Validity and Ethics in Science

Two recent events have forced scientists and others to confront the issue of ethical behavior in scientific work, leading some to question the validity of the body of accumulated scientific knowledge. But fraud and validity are separable matters, and it is important that the public understand the differences between them. Yes, the scientific enterprise may occasionally fall short in dealing with unethical behavior, but that has not threatened the reliability of our accumulated scientific knowledge.

The knowledge structure produced by science has a quality unique among the creations of the human species. Its uniqueness lies in its capacity to provide reliable quantitative predictions of phenomena within its own domain; no other aspect of human experience has that kind of capability. This predictive power is a consequence of the way scientific studies evolve—and science's validation processes, themselves unique, guarantee that power.

Science advances by trial and error, guided by past observations and their interpretations. Establishing the validity of each new result is essential. Some new findings, such as the measurement of a quantity predicted by a well-established theory, call for only modest efforts to establish validity. At the opposite extreme are results that challenge established concepts. Some apparently idiosyncratic ideas cannot be tested rigorously at the time when they are proposed. For example, continental drift, eventually called plate tectonics, could not be validated until many years after it was proposed. But the celebrated cases of "cold fusion" and "polywater" immediately produced major efforts at validation, because both would have been important were they correct. That stimulated many researchers to examine each and, in months, to discredit them.

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In these examples, the researchers doubtless believed that their results were valid. In some recent cases, it has become clear that the scientists knew they weren't. These new cases of fraudulent research, though hardly the first, raise the question of whether the validation process that corrects honest error works as well for deliberate fraud.

When any new result is presented to a scientific community, the tacit presumption is that the presenter is honest. But whether that presumption holds or not, the result will be subject to the standard validation processes that make science work. And these processes have kept the body of scientific knowledge remarkably self-consistent. Thus, it is especially important to separate two questions: how and whether science succeeds at self-validation, and how to recognize and deal with misconduct.

The history of element 116—not 118—illustrates this. A surprising report first claimed to demonstrate the transient existence of that element. Subsequently, other investigators showed that short-lived element 116 actually exists. In the meantime, incontrovertible evidence appeared from elsewhere that the initial report had been based on phantom experiments! Here the validation process established a phenomenon independent of the malfeasance of its first claimant. This bizarre case demonstrates the importance of separating how we think about the correctness of scientific information and about the correctness of human behavior.

Procedures that test the validity of scientific information may also expose malfeasance. In the recent case at Bell Laboratories, the identity of noise distributions in two spectra, presented as independent and different, differs from inconsistencies resulting from careless error or poor experimental design. The very nature of noise implies that only by being representations of the same spectrum could two noise distributions be identical. That kind of inconsistency inevitably implies deliberate misrepresentation, but those additional implications concern personal behavior, not the correctness of the science. The fraudulent claim to have found element 116 is just as reprehensible as the fraudulent claim to have found element 118. But the procedures that make scientific results trustworthy are as robust and effective as they have been since science began.

Scientific self-correction is alive and well, and it serves to maintain the validity of the body of scientific knowledge. That process may work slowly, partly because of the procedures required for validation and partly because scientists may feel little urgency to validate a particular result. Nonetheless the validation must eventually occur if the result is to be used in building further science. It is important that, despite the furor over research misconduct, the public understand that the validation process is working as it should. Cultivating, even demanding, ethical behavior in the scientific enterprise is important for other reasons, quite distinct from our need to have confidence in the enterprise itself.

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