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Communicating Science through Art

Diane Ackerman, Alan Alda, and Geneva Overholser



Communicating Scientific Facts in an Age of Uncertainty

Robert J. Zimmer, Eric D. Isaacs, Olufunmilayo I. Olopade, Robert Rosner, and Arthur Lupia



Ethics and the Global War on Terror

Gabriella Blum, Allen S. Weiner, Jennifer Leaning, and Neta C. Crawford

ALSO: Commission on Language Learning
Commission on the Future of Undergraduate Education
Dædalus explores “Russia Beyond Putin”
On the Professions—Rebecca Richards-Kortum, Carol A. Newsom,
Joachim Messing, and George M. Marsden

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MAY 2017

2nd

House of the Academy
Cambridge, MA

Reception Welcoming New Members

Hosted by the Boston-Cambridge Planning
Committee

4th

Stanford University
Physics and Astrophysics Building

Roundtable Discussion: Barriers to International Scientific Collaboration

Featuring: **Ann Arvin** (Stanford University), **Arthur Bienenstock** (Stanford University), and **Peter Michelson** (Stanford University)

5th

House of the Academy
Cambridge, MA

Friday Forum

The Girl at the Baggage Claim: Explaining the East-West Culture Gap

Featuring: **Gish Jen** (Cambridge, MA)

9th

Brown University Faculty Club
Providence, RI

Member Luncheon

11th

University of California
San Diego Faculty Club
La Jolla, CA

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17th

House of the Academy
Cambridge, MA

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Featuring: **Mary Sue Coleman** (Association of American Universities; formerly, University of Michigan), **Alan I. Leshner** (American Association for the Advancement of Science), and **Richard A. Meserve** (Covington & Burling LLP; formerly, Carnegie Institution for Science)

JUNE 2017

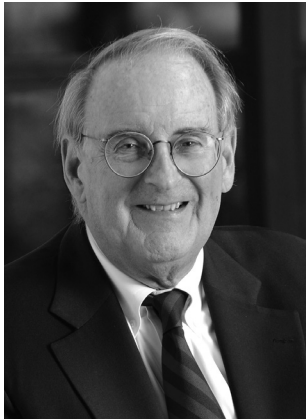
5th

Century Association
New York, NY

Reception Welcoming New Members

For updates and additions to the calendar, visit www.amacad.org.

From the President



Jonathan F. Fanton

Since its beginning in 1780, the Academy has been more than an honorary society. Our founders, John Adams, John Hancock, and James Bowdoin among them, believed the new nation would need leaders from all disciplines and professions to work together to build and sustain a democratic society. The Academy's charter embodied these beliefs. As our founders wrote, the "end and design of the institution is to cultivate every art and science which may tend to advance the interest, honor, dignity, and happiness of a free, independent, and virtuous people."

Over the last 237 years, Academy members have addressed issues critical to the health of our nation and larger world. In the early years, members formed a committee to promote improvements to agricultural practices and another group to investigate proposed methods of desalination. Members corresponded with Noah Webster on early drafts of his series on letters and grammar for schoolchildren. And members were at the forefront of research on the effects of lightning and new advances in lightning rods to protect America's buildings and the people who lived and worked inside them.

Over the course of the nineteenth century, as the nation tackled challenging issues and opportunities, Academy members made important scientific and technological advances as they focused on promoting "useful" knowledge. Members formed a committee to study meteorological observations and in 1843 raised funds to gift a telescope to Harvard University. This committee also led a collaboration with the American Philosophical Society to encourage the federal government to support North American Meteorological observations. In 1858, another group of members facilitated what were perhaps the best publicized debates on Charles Darwin's then-controversial theory of evolution. And as the century drew to a close, the Academy used its decades-old Rumford Prize to support Thomas Edison's path-breaking research.

As conflict gripped the world in the opening decades of the twentieth century, Academy members debated how the First World War might affect attitudes toward science, and discussed controversial topics such as the formation of the League of Nations. They also held a special meeting about the effects of flash and sound on American forces in France, and funded research to advance magnification for anti-aircraft guns. Amid the economic turmoil of the 1930s, the Academy published a study on the underlying sources of American discontent. And during the Second World War members held discussions and published reports on postwar problems, including ambitious topics like "technology and human relations."

As America's leadership assumed greater importance in the aftermath of that war, Academy members created new frameworks in search of global security and stability. Since 1958, the Academy has undertaken more than twenty projects related to arms control and nonproliferation. And members have also been engaged in other pressing matters. In the 1960s, for example, the Academy published two highly regarded issues of *Dædalus* on the problems facing African Americans in American society. And in the 1980s the Academy began the Fundamentalism Project to study movements of religious reaction in the twentieth century. The project inspired several scholarly volumes and books and a series of documentary film and radio programs.

The vitality of the Academy's studies and publications reflects the interests and concerns of our members. Their passion, the contribution of their time and expertise, and their instinct for issues immediate and over the horizon that matter to the health of our nation, and to human kind, have shaped our agenda. That the Academy has so often spoken to critical issues owes to the breadth and diversity of our membership, our culture of open discussion, and the collective wisdom of members who care deeply about the common good.

FROM THE PRESIDENT

It is perhaps not surprising then that the Academy's current studies reflect the concerns our members feel about the state of American democracy. Central to the health of any democracy is a well-informed population engaged in the responsibility of self-governance. To that end, the Academy has put forward three projects that collectively address the need for Americans to respect evidence and participate actively in the democratic process.

First, the Public Face of Science project, led by Richard Meserve and Geneva Overholser, explores how the public builds trust or mistrust in science and evidence, more broadly. The role of the media is central to the inquiry, which will also study how agreement among scientists about an issue can evolve into a public consensus.

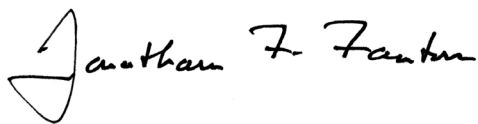
Second, a new project, made possible by a generous gift from the S. D. Bechtel, Jr. Foundation, will consider how to strengthen the practice of citizenship in the United States. Our aim is to better understand how to prepare people for citizenship, how people are engaged in their communities, and what it means to be a "good citizen" in our American democracy, especially at a time when social media have altered the contours of community interaction.

Third, the Commission on the Future of Undergraduate Education, led by Michael S. McPherson and Roger W. Ferguson, Jr., will highlight the role colleges and universities play in preparing people of all ages and backgrounds to be informed, active, and empathetic citizens. These institutions can inspire among their students a spirit of inclusion and a respect for difference that will only grow in importance over the course of this century. By 2060, the United States Census Bureau reports that no racial or ethnic group will have a majority share of the total population.

In addition to these three projects, Academy meetings across the country have addressed topics of pressing concern, for example, in San Diego on *Global Warming: Current Science, Future Policy*; in Chicago on *Communicating Scientific Facts in an Age of Uncertainty*; and in New Haven on *Courts and Law in the New Administration*. Here in Cambridge, at the House of the Academy, our 2017 Distinguished Morton L. Mandel Annual Public Lecture featured a panel on *Ethics and the Global War on Terror*.

In 1958, Academy President Kirtley Mather reflected on the mission of the Academy. What, he asked, defined the members' sense of common purpose, fellowship, and spirit of community? Ultimately, Mather observed: "No matter how far apart the search for knowledge and understanding may take the devotees of that search, they may be brought back together again by the unifying purpose of contributing to human welfare."

Indeed, our unifying purpose, that of contributing to human welfare, is the same today as it has been since the beginning of the Academy in 1780. Let us continue to work together, across disciplines and professions, to fulfill that worthy vision of our founders.

A handwritten signature in black ink that reads "Jonathan F. Fanton". The signature is written in a cursive style with a large, stylized initial "J".

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Commission on Language Learning

The final report of the Academy’s Commission on Language Learning, *America’s Languages: Investing in Language Education for the 21st Century*, was released on February 28, 2017, during a series of events in Washington, D.C. The report, which responds to a bipartisan request from four U.S. Senators and four Members of the House of Representatives, is already contributing to public discussions about the future of American education.

America’s Languages highlights the importance of language education for business, science and technology, international relations, and our civic life. It presents a national strategy “to make language learning a valued national priority, and to address a need that is more acute today than at any other time in our history.”

The Commission offers five basic recommendations, each focusing on ways to build the nation’s language capacity. The recommendations are:

1. Increase the number of language teachers in P-12 education so that every child in every state has the opportunity to learn a language in addition to English.
2. Supplement language instruction across the education system through public-private partnerships among schools, governments, philanthropies, businesses, and local community members.
3. Support heritage languages already spoken in the United States, and help these languages persist from one generation to the next.
4. Provide targeted attention to Native American languages as defined in the Native American Languages Act of 1990.
5. Promote opportunities for students to learn languages in other countries, by experiencing other cultures and immersing themselves in multilingual environments.

Academy President Jonathan Fanton and Commission Chair Paul LeClerc (Director of the Columbia Global Center in Paris and former President of the New York Public Library) introduced the report during a press conference at the National Press Club. Before a standing-room-only crowd, President Fanton explained the importance of the Commission’s work.

“This report arrives at an important moment in our history,” he said. “While English continues to be the preferred language for world trade and diplomacy, there is an emerging consensus among leaders in business and government, teachers, scientists, and parents that proficiency in English is not sufficient to meet the nation’s needs in a shrinking world. Current research suggests that only 10



Commission Chair Paul LeClerc speaks at the morning press conference.

percent of the U.S. population speaks a language other than English proficiently. We can and must do better.”

Following these remarks, a panel of Commission members spoke about different aspects of the recommendations. Ambassador Nancy McEldowney, Director of the Foreign Service Institute, offered her thoughts about the importance of languages in government. Rubén Rumbaut, Distinguished Professor of Sociology at the University of California, Irvine, described the opportunities and challenges for language learners today. And Martha Abbott, Executive Director of the American Council on the Teaching of Foreign Languages (ACTFL), discussed recommendations related to the teaching profession. She then announced the launch of ACTFL’s new campaign, *Lead with Languages*, which will reinforce the Commission’s recommendations as it educates parents and students about the importance of language education.

After the morning conference, Commission members and representatives of government agencies, academic associations, and learned societies discussed follow-up opportunities at the federal, state, and local levels.

In addition, Academy members participated in a briefing, organized by Representative Don Young (R-Alaska). Staff from over twenty Congressional offices attended. In addition to Jonathan Fanton, Paul LeClerc, and Nancy McEldowney, the speakers included Dan Davidson, President and Cofounder of the American Councils for International Education, who spoke about the implications of the report for higher education, and Jesse “little doe” Baird, Cofounder of the Wôpanâak Language Reclamation Project, who described efforts to preserve Native American languages.

During the briefing, Representative David Price (D-North Carolina) introduced the World Language Advancement and Readiness Act, a bill cosigned by Don Young, Leonard Lance (R-New Jersey), and five of their colleagues. The act proposes three-year competitive grants to support local and state school districts that want to establish, improve, or expand innovative programs in world language learning. The bill responds directly to several recommendations from *America’s Languages* and concludes with the following paragraph:

“The Commission on Language Learning of the American Academy of Arts and Sciences, requested by Congress in 2014, will re-

lease its final report on February 28, 2017. The initial data demonstrate that ‘by several measures, the United States has neglected languages in its educational curricula, its international strategies, and its domestic policies.’ It is clear that effective communication is the basis of international cooperation, and a strong national defense depends substantially on the ability of Americans to communicate and compete by knowing the languages and cultures of other countries.”

Throughout the day and in the weeks that followed, the Commission’s report and the rollout events were the subject of significant activity on social media as well as coverage in the national press. As a result, over twenty thousand copies of *America’s Languages* were distributed online and in print during the first two weeks following the release of the publication. Commission members are now engaged in an extensive, national effort to publicize the recommendations and to support language education efforts at the local, state, and federal levels.

More information about the Commission on the Language Learning is available at <http://www.amacad.org/language>. ■



Congressman David Price introduces the World Language Advancement and Readiness Act at the briefing, with (far left to right) Jessie “little doe” Baird, Dan Davidson, Paul LeClerc, Jonathan Fanton, and Nancy McEldowney.

Commission on the Future of Undergraduate Education

With generous support from Carnegie Corporation of New York, the Commission on the Future of Undergraduate Education, led by Michael S. McPherson and Roger W. Ferguson, Jr., is conducting an analysis of American undergraduate education and looking ahead several decades at the educational challenges and opportunities facing Americans. The Commission will recommend, in its final report to be released this fall, a national strategy to improve and strengthen undergraduate education to meet the demands of the twenty-first century. This ambitious agenda is both timely and necessary as the country faces serious national and global tests that can be best met with a firm and coordinated commitment to undergraduate education. With over seventeen million undergraduates enrolling in more than 4,700 colleges and universities, some of the key facts informing the Commission's considerations for the future include the following:

- Almost 80 percent of undergraduates enroll in public colleges and universities;
- One-half of all college students must take remedial (i.e., non-college level) classes;
- Only 40 percent of students complete a bachelor's degree within four years and less than 30 percent complete an associate degree or certificate within three years;
- There is a lack of clarity and consistency with regard to the quality of the educational experiences available to students;
- Students who do not graduate face the largest challenges of paying back their loans.

Prominent themes in the final report will include the quality of the educational experience, inequitable completion rates, college costs and affordability, and experimentation and innovation. The Commission's recommendations will be directed toward colleges and universities; state and federal policy-makers; organizations that affect students' pathways into college, such as K-12 systems and community services; and business and industry. The Commission's work will also seek to contribute to the national discourse on undergraduate education. A national campaign to extend the impact of the Commission's work will follow the release of the final report.

During the development of the final report and the drafting of the recommendations, Commission leadership continuously solicited feedback and suggestions from various individuals and organizations. The leadership team met with 22 members of the U.S. Senate and House of Representatives and/or their key legislative advisors; leaders from national higher education policy organizations, such as the State Higher Education Executive Offices and the National Center for Higher Education Management Systems; and dozens of Academy Fellows around the country. Academy staff also facilitated student and faculty discussion groups at several institutions – such as LaGuardia Community College; the University of Texas,

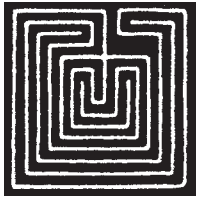
El Paso; Northeastern University; and Rasmussen College to gather their perspectives and discuss concerns about the future of American undergraduate education.

The Academy is currently developing a social media engagement strategy and will launch a campaign entitled “My Better Future,” which is designed to encourage current students and recent graduates to share video, photos, memes, and other social media posts of how they believe college will impact their futures, and why they care about going to college. This campaign, which will include the language that students use about college and their futures, will help inform the work of the Commission and establish a broader social media presence for the initiative.

In September 2016, the Commission published *A Primer on the College Student Journey*, which provides a data-rich portrait of how Americans access, pay for, and complete their postsecondary education. Four occasional papers, authored by national experts, are supporting the work of the Commission. *Undergraduate Financial Aid in the United States* by Judith Scott-Clayton (Teachers College, Columbia University) provides an overview of undergraduate financial aid – its motivations, its moving parts, and its controversies. *The Complex Universe of Alternative Postsecondary Credentials and Pathways* by Jessie Brown and Martin Kurzweil (both at Ithaca S+R) looks at the emerging innovations in postsecondary learning opportunities, identifies the growing diversity of providers and experiences, and explores the intersections between traditional undergraduate education and new models (for example, the U.S. Department of Education EQUIP pilot program).

Two forthcoming papers, which will be released this summer, will focus on improving college teaching practices and the impact on the economy of increasing educational attainment.

For more information about the Commission on the Future of Undergraduate Education, please visit the Academy's website at <https://www.amacad.org/cfue>. ■



New *Dædalus* issue on “Russia Beyond Putin”

The collection explores Russia under Vladimir Putin and the prospects for significant political changes today and in a post-Putin era.

Following the 2014 annexation of Crimea and the alleged Kremlin-backed interference in the 2016 U.S. presidential election, the United States has refocused on Russia and its enigmatic leader: What motivates Vladimir Putin? Why did the “reset” of U.S.-Russian relations fail? What potential is there for significant political change in Putin’s Russia? And what could Russia look like once he is no longer in power?

The long and eventful reign of Vladimir Putin began in 2000. In October 2017, he will turn sixty-five, while his country observes the 100th anniversary of the Russian Revolution that toppled tsarism and eventually swept the Bolsheviks to power.

Amidst these milestones and with Putin poised to retain his leadership role after the 2018 presidential election, a multidisciplinary group of authors – with expertise in modern Russian history, politics, and society – share in the latest issue of *Dædalus* their views on what Putin’s Russia represents today – and what the future may hold for Russia and the international community after he leaves the scene.

The Spring 2017 issue of *Dædalus* on “Russia Beyond Putin,” guest edited by George W. Breslauer (University of California, Berkeley) and Timothy J. Colton (Harvard University), begins by asking: Is fundamental change in Russia possible? Would it overhaul the system, or modify or improve it without transforming it? And if change were to occur, will it necessarily be change Western observers would approve of?

“From day one, the declared priority of Russia’s second president – it is no exaggeration to call it a sacred priority for him – was to engineer political and social stability,” writes Timothy Colton in his essay “The Paradoxes of Putinism.” With systemic stability, Putin has achieved economic and demographic recovery. But development on the part of Russian society has been juxtaposed with growing rigidity and control-mindedness on the part of the state. Colton explores Putin’s tenure through several core paradoxes, including that Putin’s personal popularity has not always been matched by confidence in his policies and that Russia bucks a global trend that links social and economic modernization to political democratization.

In her essay, “The Next Mr. Putin? The Question of Succession,” Fiona Hill (Brookings Institution) argues that Vladimir Putin, the person and the president, is the wild card in Russian politics. Moreover, after what could be a quarter of a century in power by 2024, Putin’s departure could be utterly destabilizing.

Russia’s political problem is determining who or what replaces Putin as the fulcrum of the state system in the decade ahead. Hill



A Russian military honor guard from the 154th Commandant’s Regiment stands at attention during a wreath-laying ceremony at the Tomb of the Unknown Soldier in Moscow, June 26, 2009. Photo by Petty Officer 1st Class Chad J. McNeeley, U.S. Navy.

examines whether Putin’s Russia – a hyper-personalized presidency supported by informal elite networks – can be transformed into a depersonalized system rooted in formal institutions with clear, predictable mechanisms to mitigate the risks of a wrenching presidential transition.

In “*Russian Revanche: External Threats & Regime Reactions*,” Keith A. Darden (American University) explores the origins of Russia’s renewed distrust of the United States and apparent military belligerence, and connects them with Russia’s increasingly authoritarian domestic rule. Darden explains that since the NATO bombing of Yugoslavia in 1999, Russian elites have increasingly seen the United States as a distinctly threatening power seeking to exploit civic organizations, ethnic groups, and other forms of domestic pluralism to overthrow unfriendly regimes. And with each new crisis in U.S.-Russian relations, Russian leadership has tightened controls over society, the press, and the state. Darden asserts that the aggressive U.S. promotion of democracy abroad has pro-

duced the opposite effect: successive Russian governments pursuing greater military and intelligence capacity to intervene abroad, and exerting authoritarian controls at home to prevent foreign exploitation of the internal pluralism that emerged in the wake of the collapse of Communism.

While post-Soviet law is highly consequential in contemporary Russia, its use tends to be arbitrary, expedient, and instrumental, rather than predictable and principled. But Russia's legal regime is unlikely to undergo major revolutionary change and may outlive Putin's tenure. In her essay, "Putin Style 'Rule of Law' & the Prospects for Change," Maria Popova (McGill University) suggests that if positive change were to take place, Russia would inch toward "authoritarian constitutionalism." But if Putin's regime weakens, the politicized use of the courts against both dissidents and political competitors within the authoritarian coalition will increase, and Russia could revert to the legal nihilism that characterized previous periods in its history.

Despite the hope of Russia evolving into a liberal democracy after the collapse of Communism and the dissolution of the Soviet Union, Putin's regime, after Gorbachev and Yeltsin, came to represent a "de-democratization" or authoritarian consolidation. A democratic breakthrough toward the rule of law is now seen as highly unlikely in the coming decade. In his essay "Images of the Future," George Breslauer (University of California, Berkeley) presents a range of alternative futures to liberal democracy (rule of law), including the possibility of continued authoritarian constitutionalism (rule by law), patronal authoritarianism (expedient use of law), or "Russite" or imperial fundamentalism (legal nihilism). He concludes the issue by combining the diverse arguments presented by the authors in this issue with his own judgments and beliefs about Russia's future.

Other essays in the issue explore the ability of the Russian system to maintain political stability in the face of prolonged economic hardships; the types of Russian nationalist actors and their potential as facilitators of change; and the potential role for the *siloviki* – Russian security and military personnel – in challenging Putin's rule or transitioning to a new form of government.

Academy members may access an electronic copy of this *Dædalus* issue by logging into the Academy's website. For more information about *Dædalus* or to order copies of "Russia Beyond Putin," please visit <http://www.amacad.org/daedalus>. ■

"Russia Beyond Putin" Spring 2017 issue of *Dædalus*

Introduction by Timothy J. Colton (Harvard University)

Paradoxes of Putinism by Timothy J. Colton (Harvard University)

The Prospects for a Color Revolution in Russia by Valerie Bunce (Cornell University)

Russian Patronal Politics Beyond Putin by Henry E. Hale (George Washington University)

The Next Mr. Putin? The Question of Succession by Fiona Hill (Brookings Institution)

The Russian Siloviki & Political Change by Brian D. Taylor (Syracuse University)

Putin-Style "Rule of Law" & the Prospects for Change by Maria Popova (McGill University)

Ideas, Ideology & Intellectuals in Search of Russia's Political Future by Elena Chebankova (University of Lincoln)

Is Nationalism a Force for Change in Russia? by Marlene Laruelle (George Washington University)

The Atlas That has Not Shrugged: Why Russia's Oligarchs are an Unlikely Force for Change by Stanislav Markus (University of South Carolina)

From Boom to Bust: Hardship, Mobilization & Russia's Social Contract by Samuel A. Greene (King's College London)

Russian Revanche: External Threats & Regime Reactions by Keith A. Darden (American University)

Images of the Future by George W. Breslauer (University of California, Berkeley)

Morton L. Mandel Public Lecture

Communicating Science through Art

On December 12, 2016, at the Century Association in New York, the Academy hosted the Morton L. Mandel Public Lecture on “Communicating Science through Art” with Diane Ackerman (poet, essayist, and naturalist) and Alan Alda (actor, director, screenwriter, and author). This program served as the Academy’s 2048th Stated Meeting and included an introduction by Geneva Overholser (Senior Fellow and Consultant at the Democracy Fund). The following is an edited transcript of the discussion.



Geneva Overholser

Geneva Overholser is a Senior Fellow and Consultant at the Democracy Fund. She is the former Director of the University of Southern California Annenberg School of Journalism. She was elected a Fellow of the American Academy of Arts and Sciences in 2001 and serves as Co-chair of the Academy’s project on The Public Face of Science.

It is a real treat for me to be here with you all tonight, and what fun to be able to conduct the conversation that we are about to have. In the Academy’s Public Face of Science project, we are trying to identify the factors that shape public attitudes toward science. What causes someone to be excited about a new discovery and to be curious about it? What does it mean that one individual, but not another, will be in-

A majority of the public does think that science has made our lives better, and they think that the government’s investments in scientific research pay off in the long run. Yet we see sizable gaps between the opinions of the general public and the views of scientists on such questions as global climate change, GMOs, vaccines, and evolution.

clined to use scientific evidence in daily decision-making? From what we have learned so far, the question of public trust in science is a really complicated one. A majority of the public does think that science has made our lives better, and they think that the government’s investments in scientific research pay off in the long run. Yet we see sizable gaps between the opinions of the general public and the views of scientists on such questions as global climate change, GMOs, vaccines, and evolution. Some of us, when we consider this gap, go immediately to the notion of scientific literacy: if we just taught science more effectively, surely we could take care of the matter. But while education is certainly important, years of research indicate that it’s not quite that simple.

The Public Face of Science project is looking at how factors such as political ideology, religion, socioeconomic status, and education level affect both views on particular issues and views of science more broadly. Consider how we encounter science: we know that the public gets information about science from newspapers, television, radio,

and the Internet, but their views are shaped as well by the more informal encounters that all of us have at museums, zoos, aquariums, national parks, or science cafes. What role do these organizations play in shaping public attitudes?

Science, of course, also finds its way into movies, television, plays, and other forms of art. These encounters provide an opportunity to reach different audiences and to integrate science more richly into our broader culture. We are eager to bring the important topic of “Communicating Science through Art” to this terrific gathering of Fellows, and to get your views. And how lucky we are to kick off the conversation with two people who so beautifully practice the art of communicating: Diane Ackerman and Alan Alda. It’s possible that you know more about Alan Alda as “Hawkeye” Pierce than you do about his truly pioneering work in science communication. And it is also possible that you admire Diane Ackerman’s *The Zookeeper’s Wife* and eagerly await the upcoming film starring Jessica Chastain, but know less about Ackerman’s

man's *An Alchemy of Mind*, which has been called "a poetics of the brain based on the latest neuroscience." All of this devotion to helping us see scientists as human beings, not as the "white-coated gurus on the mountaintop," has led Alda to establish and support a truly remarkable network nationwide of educators, who incorporate science communication and science education into the same program. And Ackerman has been called, for good reason, our foremost naturalist poet. These two obviously have a lot to teach us about telling stories about science.



Diane Ackerman

Diane Ackerman is a poet, essayist, and naturalist. She was elected a Fellow of the American Academy of Arts and Sciences in 2016.

I'm going to read two short things that I wrote:

On Discovery

When I read of the just-discovered *Symbion pandora*, a radically new life-form that's pinpoint small, trisexual (it will try anything), and lives on the lips of lobsters, my first thought was: Do lobsters have lips? But that was quickly followed by a renewed sense of wonder at the quirky fantasia of life on earth. With a mouth like a hairy wheel, and other anatomical oddities, *pandora* is so outlandish that a special phylum was created for it – *Cycliophora*, of which *pandora* is the sole member.

I must admit, I get a devilish delight when the miraculous appears right under my nose. After all, the marvelous is a weed species. One can glimpse it on one's doorstep. People often ask me where they might go to find adventure. Adventure is not something you must travel to find, I suggest, it's

Because we have swarmed across the world with our curious and agile minds, we sometimes think that nature has been fully explored, but that's far from true.

something you take with you. The astonishing can turn up in the leaf clutter, or even at a neighborhood restaurant, in a dingy tank, on the lips of lobsters.

We forget that the world is always more and stranger than we guess. Or can guess. Instead, we search for simple answers, simple laws of nature, in a sleight of mind that makes us uniquely human. Just as we're addicted to rules, home-truths, and slogans, we're addicted to certain ways of explaining things. There's bound to be a simple answer to everything, we insist. Maybe not. Maybe complexity frightens us. Maybe we fear becoming as plural as all we survey. Maybe we still tacitly believe that the universe was created for our pleasure, that we pint-sized demigods are its sole audience and goal. Then something like *pandora* turns up, minute being with a sex life even stranger than our own, a creature that breaks all the rules and gives biologists a jolt.

Because we have swarmed across the world with our curious and agile minds, we sometimes think that nature has been fully explored, but that's far from true. Plants and animals are going extinct at an appalling rate – some estimates are as high as 300 species a day – and many of them are vanishing mysteries. The riches of the natural world are slipping through our fingers before we can even call them by name. Hanging on by a suction cup, and reaching around to vacu-

um up fallen morsels from a dining lobster's lips, *pandora* reminds us that we share our planet with unseen hordes, and it hints at the uniqueness of our own complex niche.

Recently a graduate student, strolling through the woods, happened upon a fungus in a curious state of arousal. Odder still, it was sprouting behind the head of a beetle grub. Intrigued, she took it to a laboratory, studied it carefully, asked the right questions, and soon realized that she had made an astounding discovery: asexual form of a mold that produces *cyclosporin*, an immunosuppressant used to combat organ rejection. We know the tropics contain a rich pharmacopeia, but for many organisms our backyards are still unexplored, too.

Variety is the pledge that matter makes to living things. Think of a niche and life will fill it, think of a shape and life will explore it, think of a drama and life will stage it. Personally I find pampas grass an unlikely configuration of matter, but no stranger than we humans, the lonely bipeds with the giant dreams.

Variety is the pledge that matter makes to living things. Think of a niche and life will fill it, think of a shape and life will explore it, think of a drama and life will stage it.

At the heart of the word "discovery" is a boomerang. It literally means to uncover something that's hidden from view. But what really happens is a change in the viewer. The familiar offers a comfort few can resist, and fewer still want to disturb. But as relatively recent inventions such as the telescope and microscope have taught us, the unknown has many layers. Every truth has geological strata, and for some truths the opposite may be equally true (for example, you can't have a heresy without an orthodoxy).

Many discoveries are happy accidents of play. After a lifetime's search for traces of our ancestors, Mary Leakey made the most important find of her career because of a dung-tossing game. One day in 1978, in Tanzania, her researchers were hurling elephant dung at each other in a playful camp fight, when someone fell down and happened to notice markings in the clay that looked like imprints of raindrops and animals' tracks. The impressions were 3.7 million years old, and preserved in hardened ash that had eroded over the years. Only partial tracks were visible, so it was difficult to tell what left them. In time, Mary Leakey uncovered a trail of footprints left by three humans – male, female, and child – that led across the volcanic plain. As the footprints clearly showed, the female paused at one point and turned to her left. The child's footprints sometimes dawdled behind those of the adults and sometimes overlapped; the child may have been stepping in its parents' footprints on purpose, a game children still play. Mary Leakey was

changing stir of sun and shadow, a whiff of newly risen plants, an unusual land animal or bird taking flight – as she strolled happily with her mate and child. We know her life made relentless physical and emotional demands, as ours does, and she felt the basic emotions we do. She would have enjoyed family comforts; she would have feared; she would have played; she would have been curious about the world.

The moment a newborn opens its eyes, discovery begins. I learned this with a laugh one morning in New Mexico, where I worked through the seasons of a large cattle ranch. One day, I delivered a calf. When it lifted up its fluffy head and looked at me, its eyes held the absolute bewilderment of the newly born. A moment before it had enjoyed the even black nowhere of the womb, and suddenly its world was full of color, movement and noise. I've never seen anything so shocked to be alive. Discoverers keep some of that initial sense of surprise lifelong, and yearn to behold even more marvels. Trapped in the palatial rut of our senses, we invent mechanical extensions for them, and with each new attachment more of the universe becomes available. Some of the richest moments in people's lives have come from playing with a mental box full of numbers or ideas, rotating it, shaking it, while the hours slip by, until at last the box begins to rattle and a revelation spills out.

And then there are those awkward psychological mysteries. I suspect human nature will always be like mercury, a puzzle to grasp. No matter how much of the physical universe we fathom, what makes us quintessentially human will always elude us to some degree, I suspect, because it's impossible for a system to observe itself with much objectivity. When it comes to powerful emotions such as love, for instance, each couple rediscovers it, each generation redefines it. Of course, that makes studying human nature all the more sporting.

I rarely dwell on this when I go biking through the countryside, I don't worry about the mites that live among my eyelashes either. I have other fish to fry. But I get a crazy smile when I think of *pandora*. I like knowing the world will never be small enough to exhaust in one lifetime. No matter how hard or where we look, even under our own or a lobster's nose, surprise awaits us. There will always be plenty of nature's secrets waiting to be told. This is one of those tidy, simple-sounding truths I mentioned, the sort of thing humans crave.

And I believe it because I got it straight from a lobster's lips.

Be the Owl

I would be an owl if I could, an *ule*, a creature named after its sound. So, I would be a howl if I could, sweet cheat of the night, who slices open the air with soft serrated wings, so silently it doesn't warn dozy prey. How far can it see? An owl could read the bottom line on an eye chart from a mile off, or hear a mouse stepping on a twig 75 feet away. Tuning and re-tuning, I would be an owl with ears twin radar dishes, eyes winged binoculars. A screech owl because, though baby screechers screech, the adults make the most enchanting soft whinying-howl. Owl of the stethoscope ears.

I'd swallow meals whole, head first, tumbling soft and furry down my throat to the fiery plant that compacts all the inedibles into a hard pellet. Twice a day, growing bloated and queasy, I'd stretch my neck up and forward, squeeze my stomach hard, and vomit a hairy bony nugget. Oh, I'd vomit gently, all things considered, not thrash and shake the pellet free for five minutes like other inversely-constipated owls. I'd eagerly coax these dainty pukers. Not like the giant sea cucumber that hurls up its whole stomach and tosses it, literally, at the missing feet of a wall-eyed fish, then while the distracted fish feasts, steals away, a gutless wonder but alive, soon to grow another stomach.

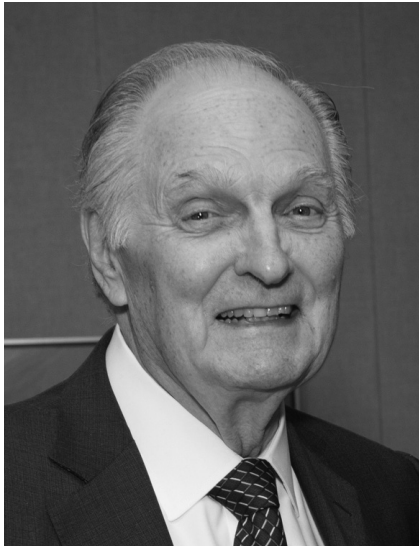
I like knowing the world will never be small enough to exhaust in one lifetime. No matter how hard or where we look, even under our own or a lobster's nose, surprise awaits us.

I'd sing of owl-puke, the pellets that pave my days with dense nuggets that offer home to fungi, beetles, and other tramps. Does it sound nicer as a fur ball? I suppose it does. But a little cat fur swallowed while grooming can't compare to a stony wadded-up girdle of rodent, shrew, mole, gecko, and snake skeleton, mixed with beetle crackle and songbird wings and oily fur, as if for a jigsaw puzzle of a chimera, part mammal, part bird, part reptile, part insect, all tasty.

Yes, all things considered, I would be an owl with a ukulele call, a cowl of grey feathers cupping my feathered jowls, talons sharp and strong as ice hooks, parachute wings, a demi-suit of down, and ingénue eyes, voodoo eyes. I would be possessed of the ultimate head swivel: upside down and around back and front again over the other shoulder. Hunting among oaks and cottonwoods and old shady maples, with broad wings outstretched and head tucked in tight, I'd flap hard and fast, rarely gliding or hovering, while listening and watching for scuffling prey in the leaf litter and lawns.

I'd sing duets with my mate during the day and be calmed by a male chorus at night, a *parliament* of owls. What a panoply of songs and calls! When frightened, I'd blend in with tree trunk or foliage, stretching my frame long, closing my eyes to slits, tightening my feathers, and standing still as old bark. In winter, I'd gobble hot meals of warm-blooded prey, and in summer cool crisp lizards, snakes and bugs. And, it goes without saying that I would marry for life, a long life of a score or two, lengthened by living in the suburbs and devouring the rat race.

I would be an owl with wide feather skirts to curtsy with when courted by bowing suitors. Oh, the formal dances of courtship, ceremonial and piquantly oriental. First a springtime male calls, robust as all get out, and I reply, we flirt like this several times, then I see him flying in, watch him perch nearby, and begin head bobbing and bowing deeply, repeatedly, now and then winking one eye. Ignore him and he just chases harder. Accept, and the bill kissing and mutual preening begins, with the preened one uttering soft whimperings of delight, both fine feathered friends amused and enthused. Yes, all things considered, I would be an owl, with owl-bright eyes, creature comforts, and wide wings with down furbelow to wrap my chicks in owl love.



Alan Alda

Alan Alda is an actor, director, screenwriter, and author. He was elected a Fellow of the American Academy of Arts and Sciences in 2006.

While working on the television show *Scientific American Frontiers* on PBS, I stumbled upon something fundamental about a different way to communicate science. My role was to interview scientists about their work, but I didn't come in with a list of questions. Instead, the questions I asked flowed from my curiosity and my desire to know more about what they were telling me. And that only increased when they spoke in a way I couldn't understand.

For the scientist, the task now was not to do a lecture for the public, but to make this poor schmoe understand it, this one person. This created a connection between us, and that connection was broken anytime the scientist turned to the camera and started lecturing. She would begin to use more jargon and her tone would become colder and more formal, less intimate and personal. But when I coaxed her back, suddenly the tone would change, and she would be just talking to me again. And as a result, when I finally under-

stood what she was telling me, the public also had a better chance of understanding it. There was this moment of "getting it."

And I thought, when the show was over, wouldn't it be wonderful if we could teach scientists to be good communicators while teaching them to be good scientists? I thought about what it takes to connect with another person; and it was my training as an actor that taught me an important skill: improvisation. Not comedy improvisation, but the kind of improvisation that lets you interact freely with another person. As an actor, you don't say your next line because it's written in the script or because you've rehearsed it. You say your next line because the other person makes you say it in response to how she behaves toward you. In the same way, I felt, communication takes place when this kind of responsive listening happens.

So I did a little experiment teaching engineering students improvisation techniques, the way actors have been taught for generations. At the University of Southern California, I got twenty engineering students

Wouldn't it be wonderful if we could teach scientists to be good communicators while teaching them to be good scientists?

together for a short workshop. First, I had them talk for a minute or two about their work. Then, after three hours of improvisation exercises, I had them talk for a minute or two about their work again, to see if there was any difference. It was extraordinary. After only three hours, most of the engineers were freer and more open. The ones who had a difficult time opening up got better. The ones who were already pretty good got even better. And everybody in the room was surprised, including me, because I wasn't sure it was going to work.

But when we're trying to communicate something complicated to an audience, there's a particular difficulty that has to be dealt with. It's called the "curse of knowledge." This is where the speaker has the illusion that the listener has the same deep understanding of the subject that the speaker possesses. There was a test developed by a Stanford graduate student about twenty years ago in which she would ask people to think of a song that everyone knows and then tap the song. The tapper was asked how many people they thought would be able to guess the song without hearing any words or music, just tapping. The tappers often estimated that more than 50 percent of the audience would identify it correctly. Some even thought that 80 to 100 percent would be able to guess the song. But the number of people who actually recognized the song, just from hearing it tapped out, was around 2.5 percent. The problem is, when we know something in a deep way, we often assume that other people understand it the way we do. Thinking about what the other person is thinking and feeling helps avoid this gap

in understanding, and improvisation helps you track the other person really well.

So I began teaching communication skills with improvisation as the central focus. We would teach them to be more aware of the audience, connecting to them in as intimate a way as possible. A two-way street is created: instead of broadcasting a message at an audience, there's more of a personal exchange.

Stony Brook University was the only place that picked up on this idea, and they started the Center for Communicating Science, which they later called the Alan Alda Cen-

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ter for Communicating Science. We have courses that teach improvisation, writing, and distilling the message. We teach media training in front of a camera. We even teach how to talk to Congress. But every step along the way, we reinforce this connection, this training in improvisation, with specific exercises that take you from a low level to a high level of connection. Over the years, we've held workshops with eight thousand scientists and medical students. With medicine, of course, you're bringing science into an intimate connection with a patient; and it's been shown that if a patient believes the doctor is empathic, the patient has a 19 percent greater chance of paying attention to the doctor's advice. This could make the difference between life and death.

So we're spreading this concept around the country. This spring, we started a collaboration with the National University of Australia, and at the beginning of next year, we're going to be working with universities in Dundee, Scotland, and Oslo, Norway.

It works and it's spreading.

And here's the thing that I want to leave you with: improvisation does more than just enable you to communicate with an audience, it also improves teamwork within the lab, which was not a benefit we anticipated. Because unless scientists are in the exact same field, and sometimes unless they're in the exact same laboratory, they have difficulty understanding one another.

They're not ready to collaborate. But scientists come out of these workshops saying, "You know, I've known this guy for forty years, but I never knew what he did." And this is a wonderful thing. Collaboration is what the world is going to depend on for new ideas and new discoveries. But the world is becoming more and more specialized, so we have to make an effort to build those bridges. And, lastly, scientists are telling us that they're doing their own work better as well, because as they learn to distill the message about their work for others, they step back from it and see it in a broader, fresher way.

I hope that we can, all of us, dedicate ourselves to communicating clearly and vividly, and in this personal way, because that's our greatest hope for people to be in touch with one of humanity's greatest achievements: the joy of science.

Discussion

Geneva Overholser

Thank you both so much. Alan, this is so effective. Why doesn't it come more naturally to us? Why is it such a challenge?

Alan Alda

It's so interesting, and it goes back to the notion of the "curse of knowledge." It was first coined by a couple of economists who saw that if you had some information about an economic or financial advantage, you tended to assume that everybody else knew it, too, and you devalued the very thing that you had private knowledge of. In the same way, scientists (and all of us) have this to some extent – we know something really well and therefore assume that it's understood by everybody else. And if you understand something well, you often forget what it's like not to know it – that's suffering from the curse of knowledge.

Diane Ackerman

As you were saying that, I was thinking this makes so much sense, in terms of just how the brain works. I think of it not as the curse of knowledge, but as habit. And the minute you start really learning something and achieve mastery of it, you blur all of the details that you saw when you first began learning about it. And you lose all of the wonder and curiosity. That's why I loved watching *Scientific American Frontiers*, because there was this sense of wonder. And for me, that's the most important thing to convey.

Alan Alda

There was a study done at the University of Pennsylvania that measured which science articles were most often emailed, and I'd

What are we going to do when we have people who don't believe in science at all? How are we going to persuade them of the facts?

have thought that the majority of articles shared would have been about health. But, rather, it was articles that expressed a sense of wonder and awe of nature. It's a surprisingly powerful thing to evoke everyone's sense of wonder.

Geneva Overholser

As someone who writes in a lot of different genres, trying to convey complex situations and information, Diane, how do you think of your audience? How do you think about transmitting that sense of wonder, but also the information you care deeply about?

Diane Ackerman

I figure that if I can let people see through the lens of my sensibility – like that of a child – in sensory detail, so that they really feel like they're there, you can persuade someone that they are going through something with you, or seeing it through your eyes. That if I see it innocently, they will see it innocently as well. But it's not something I do automatically. I have to work on it and achieve it. Because, like everyone else, I often have blinders on me.

Geneva Overholser

Both of you have talked a great deal about connection, which is clearly at the essence of this. And yet, we're at a moment of polarization when it comes to science. How do we address that? How do we connect fact and feeling?

Diane Ackerman

I don't think there's just one way to do it. I think that everybody has unique natural abilities and tendencies that they can use. I'm very happy that there are doom and gloom naturalists out there, but, for my part, I try to fill people with curiosity and wonder about things. But what are we going to do when we have people who don't believe in science at all? How are we going to persuade them of the facts? I try to enchant them. I try to trigger the child in them. I try to get someone to want to go out and imagine what it's like to be an owl.

Alan Alda

I agree that there's probably no one way to do it. One thing I hope for is that better communication on the part of scientists will instill in the public a better understanding of the way scientists think, skills they can borrow for their own lives, such as relying on evidence and not on wishes, beliefs, or superstition. And to show them the difference between evidence and beliefs, and how valuable it is to our lives to understand that difference.

Diane Ackerman

Unfortunately, there aren't many scientists who are adept at avoiding jargon and esoterica.

Alan Alda

I agree. So, what we work on is similar to what Diane does: entering into the wonder of, let's say, an animal, so that it can be more appealing to the person listening,

rather than just giving the dimensions of the animal. I love when scientists express their amazement and amusement at what they discover. It's just so full of life. And that's a great model for the rest of us, too.

Diane Ackerman

I previously taught a course at Cornell on creativity in the arts and sciences. Once a week, there would be a guest speaker – a chemist, mathematician, or physicist, for example – who talked about his or her mystery and how his or her mind worked. And the audience could ask questions. And you began to see their excitement when, for example, one said he started studying foxes because, when he was little, he wanted to be a fox. And he ran around golf courses pretending to be a fox. In those instances, the science became humanized – there was a person behind the discovery.

Alan Alda

Another thing that really humanizes the scientific story is an account that includes failure. Failure is, to me, a dramatic story. The hero is trying to achieve something of great importance, and then there's this obstacle in the way, a tremendous obstacle you've got to fight your way through. Now, the audience is thinking, how is he going to get through this? How is she going to achieve her goal? And the listener gets invested in the story and the scientific process. Stories of failure are too often ignored, but there can be no breakthroughs without failure. ■

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To view or listen to the presentations, visit <https://www.amacad.org/communicatingscience>.

Communicating Scientific Facts in an Age of Uncertainty

As the Academy continues to look at issues related to public perceptions of risk, uncertainty, and scientific research through its Public Face of Science initiative, it partnered with the University of Chicago to organize a public symposium on “Communicating Scientific Facts in an Age of Uncertainty.” The public symposium, held in Chicago on February 20, 2017, featured presentations by Olufunmilayo I. Olopade (Walter L. Palmer Distinguished Service Professor of Medicine and Human Genetics at the University of Chicago) and Arthur Lupia (Hal R. Varian Collegiate Professor of Political Science at the University of Michigan) and a discussion moderated by Robert Rosner (William E. Wrather Distinguished Service Professor in the Department of Astronomy & Astrophysics and Physics at the University of Chicago). The event, which included remarks by Robert J. Zimmer (President of the University of Chicago), Eric D. Isaacs (Robert A. Millikan Distinguished Service Professor and Executive Vice President for Research, Innovation and National Laboratories at the University of Chicago), and Jonathan F. Fanton (President of the American Academy of Arts and Sciences), served as the Academy’s 2051st Stated Meeting. The following is an edited transcript of the presentations and discussion.



Robert J. Zimmer

Robert J. Zimmer is President of the University of Chicago. He was elected a Fellow of the American Academy in 2007.

It’s a great pleasure to welcome you to the University of Chicago, and to welcome the American Academy of Arts and Sciences here for this event about communicating scientific facts in an age of uncertainty. This topic is of perennial interest, as it is always important to communicate about

In a world in which people want simple answers, in which they are most comfortable with yes or no and black or white . . . how can we actually communicate this intrinsic uncertainty of science?

science and we are forever in an age of uncertainty. The current nature of the national discourse, however, gives the subject increased salience.

Among the several challenges in communicating about science that I am sure will be discussed during this program, there is an underlying, perhaps even foundational, conundrum we need to confront: how do we communicate about uncertainty? Each of us understands that various forms of uncertainty are intrinsic to the entire scientific process. But communicating with a public audience about uncertainty in science seems to be particularly difficult.

Let me illustrate by considering one of the most natural and familiar of scientific questions, one of intrinsic public interest: does what you eat affect how long you can expect to live, your health, and how good you feel, and if so, how? Now, we all know the answer to the first part of that question is yes. But consider the ways in which

we describe work connected to the second part of the question. This is presented as a *scientific finding*, reached after a long study involving many people over many years, arriving at a definitive conclusion about what you should be eating. Usually, the only uncertainty that is implied is an acknowledgement that the conclusions are statistical—you are x percent more likely to live n years longer if you focus your diet according to some particular guidelines. Sometimes, the additional uncertainty of confidence intervals is mentioned. However, some years later there is a new *scientific finding* that asserts the discovery of this previous finding was not quite right, perhaps even all wrong. Scientists automatically recognize that it could be that the original work was flawed, but alternatively it simply may be that one has newer techniques and technological capacity, can ask and address different questions, has other related discoveries at hand that were not previous-

ly available, all of which may have contributed to reaching a different conclusion. But this understanding of intrinsic uncertainty in what we call *scientific findings* is something that we do not often communicate to a public audience.

Nor is it easy to do so effectively. In a world in which people want simple answers, in which they are most comfortable with yes or no and black or white, and are surrounded by a discourse at all levels from the time they are young that gives statements in this form, including by scientists themselves, how can we actually communicate this intrinsic uncertainty of science? Without it, one falls prey to the difficulty that when the next diet report comes out nobody actually believes it unless they want to, because it contradicts the last one, and everybody knows that another one's coming out in the future. Now this may be an extreme example, but this phenomenon, sometimes in milder form, actually appears in many scientific issues of public interest. If you fail to acknowledge uncertainty, you risk undermining confidence in the whole enterprise as results are regularly "overthrown." If you do recognize uncertainty, how do you indicate that it is still a *scientific finding*, rather than just another guess? How to communicate effectively to a general audience about this type of uncertainty is to me an unresolved conundrum.

I offer these thoughts as an introduction to our topic, which I believe is important, fascinating, and complex.



Eric D. Isaacs

Eric D. Isaacs is the Robert A. Millikan Distinguished Service Professor in the Department of Physics and the James Franck Institute at the University of Chicago. He is the University's Executive Vice President for Research, Innovation and National Laboratories.

I am a physicist, a former director of Argonne National Laboratories, and the Executive Vice President for Research, Innovation and National Laboratories at the University of Chicago and I don't believe in facts. See I'm a scientist, and as scientists, our goal is to engage in what is real, regardless of our belief systems. We look at evidence, we develop hypotheses that seem to explain the evidence, and then test those hypotheses. If belief is involved in this at all, it is my belief that science and the scientific method are the most reliable means that we have to understand our world. So we talk about science, and we talk about public policy, and the seemingly increasing disconnect between the two that we really need to understand. It's not hard to understand why some people are frightened or anxious: the ease of access to information makes it

People want reassurance; they want to hear that they can protect themselves and their families in a world that seems increasingly complex, chaotic, and dangerous. And they seem to be willing to listen to those who can offer them that reassurance and a few simple solutions.

easy to feel as though the world is entirely out of control. And people want reassurance; they want to hear that they can protect themselves and their families in a world that seems increasingly complex, chaotic, and dangerous. And they seem to be willing to listen to those who can offer them that reassurance and a few simple solutions. But that's not a message that we as scientists are really able to give the public. The best we can do is what we do really well: cite our research, give evidence, and talk about probability, or the uncertainty in the results that we share with the public. As scientists, we think that should be enough.

Many of us fly many thousands of miles a year with the knowledge that we face, on average, a one-in-eleven-million lifetime chance of dying in a plane crash. And then, most of us spend a good chunk of that time in flight trying to figure out how much our frequent flying is actually affecting our individual cost, our individual risk. But the individual sitting next to you, the one who breaks into a visible sweat and grasps your

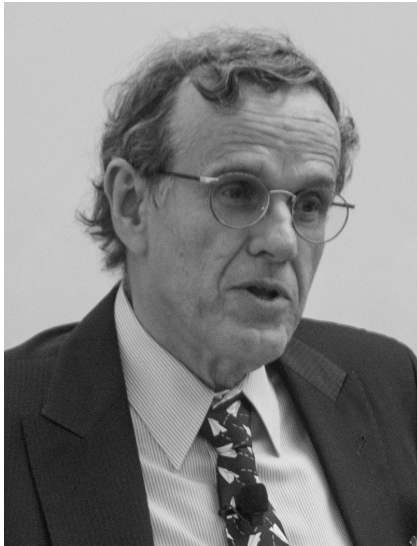
Scientists embrace uncertainty and complexity: we use the scientific method to explore and explain fundamental scientific concepts. But this can be at odds with the way that many make sense of complexity using prior beliefs, personal biases, and powerful narratives that have been repeatedly told to them.

hand when the plane takes off? He or she is unlikely to be comforted by safety statistics.

Scientists embrace uncertainty and complexity: we use the scientific method to explore and explain fundamental scientific concepts. But this can be at odds with the way that many make sense of complexity using prior beliefs, personal biases, and powerful narratives that have been repeatedly told to them. And these shortcuts can really congeal the kinds of policies from scientific evidence that we're seeing today. So here is the essential question, the one that may decide the future of our country, our nation, and our planet: how do we talk about science in a world that is shaped by belief and yearning for certainty? This is not a partisan issue; there are people on all points of the political spectrum who question the impact of climate change on the world and who also, at the same time, question the safety of childhood vaccinations. So the answer to this question cannot be found in partisan politics. It is also not an issue of intelligence: there are plenty of smart, well-educated people who have accepted ideas and policies that are not supported by scientific evidence. So the answer, as hard as it may be for us to accept, cannot be found exclusively in education and outreach. It is really hard to beat emotion solely by reciting evidence; you can't sooth the anxious air passenger next to you by telling him or her not to worry, that he or she is more likely to

die in a car crash on the way home from the airport than in the airplane itself. So we need to change the conversation. We need to understand the worldview of people who are rejecting science-based public policy. What are their concerns, what are their fears, and what can we offer them that will meet their needs? We need to find strong emotional arguments. It's hard for scientists, but it is really powerful, and something that I don't think we do enough of. I also think we need to find ways to talk about uncertainty without creating anxiety. And to understand that the words we use aren't heard in the same way we understand them by audiences that need to be persuaded. We're speaking in a language that often isn't what our audiences need to hear. So can we do this? I really believe we can.

Our panelists today will explore these topics further, sharing more about their scientific work, the controversies they face in working with patients, the public, and those who are shaping our policies, and the strategies and arguments that they have found persuasive.



Robert Rosner

Robert Rosner is the William E. Wrather Distinguished Service Professor in the Departments of Astronomy & Astrophysics and Physics at the University of Chicago, as well as in the Enrico Fermi Institute, the Computation Institute, and the Harris School of Public Policy Studies. Elected a Fellow of the American Academy in 2001, he is Codirector of the Academy's Global Nuclear Future Initiative.

Nothing illustrates the challenges of communicating science and scientific fact to the public better than the many public controversies over science-related topics. And while some of the controversies mentioned earlier, like climate change and vaccines, are contemporary, these kinds of controversies have a long history. The Greeks debated whether the Earth was round. During the Renaissance, in the debate around whether the Earth orbits the sun, Galileo paid a great personal price for his support of Copernicus's heliocentric model of the solar system: he was brought before the Inquisition and put under house arrest for the remainder of his life. There are many other examples. Is evolution real? Is

Nothing illustrates the challenges of communicating science and scientific fact to the public better than the many public controversies over science-related topics.

fluoridation safe? Is homeopathic medicine real or a fraud? What are the health effects of power lines, or in general, of electromagnetic fields? What is the role of vitamin C in cancer? Are GMOs safe? All of these are examples of controversies that have their roots in science, but have entered the public realm. But science, as we all know, is replete with controversy. There are many more controversies that do not see the light of day in the public realm; only a tiny fraction of scientific controversies become public. Why some and why not others?

Now, some cases you could argue are inherently unavoidable for reasons that are basically extrinsic to the science itself. For example, in some cases, economic interests intrude – the obvious example is smoking. Think of the efforts of the tobacco companies in funding research that tried to deny that smoking was a health issue. This is also true in the case of climate change: some fossil fuel companies, in particular the oil companies, have sponsored similar kinds of research to protect their financial interests. Then there is the theological side of things. Galileo, who I mentioned earlier, had a formidable opponent in the Catholic Church. The same happened with evolution. In that case, it was predominantly Protestants in the South who supported the Scopes trial and the conviction of John Thomas Scopes, the teacher who dared to discuss Darwinian evolution. But what about the rest? What about the scientific controversies in the public realm that are not driven by concerns like theology or profit? And is it the case that, somehow, we are not figuring out how to communicate our concerns, as Bob Zim-

mer said, and the uncertainties in our results, in a way that the public can accept and understand? The other side of the coin is, in fact, the social science issue: to what extent do people, when confronted with facts that seem to be opposed to their deep-seated beliefs, actually change their mind? *Do* they change their mind?



Olufunmilayo I. Olopade

Olufunmilayo I. Olopade is the Walter L. Palmer Distinguished Service Professor of Medicine and Human Genetics, Dean for Global Health, and Director of the Center for Innovation in Global Health at the University of Chicago. She was elected a Fellow of the American Academy in 2010.

I'm going to speak as a scientist and also as a medical doctor. I happen to work in genetics, one of those areas that's actually quite controversial. Controversial in the sense that we know that genetics is not deterministic, and yet, any time you hear geneticists talk about the importance of their work, it's about how they cloned a gene, it does XYZ, and, as a result, if you have an alteration in this particular gene, you may get cancer. And so, when I started my career at the University of Chicago, I really wanted to understand genetics a little bit deeper, because my mentor had spent her career arguing with her colleagues about the importance of genetics in cancer etiology. At that time, everyone thought chromosome alterations in cancer were epiphenomena. Everyone was convinced that cancer was caused by what we

Scientists need to do a better job of not only doing the discovery, but actually talking to people about how the results of their research would actually impact them.

had in our food or the environment, and so it possibly had nothing to do with genetics.

Pierre Paul Broca, the famous French scientist, observed generations of women in families who developed breast cancer. In 1866, he wrote about it. But the process took generations, in fact it took nearly twenty-five years for modern day geneticists to find families like Broca's to finally map and identify the long arm of chromosome 17 as the locus for the BRCA-1 gene. At the time, Mary Claire King and Francis Collins really pushed to map disease genes that explain the genetic bases of diseases. Then, scientists went to Congress to ask for \$5 billion to execute the Human Genome Project. The proposal was basically: Why map genes one at a time? Why don't we just find all of them? The assumption was that each of us has maybe five or more genes that are altered and could potentially cause disease, and if we could identify those genetic mutations, then we would certainly get to predictive and precision medicine.

One important aspect that came out of the Genome Project was remembering that genetics had, in fact, been used for bad purposes in the past. Eugenics, of course, arose from physicians who actually believed that you needed to get rid of people who were not "fit." So, in the proposal to Congress, 5 percent of the Human Genome Project budget was devoted to studying the ethical, social, and legal implications of the research we were about to do. I remember participating in interdisciplinary groups that came together to think about these issues. As doctors, we had initially just said why not? Let's find the harmful genetic muta-

tions and figure out a way to cure genetic disorders. Then, we met with religious leaders and social scientists who asked why we assumed that's what people would want. That was really humbling early in my career, when I had thought that if we just found this gene, we could actually prevent people from getting breast cancer. And it turned out it was the wrong answer. Not only are there many reasons why people want to live with whatever variations that they have, it's also not realistic to expect that we're going to get everyone to a perfect state of health. And it turned out that, as we did more studies, our knowledge about the Human Genome was incomplete: we couldn't have just one Human Genome Project, because each of us has our own personal genome. It cost us \$5 billion to clone and put together the first map of the genome, but the more we've studied, the more we realize that there's still so much dark matter in our genome that we don't yet understand.

So it's been twenty years since we identified BRCA-1 and we've successfully translated the science in the clinic. We can now test for a large number of cancer susceptibility genes, but we don't know nearly enough to guide every patient through the process. Even though we thought we could use genetic testing to predict who was going to have cancer and who was not, it's still probabilistic, not definite. How do you communicate cancer risk when we don't even fully understand how these genes function in a complex human being? As scientists we need to learn how to help patients when we can, but also realize our limitations when we don't have all the information.

How do we appropriately communicate risk? I have come across many situations in families segregating breast and ovarian cancers when individuals will choose not to know or accept our scientific explanation. Based on personal beliefs, some families will reject inherited genetic mutation as causal, convinced that all the cancers in the family were related to environmental exposure. There are also instances where families are afraid to come forward, because they are concerned about stigma, insurance discrimination, or other social aspects that scientists don't always consider. Thus far, we have been unable to deliver on the promise of improved population health from our investments in the Human Genome Project. This is just one example of how we can promise too much, and unless we deliver in full to the public, they're not going to be willing to accept the fact that these discoveries, limitations and all, can actually improve

don't need to know, still want to know. And that's really the beauty of human beings, right? We're unpredictable.

My second example involves the Human Papillomavirus (HPV) vaccine. We can eradicate cervical cancer as a leading cause of cancer deaths in women globally by vaccinating young girls before the age of eleven. The former governor of Texas had planned to get every student in Texas vaccinated. And then the pushback began with people thinking that vaccinating children against HPV was akin to giving them permission to be promiscuous. And that was the end of it. So now the United States is one of the countries with the lowest rates of HPV vaccination, even though we have scientific evidence that shows you can essentially eliminate cervical cancer through herd immunity by vaccinating the majority of young girls in a community. And what's one of the fastest growing cancers in men in this country?

nately, this vaccine that can essentially eliminate cervical cancer can only save lives if it is widely accepted and adopted.

We have such a well-educated population, and we're making such sophisticated scientific discoveries in this country, and yet so many of us now doubt that well-proven and long-standing techniques, like vaccination, actually work. Or rather, some believe that they actually cause more harm than good. And I think we, as physicians, have wasted some opportunities to educate the general public. Because in the early part of the twentieth century, children were becoming paralyzed from polio and dying of measles or chicken pox, and the average lifespan was less than sixty years. But now that people are living longer, we've somehow forgotten what it used to be like. So it's up to us also to convey the importance of our work, including these enormous past successes.

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human health. Scientists need to do a better job of not only doing the discovery, but actually talking to people about how the results of their research would actually impact them. As a physician who always tries to talk to families, I have come to understand that there are individuals who simply don't want to know, and that's their right. And there are others who, even if you tell them that they

Head and neck cancers related to HPV. Of course, in order to have herd immunity, we need a certain proportion of the population to be vaccinated. But a lot of families aren't adopting HPV vaccination because of their religious beliefs. So our vaccination rate is about 37 percent, whereas in other countries it's significantly higher, such as in Australia, where it is up to about 90 percent. Unfortu-



Arthur Lupia

Arthur Lupia is the Hal R. Varian Collegiate Professor of Political Science at the University of Michigan and Chair of the National Academy of Sciences Roundtable on the Communication and Use of Behavioral and Social Sciences. He was elected a Fellow of the American Academy in 2007.

I work on how people make decisions when they don't know very much, which, conveniently, is pretty much always. I also work on how to convey complex ideas to diverse audiences. I apply this research in my work with many different science and public service organizations on developing, implementing, and evaluating communication strategies. As a result of what I have learned in that work, I'm now bilingual: I am fluent in "Democrat" and "Republican."

In the context of science communication, I think we all agree that science's insights continue to transform our lives: they improve quality of life for people around the globe by helping individuals and governments make decisions that improve health and reduce disease. Science's insights grow the economy by increasing the effectiveness of factories, offices, and farms.

Motivated reasoning is the practice of paying attention to and seeking to inflate the importance of information that's consistent with a point of view you already hold. Motivated reasoning also entails ignoring or minimizing the importance of information that challenges your existing views. A less technical term for this phenomenon is hearing only what you want to hear.

Given the range of science's influence in the world today, you would think that science's future as a generator of social value would be very bright. But it doesn't feel like that, does it? A lot of people feel that science is under attack. People are nervous and they're scared.

Many people believe that our continuing capacity to understand our world and make life better for present and future generations depends on science. They want to know what they can do to help science continue to provide great value to society. For these people, I want to point to two challenges in attempting to communicate scientific facts in an age of uncertainty. One of these challenges is called *motivated reasoning*. And the other has to do with increased competition for attention and influence. Let's talk about motivated reasoning first.

Motivated reasoning is a way of processing information. But I didn't initially believe in this concept. I have some background in mathematics, and when I was in graduate school, I wanted to believe that people are efficient information processors: that they would take information, evaluate it by its accuracy, and then move forward accordingly. Unfortunately, almost all of the evidence suggests that people don't process information in this way.

Motivated reasoning, a term from psychology, describes a different way people

process information. It leads some people to love science and leads other people to work very hard to deny science's relevance or value. So how does motivated reasoning work?

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Motivated reasoning affects a lot of people, and this next point may be controversial, but that group includes you. Suppose you are a liberal who identifies with Democrats and regularly votes for them. And suppose this evening I were to ask you to welcome our next speakers, Ann Coulter and Ted Cruz (who, by the way, are both highly educated). Would you be willing to listen to them tonight with an open mind? And for conservatives, would you listen to Rachel Maddow and Elizabeth Warren with an open mind? Or, in either case, would you only think about how "they just don't get it?"

This is a problem for all of us. I work with a lot of groups, and in one climate communication organization, our goal, and I apologize if I offend anyone with what I am about to say, is to keep the right from lying and the

left from exaggerating – and try to be accurate in terms of what science really knows. In each case, we are trying to counter effects of motivated reasoning in how people process information about climate.

Now let's turn to the topic of competition. More people than ever are using the Internet to distribute information of all kinds, leading to a hyperintensive competition for attention and influence. This avalanche of content has changed people's expectations about the kind of information they can get, the kinds of information they should be able to get for free, and most important, the kinds of information they can trust. When we put scientific information on the Internet, it's important to know that not only are we dealing with people who are motivated reasoners, but we're also competing with all of the other content on the Internet – I'm talking about cat videos and Pokémon, which many people find highly entertaining. For science information to educate a particular group of people, that group has to decide to access our content and then stay with it long enough to learn from it. With that competition in mind, the question becomes, why would they do that?

In *Uninformed*, my most recent book that Oxford University Press published last year, I point to the importance of providing information that is not just factually accurate, but conveyed in ways that people will want to hear. This means rigorously pursuing the intersection between the content of your science and the problems that are most important to your target audience.

If I could tap into someone's core concerns, that is, the things they worry about when they go to sleep at night or when they look at their children, and find a link between my science and those core concerns, I would have a better chance of speaking to a receptive audience. But if I speak in abstractions that they can't access, the likelihood of me losing the battle for attention to cat vid-

eos or Pokémon is great. And this isn't because people have bad character.

One of the reasons we can't help using motivated reasoning is that our attentive capacity is so profoundly limited. But our brain has great ways of tricking us to think we perceive more than we know. We pay attention to very little of what we're exposed to, we remember very little of what we pay attention to, and we use very little of what we remember. So motivated reasoning is a way for us to try and make sense of the world. And it's only in rare moments that we counteract that instinct. Most of the time we're looking for information that will make us feel good.

With these challenges in mind, some of us want to communicate scientific information in an age of uncertainty to improve people's lives. And that means improving decisions. When you walk into an area like

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policy, the competition for science isn't just cat videos, it's other ways of knowing. In policy and in other decision contexts, there are four ways of defending a claim to know something. These four ways are collectively exhaustive, but not mutually exclusive.

One way of knowing is *appeals to metaphysics*. That is, we say that there are phenomena beyond our ability to perceive and that these phenomena affect what is true and what is false, what is good and what is bad. There are some people in our society who claim to have special access to these phenomena and there are others who rely on them

for guidance about what is true and what is good. This is a very powerful way of knowing throughout the world.

A second way of knowing is *appeals to personal experience*, or testimony. That is, a person tells you about what they saw or how they felt at a particular moment. They describe their feelings and testify to the validity of what they felt. These personal narratives are a common way of trying to help other people understand some things about the world.

A third way of knowing is what I'll call *the space between God and man*. We could call it culture. This is history, art, and other pursuits that take elements of the past, represent them in a digestible way for audiences in the present or future, and say that because this happened in the past and we interpret that past in a certain way, we can now know something important about the present or future.

I would like to describe the fourth way of knowing through an analogy. Suppose I have a device I can hold in my hand, and at one end there's a big red button, at the other end there's a green light, but it's not lit. When I press the button, the light turns green. And someone might ask, well what happens when I press the button? If I have conducted my science in accordance with best practice, I can answer that it turns green, and that it does so regardless of who presses the button. In other words, when science is done in accordance with best practices, when we're rigorous about how

When science is done in accordance with best practices, when we're rigorous about how we choose cases, how we categorize what we observe, how we analyze what we categorize, and how we interpret what we analyze, we create knowledge that's true regardless of theological commitments, personal experiences, or cultural connections. That is the power of science.

we choose cases, how we categorize what we observe, how we analyze what we categorize, and how we interpret what we analyze, we create knowledge that's true regardless of theological commitments, personal experiences, or cultural connections. That is the power of science. That is what gives science special ability to improve policy. In some cases, science is our last and best defense against wishful thinking.

In a complicated world, there are moments when we need that kind of knowledge, but we have to understand that the other three ways of knowing don't disappear. In fact, there are many moral and ethical questions for which the other ways of knowing offer better guidance about what should be done. Sometimes in science we forget about the power of the other ways of knowing. When we present ourselves as having the only way of knowing, particularly in policy contexts in which other people are smart enough to recognize our error, people trust us less and we actually do damage to our ability to use science to improve quality of life in situations in which other ways of knowing are useful.

So when scientific claims are competently conveyed – that is, with respect to the core interests of an audience – the target audience is more likely to be interested in what we have to say. And when we are true to the

scientific method, we can use that moment to convey information that is true for them, true for other people, and can serve as the basis of a stronger society.

Discussion

Robert Rosner

As a question regarding other ways of knowing, I would like to bring up the case of vaccination. In 1998, *The Lancet* published an article by a physician named Andrew Wakefield who claimed that there was a connection between vaccination and autism. That paper has since been debunked and retracted. Yet it remains true that there are those, including a son of Robert F. Kennedy, who simply do not accept that there is no connection. So the obvious question is, why is it that a presumably highly educated person would be so motivated to hold onto a belief that's directly contradicted by scientific studies?

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I think one of the challenges of really dealing with human beings who have suffered, whether it be a loss or a disease, is understanding that they're looking for explanations for what went wrong, they're looking for something to hold onto. And so, autism is on the rise – we know that – and there are many families who are experiencing the challenges of raising autistic children. And because we don't always have a reason to explain a phenomenon, patients who are suffering will find their own explanations. Cancer is another subject that we can't sufficiently explain that has motivated a lot of people to actively search on the Internet for answers. And people are comforted by the answer that best explains what they think has just happened to them or their loved ones. Grief turns into activism and advocacy. In some cases, those advocates have actually helped us to advance science communication. But the challenge that we face is assuming that this way of thinking is not legitimate. I've been challenged by advo-

cates who absolutely would not accept the fact that all the cancers in their family were caused by genetics, because they're holding onto something else. The motivations, the cultures, and the beliefs that people hold onto are not only informed by science, they're also informed by their lived experience. And until we have definitive answers, there will be alternative ideas out there. Our job is to keep looking for solutions to alleviate the suffering, and reduce that need for answers.

Arthur Lupia

To add to that comment, sometimes people who believe in the power of vaccines inflame the controversy by using the term *antivaxers* and then going out in public and attacking the folks with these other beliefs. That action in and of itself heightens the idea that there's a controversy on the subject of vaccine effectiveness and safety. And so, people know that autism is frightening,

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they're afraid for their children, and now they are being reminded that there's a controversy. In some cases, people feel backed into a corner, and that's when motivated reasoning really kicks in.

Dan Kahan at the Yale Law School has a cultural cognition project. He shows that

these are really instances in which people no longer hear the debate, they just kind of dig in on their side. The best way to make progress is to focus on the benefits of the vaccine, to talk about how horrible the diseases are, and try and create a channel through which people can refocus on the benefits of vaccination. If you spend so much of your time participating in controversy and repeating false claims in an effort to debunk them, you're fighting against yourself.

Robert Rosner

And who are the right promoters in society of this kind of message that focuses on the benefits of vaccines? Is it the scientists themselves?

Olufunmilayo I. Olopade

This is one of the reasons why scientists should get out of their bubbles. Scientists need to interact with real human beings.

If you can't communicate your science to somebody who's totally clueless about your work, then you are actually doing yourself a disservice. When you publish a paper and you think it's the definitive result, and you communicate it in that way, then you have not done the public a service. We need the

humility that requires us to be suspect of our own findings. We can't just hype the results. And as exciting as immunotherapy for cancer may be, for example, we can't overplay it and set impossible expectations. If we want the public's support, we need their trust. But I do think the American public supports a lot of science. Now we need to show our appreciation by going out and talking to more people about it.

Arthur Lupia

Scientists aren't always the best messengers. One of the things that an audience has to do is trust you, because if they don't trust you, they can't hear you. Where does trust come from? One of the places it comes from is a *perception of shared values*. So, if we are looking down our nose at an audience, they usually pick up on that. When I was working with climate scientists about fifteen years ago, one of the things we talked about was the importance of religious leaders in the climate sphere. There were some pastors, particularly in the evangelical faith, who talked a lot about the responsibility of their congregation for stewardship of God's creation. And if they could reach their congregation by reminding them of this responsibility, something the congregation already firmly believes, and if the pastor can connect that shared belief to a call to protect the environment, that would be much more effective than a scientist giving an abstract lecture on global climate change.

Audience Question

With regard to the issue of the whole process being distorted by somebody deliberately trying to affect an audience's reasoning, such as the tobacco industry funding research to protect its own business interests, what do you recommend for communication strategies in that particular case?

Arthur Lupia

The initial reaction to a piece of information is almost always emotional. To the extent that there is any rational or cognitive element, it happens later. And usually it doesn't happen at all. We react, we have a feeling, and we move on to the next thought. In terms of how to get people to engage a scientific view of climate, here's an analogy I like to use: imagine a tall man and a

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short man in a wrestling match. You might think that the tall man, because he's much bigger, has the advantage. But in wrestling, the smaller man, closer to the ground and crouched down, can bring the bigger man down. The same is true when you enter a debate with someone assuming you have all the facts and they don't. In terms of communication, you have to get close to the ground, down to where the core problems and concerns of the public are. Often scientists will tell the abstract story first, and then later on we move to how it can directly affect someone's life. But the way to approach an audience is to connect the information to their core concerns first and then move to abstractions later, if you can get them sufficiently interested. This approach means beginning by asking people, What about the health of your children? What about pollutants in your water? What about something you care about directly in your life? Wouldn't you like to know how to protect it? If you tell that story, some people will want to know more, and then you will

have an audience. Most of the time, we tell the story backwards, and we turn off people who would listen to us otherwise.

Eric Isaacs

This is very similar to a related problem: selling science in general, not just the big problems you're talking about. If you're trying to sell material science, for example, which is a fundamental science that in-

cludes the discovery of new materials, why should I care? You could just tell me to pick up my iPhone, which uses materials discovered thirty years ago. But most scientists want to avoid that approach because it starts with the promise of a miracle. It is harder to express, though, that we don't know what the outcome will be, or if we'll be able to overcome the challenges anytime soon. That isn't necessarily going to inspire a nonscientist.

Arthur Lupia

And when I talk about strategy, I'm *not* talking about dumbing it down; I'm talking about us *smartening up about how we convey what we know* to other people. Most of us in science are trained to talk to folks who study almost exactly what we study using some of the methods that we use. We call them "ideal reviewers" or "the ideal conference panel discussant." But when we want to reach other people, it's an away game. Most everything interesting about an act of learn-

ing happens between the other person's ears. So, we have to start with narratives and facts that they can hear. And then we can build understanding that way.

Audience Question

Returning to the autism and vaccination issue, as an example, do you think that a way of reaching the resisters could be to present the problem in terms of which is the worse, or the least bad decision? What are the chances of developing autism versus the chances of the disease you're vaccinating against? What are the relative harms of the two? Would that be a way of addressing the issue, and persuading people to look at it in a little bit more open-minded way?

Arthur Lupia

Based on the research that I've done, I think that most of the people who are currently skeptical of the vaccines/autism link would not be interested in that conversation. It's like asking them to make a tradeoff between a cow and magic beans. The autism is the cow; they know what it is, they've seen children with autism. They fear autism. The other diseases, like measles, are abstractions, the magic beans. They can't really imagine them. A better strategy is to have human scale stories about the effects of these diseases and circulate them. But for the folks who have already made the decision against vaccination, it's likely they'll never get the statistics, because autism is this real scary thing that they want to avoid pretty much at all costs.

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Another thing to consider is that everyone can post their opinion on the Internet. There are communities of people chatting online independent from so-called experts,

and now, in medicine, most patients come in having already done some online research and may even have an opinion about what you're trying to get them to do. So I think the conversation that scientists ought to be having is how to get our voices out there more often, including into these online forums, so that we can amplify the voice of science. People are already having these conversations and recruiting others to their views, so how can we expect, with one publication, to get all of them to come to our opinion? There's a deep pool of ideas that are out there, and you need to compete. Scientists can't take for granted that because we have done the research that everyone is going to accept it as the gospel truth.

Audience Question

We as scientists focus on how best to portray facts and convince people of facts. Whereas social scientists have looked at this question of whether rhetorical prowess alone is more important than if you've got your facts straight. Your ability to present may be as important as whether or not you have the accurate portrayal in a debate. I'm curious what you would say about that.

Arthur Lupia

I think that it's overstated just a little bit. We can all think of an example where somebody used rhetorical prowess over fact. And we assume it must happen all the time. But in fact, most efforts to convince people of most things fail. Most communication campaigns fail to have their intended effect. But if we're talking about something and it's consistent with a person's lived experience, they'll accept it. If we talk to a person and we agree on what the problem is, and on what a good and bad solution is, and there's an idea that science can help it, then there's a lot of interest in that science. Where the interest starts

to fall apart, or where the doubt comes in, or where rhetoric can really have an effect is when we don't agree on what the problem is, or we don't agree on what a good or bad solution is, because the problem could be primarily moral or ethical. That's where someone could use a rhetorical flourish to move a conversation away from facts, and persuade through morals and ethics. But if we agree on what the problem is and we seek a more technical solution, it's harder to do that.

Audience Question

Thinking about alternative sources of information and these online communities, it seems that the numbers aren't in our favor. Even if we're very, very skilled scientists, and know how to tell stories and listen, we are outnumbered. So often, the most trusted people in our lives are our friends and family, whereas even if scientists do a good

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job of trying to talk with people, they actually don't rate among the most trusted voices. So I'm not convinced that asking scientists to communicate in a different way is going to get us anywhere here in this new world. What are some of your ideas about that?

Arthur Lupia

I'm not certain that we're outnumbered on the science. Let's take climate change, for example. I think the most reputable polls on climate change will say that 80 to 90 percent of self-identified Democrats and 50 to 60 percent of self-identified Republicans endorse the two basic propositions that cli-

mate change is occurring and that it's human-caused (and the partisan divide largely happened after Kyoto, for what it's worth). But where things break down is not on that, it's on the moral and ethical question: what should we do about it? Some very well-informed conservative legislators accept the two propositions, but don't want to do anything about it. In private, they will tell you that they understand the science, but publicly they can't "go there," because once they do, they'll be pressured to do something. So in public, they say, "the science is uncertain, so we can't act." And in the case of vaccines, there is a very small segment of the population who connect vaccines with autism – it might not even be above 20 percent. So, in that case, these are huge victories in terms of science.

Our problem in the scientific community is that we want it to be 100 percent, and we don't understand why it isn't. But there are

many cases in which science conflicts with other things that people want to believe. And so we're not going to get 100 percent on these issues, particularly if we're trying to influence policy. What I am trying to do with my work is to help scientists not slash our own tires before we leave the driveway. A lot of times, we make it worse for ourselves by not knowing how to talk to other people.

Olufunmilayo I. Olopade

It's also important to cultivate the culture of the scientific method early on in life. Let's not start talking about science only when you get into high school or the university;

we need to develop a scientifically literate citizenry, and that has to start early. Unfortunately, I think that the vast majority of the population live in a place where they can't access scientific discoveries, and if they can't access the information, they can't believe it or experience it. And that lived experience really influences a lot of decisions that people make.

Audience Question

I'm wondering how much of this is just, perhaps, that society has changed? Particularly American society. At one point post – World War II, science was a hero, science was go-

wasn't very much in the newspaper, on TV, or on the radio. And most people didn't have the wealth or the resources to go to another town to get scientific information.

For about nine hundred years, people who studied at universities and became scientists had a monopoly over the provision of information. And we got used to it. We got used to not being questioned by the public. We got used to giving terrible presentations and blaming it on our students if they didn't get it. The Internet broke the monopoly.

So the first thing to realize is that now we have to compete with many more sources of information. If we do not compete in this information space, people who can tell their

and show that science is a form of critical thinking that can help them. And if we're not competing in the information space to try and find the link between our science and people's core concerns, we're going to lose the battle for attention.

Audience Question

Marketing is a bad word in academia. But if you look at the Republican Party or a company that's trying to sell something, they have a large communications arsenal behind it. You can argue that scientists have a large arsenal, too, but it's not a coherent group that speaks with one voice. So, there needs to be kind of a communal push on some of these ideas. Otherwise, they can't stick. Sometimes there's a lone voice, or sometimes scientists are out there promoting conflicting ideas, because they have differing opinions about a scientific fact or approach. Can you say a little bit about that kind of collective marketing?

Arthur Lupia

One-size-fits-all is really dangerous, because you're competing on all different types of levels. When I work with an organization to try to help it communicate more effectively, we focus on two things. First is the mission statement: what is the value that you provide to a particular group? That's the core of a narrative. Second, we look at a set of prospective learners, people we want to talk to. If there is nothing that they care about, then we have nowhere to go. But if we can find an audience where there's an intersection, then we have to hit that intersection. This isn't like some kinds of marketing because you aren't selling your soul. Instead, you're working really hard to think about this intersection between the content of your science and the set of things people want to hear.

One thing that's important is to get people used to the idea of critical thinking: show how examples of critical thinking can help them with decisions, and show that science is a form of critical thinking that can help them.

ing to solve all of our problems. Now, people aren't so sure. We need to create a society in which our children, young adults, and adults are good consumers of information, so they can make decisions and understand that there is a government process and a scientific process. Can you comment on that?

Arthur Lupia

I would like to respond in two parts. First, one of the fundamental things we have to understand in science, to articulate a strategy, is how the world has changed for us.

Prior to about forty years ago, for most people, most of the information about science they could get was in their home, in their library, in their local school, and maybe in their church. And that was it. There

stories much more effectively are going to get more eyeballs.

Second, how do we get people to pay attention to facts? In policy, there's not always a distinction between facts and values, because your values affect what facts you think are important. For example, one of the most divisive debates in America today is over abortion. Both pro-life and pro-choice people have some pretty interesting facts on their side, many of which can be validated by science. Although these different groups will have huge disagreements on which facts are most important, both sides actually have facts at their disposal. So I think one thing that's important is to get people used to the idea of critical thinking: show how examples of critical thinking can help them with decisions,

The National Academy of Sciences, for example, has struggled with this kind of messaging for years. On their new website, “From Research to Reward,” they have a five-minute film talking about the relationship between a set of economic algorithms and kidney transplants. And if you’re not moved or crying by the end of it, we need to check if you have a pulse.

The story is that an economist, Al Roth, developed these algorithms several decades ago, but now they are used to form networks of people who can donate and receive kidneys: these algorithms are used to match large sets of people up, so that if you wanted to donate a kidney to your loved one, but you’re not a match, you can go into these marketplaces, these algorithms, and they’ll find someone who is a match for you and they’ll find someone who’s a match for your loved one, and you fill each other’s need. And thousands of people now are alive because of it. The couple in the movie are from central casting, so, in a sense, they’re not necessarily science advocates. But they’re telling the story, they’re taking this thing and making it human. It’s just math. But at the end of the day, this math saved this life – these thousands of lives. That’s an example of a way to stay true to the science but communicate it in ways that people can really hear.

Audience Question

I think there’s an interesting question about the role of public education in the preparation of consumers of knowledge, and I think there’s a distinction to be made between individual decision-making and public policy. And in a democracy, people have rights to make decisions that affect their lives: they can choose whether or not to vaccinate their children. And we can tell them their child cannot go to public school without being vaccinated. So my question is, how do we begin to prepare citizens, in

public education settings, which is the only place that we can do that, to be willing to develop dispositions to wrestle with uncertainty? And what are the criteria that we’re going to use in making these difficult kinds of decisions? I’m suggesting there’s another partner in this, beyond, first, the scientific community and, second, people who are listening to scientists and communicating their ideas. The other leg in this tripod, if you will, is public education. And it’s not just about early preparation in science as a field; across many of the disciplines we’re teaching in schools, there are issues of probability. So how do we help young people become disposed to approach and confront uncertainty?

Olufunmilayo I. Olopade

That’s a good point. One thing that’s different in a lot of countries that have good health systems, in which they can actually use research to inform policy, is that a lot of vaccines are tied to school attendance. In other countries, the government tells everyone to go get vaccinated, and they get vaccinated, and there are no questions around it. But here, because we don’t have a unified system of educating our children and supporting their health, or anything that is sort of communal, then it becomes individualized. You have to go find your doctor to recommend vaccination, and depending on what state you live in, or even what community you live in, you may not have access to vaccination even if you wanted it. So there’s a lot of work to be done in terms of the public sphere: How do we educate for science? How do we make sure people have access to science early on? And how do we do science that can inform policy that we would all accept? ■

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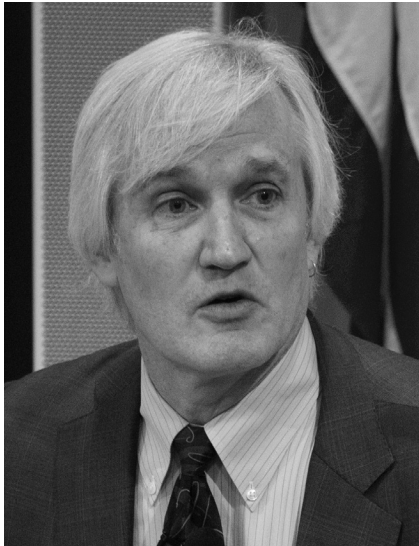
2017 Distinguished Morton L. Mandel Annual Public Lecture

Ethics and the Global War on Terror: Can Conflicts with Non-State Actors Be Fought in a Just Way?

On March 8, 2017, Allen S. Weiner (Senior Lecturer in Law and Director of the Program in International and Comparative Law at Stanford Law School), Neta C. Crawford (Professor of Political Science at Boston University), Jennifer Leaning (François-Xavier Bagnoud Professor of the Practice of Health and Human Rights at the Harvard T.H. Chan School of Public Health and Director of the FXB Center for Health and Human Rights at Harvard University), and Gabriella Blum (Rita E. Hauser Professor of Human Rights and Humanitarian Law at Harvard Law School) participated in a discussion of the war on terror and whether conflicts with non-state actors can be fought in a just way. The program, which served as the 2017 Distinguished Morton L. Mandel Annual Public Lecture and 2052nd Stated Meeting, was live streamed to groups of Academy members and other participants gathered at George Washington University, Stanford University, and the University of Notre Dame. The following is an edited transcript of the presentations.

“In wars, when we look at consequences, they are not just in medicine and public health. There is a longer-term aspect that concerns the destruction of the environment and ecosystem, obliteration of cities, targeting that actually engulfs museums, libraries, and cultural sites, and all of the aspects that sustain memory and confer meaning for societies.”

– Jennifer Leaning



Allen S. Weiner

Allen S. Weiner is Senior Lecturer in Law and Director of the Program in International and Comparative Law at Stanford Law School.

Tonight's program draws upon an Academy project that examines New Dilemmas in Ethics, Technology, and War. Under the leadership of my colleague and co-teacher Scott Sagan of Stanford University, this project explores how the changing character of warfare and the deployment of new military technologies affect the moral and legal behavior of states in war. The project has produced two issues of *Dædalus*: "Ethics, Technology & War," published in Fall 2016, and "The Changing Rules of War," published in Winter 2017. I had the privilege to participate in a series of extraordinary workshops that resulted in the production of these two special issues, under Scott Sagan's outstanding editorial direction. Our panelists tonight will present different dimensions of what has been dubbed the "war on terror" and will address the overarching questions of whether conflicts with non-state actors can be fought in a just way and, if so, how.



Neta C. Crawford

Neta C. Crawford is Professor of Political Science at Boston University.

Although there are many approaches to the ethics of war, the laws of war are rooted in the Western tradition that regards war as something that ought to be avoided and quite distinct from peace. If war cannot be avoided, then it must be limited by concerns of justice. Just wars are circumscribed in their causes, aims, duration, and conduct; they should not go on *ad infinitum*, with no clear end in sight.

Jus ad bellum questions concern legitimate authority, which usually means that only sovereign states can make war, with the aim being the return to peace. Revenge, justice, or religious conversion are no longer proper objectives. The only just cause is self-defense, understood as the response to an armed attack that is actual or imminent in the sense that it has already begun. Further conditions include concerns such as: last resort, other options have been tried; there is a good chance of success, force will be effective, ends can be achieved; that war is necessary, nothing else will work; and the propor-

tionality of ends – even a just war does some harm, so the overall good of the war should outweigh that harm.

If war is justified, its conduct should be limited by the principles of distinction and proportionality, distinguishing between combatants and noncombatants or fighters, and using due care to attempt to limit harm to the latter and avoid gratuitous destruction. Justice after war focuses on individual and state responsibility for acts of aggression.

The just war tradition keeps all these considerations on the table. In sum, this tradition is complex and comprehensive, flexible and influential. It is also less precise than the law. So, if we ask whether a counterterror war can be just, we have to ask whether such a war is necessary and if it can be limited in its cause, aims, duration, and conduct.

I am going to discuss the ethics of counterterror war by way of a particular tactic: namely, the use of targeted killing strikes, whether by cruise missiles, manned aircraft, or drones (most of these strikes to date are conducted by drones). The goal of the strikes is to kill the leaders of military organizations, to reduce their capacity to attack the United States and its allies. Since 2002, the number of drone strikes per year, their locations, and the kinds of people considered legitimate targets have expanded. These strikes are now less about retaliation against al Qaeda for 9/11 than about prevention of potential attacks in the United States and abroad by al Qaeda and other organizations. Drone strikes are said to be discriminate and proportionate. Their advocates claim that the strikes are surgically precise. If all goes well, they get the bad guy and do not harm the innocent. It is possible, in theory, to be attentive to discrimination in target selection and in the conduct of individual drone strikes. Due care for civilian life and minimizing harm to civilians are already key criteria. Since Dresden, To-

If we ask whether a counterterror war can be just, we have to ask whether such a war is necessary and if it can be limited in its cause, aims, duration, and conduct.

kyo, and Vietnam, things have improved for civilians.

Drone strikes usually kill fewer civilians than large bombs, but drone strikes do kill and injure civilians, and they may also lead to war. These are the questions at the level of *jus in bello* and *jus ad bellum*. The strikes are not consistent with the just war tradition's admonition to avoid war and other *jus ad bellum* concerns.

How did I come to these conclusions? On a basic level, the drone strike program rests on familiar, now taken for granted, assumptions about the war on terror and targeted killing in that war. First, that criminal law and law enforcement are inadequate to prevent these attacks. Second, that we live in a perpetual state of imminent threat, which justifies the resort to arms and to war as a means of defense. The sky has fallen, is falling, and will continue to fall. Only war can save us. Third, and Donald Rumsfeld put this most succinctly: "There's no way to defend everywhere, at every time, against every technique." He said, "Therefore you simply have to go after them." The claim is that the inability to protect all assets from the risk of attack places a premium on prevention, often exclusively defined as preemptive military strike. Terrorists are combatants who must be targeted for killing because they pose, in Obama's words, "a continuing and imminent threat." People defined as terrorists are a legitimate target who may be killed preemptively.

Targeted killing is supported by additional claims. First, targeted killing is ethical because it is defensive and necessary – we

cannot arrest potential terrorists. Second, it is a form of justice, in which militants get their just deserts. Further, drone strikes are discriminate and cause few casualties. As Obama said at West Point in 2014, "In taking direct action, we may uphold the standards that reflect our values. That means taking strikes only when we face a continuing imminent threat and only where there's near certainty of no civilian casualties." We have come to believe "near certainty of no civilian casualties" is possible because surveillance technologies enable the CIA to be omnipresent, making it and the United States omniscient, able to know what people are doing, and more importantly what they intend to do or may be capable of doing.

The claim is that the inability to protect all assets from the risk of attack places a premium on prevention, often exclusively defined as preemptive military strike.

It is also argued that drone strikes are low cost, low risk to American soldiers, and that drone strikes are limited and distinct from other elements of the war on terror. There is little risk of escalation of the conventional uses of force by our allies. These arguments can seem quite compelling, but they have numerous problems. First and most simply, the strikes are not as discriminate as we supposed, although there is some debate about who and how many are killed in the strikes. The strikes are indiscriminate because they

hit civilians and cause or contribute to wider wars that harm civilians. Second, just wars are meant to be limited. Counterterror war is essentially unlimited in its justification because the aim is total security from what might happen. Counterterrorism may go on as long as it takes.

In sum, drone strikes don't help us limit the war on terror by titrating the use of force and calibrating and controlling its consequences. The effect is just the opposite. As Michael Walzer argues in his recent *Dædalus* article, drone strikes are so easy to conduct that they decrease the threshold of the use of force. Because immediate costs are low, we discount or imagine that we can mitigate or control any future cost and long-term consequences. Further, the distinction between the supposedly isolated precision drone strikes and other uses of force don't exist at an operational level. Drone strikes usually occur in the context of occupation, aggression, or – as in Yemen and Pakistan – are integrated into conventional actions by U.S. proxies who are armed, trained, and fi-

nanced by the United States. We thus have the illusion of controllability and precision and the fantasy of providing security.

Third, the evidence does not show that the United States has reduced the risks, namely risks to those who conduct the strikes and risks to Americans and their allies. There is no clear causal connection between the strikes and the actions of militants. The United States says the strikes decrease militant activity in the short run. Militants say they strike in response to drone attacks.

Drones and the global war on terror challenge and blur categories. When the threat is understood as imminent, we blur the temporal distinction between current threats and future threats. We also blur distinctions between the battlefield and zones of peace.

As Walzer notes again in his *Dædalus* essay, the war on terror is increasingly about hearts and minds, but “drones don’t win hearts and minds.” No one can make everyone, everywhere, safe at all times. Thus, we are caught in an endless loop of killing and searching for new threats. Drone use escalates and then war escalates. There is a beginning and a continuation but no end, and no plan for an end, only the assumption that we can somehow achieve victory by killing everyone who might pose a threat.

Drone strikes don’t meet *jus ad bellum* criteria. Democracy is undermined by a lack of transparency and accountability; self-defense is a just cause, but it is defined too broadly to include potential future threats. Last resort is undermined because the premises of the war on terror have been institutionalized. It is not clear that drone strikes are necessary or the only way to accomplish the ends, or even if they accomplish what they set out to do in a strategic sense. Right intention is not served if war is ongoing and peace is not achievable. We are not able to evaluate the proportionality events because we don’t have data and we are fighting a permanent and perpetual war.

Drones and the global war on terror thus challenge and blur categories. When the threat is understood as imminent, we blur the temporal distinction between current threats, ones that are now manifest, and future threats. We also blur distinctions between the battlefield and non-war zones

or zones of peace. Further, drone warfare, which attacks potential future combatants, blurs the roles between combatant and noncombatant, fighter and civilian. Targeted killing everywhere, at any time, blurs the distinction between territorial self-defense and global self-defense, when the self is defined globally. Finally, distinctions about the level of risk we might tolerate are blurred. In other words, the distinction between war and peace is blurred.

The fallacy of drone strike precision is believing that if we can control the time and place of the strikes, we can control the consequences of those strikes and minimize any unintended effects, including the increased radicalization of people who live in areas where the strikes occur. Drone warfare is part of a larger war that is unethical, because it is not limited in the sense that just wars are limited. A hard charge but I believe it is so. Drone strikes can lead to escalation.



Jennifer Leaning

Jennifer Leaning is the François-Xavier Bagnoud Professor of the Practice of Health and Human Rights at the Harvard T.H. Chan School of Public Health and Director of the FXB Center for Health and Human Rights at Harvard University.

It is a privilege to be participating in this panel of distinguished scholars. I would like to establish a certain zone of expertise and my bona fides for being here. In the last thirty years, I have worked in or studied the following countries or regions at war: Somalia, early 1992; Kosovo, 1998–1999; Afghanistan, January 2002; Gaza, 2014; Jordan, Lebanon, and Syria, 2014 to the present; Rwanda, 1997; and Angola, 2005. I also have studied refugees in many settings, related to these wars and others, from the perspective of what access and support should be provided for humanitarian aid.

As a human rights investigator, I have been compelled to become conversant with relevant provisions of international humanitarian law, and in that regard, I would like to offer some somber observations. The first, in my view, is that just war theory is eclipsed by the current military, geopolitical, and

The body of international humanitarian law is not sufficiently robust to protect non-state armed actors, and it is also not robust enough to protect civilians caught up in these wars.

technological situation. This is a setting where, as Neta was saying, wars are very hard to define in terms of limits. Civilians are entrained; technology makes war fighting relatively easy to initiate; the humanitarian architecture, established since 1945, has collapsed; and the humanitarian international security system – the one that is deployed to deal with the excesses of war and criminality – has also failed. This is a pivotal moment and there is much work to be done.

Second, non-state actors, by intent and constraint, target civilians deliberately. In this context, I am not talking about terrorists. Rebels are fighting for what they perceive to be a reasonable political and just cause. People involved in fighting civil wars, individuals who have been entrained in wars in which the state has failed (terrorists may seep into these wars but they are not the drivers of them and they have not defined the political context), are by intent and constraint out to defeat the other side. The other side includes other armed fighters, perhaps the state, and civilians who are perceived to be allied with the other side. Many of these wars have very ethnic, sectarian, and communal attributions, so the civilians are considered as much the enemy as whatever ragtag army has been developed in those contexts. They attack civilians because they are interested in driving the civilians out. They may or may not be intent on committing atrocities, such as ethnic cleansing, but they are interested in controlling territory and wealth. These non-state combatants and non-state armies don't have the resources or the technological capacity to hold land once it is pop-

ulated. They don't have command of the air; they don't have communications; they don't have vast resources; they have to live off the land. So they are constrained to drive people out, and those are often brutal interactions and lead to many cycles of refugees.

Third, *jus in bello* – international humanitarian law (IHL) – is deeply inadequate in these current wars, which are waged by non-state armed actors. The wars may be solely internal, within the boundaries of a nation-state or a failed state. They may be internationalized internal conflicts, such as in Afghanistan and Iraq, and lately in Syria.

In my view, just war theory is eclipsed by the current military, geopolitical, and technological situation.

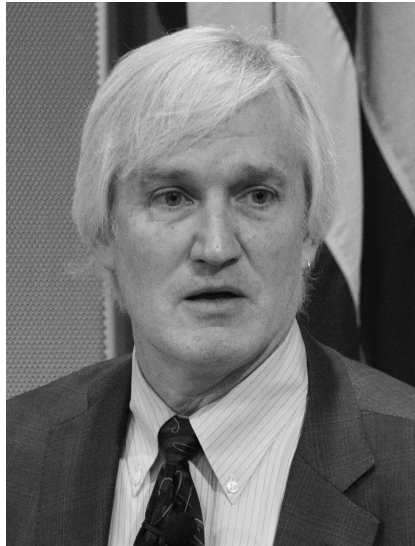
Fourth, IHL was developed in the context of nation-states with formally trained military. There were lines of accountability; wars took place in accessible political contexts. There was a central nervous system: there was a sovereign state on both sides and there was the potential for a more international playing field – for great state intervention, moderation, diplomacy, and discipline prior to, during, and very importantly enabling the end of the war. Those conditions no longer apply.

Fifth, the body of international humanitarian law, here I'm speaking of *jus in bello*, is not sufficiently robust to protect non-

state armed actors, and it is also not robust enough to protect civilians caught up in these wars. There is a large vacuum in IHL when you get below the level of the sovereign nation-state. There are limited protections for civilians from attack, there is no protection given to the fighters when they are captured, and it is very difficult to argue that there should be convoys and humanitarian aid because the law doesn't say those things are necessary.

Let me mention a concept in public health and medicine that I have been calling the burden of war. In wars, when we look at consequences, they are not just in medicine and public health. There is a longer-term aspect here that concerns the destruction of the environment and ecosystem, obliteration of cities, targeting that actually engulfs museums, libraries, and cultural sites, and all of the aspects that sustain memory and confer meaning for societies. And when we think about refugees, we need to consider the dismay they feel when they consider what am I going back to, what is there, what holds me?

Regardless of what status they have in international refugee law, refugees are in some fundamental way alienated from their home and stateless. This is a devastating thing to do to societies and this is what these wars are creating. In my view, we need much stronger international humanitarian law, and that can only be developed through policy formulation and through sidebar conversations with the International Committee of the Red Cross. We need to look at the gaps in civilian protection in these internalized wars, to say what needs to be done so that civilians are protected and the fighters, when they are captured, are not tortured or killed.



Allen S. Weiner

Allen S. Weiner is Senior Lecturer in Law and Director of the Program in International and Comparative Law at Stanford Law School.

My remarks will focus on the distinction between international armed conflict and non-international armed conflict, or what we think of as asymmetric wars, i.e., wars between states and non-state groups.

Let me disclose in advance that the subject of my remarks is in some ways perhaps the narrowest or the most esoteric of the presentations you will be hearing today, but I think the implications of the way we think about the “war rights” of fighters for non-state groups in asymmetric war, which is the kind of conflict that is the most pervasive in the world today, may have deeper and broader questions for our imagining and understanding of war.

I will try to describe the problem of applying just war theory to wars between states, on the one hand, and non-state groups, on the other. The problem is a relatively easy one to state. The deep challenge is to try to work out a solution.

In wartime, it is permissible for fighters to kill enemy soldiers, and it is permissible for fighters in wartime to destroy enemy property if it is a legitimate military target. Combatants in a war between states are not subject to criminal accountability for their actions.

Let me set the stage. Under traditional just war theory, we separate the justice of the conduct of the war from the justice of the recourse to war, i.e., we distinguish between *jus ad bellum* and *jus in bello*. Once the war begins, we treat soldiers as moral equals, without regard to the justice of their cause. Because soldiers face one another on the battlefield as moral equals, a German soldier in World War II possessed the same rights to wage war and was entitled to the same protections as an American soldier in World War II, without regard to the justice of the two states' underlying cause for fighting. That is a deeply settled principle in traditional just war theory.

One may wonder what kinds of rights am I referring to when I talk about the “war rights” of combatants. Essentially, I am interested in the question of what is known as the combatant's privilege, which is the right to wage war. In wartime, it is permissible for fighters to kill enemy soldiers, and it is permissible for fighters in wartime to destroy enemy property if it is a legitimate military target. Combatants in a war between states

States, in non-international armed conflict, claim for their soldiers the combatant's privilege: the right to kill enemy fighters and destroy enemy property. But international law does not accord equivalent rights to the fighters of the non-state group.

are not subject to criminal accountability for their actions. If they are captured, they may be held as prisoners of war prophylactically and removed from the battlefield, but they cannot be punished for having waged war. A necessary corollary of the combatant's privilege is the concept that captured combatants benefit from a degree of benevolent protection. In the law of international armed conflict, there is an extraordinarily detailed set of protections to which prisoners of war are entitled. Among the most basic are the principles that POWs have the right to be held in conditions that are comparable to those of the detaining state's soldiers, and not as criminals; and the right not to be subject to torture, mutilation, or murder. There is a whole series of additional rights and entitlements that go well beyond a minimum standard of humane treatment. In international armed conflict, combatants on both sides may claim this very elaborate set of entitlements, regardless of the justice of their cause.

Now, the situation is quite different in conflict between states, on the one hand, and non-state groups, on the other. As for the law, it seems to be quite clear that war rights are routinely claimed and exercised by the state party to the conflict. States, in non-international armed conflict, claim for *their* soldiers the combatant's privilege: the right to kill enemy fighters and destroy enemy property. But international law does not accord equivalent rights to the fighters of the non-state group. A fighter for a non-state group, if captured, could be prosecuted

for murder – he can be prosecuted not only if he has engaged in terrorist acts, or for having facilitated a suicide bombing, or for blowing up a market, but for a purely military action like shooting a soldier on the battlefield. And we have seen this in practice. There are cases of detainees at Guantanamo who have been prosecuted for wartime acts because of their legal status as “unprivileged belligerents.” They have been charged with, among other things, the crime of murder for shooting American soldiers in a firefight in the field. Had this been a fight in Normandy, between a German soldier and an American soldier, the German soldier would not have been subject to prosecution for those acts, but a fighter for al Qaeda or another non-state group would be.

I argue that we should not base our judgments about who should be permitted to claim war rights on the basis of the moral worthiness of the underlying cause of the fighters.

In contrast to international law, just war theory does not categorically reject the idea that fighters for non-state groups have no war rights, but it has struggled to come up with a standard for when non-state armed group fighters acquire these rights. For my part, and this is the argument that I make in the essay that I have published in *Dædalus*, I find the asymmetry of rights in asymmetric conflicts to be deeply problematic. Al-

though medieval just war theory held that the rights of fighters are derived from fighting for a legitimate authority, contemporary just war theory does not treat soldiers as moral equals simply because they fight for a state. That is a proxy for a deeper concept, namely, that war is a collective endeavor, not an individual one. Soldiers fight out of loyalty to their side and act on the basis of what they are told are their side's causes for going to war. More fundamentally, we might say that the individual fighter is not the relevant unit of moral analysis. But if that is correct, it applies as well to wars between states, on the one hand, and non-state groups, on the other.

So, if you agree with me that belonging to the armed forces of a state is not alone a sufficient moral reason for conferring war rights on fighters, we still must decide what criteria we should use to decide if the principle of moral equivalence of soldiers should apply in any particular asymmetric armed conflict. I argue that we should not base our judgments about who should be permitted to claim war rights on the basis of the moral worthiness of the underlying

cause of the fighters. A number of just war theorists link war rights to the justice of the cause, but in my mind that ignores the separation between the justice of recourse to war and the justice of the conduct of war that underlies traditional just war theory. Moreover, I think there are deep problems in trying to allocate war rights on the basis of our judgment about the worthiness of the fighters' cause. There are epistemologi-

cal problems in determining how a fighter is to know whether his cause is just, of course, but the deeper problem is that participants in conflict, as a psychological matter, invariably demonize their adversaries. If we find ourselves in a situation in which states accord war rights to non-state fighters only if they conclude that the cause of the non-state group with which they are waging war is just, then war rights will never in practice be conferred on non-state fighters, which I contend is a problem.

My basic view is that we should accord war rights to non-state fighters – that is, we should depart from the presumption that a state is entitled to prosecute people who use force against the state and imprison them – if the fighting is taking place in what I call an “other governed space.” This test is met in cases where the state no longer exercises control over a meaningful portion of its own territory. It is also met where the conflict – as is the case with most of the non-international armed conflicts we see today – takes place outside the territory of the state, i.e., when it is a transnational armed conflict. In those circumstances, the moral argument for the application of the state’s domestic criminal law no longer applies, and fighters in those circumstances should be accorded moral equivalence, just as is the case when states wage international armed conflict against other states.



Gabriella Blum

Gabriella Blum is the Rita E. Hauser Professor of Human Rights and Humanitarian Law at Harvard Law School.

War used to be a lucrative business. States, or rulers at the time, would fight as a way to aggrandize or preserve their territory – even though there was not necessarily a distinction between the two. Wars were legitimate ways to convert the conquered to a new religion, to proselytize and spread religion.

Wars were also an instrument of justice, a dispute resolution mechanism. They allowed the resolution of a contest over disputed territory or a dynastic succession. They were an enforcement tool. They allowed the collection of an unpaid debt or the restoration of something unlawfully taken. They were a legitimate punitive method that allowed for one ruler to avenge injury. For instance, if a ruler violated a treaty or committed any injury, another ruler could engage in war as punishment, and that punishment allowed for both retribution for past injuries as well as deterrents against future injuries. And this is not just a

In the twentieth century, international law sought to move us toward a more pacifying stance by limiting the causes of war: you could no longer engage in war to expand territory, spread religion, resolve disputes, restore or enforce a debt, or exact punishment.

description of what states actually did, but in fact is the definition of just war theory. To the victors went the spoils and those spoils were no less legitimate than a fine imposed by a judge at the end of a trial. This meant that you could regain any expenses in the conduct of the war, as well as meting punishment for the original injury.

In the twentieth century, international law sought to move us toward a more pacifying stance by limiting the causes of war. Beginning with the Kellogg-Briand Pact in 1928, war became more limited: you could no longer engage in war to expand territory, spread religion, resolve disputes, restore or enforce a debt, or exact punishment. In fact, there is only a very narrow exception for self-defense, and that is subject to the principles of necessity and proportionality.

Now, self-defense is seemingly a very narrow and straightforward paradigm, so what is the problem? The problem is applying that in practice. Victory today is not about something tangible. It is not about territory or religious conversion or the collection of debt. It is about the absence of threat. But what is the absence of threat today, and how

do we know when we are safe? How safe can we seek to be and at what cost to others? These are tough questions, even when you put aside the war on terrorism and look at more traditional battlefields.

Consider Iraq and Afghanistan, leaving aside for the moment the question of whether there was just cause for these wars. What are the legitimate goals in the name of self-defense? Destruction of military forces, military capabilities, regime change, democracy, building schools for girls, improving infrastructure, improving agricultural production, child literacy? All of these were in fact offered as metrics of success and necessary components of self-defense at one point or another by different actors, with the assumption that achieving those metrics would tell us whether we should feel safe again. Of course, if schooling for girls is a legitimate goal of war, then you can use force until you achieve this goal.

What are the legitimate goals in the name of self-defense? Destruction of military forces, military capabilities, regime change, democracy, building schools for girls, improving infrastructure, improving agricultural production, child literacy?

Now shift back to the war on terrorism. Even when the focus is on the military side, the answers to what constitutes a legitimate goal of self-defense may not be so simple or straightforward.

Immediately after 9/11, President Bush declared, “A war on terror begins with al Qaeda but it does not end there. It will not end until every terrorist group of global reach has been found, stopped, and defeated.” The statement was undoubtedly hyperbole and U.S. policy has never aimed to defeat every terrorist group everywhere, and yet the presidential declaration clearly pre-

As we have separated victory from any tangible gain and demanded that it only prevent loss, victory has become elusive and more difficult to judge.

supposed the view that it would be just to keep fighting until the American risk from international terrorism approached zero. If one was looking for a more detailed statement of goals, one could perhaps find them in President Obama’s statement in 2013, “Our systemic efforts to dismantle terrorist organizations must continue until the United States will degrade and dismantle the operational capacity and supporting networks of terrorist organizations like al Qaeda, to such an extent that they will have been effectively destroyed and will no longer be able to attempt or launch a strategic attack against the United States.” None of these statements suggest that the U.S. strategy

their use of force under Article 51 of the UN Charter, claiming self-defense against ISIS in Syria. None has offered a clear statement about what it hopes to achieve through these strikes and consequently about when and how that self-defense interest will be satisfied. As a matter of international law, it is much easier to say that the United States cannot fight for oil than to say what the United States can fight for.

As we have separated victory from any tangible gain and demanded that it only prevent loss, victory has become elusive and more difficult to judge. International law today, unfortunately, does not give us an answer to what victory can be about. If it is a legitimate goal to seek zero risk from international terrorism, we will surely find ourselves in an indefinite war, and it is an indefinite war in which we transpose risk from ourselves onto others, for instance, through targeted killings. It seems to me that zero risk cannot be a legitimate definition of victory. We need to build a new international consensus that would apply to all fronts, at all times, by all actors. ■

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Ending Preventable Newborn Death in Africa

Rebecca Richards-Kortum

This is a tale of two families. The first is my lab manager's family, which is shown on its original homestead in Seaguin, Texas, in 1910 (see Figure 1). Two of the eight children – the two little ones in the front – died before they turned five. These two children, if born today, would most certainly live to adulthood, but at the time, two in ten children in the United States did not live to see their fifth birthday. The second family, shown in a photograph I took recently, lives in rural Malawi (see Figure 2). Despite significant reductions in global child mortality, the chances of these children perishing in Malawi today are approximately the same as those in the United States in the 1930s.

Although global child mortality has dropped by 50 percent since 1990, neonatal mortality has declined much more slowly. Newborns now represent more than 40 percent of under-five deaths,¹ and preterm birth is the world's leading killer of children.² Multiple evidence-based global health priority setting exercises recommended strengthening hospital care for small and sick babies.³ Despite these calls for action, at current rates of progress, it will be 150 years before a baby born in Africa has the same chance of survival as one born in North America.⁴

In the United States, neonatal intensive care units (NICUs) played a key role in reducing newborn death rates;⁵ when regional NICUs were introduced in the 1960s, neonatal mortality fell by 60 percent.⁶ Modern NICUs combine excellent clinical care with advanced medical technology to address the needs of small and sick babies. In contrast, a typical newborn unit at a community hospital in Africa is staffed by dedicated clinicians but lacks even the most basic medical technology, such as oxygen concentrators or radiant warmers.

Even with its stunning consequences for African families, this technological gap persists for two reasons. First, equipment designed for use in a high-resource setting simply fails in Africa due to harsh environmental conditions, complex maintenance requirements, or from the lack of stable infrastructure, such as consistent electricity.⁷ Donated equipment thus ends up in "graveyards": stockpiles of expensive but unsuitable technologies. Second, there is no viable business model for producing and delivering these technologies. Multinational med-tech companies lack sufficient commercial incentive, while local entrepreneurs lack access to biomedical expertise and necessary facilities to fill this gap.⁸ Without efforts to provide affordable, appropriate technologies, and build local capacity to support and sustain their adoption, one million African newborns will continue to die unnecessarily each year.

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Three key actions are needed to address the persistent global challenge of newborn death. The first is to develop a set of affordable, rugged technologies that enable quality comprehensive newborn care in low-resource settings. Eighty-five percent of newborn deaths in low-resource settings are the result of three causes: complications of labor and delivery, infections, and prematurity. The majority of these deaths could be prevented using seventeen simple technologies, such as tools to keep babies warm, to help them breathe, to monitor labor and delivery, to diagnose jaundice and other conditions, and to deliver fluids and medications safely.⁹ Yet, current coverage is low; the needed technologies are simply not available.¹⁰ A growing community of innovators is beginning to address this need. Using principles of frugal design, engineers are developing appropriate technologies that are as effective as those in high-resource settings but cost between ten to a hundred times less. These technologies are designed to function in harsh environmental conditions, to meet international regulatory standards, to last more than five years, and to require no skilled maintenance and only inexpensive parts. For example, we designed a rugged, low-cost bubble continuous positive airway pressure (CPAP) system to help premature babies breathe. This CPAP system delivers the same flow and pressure as alternatives used in high-resource settings but at a ten-fold cost reduction.¹¹ Its use improved survival for premature babies suffering from respiratory distress syndrome from 24 percent to 65 percent,¹² mirroring the improvement seen when CPAP was introduced in the United States. Licensed to industry with preferred pricing in low-resource settings, the system has received international regulatory approval and is now being used in more than twenty countries.¹³

Other groups are using similar approaches to improve maternal and newborn health in low-resource settings. For example, Burke and colleagues developed an ultra-low-cost kit (less than \$5) to prevent maternal death from postpartum hemorrhage, a condition that accounts for more than 30 percent of global maternal deaths. Their ingenious approach, using locally available materials, reproduces the expensive uterine balloons used in high-resource settings to stop blood loss: they use a condom tied to a Foley catheter that is then inflated with clean water through a syringe and one-way valve.



Figure 1

Clinical evaluation of the system in five African countries shows that the system rapidly and effectively controlled blood loss in hemorrhaging women.¹⁴ Similarly, the non-profit Laerdal Global Health recently developed a low-cost fetal heart rate monitor designed to improve safe monitoring of labor in low-resource settings that lack access to traditional electronic monitoring systems.¹⁵ A clinical trial is underway in Tanzania, comparing the automatic use of the low-cost monitor to that of a hand-held Doppler ultrasound for detection of an abnormal fetal heart rate.¹⁶

Second, new technologies must be introduced in parallel with appropriate clinical education programs to ensure that they are used safely and effectively; but they must also be paired with appropriate technical education programs to ensure that technologies can be maintained and repaired. In particular, support for technical education programs in sub-Saharan Africa has lagged and there is an important need to build capacity. For example, a recent report from the Royal Academy of Engineering, which focused on identifying engineering capacity needs in the region, noted that the number of engineers emigrating annually from South Africa in the early 2000s matched the number of engineers graduating.¹⁷ Strengthening technical education programs can lead to immediate improvements in health outcomes. For example, we developed low-cost phototherapy lights to treat newborn jaundice, which, in a randomized controlled study, were shown to deliver therapy equivalent to traditional methods¹⁸ and at a significant cost reduction. We worked with engineers at Malawi Polytechnic to improve the de-



Figure 2

sign for local manufacture, and the lights are now being manufactured in Malawi and distributed through partnerships between the local engineering and medical school.

Finally, new business models are needed to sustain the delivery of medical technologies and supplies to low-resource settings. Collaborations with private-sector partners who can support manufacturing, regulatory affairs, and sales and distribution are needed to sustain improvements in care. Economic analyses that document the health benefits of investments in technology are needed to incentivize both private sector and government investment in strengthening capacity for facility-based newborn care.

It is possible to end preventable death in Africa – not in 150 years but in a decade – if we create a supportive ecosystem of well-trained clinicians, inventors, and entrepreneurs working together to transform the ability of community hospitals across Africa to ensure that every newborn has a chance at a healthy life.

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Jigsaw Puzzles, Paper Doll Chains . . . and Computers: Material Reconstruction of the Dead Sea Scrolls

Carol A. Newsom

The visual image that most people have of the Dead Sea Scrolls is likely of one of the beautifully preserved manuscripts stored in stone jars, discovered in the hill caves of Jordan in the late 1940s. Unfortunately, only a handful of the scrolls were preserved in this way. Most of the manuscripts recovered from the eleven caves of Khirbet Qumran had been stored loose on wooden shelves, which eventually collapsed, piling the scrolls onto the floors of the caves. Over the centuries moisture from the floors, falling debris from the ceilings of the caves, and other damage from rodents and insects meant that most of what we refer to as the “Dead Sea Scrolls” should more properly be described as the Dead Sea *fragments of scrolls*. What was finally recovered from the Bedouin explorers and the archaeologists in the late 1940s and early 1950s consisted of over 15,000 detached fragments from approximately a thousand different manuscripts. Because many of the finds came from Bedouin collecting activities, they were not properly excavated and were sold to authorities without information about how they had been found in situ. As one recent scholar characterized the problem, it was like receiving eleven jigsaw puzzles, with 95 percent of the pieces missing and no picture on the cover to tell you how to put the puzzles together.

Scholars are a foolhardy lot, however, and the original six members of the international team were uncommonly gifted not only with linguistic and historical knowledge but also with acute visual perception and memory. Since scribes in antiquity had handwriting that was as distinct as handwriting is today, the team was able to sort the piles of fragments into lots that represented the work of an individual scribe. Although in a few cases a single scribe had copied several manuscripts that had to be sorted according to content, in most cases the scribal hand represented a distinct manuscript.

Once that work was done, the team attempted to use jigsaw puzzle techniques to make as many direct joins as possible. Many of the photographs that one sees in publications today representing “a” fragment from one of the scrolls are actually painstaking compilations of many small fragments into contiguous joins. By the mid-1950s it appeared that the Humpty-Dumpty of the scrolls had been put together about as well as could be.

Most scholars who worked on the scrolls in the early years focused solely on the content of what remained. What made the work so frustrating was that, in addition to the fact that one was often working with only a few lines of text or even a few half-lines of text in a fragment, one had no way of knowing how the many fragments related to one another. To what extent could one reconstruct the original placement of noncontiguous fragments of a manuscript? If one was dealing with a biblical text, then the preserved medieval manuscripts provided the “cover picture” for the jigsaw puzzle, and the pieces could be fitted into place – assuming, of course,

that the ancient manuscript and the medieval one preserved the same text without significant alteration. And while in most cases that did prove to be the case, in some instances the ancient manuscripts were divergent, so that the medieval manuscripts could not be an exact key. But the acute problem was the non-biblical manuscripts. Most of these were texts that were entirely new to scholars. No “cover picture” existed.

Nevertheless, one of the most brilliant and legendarily colorful members of the original team, the Polish priest and scholar Josef Milik, intuited the solution to the problem already in the early 1950s. Although he did not describe his method, he realized that rolled scrolls, being spiral tubes of leather or papyrus, would exhibit mathematically related patterns of damage, whether they were damaged by moisture deterioration at the top and bottom, creating scallop patterns, or whether they were damaged by crushing from above, creating vertical or longitudinal crack patterns. The damage patterns would not only be “echoes” of each other for each successive roll of the scroll but would also be mathematically related to one another as each successive roll of the scroll grew larger or smaller. Milik never worked out his intuitions systematically, but he used them to reconstruct one of the damaged scrolls he was entrusted with publishing.

Surprisingly, other scholars did not seem to recognize the significance of his insights. Only a German graduate student in the early 1960s, Hartmut Stegemann, grasped the importance of Milik’s perception. He systematized Milik’s insights, worked out the mathematical formulae that accounted for the thickness of the leather and how tightly or loosely a manuscript might have been rolled – whether it was rolled from the outside in or from the inside out and other variables – and began to apply this approach to additional manuscripts. Already in his dissertation in 1963 he recon-

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structed one of the most important of the Dead Sea Scrolls, the Hodayot (Thanksgiving Psalms). Because he was a perfectionist, however, he did not publish his work, waiting until he could resolve some lingering puzzles of the reconstruction.

Scrolls scholarship languished during the 1960s and 1970s for various reasons. But during the late 1970s Stegemann and John Strugnell of Harvard University consulted about a number of manuscripts that had been entrusted to Strugnell. Stegemann suggested that several of the manuscripts preserved sufficient physical markers to enable the kind of material reconstruction that he had pioneered. In 1978, Strugnell had assigned to me fragments of seven partially overlapping manuscripts of an apparently mystical cycle of songs that described the liturgy of angels in the heavenly temple, the Songs of the Sabbath Sacrifice. Initially, I worked on these texts as had most scholars, analyzing the fragments in isolation. While I was able to say a few things about the manuscript as a whole, my findings on the structure of the cycle were minimal when I submitted my dissertation in early 1982.

One day in the fall of 1982 I received a parcel from Germany from Hartmut Stegemann, whom I had never met. The package included his tentative reconstruction of one of the manuscripts of my Sabbath Songs. He had sent a series of taped together card-stock panels with cutout Xerox copies of fragments from my manuscripts taped on and laid out with red marker notations indicating the recurrent damage patterns on each fragment. I saw in an instant his insight into how one could use evidence from the material nature of fragments to reconstruct their relative relation to one another. It was like a reverse engineering of the paper doll chains I had made as a child. We worked together for the next two summers. When I published my work in 1985, I was able to reconstruct the sequence of the majority of the fragments from my various manuscripts and to give an account of the poetic and rhetorical structure of the document, which had been almost totally inaccessible before the reconstruction. An immense amount of “lost” information had been recovered by the application of his techniques.

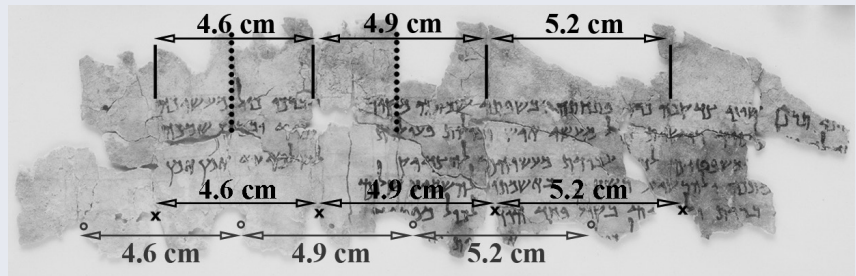


Figure 1. Recurrent damage marks on a large fragment. Image courtesy of Joseph L. Angel and the Israel Antiquities Authority.

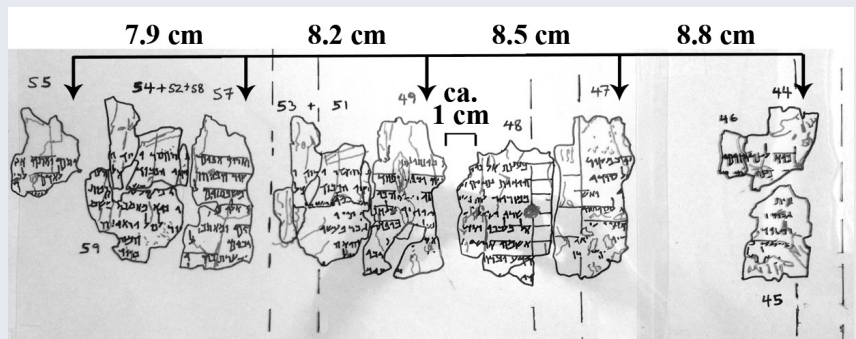


Figure 2. Damage marks and scribal dry lines used to reconstruct noncontiguous fragment placement. Image courtesy of Joseph L. Angel and the Israel Antiquities Authority.

In 1989, an impressive confirmation of Stegemann’s method was provided when Emile Puech, of the École Biblique in Jerusalem, published a reconstruction of the Hodayot that he had developed independently of Stegemann by using similar methods. His reconstruction was essentially identical to Stegemann’s. In the years since, the significance of Stegemann’s method has become widely recognized in Dead Sea Scrolls scholarship, and younger scholars have been turning to previously published texts of the scrolls to see if his methods could be used to reconstruct additional scroll sequences from what had been published as mere fragments. In several cases there have been such impressive results that they deserve to be recognized as a second “discovery” of the scrolls (see Figures 1 and 2).

The technique originally used – Xerox cutouts measured and pasted to mock paper scrolls – was reasonably effective but undeniably crude. The newest stage of the work, unsurprisingly, is computerized. Using newly available high resolution, multispectral digital images of the scrolls, a joint German and Israeli research project, the Scripta Qumranica Electronica project, creates online workspaces that simplify the process of taking measurements, allows the testing of proposed new joins and fragment arrangements, and evaluates the reconstructions. The tedious work of hair follicle and fiber pattern analysis for leather and papyrus scrolls will also be made much simpler. Material reconstruction of scroll fragments are, of course, just one aspect of the work of the Scripta Qumranica Electronica project. The new digital editions of the scrolls will make possible more sophisticated analysis of the contents, as well as the relation of the textual variants between the Qumran biblical scrolls and other ancient and medieval manuscripts. The project is a significant contribution to the emerging work of manuscript edition in the age of digital humanities.

The ancient scribes of Qumran – who painstakingly prepared their leather and papyrus, sewed the sheets together, dry-lined the prepared scroll, mixed their ink, and carefully copied their manuscripts – would likely be perplexed by the techniques of their latter day successors. But I think they would recognize and appreciate the same dedication to the preservation of tradition that motivated them to such effort.

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Does Investment in Research Always Pay Off?

Joachim Messing

You would expect a scientist like me to be defensive and offer an enthusiastic “yes” to the question of whether investment in research always pays off. However, my answer is a “qualified no,” with a few rare exceptions. Research funding is not unlike food production; it is not the amount, but the distribution of research funds that matters. Government funding for research, in particular, has become more and more dependent on project specifications designed by lawmakers and their staff and the interpretation of these specifications by government employees, who are usually quite removed from scholarly activity. Of course, there are panels of experts that assess the applications. Because these panels are composed of people who like to see funding in their own areas of interest, and since they prefer projects with predictable outcomes, they are usually unlikely to select an application proposing to explore uncharted waters. Such a system is averse to high-risk, out-of-the-box proposals. However, history has shown that it is often precisely this type of research that leads to true innovation.

Let us examine this a little bit further! There was no question that the human genome project was a worthy and excellent proposal and that the National Institutes of Health was the appropriate U.S. agency to oversee the country’s participating laboratories. In scope and complexity, this project was an endeavor not unlike that of putting a man on the moon. As a founding member of the Human Genome Study Section in 1989, I can say that initially we received many applications proposing alternative methods for physical mapping and DNA sequencing. Interestingly, however, the method for whole genome sequencing that produced the human genome sequence announced by President Clinton at the White House in 2000¹ already had been published in 1981.² The only new elements were to enhance the throughput of this “shotgun DNA sequencing” method by deploying robotics and advances in computing hardware, which were mainly financed by the private sector. The shotgun sequencing method itself, however, which by that time already had produced the first complete genome sequence, was supported by a relatively modest grant from the U.S. Department of Agriculture’s (USDA) Competitive Grants Program.³

There was something impressive about this USDA program: 1) my application was essentially high risk because nothing similar to this new method had ever been contemplated; 2) the amount of money, \$50,000, was very small compared to the later NIH funding; and 3) the government program was run by a prominent plant geneticist on a one-year leave from a university rather than by a government employee, and he had the vision that funding such a project might have a disproportionate impact.

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It is important to note that a consideration of expected impact can render the publication process superficial. Peter Czernilofsky, who sequenced the first retroviral oncogene⁴ that provided a basis for the work leading to Harold Varmus’s and Michael Bishop’s Nobel Prize in Physiology and Medicine in 1989, suggested to me that I should ask Bishop to communicate my manuscript to the *Proceedings of the National Academy of Sciences*, but a reviewer persuaded Bishop that it was too trivial an improvement and not worthy of being published in the *Proceedings*. Thus, the review of grant applications and manuscripts contributed by outsiders may well hinder innovation. When the work was eventually published, in *Nucleic Acid Research* in 1981, it laid the foundation for a citation record⁵ and Fred Sanger, winner of two Nobel Prizes, later, in a hand-written note, acknowledged “shotgun sequencing” to be synergistic to his own “Sanger sequencing” method (see Figure 1). As illustrated by this example, outsiders can still be successful, even with limited resources, and eventually overcome the bias of the establishment.

There is always a race between new methods and discoveries. While most research funding today is directed to what is seen as fashionable by non-scientists, like politicians and administrators, discoveries are serendipitous. Perhaps more importantly, they are often made by individuals, not by teams or large programs. I had conceived the shotgun sequencing method in 1974, at an EMBO workshop on restriction enzymes and DNA sequencing in Belgium, and reduced it to practice in 1980 at UC Davis using the small USDA grant I mentioned above. I worked mostly by myself, with only a few volunteers. As a non-faculty member, I did not even have my own laboratory.

Another example that illustrates the power of individual vision and endeavor in science is the work of Selman Waksman, a soil bacteriologist who was the founder of my Institute at Rutgers University. Waksman’s laboratory developed a cross streak test to screen soil samples for bacteria, which secrete toxins that kill other bacte-

ria.⁶ This was done before NIH and NSF funding became available. I would venture to say that even with NIH in existence, this type of research likely would have been regarded, at the time, as not relevant for medicine. Remarkably, however, it led to the discovery, by Waksman's student Albert Schatz, of a bacterium that produces streptomycin, which became the first cure against tuberculosis. The discovery, and its reduction to practice, was recognized by the 1952 Nobel Prize in Physiology and Medicine awarded to Waksman.

These examples illustrate that innovation requires a certain level of risk-taking and a sustained commitment to invest in individuals. To illustrate the success of this principle of guiding research funding, I would like to point to three examples: the Kaiser Wilhelm Gesellschaft, today the Max Planck Gesellschaft, which operates many institutes in Germany; the former Bell Laboratories; and the Carnegie Institution for Science.

The concept of the Kaiser Wilhelm Gesellschaft was to appoint outstanding scientists and provide them with a general research budget to work on whatever they chose. During the first decades of the twentieth century, the staff included legendary scientists such as Max Planck, Albert Einstein, Otto Hahn, and Werner Heisenberg. It later included several other famous chemists, such as Feodor Lynen, who co-discovered the regulation of cholesterol and whom I was fortunate to have on my thesis committee. In total, these scientists won an impressive 33 Nobel Prizes for their path-breaking discoveries. Continuing this tradition of investing in individuals and their vision, each Max Planck Institute lab director today still receives a certain level of basic funding for scientists, technicians, supplies, and equipment, although many research projects also require supplemental funding from competitive grants programs, which are also restricted to specific subjects.

True independence from outside funding for basic research was possible at Bell Laboratories, the R&D organization initially of the Bell Telephone Company, and later of AT&T. The organizing principle at Bell Labs was to allow a carefully selected group of research scientists to work mostly independently, within the larger context of the organization, with very limited support staff, and to pursue their own research programs in materials science, chemistry, physics, mathematics, and computer science.

Bell Labs produced thirteen Nobel Laureates, including many in physics: Clinton J. Davidson in 1937 for characterizing matter; John Bardeen, Walter Brattain, and William Shockley in 1956 for inventing the transistor; Philip Anderson in 1977 for characterizing the electronic structure of glasses and magnetic materials; Arno Penzias and Robert Wilson in 1978 for discovering cosmic background radiation; Steven Chu in 1997 for new methods to study atoms with laser light; Horst Störmer and Daniel Tsui in 1998 for the discov-

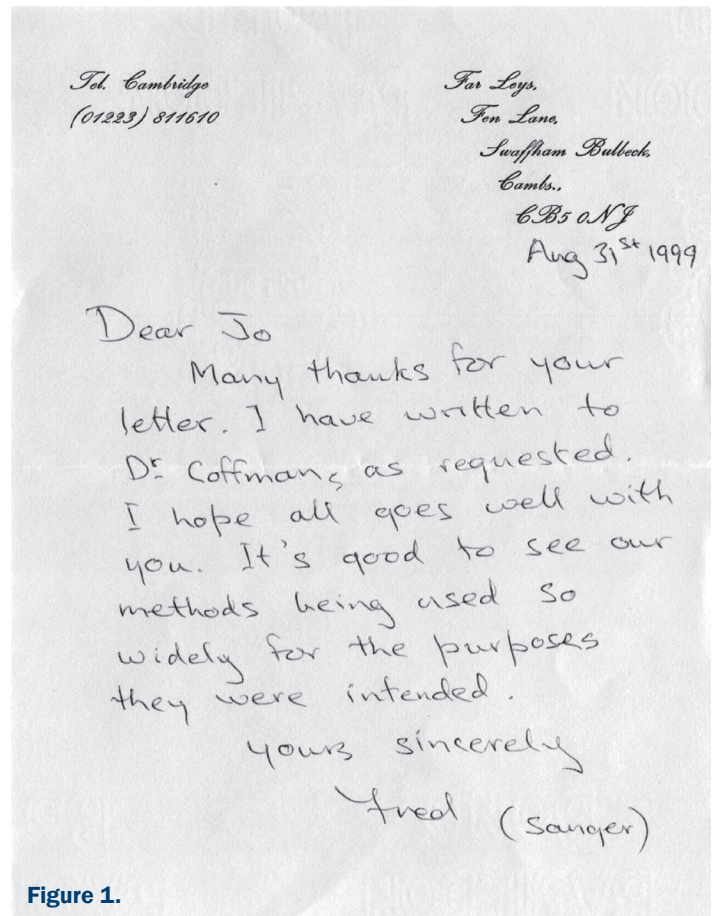


Figure 1.

ery of the fractional quantum Hall effect; and William Boyle and George Smith in 2009 for inventing CCD sensors. Eric Betzig broke the stream of physics prizes with his 2014 Nobel Prize in Chemistry for near-field optical microscopy. In addition, scientists and engineers at Bell Labs have had a major impact on the development of communications technology, including the development of the ion laser by Eugene Gordon and others; and on computation, including the seminal contribution to information theory by Claude Shannon, the creation of new programming languages like C by Dennis Ritchie and Brian Kernighan and C++ by Bjarne Stroustrup, and the introduction of the revolutionary UNIX operating system by Ken Thompson and Dennis Ritchie. These largely individual endeavors have enabled the development of new technologies and the creation of entire new industries that have transformed society.

The Carnegie Institution for Science supported Barbara McClintock, who never applied for federal funds, did not have many assistants over the course of her career, and did not like to publish

peer-reviewed articles. Yet she won the Nobel Prize in Physiology and Medicine in 1983 for her discovery of transposable elements. She told me that once when a manuscript she had submitted for publication was rejected, she decided not to bother with publications in the future. Instead she published her results in the Carnegie Institution's Yearbook, a decision that may have saved her much time and aggravation. She was not the only Nobel Laureate affiliated with the Carnegie Institution: others laureates include Alfred Hershey, who won the 1969 prize in Physiology and Medicine for discovering DNA as the basis for genetics, and Andrew Fire, who won the 2006 prize in Physiology and Medicine for RNA interference.

These examples, covering many fields of science and engineering over a period of a hundred years or more, illustrate the following key point: discoveries leading to true innovation, often serendipitous, reflect the vision of individuals. Neither government nor philanthropic organizations will be able to consistently make the right prediction as to where to direct research support for maximum impact. Instead, a hybrid system, encouraging and enabling both directed and free research, may offer a reasonable solution, which may well be more economical than today's preference for funding large programs, consortia, and institutions. Thus, public universities in the United States have recognized that establishing endowed chairs, while not covering the holder's salary, does provide a base-level of independent funding to pursue risky ideas, as in today's Max Planck Institutes, and may offer an alternative to conventional research programs.

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A Renewal of Evangelical Scholarship

George M. Marsden

One of the most notable developments in American academic life of the past sixty years has been intellectual renewal where it might have been least expected: among evangelical Christians. Because public discussion in America is so dominated by politics, where “evangelical” has been reduced to mean white Republicans who say they are “born again,” this renewal is easily overlooked. Evangelical Christianity, which comes in many varieties in this country and around the world, features an emphasis on personal conversion to Christ and loyalty to the Bible as the Word of God. In American history, evangelicals have often been criticized, including from within their own numbers, for anti-intellectualism. As late as the 1950s, there was hardly an evangelical intellectual community outside of a few theological seminaries, a number of smaller undistinguished colleges, and some Bible institutes – and these were dedicated largely to the defense of the faith and to winning converts.

Viewed from that perspective, recent changes have been remarkable. Today the Council for Christian Colleges and Universities (CCCCU) numbers well over one hundred member schools. Many of these schools have strong liberal arts curricula and well-credentialed faculties, with quite a few of their professors trained at some of the nation’s best graduate programs. It has been a buyer’s market for these schools, especially over the past quarter century. Because young evangelical scholars have been flooding into graduate programs, colleges and universities often have scores of qualified applicants for any single opening. Beyond the CCCCU, the numbers of scholars of broadly evangelical convictions have also increased at non-religious colleges and universities.

Two factors have been primarily responsible for this resurgence of evangelical intellectual life. The first is sociological. A wide range of evangelical churches and movements has prospered in recent generations, often in suburban and high-tech regions. Large percentages of the young people in these areas have been going to colleges or universities, both to religious and non-religious institutions. Along with that demographic development a substantial sub-movement within evangelicalism itself now perceives intellectual life as a worthy calling. A few older leaders and many of the rising generation have been urging churches with anti-intellectual tendencies to recover historical traditions of sophisticated Christian thought. Inspired in college or perhaps by a university campus ministry, an increasing number of evangelicals has not only gone on to graduate school, but has done so from distinctly religious motives. Their hope is to serve humanity through engaging significant dimensions of the liberal arts, the sciences, technology, and the professions.

Although the self-consciously “Christian” scholars of the CCCCU and their many fellow travelers in non-religious colleges and universities by no means constitute a large proportion of the American professoriate, they now make up a significant minority whose very presence marks a major change for their own religious communities. Although strong anti-intellectual tendencies can still be found in these communities, active nurturing of intellectual life has also become more common. As that encouragement grows, it connects readily with theologically conservative Christian traditions where intellectual life has always enjoyed support. Leadership in America for developing evangelical life has come especially from Reformed communities, which trace their roots to the formidable intellectual heritage generated by the Calvinist Reformation. As intellectual life in evangelical circles continues to develop, other influences have also expanded, including guidance on some questions from Catholic scholars and others from those in mainline Protestant churches who would not be comfortable with the “evangelical” designation.

For most major liberal arts disciplines today, a “Christian” sub-organization arranges conferences for its members and publishes a peer-reviewed academic journal. For instance, in my field of history, the Conference on Faith and History, founded in 1968, publishes *Fides et Historia*. Similarly, the Conference on Christianity and Literature, founded in 1956, has *Christianity and Literature* as its journal. The Society of Christian Philosophers, founded in 1978, is probably the most notable of such organizations. Its membership includes Catholics and mainline Protestants as well as evangelicals, and it cooperates closely with the older American Catholic Philosophical Association. At least a half dozen of these self-identified Christian philosophers have served as the presidents of the American Philosophical Association and a similar number have been elected as Fellows of the American Academy of Arts and Sciences. One of the major motifs in the work of such Christian philosophers has been to show that, considered with strict philosophical criteria, traditional Christian belief is as rational as any other belief system and (con-

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trary to what was commonly held in the early twentieth century) does not inherently conflict with modern scientific outlooks.

Although the emergence of such societies as well as the intellectual maturation of CCCU schools represent a significant intellectual development, evangelical intellectual life continues to encounter real challenges. CCCU institutions face the difficulties confronted by almost all smaller private colleges. Particularly in the liberal arts, where distinctly Christian efforts have been most evident, the schools must deal with the same pressures that others face as higher education turns increasingly to technical training. Evangelical colleges also must keep the trust of their constituencies, which tend to be more politically conservative than their faculty members. The challenge also remains of assuring evangelical constituencies that participation in higher learning does not mean compromising Christian faith.

Despite these challenges, evangelical intellectual renewal is making a difference. Evangelicals from the CCCU colleges or who were nurtured by religious groups at secular universities are now active in many professions, even as they contribute as thoughtful laypeople to their local churches. Scholars from such church communities, alongside a good many British counterparts, annually publish hundreds of books and articles on theological topics and on all aspects of modern life, including the sciences and the creative arts. Publishers like Baylor University Press, Eerdmans, Baker Academic, Brazos, InterVarsity Press, and Zondervan offer lengthy lists of academic works, and increasing numbers of evangelical scholars are publishing with mainstream university presses. Moreover, as the center of worldwide Christianity continues to shift away from the former centers of Christendom toward Africa, South America, and Asia, Christian intellectual life and self-consciously evangelical universities have spread into those regions. In this country, evangelical colleges and especially theological seminaries have become strikingly diverse internationally. Despite racial, ethnic, and national differences, common beliefs and concerns foster a sense of cross-cultural unity. Similarly, because evangelical and other sorts of Christian scholars share common concerns with those not in their own fields, they have larger interdisciplinary interests and communication than in much of academia today, plagued as it is by the isolation of narrow specialization.

Thus, despite the widespread public image, a surprisingly vital intellectual sub-community flourishes within the American and worldwide “evangelical” movements. As an identifiably “evangelical” phenomenon, most of this intellectual vitality is relatively new. At the same time, this recent development draws on the rich resources of older traditions of Christian thought, including Catholic and Orthodox, that stretch back over two millennia. In the con-

temporary setting, such thoughtful modes of religious expression will continue to be challenged both by the populist elements in their evangelical constituencies and by some in the larger academy who question the compatibility of traditional religious belief with mainstream academic standards. ■

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In Memoriam: Mary Maples Dunn

Elected to the Academy in 1994



When Mary Maples Dunn in 2011 began her final administrative position, as co-director of the Visiting Scholars Program at the American Academy, she announced that she would act as “mother hen” to the Scholars. Her definition of that role, it turned out, included much more than her warm supportive interest in each of her charges. She brought to her work with the Visiting Scholars Program high intelligence, a broad range of knowledge, and an unflinching enthusiasm for intellectual exploration. At least equally important were her rigorous intellectual standards, her willingness to articulate them, and her ability to criticize a Scholar’s work even harshly without making its author feel personally attacked. The Scholars loved her, appreciating her commitment to their enterprise, enjoying her zest for life, and responding to her “wicked humor” (as one of them called it) as well as to her energy, her wisdom, and her warmth.

She brought these same qualities to a series of important and previous posts, serving as Dean of Bryn Mawr College, where she had obtained her Ph.D.; President of Smith College; Director of the Schlesinger Library; first Dean of the Radcliffe Institute; and co-Executive Officer of the American Philosophical Society. Earlier, she pursued a scholarly career as an early-American historian, pioneering in interdisciplinary work. In all these roles, she demonstrated her gift for enabling others to manifest their best selves. Both forthright in articulating her own views and generously open to opposed possibilities, she leaves a record of progress achieved in several institutions, from Bryn Mawr College, Smith, and Harvard to, toward the very end of her life, the Bryn Mawr Bookshop in Cambridge, on which she bestowed, to good effect, her organizational skill and her extraordinary energy.

The qualities that made Mary Dunn a great administrator also made her a marvelous friend and companion. The frequent dinners she gave (and cooked) for the Visiting Scholars became occasions for relaxation and merriment, never stiff and formal. As the Scholars arrived, Mary would enlist them in the common enterprise: setting the table, answering the door, hanging up coats, carrying dishes from the kitchen. This unexpected manifestation of her administrative skill helped make social life seem easy and natural. Being with her meant having fun.

Samuel Johnson, the eighteenth-century English moralist, notoriously preferred a woman who could make an apple pie to one who could write a scholarly book. Mary could do both, with equal enthusiasm and with striking success. The coherence and integrity of her life and work embodied a humanistic ideal that cheered and enlightened her associates.

Mary Maples Dunn died in Winston-Salem, NC, on March 19. She is survived by her husband, Richard Dunn, and two daughters.

Patricia Meyer Spacks
University of Virginia

Select Prizes and Awards to Members

Richard Alley (Pennsylvania State University) was awarded the 2017 Wollaston Medal by the Geological Society of London.

James P. Allison (University of Texas MD Anderson Cancer Center) was awarded the inaugural Sjöberg Prize for Cancer Research. He shares the award with **Tony Hunter** (Salk Institute for Biological Studies).

Margaret Atwood (Toronto, Canada) received the National Book Critics Circle Ivan Sandrof Lifetime Achievement Award.

Eric Becklin (University of California, Los Angeles) is the recipient of the 2017 Henry Norris Russell Lectureship Award, given by the American Astronomical Society.

Tim Berners-Lee (Massachusetts Institute of Technology) received the Association for Computing Machinery A.M. Turing Award.

Mark A. Cane (Columbia University) was awarded the 2017 Vetlesen Prize for achievement in earth sciences. He shares the award with **S. George Philander** (Princeton University).

Tobias Colding (Massachusetts Institute of Technology) was named a 2017 Simons Fellow in Mathematics.

Jennifer Doudna (University of California, Berkeley) was awarded the 2017 Japan Prize by the Japan Prize Foundation. She shares the award with Emmanuelle Charpentier (Max Planck Institute for Infection Biology, Berlin).

Catherine Dulac (Harvard University) is the recipient of the 2017 Edward M. Scolnick Prize in Neuroscience, awarded by the McGovern Institute for Brain Research at MIT.

Cynthia Dwork (Harvard University; Microsoft Research) was awarded the 2017 Gödel Prize. She shares the award with Frank McSherry (San Francisco, California), Kobbi Nissim (Ben-Gurion University), and Adam Smith (Pennsylvania State University).

Marian Wright Edelman (Children's Defense Fund) has been awarded the 2017 Inamori Ethics Prize.

Louise Erdrich (Minneapolis, Minnesota) is the recipient of a National Book Critics Circle Award for Fiction.

Charles Fefferman (Princeton University) has been awarded a 2017 Wolf Prize in Mathematics. He shares this prize with **Richard Schoen** (University of California, Irvine).

Nancy Foner (Hunter College, City University of New York) was awarded a 2017 Guggenheim Fellowship.

Joachim Frank (Columbia University) was awarded a 2017 Wiley Prize in Biomedical Sciences. He shares the award with Richard Henderson (MRC Laboratory of Molecular Biology) and Marin van Heel (Institute of Biology Leiden).

Elaine Fuchs (Rockefeller University) is the recipient of the 2017 McEwen Award for Innovation, given by the International Society for Stem Cell Research.

Temple Grandin (Colorado State University) has been named to the National Women's Hall of Fame.

Geoffrey Hinton (University of Toronto) received the BBVA Foundation Frontiers of Knowledge Award in Information and Communication Technologies.

Tony Hunter (Salk Institute for Biological Studies) was awarded the inaugural Sjöberg Prize for Cancer Research. He shares the award with **James P. Allison** (University of Texas MD Anderson Cancer Center).

Lily Jan (University of California, San Francisco) and **Yuh-Nung Jan** (University of California, San Francisco) have received the 2017 Vilcek Prize in Biomedical Science.

Jennifer A. Lewis (Harvard University) has been elected to the National Academy of Engineering.

John Lithgow (Los Angeles, California) was awarded a 2017 Harvard Arts Medal. He also received a Screen Actors Guild Award for "The Crown."

Jane Lubchenco (Oregon State University) was awarded the 2017 Public Welfare Medal by the National Academy of Sciences.

Ulrike Malmendier (University of California, Berkeley) was awarded a 2017 Guggenheim Fellowship.

Hazel Markus (Stanford University) was named a 2017 William James Fellow by the Association for Psychological Science.

Yves Meyer (L'École Normale Supérieure de Cachan) was awarded a 2017 Abel Prize.

Tomasz Mrowka (Massachusetts Institute of Technology) was named a 2017 Simons Fellow in Mathematics.

Indra Nooyi (PepsiCo) was awarded a 2017 Ellis Island Medal of Honor.

Lynn Nottage (Columbia University) was awarded the Pulitzer Prize for Drama.

S. George Philander (Princeton University) was awarded the 2017 Vetlesen Prize for achievement in earth sciences. He shares the award with **Mark A. Cane** (Columbia University).

E. Ward Plummer (Louisiana State University) received the Award for International Scientific Cooperation from the Chinese Academy of Sciences.

Barry Posen (Massachusetts Institute of Technology) is the recipient of the International Studies Association's International Security Studies Section 2017 Distinguished Scholar Award.

Lisa Randall (Harvard University) was named a 2017 Simons Fellow in Theoretical Physics.

Jeffrey V. Ravetch (Rockefeller University) is the recipient of the 2017 Ross Prize in Molecular Medicine, given by the Feinstein Institute for Medical Research.

Scott D. Sagan (Stanford University) received the Susan Strange Award from the International Studies Association.

Richard Schoen (University of California, Irvine) has been awarded a 2017 Wolf Prize in Mathematics. He shares this prize with **Charles Fefferman** (Princeton University).

Stephen Sondheim (New York, New York) has been awarded the 2017 PEN/Allen Foundation Literary Service Award.

Gigliola Staffilani (Massachusetts Institute of Technology) was named a 2017 Simons Fellow in Mathematics and awarded a 2017 Guggenheim Fellowship.

Eva Tardos (Cornell University) is the 2017 recipient of the European Association for Theoretical Computer Science Award.

Alice Waters (Chez Panisse) was awarded a Thomas Jefferson Foundation Medal in Citizen Leadership.

William Julius Wilson (Harvard University) is the 2017 recipient of the SAGE-CASBS Award.

Maciej Zworski (University of California, Berkeley) was named a 2017 Simons Fellow in Mathematics.

New Appointments

Pedro Almodóvar (El Deseo Production Company) has been named president of the Cannes Film Festival Jury.

Mary Beckerle (University of Utah) has been appointed to the Board of Directors of Johnson & Johnson.

Carolyn Bertozzi (Stanford University) has been elected to the Board of Directors of Eli Lilly and Company.

Herbert Boyer (University of California, San Francisco) has been appointed to the Board of the Scripps Research Institute.

Russel Cafilich (University of California, Los Angeles) has been named director of the Courant Institute of Mathematical Sciences at New York University.

Ashton Carter (Harvard Kennedy School) has been named director of the Belfer Center for Science and International Affairs at Harvard Kennedy School.

Gerald Chan (The Morningside Group) has been appointed to the Board of the Scripps Research Institute.

Chi Van Dang (University of Pennsylvania) was appointed scientific director of the Ludwig Institute for Cancer Research.

Ernest J. Moniz (Massachusetts Institute of Technology) has been named chief executive officer and co-chairman of the Board of Directors of the Nuclear Threat Initiative.

Penny Pritzker (PSP Capital Partners) has been named to the Board of Trustees of the Carnegie Endowment for International Peace.

Stanley B. Prusiner (University of California, San Francisco) has been appointed Chair of the Scientific Advisory Board of Alzheimer, Inc.

Anjana Rao (La Jolla Institute for Allergy and Immunology) has been named to the Scientific Advisory Board of Cambridge Epigenetix.

David St. John (University of Southern California) has been named a Chancellor of the Academy of American Poets.

Christopher T. Walsh (Harvard Medical School) has been appointed to the Board of the Scripps Research Institute.

Kevin Young (Schomburg Center for Research in Black Culture) has been named poetry editor of *The New Yorker*.

Select Publications

Poetry

Jorie Graham (Harvard University). *Fast: Poems*. Ecco, May 2017

Susan Stewart (Princeton University). *Cinder: New and Selected Poems*. Graywolf Press, February 2017

Fiction

Margaret Atwood (Toronto, Canada). *A Trio of Tolerable Tales*. Groundwood Books, March 2017

Paul Theroux (East Sandwich, Massachusetts). *Mother Land*. Houghton Mifflin Harcourt, May 2017

Colm Tóibín (Columbia University). *House of Names*. Scribner, May 2017

Nonfiction

Alan Alda (New York, New York). *If I Understood You, Would I Have This Look on My Face? My Adventures in the Art and Science of Relating and Communicating*. Random House, June 2017

Peter Brooks (Princeton University). *Flaubert in the Ruins of Paris: The Story of a Friendship, a Novel, and a Terrible Year*. Basic Books, April 2017

Joan Didion (New York, New York). *South and West: From a Notebook*. Knopf, March 2017

Jennifer A. Doudna (University of California, Berkeley) and Samuel H. Sternberg (Caribou Biosciences). *A Crack in Creation: Gene Editing and the Unthinkable Power to Control Evolution*. Houghton Mifflin Harcourt, June 2017

Eric Foner (Columbia University). *Battles for Freedom: The Use and Abuse of American History*. I.B. Tauris, April 2017

William V. Harris (Columbia University). *Roman Power: A Thousand Years of Empire*. Cambridge University Press, August 2016

Gish Jen (Cambridge, Massachusetts). *The Girl at the Baggage Claim: Explaining the East-West Culture Gap*. Knopf, March 2017

Charles Larmore (Brown University). *Das Selbst in seinem Verhältnis zu sich und zu anderen*. Klostermann Verlag, March 2017

Ira M. Millstein (Weil, Gotshal & Manges LLP). *The Activist Director: Lessons from the Boardroom and the Future of the Corporation*. Columbia University Press, January 2017

Condoleezza Rice (Stanford University). *Democracy: Stories from the Long Road to Freedom*. Twelve, May 2017

James Stavridis (Tufts University). *Sea Power: The History and Geopolitics of the World's Oceans*. Penguin Press, June 2017

Geoffrey R. Stone (University of Chicago). *Sex and the Constitution: Sex, Religion, and Law from America's Origins to the Twenty-First Century*. Liveright, March 2017

Calvin Trillin (*The New Yorker*). *Killings*. Random House, April 2017

James Wright (Dartmouth College). *Enduring Vietnam: An American Generation and Its War*. Thomas Dunne Books, April 2017

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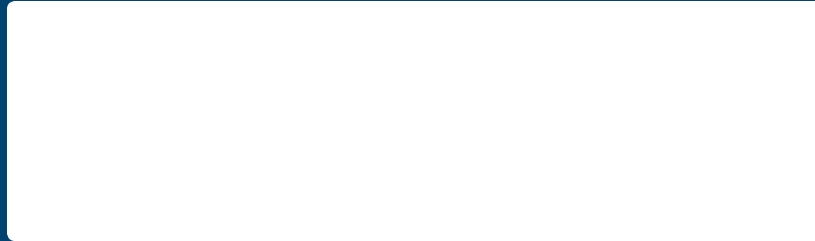
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