

— is to use a paper ballot marked by the voter or by a machine in view of the voter. Yet, today we still do not have a national standard for voter-verified, auditable ballots.

Scientific thinkers are also more alert to the cognitive biases that can lead to irrational decisions. For example, politicians (like everyone else) are often guilty of 'short-term-ism': the desire to enjoy rewards now rather than invest them for later. Yet government actions — infrastructure projects, say, or education programmes — play out over decades, long past the careers of individual lawmakers. Scientists are generally comfortable thinking about processes on different timescales — of millions or even billions of years. Scientific thinking can thus build strong arguments for investment in roads, bridges, trains and laboratories that will not produce profits tomorrow but will pay off powerfully in the decades to come.

NUMBERS GAME

Many lawmakers are uncomfortable with statistical reasoning. Take surveillance, for example: the New York City Police Department, as part of its counterterrorism programme, has conducted surveillance of suspected Muslims at restaurants and stores and monitored student groups and mosques around the United States. When I spoke in opposition to these surveillance programmes and called them 'profiling', some of my non-scientist colleagues said that such profiling is keeping the United States safe, even if it is ethnically discriminatory.

But my colleagues were disregarding the fact that terrorists are exceedingly rare. Since

2001, Muslims have boarded planes in the United States perhaps 50 million times. If officials had screened each of these travellers using a protocol that could detect terrorists with, say, 99.9% accuracy, about 50,000 people would have been wrongly accused of terrorism. Billions of dollars would have been wasted in profiling and detaining innocent people, creating profound distrust among targeted communities.

“Scientific thinking builds arguments for investments that will pay off powerfully in the decades to come.”

Scientists are just more comfortable with uncertainty than non-scientists. This trait would come in handy for lawmakers, who often must take action despite conflicting evidence. For example, a failure to understand ordinary fluctuations in noisy climate data allows some members of Congress to believe that claims of human-induced climate change are a hoax, or that the data are so chaotic that no policy action can be devised.

A similar discomfort with uncertainty is evident on the first Friday of each month, when politicians react to the labour department's monthly jobs report. Earlier this month, legislators (egged on, it should be said, by the news media) spent countless hours debating the implications of a report that businesses created 29,000 fewer jobs in August than economists expected. Yet few

Statistical reasoning would lead one to recognize that this money would be far better devoted to on-the-ground intelligence gathering.

grasped that the survey's margin of error was 100,000 jobs at the 90% confidence level. Those 29,000 jobs could very well have been a statistical blip rather than a real trend.

How can we increase scientific thinking in Congress? One way, of course, is to elect more scientists — and I strongly encourage scientists to consider seeking political office. But that is an unlikely solution. More non-scientists need to feel comfortable thinking like scientists. This is not without precedent — not all legislators hold law degrees, but all must be comfortable thinking like lawyers when drafting a bill or reading a statute. When I need to think like a lawyer, I turn to legal professionals for help. Congress has a staff of lawyers at the Office of Legislative Counsel, which helps members to turn their ideas into legislative language. Shouldn't legislators who have scientific questions be able to seek similar guidance from scientists and, over time, pick up more scientific ways of thinking?

Until 1995, Congress had a dedicated staff of professional scientists in the Office of Technology Assessment. This office was eliminated in a round of foolish budget cuts. It should be re-established, and in the interim, we scientists should seek to make our voices heard in other ways: through meetings with members of Congress, letters to editors, town halls and other public forums. ■

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Know your representatives

Lawrence Goldstein urges researchers to talk to lawmakers about science.

Twenty years ago, after moving to San Diego, California, I went to visit the US congressman for my new district. I was responding to the American Society for Cell Biology, which had encouraged its members to visit their congressional representatives and tell them why federal funding for the US National Institutes of Health (NIH) was important to the welfare of the United States. I had heard that this congressman was a former fighter pilot and very conservative, but nothing could have prepared me for our first meeting.

As soon as we sat down, he told me that he thought that the NIH should be privatized. I was surprised, but being stubborn, I continued to visit him once or twice a year for the next few years. Each time, I would explain

how biomedical research leads to a better understanding of basic biology and disease, and how this translates to new and successful approaches to disease therapy. Over time, his meetings with me and with other scientists and patient advocates in our community led to a dramatic change in his view on public funding for biomedical research.

This conservative congressman became a member of a key appropriations subcommittee, on which he fought for substantial increases in NIH funding and even voted to loosen restrictions on funding for embryonic

stem-cell research. Personal interactions between scientists and legislators are crucial in today's increasingly technological world, in which science policy and funding become more important with each passing year.

GOOD INFLUENCE

Some of my colleagues prefer not to interact with members of Congress — they think that one scientist's voice doesn't carry much weight amid the cacophony that assails most officials. Yes, the executive branch of the US government receives considerable formal advice on science policy¹. But the president can get very little done without the support of Congress.

Members of Congress determine the amount of money available for science,



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and they often pass major laws affecting science policy. Many of them have never met a working scientist. It is here that individual scientists can have great personal and scientific impact.

This is true at the state level as well. In California, individual scientists have influenced lawmakers in positive and important ways². For example, following the moratorium on the use of human materials in nuclear-transfer experiments after Dolly the sheep was cloned in 1997, California senators requested advice from me and other biomedical scientists about how to proceed with the technology. We travelled to the state capitol several times to speak to policy-makers and give briefings to members of the legislature. We helped them to understand the research issues and ramifications of various legislative approaches to the issue.

Ultimately, the legislators crafted laws that have served as a good model for how to approach stem-cell science in a thoughtful way. The laws created a regulatory system that restricts the few practices that all would agree are inappropriate, namely the implantation of any product of nuclear transfer using human materials. They also established a group to develop additional regulations in California.

In 2003–04, another group of scientists (myself included) and patient advocates worked together to develop and secure voter approval for California's landmark Proposition 71, which provides US\$3 billion for stem-cell research over ten years in a competitive, peer-reviewed funding system. The initiative included requirements for ethics regulations and rigorous review of funding proposals, partly because of the advice my colleagues and I provided during drafting.

BUILD BRIDGES

Developing relationships with potential allies takes surprisingly little time and effort. A couple of visits a year to the capitol or a legislator's local offices, reinforced by the occasional letter, can go a long way towards building a long-lasting rapport. Scientists will not always make an impact on the first try; they must maintain contact and a consistent message over time.

“Providing accurate information can have a large influence on legislation.”

Some non-scientists have frustrating initial opinions based on incomplete data. My colleagues and I often encountered the mistaken belief that embryonic stem cells come from aborted fetuses. But providing accurate information while being respectful of people's values and beliefs can have a large



California's Proposition 71, passed with scientists' help, provides US\$3 billion for stem-cell research.

influence on legislation. Patient advocates, in particular, bring a human touch that reminds legislators (and scientists) of the important consequences of their work.

Scientists should follow a few simple principles when meeting with lawmakers. It is important to be friendly and informative, and to avoid jargon. People will not care about your message if they cannot understand it: for example, say 'blood-forming' instead of 'haematopoietic'. Also, focus on science during meetings; do not stray to other issues. To avoid seeming parochial, keep conversations in the context of what is good for the nation and society at large; do not talk only about what is good for science and scientists. Bring promising statistics — such as estimates that every dollar the NIH spends on research creates \$2.20 in local economic growth, or that gains in average lifespan due to scientific research have added \$3.2 trillion a year to the US economy since 1970 (ref. 3).

Do not focus solely on lawmakers. Interact also with their staff members, who are usually bright and motivated and can be relied on for information and informal communication throughout the year. Finally, remember that you do not have to be a well-known senior scientist to make an impact. An educated and concerned approach to scientific issues is the most important credential you can bring to a meeting⁴.

Lawmakers need to hear about why

research matters. For example, the United States spends more than \$200 billion a year caring for people with Alzheimer's disease, yet the NIH and private foundations spent less than \$500 million during the 2011 fiscal year to fight the disease. This 400:1 ratio is inadequate, even in a time of fiscal crisis. It is comparable to a family spending \$10,000 a year on a problem but only \$25 a year on finding a solution.

As scientists, it is a mistake for us to say we are too busy to reach out to lawmakers. If we do not try, science funding will continue to decrease in the coming years; lawmakers will enact restrictive policies that are not informed by the best scientific information available; and society will be poorer for our absence. ■

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