COLLOQUIUM INTRODUCTION

The Science of Science Communication III

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Three National Academy of Sciences colloquia have sought to create the science of science communication as a unique discipline, fostering collaboration across disciplines and between researchers and practitioners. Each colloquium has engaged researchers from the social, behavioral, and decision sciences needed to connect the scientific community with those who depend on it. Each colloquium has also engaged both communication professionals and consumers of scientific knowledge, to share their expertise and experiences. Each colloquium has produced an open-access special issue of PNAS with peer-reviewed articles based on selected scientific presentations (1, 2) (see also "The Science of Science of Communication," https://www.pnas.org/content/110/Supplement_3, and the "Science of Science Communication II," https://www.pnas.org/content/111/Supplement_4).

Video recordings of the full, rich discussions can be found online for all three of the Sackler Colloquia on The Science of Science Communication on their respective web pages: www.nasonline.org/programs/sackler-colloquia/completed_colloquia/agenda-science-communication.html; www.nasonline.org/programs/sackler-colloquia/completed_colloquia/agenda-science-communication-II.html; and www.nasonline.org/programs/sackler-colloquia/completed_colloquia/Science_Communication_III.html.

This special issue includes articles from the third colloquium, which built on *Communicating Science Effectively*, a National Academy of Science (2017) consensus report (3), prompted by the previous colloquia. In addition to summarizing past research and future research needs, that report highlights the organizational contexts within which science communications are produced and the political contexts within which they are consumed. Those topics are central to the 10 articles in this issue. Six articles expand the set of sciences whose theory, method, and results can inform—and be informed by—science communication. Four articles show the sciences of communication in action, as applied to issues where understanding science is essential to sound decision making.

In "Communicating uncertainty in policy analysis," Charles F. Manski (4) demonstrates how public policy analyses often convey greater certitude than their results warrant. As a result, they can mislead readers, who may take unrecognized risks and invest too little in research to reduce that uncertainty. After presenting multiple examples, Manski offers analytical procedures for characterizing uncertainty when conducting policy analyses and practical suggestions for reporting it.

In "Conflicts across representational gaps: Threats to and opportunities for improved communication," Matthew A. Cronin and Laurie R. Weingart (5) describe a common barrier to communication that can be particularly acute with science information: stakeholders with different backgrounds may conceptualize, or represent, topics in fundamentally different ways. The authors offer methods for revealing and bridging such representational gaps, thereby avoiding needless conflict due to misunderstanding.

In "Science, health, and cultural literacy in a rapidly changing communications landscape," Susan C. Scrimshaw (6) addresses such gaps in the specific domain of health communication. She describes lessons learned from anthropological research that can identify cultural variations often missed by untrained observers. Scrimshaw proposes communication practices that can adapt to changes in information needs and channels, with an emphasis on community-based approaches.

In "Scientific communication in a post-truth society," Shanto Iyengar and Douglas S. Massey (7) address situations where the conflicts are real, and not just matters of misunderstanding, and scientific communication itself is a battlefield. The authors describe and illustrate how structural shifts in the political arena and media environments promote dissemination of misleading information. They

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offer scientists guidance on online strategies that can protect their work from misuse by friends and foes.

In "Science audiences, misinformation, and fake news," Dietram A. Scheufele and Nicole M. Kraus (8) summarize research addressing the lay public's vulnerability to misinformation campaigns that exploit common gaps in basic scientific knowledge. They trace those gaps to multiple sources, including incomplete or biased science education, personal experience, media exposure, and social networks. The authors conclude by advocating a systems approach able to address these diverse factors.

In "Evaluating science communication," Baruch Fischhoff (9) proposes practical methods—grounded in social, behavioral, and decision science—for designing and evaluating communication programs with a systems approach. These methods ask whether a program has assembled professionals with the relevant skills and knowledge, organized them for effective collaboration, and established the continuing two-way communication with stakeholders needed to focus the work and monitor its success.

In "Reflections on an interdisciplinary collaboration to inform public understanding of climate change, mitigation, and impacts," the first of four case studies, Wändi Bruine de Bruin and M. Granger Morgan (10) describe two projects that apply a mental models approach to creating communications on topics central to mitigating climate change. One explains low-carbon electricity generation technologies. The second makes the long residence time of carbon dioxide in the atmosphere more intuitive.

In "On the future of transportation in an era of automated and autonomous vehicles," Peter A. Hancock, Illah Nourbakhsh, and Jack Stewart (11) address the challenges of creating realistic expectations regarding these emerging technologies. The authors consider uncertainties regarding both how the technologies will evolve and their potentially far-ranging impacts on transportation systems, social interactions, employment opportunities, and social equity. Hancock et al.'s article is one of two in this special issue written jointly by a professional journalist, a social scientist, and a bench scientist, all with a stake in helping society deliberate policy options informed by the best available scientific evidence.

The second article drawing on such joint expertise is "Promises and perils of gene drives: Navigating the communication of complex, post-normal science." Dominique Brossard, Pam Belluck, Fred Gould, and Christopher D. Wirz (12) explain the basic science of gene drives. Then, using pest control as an illustrative application, the authors describe the roles of scientists in characterizing uncertain benefits and risks, and of science communicators in conveying those assessments to people affected by the technology and whose opinions may affect its development and regulation.

In "How to communicate large-scale social challenges: The problem of the disappearing American corporation," Gerald Davis (13) presents a case study in communicating science that requires little technical knowledge, but is unintuitive or unwelcome: the decline of the large corporations that were central to social mobility and stability after World War II. Davis identifies communication channels best suited to conveying sociological research that can help people decode their everyday experience.

Without effective communication, the scientific community cannot fulfill its promise to society or secure the trust needed to support its enterprise. Because science affects stakeholders with diverse backgrounds, interests, and incentives, that communication requires contributions from across the social, behavioral, and decision sciences. This special issue of PNAS adds disciplinary perspectives and applications to those in the two previous special issues (1, 2). Together, they provide introductions to the sciences of science communication that should be accessible to anyone interested in applying or extending the science needed for this vital endeavor. The next step is a colloquium in Irvine, California, dealing with a next frontier of science communication: "Advancing the Science and Practice of Science Communication: Misinformation about Science in the Public Sphere."

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5 Cronin MA, Weingart LR (2019) Conflict across representational gaps: Threats to and opportunities for improved communication. *Proc Natl Acad Sci USA* 116:7642–7649.
6 Scrimshaw SC (2019) Science, health, and cultural literacy in a rapidly changing communications landscape. *Proc Natl Acad Sci USA* 116:7650–7655.
7 Iyengar S, Massey DS (2018) Scientific communication in a post-truth society. *Proc Natl Acad Sci USA* 116:7656–7661.
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10 Bruine de Bruin W, Morgan MG (2019) Reflections on an interdisciplinary collaboration to inform public understanding of climate change, mitigation, and impacts. *Proc Natl Acad Sci USA* 116:7676–7683.
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12 Brossard D, Belluck P, Gould F, Wirz CD (2019) Promises and perils of gene drives: Navigating the communication of complex, post-normal science. *Proc Natl Acad Sci USA* 116:7692–7697.
13 Davis GF (2018) How to communicate large-scale social challenges: The problem of the disappearing American corporation. *Proc Natl Acad Sci USA* 116:7698–7702.