

SCIENCE

<http://www.aaas.org>

Publisher: Richard S. Nicholson
Editor-in-Chief: Floyd E. Bloom
Editor: Ellis Rubinstein
Managing Editor: Monica M. Bradford
Deputy Editors: Philip H. Abelson (*Engineering and Applied Sciences*); John I. Brauman (*Physical Sciences*); Thomas R. Cech (*Biological Sciences*)

Editorial Staff

Assistant Managing Editor: Dawn Bennett
Senior Editors: Eleanore Butz, R. Brooks Hanson, Pamela J. Hines, Barbara Jasny, Katrina L. Kerner, Paula A. Kiberstis, Linda J. Miller, L. Bryan Ray, Phillip D. Szuromi, David F. Voss
Associate Editors: Gilbert J. Chin, Suki Parks, Linda R. Rowan
Letters: Christine Gilbert, *Editor*; Steven S. Lapham, *Assistant Letters Editor*; Charlene King, *Assistant*
Book Reviews: Katherine Livingston, *Editor*; Jeffrey Hearn, *Editorial Assistant*
Editing: Valerie Jablow, *Supervisor*; Cara Tate, *Senior Copy Editor*; Jeffrey E. Cook, Harry Jach, Erik G. Morris, Christine M. Pearce
Copy Desk: Ellen E. Murphy, *Supervisor*; Sherri Byrand, Joi S. Granger, Daniel T. Helgerman, Beverly Shields, Kameaka Williams, *Assistant*
Editorial Support: Carolyn Kyle, *Editorial Assistant*; Michele Listisard, Diane Long, Patricia M. Moore, Ted Smith, *Manuscript Assistants*
Administrative Support: Sylvia Kihara, Brent Gendleman
Computer Specialist: Roman Frillarte
Telephone: 202-326-6501; **FAX:** 202-289-7562; **TDD:** 202-408-7770

News Staff

News Editor: Colin Norman
Features Editor: Tim Appenzeller
Deputy News Editors: Joshua Fischman, Jean Marx, Jeffrey Mervis
News & Comment/Research News Writers: Linda B. Felaco (copy), Constance Holden, Jocelyn Kaiser, Richard A. Kerr, Andrew Lawler, Eliot Marshall, Elizabeth Pennisi, Kimberly Peterson (intern), Robert F. Service
Bureaus: Marcia Barinaga (Berkeley), Jon Cohen (San Diego), James Glanz (Chicago), Dennis Normile (Tokyo), Wade Roush (Boston)
Contributing Correspondents: Barry A. Cipra, Elizabeth Culotta, Ann Gibbons, Charles C. Mann, Anne Simon Moffat, Virginia Morell, Gary Taubes
Administrative Support: Scherraine Mack, Fannie Groom
Telephone: 202-326-6500; **FAX:** 202-371-9227;
Internet Address: science_news@aaas.org

Art & Production Staff

Production: James Landry, *Director*; Wendy K. Shank, *Manager*; Elizabeth A. Harman, *Assistant Manager*; Laura A. Creveling, Cynthia M. Penny, *Associates*; Leslie Blizard, *Assistant*
Art: Amy Decker Henry, *Director*; C. Faber Smith, *Associate Director*; Katharine Sutliff, *Scientific Illustrator*; Holly Bishop, Elizabeth Carroll, *Graphics Associates*; Preston Morrighan, Patricia M. Riehn, *Graphics Assistants*
Technology Manager: Christopher J. Feldmeier

Science International: Europe Office

Editorial: Richard B. Gallagher, *Office Head and Senior Editor*; Stella M. Hurtley, Julia Uppenbrink, *Associate Editors*; Belinda Holden, *Editorial Associate*
News: Daniel Clery, *Editor*; Nigel Williams, *Correspondent*; Michael Balter (*Paris*), Patricia Kahn (*Heidelberg*), Richard Stone (*Russia*), *Contributing Correspondents*
Administrative Support: Janet Mumford; Anna Sewell
Address: 14 George IV Street, Cambridge, UK CB2 1HH
Telephone: (44) 1223-302067; **FAX:** (44) 1223-302068
Internet address: science@science-int.co.uk

Science Editorial Board

Charles J. Arntzen	F. Clark Howell
David Baltimore	Paul A. Marks
J. Michael Bishop	Yasutomi Nishizuka
William F. Brinkman	Helen M. Ranney
E. Margaret Burbidge	Bengt Samuelsson
Pierre-Gilles de Gennes	Robert M. Solow
Joseph L. Goldstein	Edward C. Stone
Mary L. Good	James D. Watson
Harry B. Gray	Richard N. Zare
John J. Hopfield	

Science's Next Wave

Editor: John Benditt

EDITORIAL

Ambiguity in the Practice of Science

In their 1995 report *Integrity and Misconduct in Research*, the U.S. Department of Health and Human Services' Commission on Research Integrity (CRI) established as a point of departure "the fundamental principle that scientists be truthful and fair in the conduct of research and the dissemination of research results" (p. 9). This approach, however, does not adequately take into consideration the ambiguity inherent in the normal practice of science. As a consequence, the definition recommended by CRI is inappropriate and will add to rather than resolve what has been an ongoing controversy.

Many examples of ambiguity in the day-to-day practice of research can be found in the writings of famous scientists. In her autobiography,* Rita Levi-Montalcini tells of the discovery of nerve growth factor and refers to "the law of disregard of negative information . . . facts that fit into a preconceived hypothesis attract attention, are singled out, and remembered. Facts that are contrary to it are disregarded, treated as exception, and forgotten" (p. 158). No amount of science education can make clear the difference between facts to be remembered and facts to be ignored. Discovery means recognizing something when you don't know what it looks like. Although formal heuristic principles can be helpful in deciding what results might be seen as data, the final outcome will depend on an investigator's experience, intuition, and creative insight. To some, this selection process will appear arbitrary and self-serving.

Another example comes from François Jacob's autobiography.† Writing of the summer that he and Sydney Brenner spent studying the "X" factor (messenger RNA), Jacob says: "But nothing worked. We had tremendous technical problems. . . . Full of energy and excitement, sure of the correctness of our hypothesis, we started our experiment over and over again" (p. 315). Most researchers believe in their hypotheses and don't give them up readily. Limited by time and money, investigators know that they will have few chances to make major discoveries during a lifetime of science and try to choose their hypotheses wisely. They also are prepared to fight for what they believe. The same features that make a hypothesis exciting—novelty and unexpectedness—will cause peers to resist the idea because it contradicts prevailing beliefs. Overcoming this resistance requires commitment in the face of skepticism and rejection. Being fair usually implies being impartial. In science, the community, not the individual, is the real source of impartiality.

A final example of ambiguity is the research paper itself. Jacob says, "writing a paper is to substitute order for the disorder and agitation that animate life in the laboratory . . . to replace the real order of events and discoveries by what appears as the logical order, the one that should have been followed if the conclusions were known from the start" (p. 318). The formal presentation of science as a historically reconstructed, self-consistent, logical process provoked Sir Peter Medawar to write his essay "Is the scientific paper a fraud?"‡

In their report *Responsible Science*,§ the National Research Council recognized the problem of ambiguity in a section on questionable research practices. They wrote: "The selective use of research data is another area where the boundary between fabrication and creative insight may not be obvious" (p. 29). By blurring the boundary between creative insight and scientific misconduct, ambiguity will frustrate any attempt to deal with misconduct through the application of fundamental principles. We need instead to begin with a narrow definition of misconduct based on conceptually unambiguous examples such as reporting experiments never carried out or reporting as one's own the published work of another. What makes these examples unambiguous is that they never are part of the normal practice of science, that a single performance of one of these actions is sufficient to indicate misconduct, and that the intent to deceive is implicit in the action itself. With such a narrow but clear definition in place, we will be able to more realistically assess cases in which ambiguity blurs the line. Unless we understand that ambiguity is an inherent feature of research, we may find the practice of science restricted in ways that make creative insight far more difficult.

Frederick Grinnell

The author is with the Department of Cell Biology and Neuroscience, University of Texas Southwestern Medical School, Dallas, TX, and is the author of *The Scientific Attitude*.

**In Praise of Imperfection* (Basic Books, New York, 1988). †*The Statue Within: An Autobiography*, F. Philip, Transl. (Basic Books, New York, 1988). ‡*The Listener* (12 September 1963), p. 377. §*Responsible Science: Ensuring the Integrity of the Research Process* (National Academy Press, Washington, DC, 1992).