), and each journal or publisher has its own set of rules, procedures, and criteria for evaluating submissions. Although one could examine several in detail, a more effective approach is to equip you with an understanding of the foundational elements of peer review by studying four specific examples: peer review of a research grant proposal submitted to NSF, NIH, and NEA, and peer review of a manuscript submitted to a generic archive journal. One might refer to these as examples of "classical peer review," upon which many variations have been developed (section 7.5). Once you understand these examples, others will be easier to grasp (US Government Accountability Office 2014, figure 1 provides an excellent generic life-cycle workflow for federal grants). Other examples and applications (e.g., juried performances and exhibits) are described in the references (e.g., Hunter and Russ 1996; Lerch et al. 2020).

For the first example, assume you have written a research grant proposal, as described in chapter 6, to study tornadoes and have submitted it to NSF via the electronic system at https://www.grants.gov. Upon receiving it (figure 7.1), and after the automated system has determined the proposal meets all agency requirements for format and completeness of information provided, NSF assigns the proposal to the appropriate program for review, in this case the Physical and Dynamic Meteorology Program within the Division of Atmospheric and Geospace Sciences. Although the overall process is supervised by the division director, a specific program officer is given responsibility for stewarding most of the peer review steps. Note that, for some federal agencies and programs and even some private foundations, proposals are reviewed internally, by organization personnel only, without involvement of outside subject matter experts.

The NSF merit review[2] process (figure 7.1) proceeds with the selection of reviewers who are familiar with the subject area as determined by personal knowledge of the program officer, reference to reviewer work in the proposal itself, reviewers recommended by the principal investigator, and databases that list researcher expertise. In considering possible reviewers, the program officer checks for conflicts of interest, which might take the form of familial relationships, prior or current collaborations, institutional affiliation, or significant


**Figure 7.1**
Merit review process for grant proposals submitted to the National Science Foundation. *Source*: National Science Foundation (n.d.-b).

financial interest such as ownership of stock by the principal investigator in a corporation led by a reviewer. We address these and related compliance issues in chapter 10.

Once reviewers have been selected, the proposal is provided to them for review. Although reviewers know the identity of the investigators proposing the work, the investigators do not know the identity of the reviewers unless the reviewers choose to make their identity known. This is known as the *single-blind model* of review. NSF requires reviewers to maintain strict confidentiality of their reviews within the process being utilized. It also requires that reviewers not take ideas from the proposal for their own use nor share the proposal with others, and that they destroy or return the proposal when the review is completed.

NSF utilizes two criteria for merit review, the first involving the intellectual merit of the work being proposed and the second involving broader impacts. Detailed guidance is provided to reviewers regarding how to assess these criteria, and once reviews are received, the program officer evaluates them to render a decision regarding funding. Sometimes, panels of experts are utilized to review a group of proposals, and in the process, they meet, either in person or virtually, to share their reviews and arrive at consensus

recommendations given to the program officer. This is a form of "consultative review," described subsequently (see also section 4.8), and is quite valuable for helping clarify misinterpretations and oversights that easily can occur when peer reviewers do not see each other's assessments.

In making the decision whether to fund the proposal, the program officer sometimes seeks answers from the proposer(s) to questions raised by peer reviewers. Additionally, the program officer considers not only the merit reviews themselves, but also other factors. These include the body of work already being funded by NSF in the topic being proposed, the amount of funding already being provided by NSF to the investigator or investigators, and the amount of funding available. To ensure accountability of the process, the division director reviews all materials associated with the review process and either concurs or disagrees with the program officer decision. In either case, the principal investigator and their institution are notified of the outcome.

NSF conducts external reviews of its merit review process through a mechanism known as the committee of visitors. Members of the committee conduct periodic assessments of proposals and their associated reviews and agency decisions drawn at random from those that were both funded and rejected. Additionally, they examine other aspects of the review process, and make recommendations for change, to ensure that the peer review system is operating at the highest levels of integrity.

With the NSF example now in hand, it is useful to briefly examine the overall characteristics of procedures used by two other key federal agencies.

The NIH review process (National Institutes of Health n.d.-c) shares some features of that used by NSF, though notable differences exist. They occur in part because NIH itself consists of a number of centers and institutes, each of which performs research (known as intramural research) and has its own variations upon the foundational NIH review process. (NSF itself does not perform research or operate facilities, and although its directorates operate a wide array of programs, all reviews utilize the aforementioned two criteria.)

Generally, a research proposal submitted by an academic scholar to NIH is assigned to a study section, which comprises expert reviewers who conduct the initial peer review. If the proposal has institute-specific features, the relevant institute coordinates the review. Numerous criteria are considered in the review process (e.g., significance, innovation, approach, capabilities of the investigators), and the outcome of the first review is expressed as an overall impact score, with the scores for a given study section ranked into percentiles. Additionally, reviewer comments and a summary statement are prepared.

The second level of review is performed by NIH institute or center councils or boards which, in addition to subject matter experts, include other individuals

having expertise in health and disease. In many cases, a payline then is determined based upon funding available, the number and quality of submissions, and other factors. Submissions falling within the payline generally are funded, though exceptions can be made.

In the case of NEA, the peer review process is less elaborate but nonetheless rigorous (National Endowment for the Arts n.d.). As for NSF and NIH, proposals submitted are first evaluated to ensure they conform to stated formats and timelines. NEA staff then review the submissions for eligibility and completeness and assign proposals to an appropriate review panel of subject matter experts. Typically, a panel consists of six experts who handle up to forty submissions in a given review cycle. In this first level of review, each panelist assesses every submission and provides each proposal with a rating, according to NEA criteria. The panel meets as a group in closed session to discuss the ratings, which may be changed based upon that discussion.

In the second level of review, the National Council on the Arts (NCA) assesses the panel recommendations and considers available funding to arrive at a final recommendation for each proposal. These recommendations are forwarded to the Chairman of the Council, who renders the final decision.

This second level of review is quite similar to that for exceptionally large or otherwise special proposals that come before NSB, which is the governing body of NSF. However, instead of recommending to the NSF director which proposals should be funded, NSB makes the final decision and formally authorizes the director to make the award. Interestingly, both NSB and NCA members are presidential appointees serving six-year terms.

Research grant proposal review procedures used by other federal agencies are similar to those described here, though for many mission agencies (section 6.1), only internal agency review or limited external review is utilized. Additionally, some mission agencies require only brief statements of work and budgets for continued funding, or for proposals that address specific mission requirements.

Turning now to the review of a manuscript submitted to a generic archive journal, the process is quite similar to that just described for a proposal submitted to NSF, though with some important variances. Of course, in reality, the process varies by journal, discipline, and type of publication.

As shown in figure 7.2, the principal author submits the article to a chief editor or editor. The submission undergoes a compliance check to ensure it meets criteria for topical relevance and is properly formatted according to journal policies. If the article fails the compliance check, it is returned to the author. Otherwise, it is assigned to an editor or associate editor who identifies appropriate reviewers using much the same process as described for an NSF proposal. As always, conflicts of interest (chapter 10) are managed appropriately. The

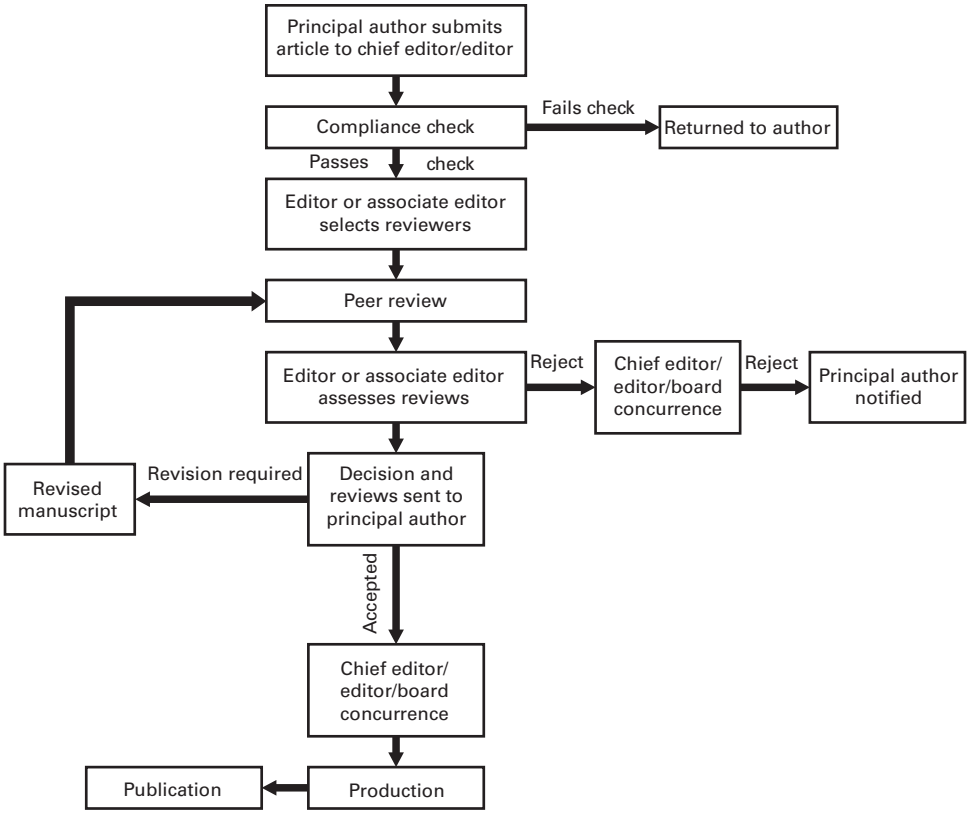


**Figure 7.2**
Generalized peer review process for archive journal publications. The actual process depends upon the publisher and type of publication.

reviewers are provided with the manuscript, along with guidelines, and submit their review to the assigned editor. Typically, publishers apply the single-blind model.

The editor then evaluates the reviews and renders a decision, which usually is provided to the chief editor or editorial board. This decision can include (figure 7.2) outright rejection, whereby the manuscript is returned to the author, acceptance with minor revision that requires no additional review apart from that of the assigned editor, or provisional acceptance subject to revision and possibly multiple rounds of assessment by the original reviewers. If the manuscript eventually is accepted by the assigned editor, it usually is passed to the chief editor or editorial board for concurrence, and then to the publisher for production and then publication.

### 7.4 Strengths and Weaknesses of Peer/Merit Review

Although peer review has stood the test of time and frequently is referred to as the "gold standard" for scrutinizing scholarly activity, it is not without its limitations and critics, especially those involved in the process itself. Studies of peer review, though not numerous by traditional measures or involving huge amounts of data, have been quite valuable in identifying challenges and recommending improvements (section 7.5). Thus, we examine both the strengths and limitations of peer review as a natural preface for considering the value of possible improvements. What follows is generally applicable to all disciplines.

Starting with the strengths of peer review, many exist. First, as classically applied, peer review involves the use of highly knowledgeable subject matter experts who comment on and independently verify or validate results, spot problems with design and interpretation, identify fraud or plagiarism, clarify vague explanations, interpret expression, assess performance skill, identify and suggest ways of removing bias (chapter 8), and provide insight into omissions and missed opportunities for more effectively achieving the goals of the work. For grant proposals, peer review also provides an assessment of researcher capability, an evaluation of the history of collaboration, if appropriate, data and project management plans, and the availability of necessary resources, including facilities, for performing the work.

Second, peer review traditionally has involved maintaining anonymity of reviewers, which allows them to comment openly and honestly (though in some cases, overly harshly and even vindictively). Additionally, the material being reviewed traditionally is required to be held in confidence, with reviewers bound to not disclose or use it to their advantage. In this regard, as in so many aspects of the research enterprise, trust is foundational to the effective application of peer review. We will see in the next section that some of these traditions now are being modified in favor of new approaches that seek to enhance the review process as well as its transparency and accountability.

The third strength of peer review is that those receiving the reviews gain insight into how others think and approach problems. This not only improves the research itself but also educates researchers and broadens their own views. In fact, it is not unusual for a new idea to be birthed, or a better approach to be identified, as a result of the peer review process. Researchers also gain value by serving as peer reviewers, not only in understanding how to conduct reviews, but also in assessing how their own research might be reviewed—thereby improving its quality prior to submission.

Fourth and finally, in the context of grant proposals, peer review is an important mechanism for ensuring that proposed budgets align with the work to be

performed, that the research is consistent with the mission or goals of the organization providing the funding, and that protocols—such as those involving human and animal research (chapter 10)—have been appropriately structured, thoroughly evaluated and effectively are integrated into the work plan. This scrutiny is important for ensuring public trust, both in the expenditure of taxpayer dollars as well as in the outcomes of the research itself. It also creates a sense of prestige for projects chosen for funding.

Turning now to challenges associated with peer review, you may not be surprised to learn that some are the obverse of the strengths just mentioned. First, by its very nature of thoroughness and involving subject matter experts from around the world, peer review is a slow process. The time elapsed from submission of a grant proposal to final decision can be six months or more. Journal manuscript processes generally are somewhat faster, though books often require up to a year for review. The evaluation of performances and exhibits generally occurs more quickly, though with no less degree of intensity.

Second, although peer review represents a measure of quality control, papers containing errors, flaws, plagiarism, and fraud sometimes do get published, though they are relatively rare among the more than one million papers published, and tens of thousands of grant proposals funded, every year. New technologies exist to help identify plagiarism and other issues, and as discussed in section 4.7, mechanisms are available in some disciplines to attempt the reproduction of research results prior to publication.[3] Additionally, several studies have examined the ability of peer review to identify an array of problems and can be found in the references (e.g., Jefferson et al. 2002; Nature 2006; Smith 2006; Ware 2008).

Unfortunately, given the heavy research and teaching workloads of most college and university faculty and the number of documents they are called upon to review, not every paper or proposal receives the sort of in-depth analysis for which peer assessment was designed. Also, for large national-scale activities involving dozens or hundreds of researchers, especially in one or a few disciplines, finding experienced peer reviewers who are not conflicted is sometimes difficult.

A third limitation of peer review, transparency and openness, is related to one of its traditional foundational principles, namely, confidentiality. The traditionally closed nature of peer review makes it subject to speculation regarding things that may or may not be happening "behind the curtain." For example, making certain that all processes are clearly articulated to authors or researchers submitting proposals; that reviewers are not conflicted and are free from bias, including partiality for or against the researchers involved; that reviewers truly understand how to utilize the criteria provided; that the

process is consistently applied; and that decisions rendered are supported by written material that adequately explains the reasoning involved. These points are important not only for the research enterprise, but also for the general public. One solution for the transparency challenge, known as open peer review, is discussed in the next section.

A fourth limitation of peer review is its admittedly subjective nature, which has led some to question whether the outcomes it produces are better than flipping a coin. Most researchers certainly believe peer review is the better option, though quantifying the ability of peer review to identify the "best" among many, as noted previously, can be problematic. This has led to calls for developing quantitative measures of peer review and applying science to assess its value.

A fifth limitation that exists in peer review, but in other aspects of our lives as well, is bias. So important is this topic that chapter 8 is devoted to it.

Sixth, peer reviewers sometimes find difficult the task of judging inter- or multidisciplinary work; that is, research and creative activity involving scholars from more than one discipline (chapter 13). This issue occurs in both evaluating proposals as well as outcomes of research. Although finding subject matter experts is not difficult, the challenge they face involves understanding and passing judgment on the contributions and relevance to the work of disciplines other than their own.

For example, the study of an ancient language might involve anthropologists, linguists, computer scientists, mathematical modelers, and historians—all of whom have different disciplinary lexicons, research methods, and views of the project. Coming to a consensus view of a grant proposal, for example, by integrating these dimensions is a challenge indeed, though one that increasingly is the norm in the research enterprise.

Finally, as noted in chapter 1, research generally advances by relatively small increments of progress. However, big ideas sometimes lead to breakthroughs that result in transformational capabilities for society. Examples include the transistor, LASER, nuclear reactor, and blood thinner, Warfarin. Unfortunately, peer review, especially for grant proposals submitted to federal agencies and those reviewed by panels, tends to "regress to the mean," which means that particularly big, potentially transformative ideas often are viewed as too risky to be funded. Indeed, it is generally the case today that, in order to obtain federal funding for research, one must have sufficient results in hand to convince reviewers that the outcomes are fairly certain. Why? Because federal research budgets are extremely stressed and the competitive demand for funding is huge and continues to grow.

Additionally, overturning established paradigms[4] can be difficult when some of the individuals responsible for creating them are reviewing your proposal!

Combined, these factors have the effect of suppressing even the submission of the most creative, potentially transformative ideas. Researchers simply don't bother. And that is a problem for our nation because it means we risk losing the creative spirt that led the US to become the world leader in research and creative activity. You can learn more about potentially transformative research in National Science Board (2007).

### 7.5 Variations on Classical Peer/Merit Review

It is the very nature of researchers to search for ways of building upon and improving existing knowledge and capabilities. Also true is that advances in technology, especially the Internet, open doors to new capabilities. Peer review is no exception to both of these realities. As a result, numerous variations on the classical peer review model described in the preceding sections are being developed and evaluated. The goal is not to create the perfect model, for we know this is impossible owing to the diversity of circumstances to which peer review is applied, the multiple dimensions of its purpose, and its inherently human-based subjective nature. Rather, the goal is to address known limitations of peer review to maximize its utility for the situation at hand. One of the most important contributors to this goal involves training reviewers to understand the review process and be effective in applying it.

Space does not allow for a comprehensive assessment of every alternative model or possible improvement, so I provide here information about those receiving the most attention.

The simplest variation on the classical model of peer review involves whether the identities of both researchers and reviewers are mutually disclosed. We have examined the single-blind model, which means the identity of the author or investigator is made known to the reviewer, but the identity of the reviewer remains confidential. In the *double-blind model*, the identities of both the reviewer and researcher or author are held in confidence. This strategy is motivated in part by studies showing the presence of bias in reviews (chapter 8) owing to the author or researcher's sex, institutional affiliation, race, or nationality (as might be determined by a web search or simply one's name). As you might imagine, it is difficult to truly double-blind the review process because, in many papers and proposals, authors describe their previous work and build upon it.

On the other hand, the most complex variation on the classical model takes exactly the opposite approach to double-blind review; namely, an open process in which everyone's identity is disclosed, and in the extreme case, where proposals, manuscripts, and other items are made available on the Internet for

public input. Known generally as *open peer review*, this framework seeks to enhance transparency and accountability, in some situations accelerate the review process, and improve the quality of assessments provided, including reducing bias.

Consider two specific versions of open peer review, the first of which is referred to as "consultative" peer review. This process involves all participants in the review process—authors and editors in the case of publications, and researchers and program officers in the case of grant proposals—working together, sharing information and exchanging reviews and responses. The collaborative nature of the process helps resolve conflicting statements made among reviewers as well as uncertainty regarding their understanding of the work. It also helps reduce calls for unnecessary or redundant additional work on the part of authors or grant proposal investigators and increases transparency of the process. Ironically, although consultative review was envisioned as a more efficient strategy than confidential review, it can in fact lengthen the process.

In the more elaborate form of open peer review, manuscripts or proposals are submitted as usual and assigned to editors and reviewers. However, the submissions also are posted on the web for public comment, and input from those comments, which usually cannot be submitted anonymously, is added to those from subject matter experts, with the consultative mechanism previously described used to arrive at a final decision. The advantages of this approach are the same as for consultative peer review, though by making the work as well as all reviews and reviewer identities public, it is believed reviewers will be more tactful and constructive in their comments and more likely to be thorough.

Additionally, efforts to suppress a manuscript from being published, or prevent a proposal from being funded (section 10.3), are arguably more difficult to undertake in the open peer review framework, thereby enhancing accountability of the process. Allowing the public to comment challenges the notion of a subject matter expert and posits that someone with considerable knowledge, though lacking formal credentials, can still contribute to scholarly research and creative activity (section 4.6).

Nevertheless, fully open peer review has an important drawback for grant proposals. Namely, by placing proposals on the web, one loses the ability to prevent misappropriation of the ideas and methods being proposed. That is, stealing ideas from proposals—which is explicitly prohibited in classical peer review, as discussed previously—becomes very easy. Few things are as important to scholars as their ideas and proposed research, and fully open review places those things in jeopardy. Although proposals posted on the web for open review obviously do not contain classified information, they could

include information considered to be "dual use" (that is, applicable to both civilian and military purposes). This is a particularly important issue for certain topics of national importance, such as artificial intelligence, quantum information science, advanced manufacturing, microelectronics, and biotechnology. Additionally, in the increasingly globally competitive research enterprise and the intentional subversion of America's research enterprise by some governments (section 10.3), extra care must be taken to balance openness against protection, intentional collaboration against illicit competition.

Interestingly, the open peer review model is used by the federal government to allow the public to comment on proposed changes to policies and rules, including those governing research. The document being reviewed in this case is known as a Notice of Proposed Rulemaking (NPRM), and they are posted almost continuously in the Federal Register. The main disadvantage of open peer review is that it can cause reviewers to be less forthcoming or critical, especially if they are critiquing someone well known in the field. Additionally, rebuttals of reviews, or other mechanisms for conveying how the reviewer comments were or were not included, generally are not part of the open process owing in large part to the sheer magnitude of the input typically received.

Other models of peer review exist, including hybrid review, *a posteriori* review, and *a priori* review. With all of that, as you might expect, considerable debate exists regarding the value of the various alternative methods of peer review, and references are provided so you can further explore these issues (e.g., DeCoursey 2006; Kelly, Sadeghieh, & Adeli 2014; King 2017; Tennant 2018).

One thing seems certain, however. For all its shortcomings, no one has yet found a better approach to scrutinizing scholarly research and creative activity than peer review.

## 7.6 Using Criticism Effectively

I want you to be completely honest in answering the following question: Do you enjoy being criticized, even if you know it is coming? Say, on a term project, thesis, dissertation, journal manuscript, performance, or exhibition? Do you find criticism valuable? Do you *actively* use criticism to your advantage? That is, do you think carefully about the critique, determine whether it is valid, and then seek to improve your work from it?

The influential French Renaissance philosopher Michel de Montaigne said the following: "We need very strong ears to hear ourselves judged frankly, and because there are few who can endure frank criticism without being stung by it, those who venture to criticize us perform a remarkable act of friendship,

for to undertake to wound or offend a man for his own good is to have a healthy love for him" (Montaigne 1958). In the context of this book, I would modify that last sentence to read "is to have a healthy love for the research enterprise."

In the present chapter and in chapter 6, we addressed the importance of scrutinizing scholarship, especially via peer review. How, then, does one actually utilize critique effectively and, as de Montaigne states, not be stung by it but rather see it as a favor done for you? Here is some important and generally accepted guidance about using criticism effectively. It does not address the issue of how one *provides* effective criticism because, in the context of research, it varies widely among disciplines and circumstances. However, I believe you will gain insight into this aspect of critique by understanding how to handle it yourself, thus preparing you to provide it to others.

First, realize that critical assessment of your work is foundational to the research process, and that irrespective of the feedback provided—be it highly critical or even something with which you disagree—you can always learn from it. Once you accept this fact, criticism won't be a hard pill to swallow. As M. Scott Peck famously said in his classic work *The Road Less Traveled* (Peck 1978, 15), "Once we truly know that life is difficult—once we truly understand and accept it—then life is no longer difficult. Because once it is accepted, the fact that life is difficult no longer matters." I therefore urge you to be positive about criticism and accept and embrace it!

Second, carefully review critiques of your work to fully understand what each reviewer is trying to convey. Our human tendency is to react to criticism by defending ourselves rather than being open minded and accepting that we might learn from it. This often causes us to miss the message which, in research, could lead to a proposal or paper being rejected, or an opportunity to exhibit being denied.

Third, judge the criticism carefully to discern which comments are factual and which are patently false. Although all critique has value, some feedback may obviously be wrong and should be dismissed out of hand.

Fourth, take time to process the critique and do not prepare your responses immediately. This is especially important if your initial reaction to the critique is one of indignity. Remember, research inherently involves debate and disagreement, and being able to handle criticism is an important and necessary skill you will develop over time.

Fifth, never take critiques personally. In other words, the critique is of your work and not of your personality or value as an individual.

Finally, be calm and measured in your response if one is required. Use data and facts to bolster your arguments, and if possible, have others review them prior to submission. Focus on the points raised and not the tone of the critique,

which sometimes can be quite harsh. Also, avoid negative or emotionally driven responses. Simply respond to the critique, point by point to avoid ambiguity, and make your responses as easy as possible for reviewers to digest, especially if they are measuring your responses against enumerated criteria.

In some of the courses I teach in meteorology, students undertake term projects and prepare conference-style papers which they then review—as peers—via the single-blind process. I find it fascinating that students are very adroit in identifying shortcomings in the work of their classmates, while making *exactly* the same mistakes in their own papers! This is why peer review is valuable, and why we, as scholars, must rely upon and *trust* one another to thoughtfully critique each other's work. In this way, we help ensure the research enterprise operates with maximum quality and integrity.

### Assess Your Comprehension

1. What are some of the foundational benefits to subjecting research and creative activity to critical evaluation and scrutiny?
2. Define peer review and explain its core components. How does it relate to merit review?
3. Explain the foundational principles of peer review.
4. To what forms of scholarship can peer review be applied?
5. Outline the process of peer review utilized by the National Science Foundation (NSF).
6. Describe the two review criteria used by NSF to assess research grant proposals.
7. List a few ways in which the proposal review processes conducted by the National Institutes of Health (NIH) and the National Endowment for the Arts (NEA) differ from those of NSF.
8. What is a committee of visitors at NSF?
9. Outline the generic process of peer review applied by journals.
10. Describe key strengths and weaknesses of classical peer review.
11. Compare and contrast single-blind and double-blind peer review and list strengths and weaknesses of both.
12. What is meant by open peer review, and how does it differ from the classical model?
13. Describe other variations on classical peer review and ways in which they are formulated to improve upon the traditional process.

14. List several ways to most effectively interpret and utilize critical evaluation of your work.
15. What things should you carefully avoid doing when responding to critical evaluation of your work?

### Exercises to Deepen Your Understanding

**Exercise 1:** This chapter described a number of strengths and weaknesses associated with peer review and also presented several alternative models now being explored. Using that information plus references provided, devise a new, never-before tried method of peer review and describe your rationale for it. Note that your new method can be a variation upon an existing method but must be different from what now exists. What problems or limitations does your method seek to address? Why do you feel your method improves upon existing methods? How might you suggest conducting a pilot project to evaluate your method in a head-to-head competition against existing methods?

**Exercise 2:** Describe a situation in which you, or your work, were evaluated either by a peer or a mentor or teacher. Consider sports, presentations, performances, a paper or proposal, and so on. What form did the evaluation take, and did it utilize specified criteria? How did you react initially to the evaluation, and ultimately, how did you utilize it? Did you find it helpful? Now turn the tables and describe a situation in which you evaluated the work of someone else. Were you reluctant to be critical? Was your identity known to the one being evaluated? How did they respond to your evaluation, and did you have an opportunity to discuss it with them? To your knowledge, did they benefit from it? If so, how?

**Exercise 3:** The merit review principles and criteria used by the National Science Foundation (NSF) may be found at the following link (see the table of contents): https://www.nsf.gov/pubs/policydocs/pappg22_1/nsf22_1.pdf. Read them carefully and provide a critical analysis of their strengths and weaknesses. What recommendations would you make to NSF to improve both the principles and the criteria, and how might such changes, if implemented, be viewed by the research community? Also, comment on how your recommended changes might impact public perception about the effective use of taxpayer dollars to fund basic research.

**Exercise 4:** Select two federal agencies (other than NSF) and two nonprofit foundations that provide funding for research and compare and contrast their criteria for evaluating grant proposals. A list of federal agencies is

located at https://www.grants.gov/learn-grants/grant-making-agencies.html, and a list of several private foundations that fund science is located at https://sciencephilanthropyalliance.org/. Additional foundations may be found at https://oedb.org/ilibrarian/100_places_to_find_funding_your_research/. The reader can locate other foundations in nonscience/STEM fields via an Internet search. What are the greatest similarities and differences? How could both federal agencies and nonprofit foundations benefit from using certain elements of each other's procedures and criteria, and why did you select those procedures and criteria as mechanisms of improvement?

**Exercise 5:** Over the past several years, Congress has entered the debate about merit review, in some cases with a specific desire to improve transparency and accountability. This includes ensuring that the "good old boy" system, in which those traditionally receiving high marks continue to receive them, does not prevent entry of investigators who are in earlier stages of their career, and that the work being funded by the federal government indeed is worthy of taxpayer dollars. Proposed actions have included publicly disclosing, on federal funding agency web sites prior to a decision being made by program officers, full proposals as submitted, complete reviews of proposals including reviewer names and affiliations, and full responses to reviews. Describe the potential benefits and drawbacks to these proposed actions, taking the point of view of investigators, funding agencies, academic institutions, taxpayers, national security interests, and the science enterprise broadly. Do you feel, on balance, that such actions would be beneficial or harmful, and why?

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