Chapter 7
Science and Technology: Public Attitudes and Understanding

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Highlights

Information Sources, Interest, and Involvement

The Internet is the main source of information for learning about specific scientific issues such as global climate change and biotechnology.

- Americans are now about equally likely to rely on the Internet as on television as their primary source of general science and technology (S&T) information.

Americans have consistently expressed interest in S&T, with 41% reporting they were "very interested" and 50% reporting they were "moderately interested" in new scientific discoveries.

- However, Americans also express similar or higher levels of interest in a range of other news topics.
- On average, Europeans appear to express lower levels of public interest in "new scientific discoveries and technological developments" relative to Americans, although there is considerable variation among different European countries.

In 2008, a majority of Americans said they had visited an informal science institution such as a zoo or natural history museum within the past year. This proportion is generally consistent with results from surveys conducted since the 1980s.

- Americans with more formal education are more likely to visit informal science institutions.
- Visits to informal science institutions tend to be less common in Europe, Japan, and Brazil. Visits to a zoo are about equally common in China and the United States.

Public Knowledge About S&T

Many Americans continue to give multiple incorrect answers to questions about basic factual knowledge of science or the scientific inquiry process. In the United States, levels of factual knowledge of science have been stable for more than a decade.

- Americans' factual knowledge of science is positively related to their formal education level and the number of science and math courses they have taken. Younger generations also exhibit higher levels of factual knowledge about science than older generations.
- Men tend to score higher than women on factual knowledge questions in the physical sciences; women score equally well as men on questions in the biological sciences.
- People who score well on factual knowledge measures also tend to know more about emerging science topics such as nanotechnology.

Levels of factual knowledge of science in the United States are comparable to those in Europe and appear to be higher than those in Japan, China, or Russia.

- In Europe, China, and South Korea, demographic variations in factual knowledge are similar to those in the United States.

Americans' understanding of the process of scientific inquiry is stable, after modest improvements since the mid-1990s. Understanding of what constitutes an experiment is greater in 2010 than in previous years.

- Americans' understanding of scientific inquiry is strongly associated with their factual knowledge of science, their level of formal education, and the number of science and mathematics courses they have completed.
- Men and women obtain similar scores on understanding of scientific inquiry.

Public Attitudes About S&T in General

Americans in all demographic groups consistently endorse the past achievements and future promise of S&T.

- In 2010, 69% of Americans said that the benefits of scientific research have strongly or slightly outweighed the harmful results; 9% said the harmful results outweighed the benefits.
- Americans tend to have more favorable attitudes about the promise of S&T than Europeans, the Japanese, Malaysians, Indians, and the Chinese. Attitudes in South Korea tend to be more favorable than those in the United States.
- Reservations about science accompany these favorable attitudes. Nearly half of Americans agree that "science makes our way of life change too fast," and large proportions of Chinese and South Korean residents voice the same sentiment.

Support for government funding of scientific research remains strong.

- In 2010, 82% of Americans expressed support for government funding of basic research.
- In 2009, 73% of Americans said spending on basic scientific research "usually pays off in the long run"; fewer than two in ten said such spending was "not worth it." About the same percentage (74%) said spending on engineering and technology "usually pays off in the long run."

The public continues to expresses confidence in science leaders.

- In 2010, roughly equal percentages of Americans expressed "a great deal" of confidence in medical leaders and scientific leaders; military leaders were the only group in whom more Americans expressed a great deal of confidence.

- On science-related public policy issues (global climate change, stem cell research, nuclear power, and genetically modified foods), Americans regard science and engineering leaders as both knowledgeable and impartial—relative to other leaders—and believe they should be influential in decisions about these topics.
- However, Americans also perceive a considerable lack of consensus among scientists on these issues.

A majority of Americans accord scientists "very great prestige." Ratings for engineers are lower but nonetheless better than those of most other occupations.

- In 2009, more Americans rated scientists as having "very great prestige" than did so for almost any other occupation surveyed, second only to firefighters.
- Nearly four in ten (39%) Americans rated engineers as having "very high prestige"—well above most other occupations considered on the survey.

Public Attitudes About Specific S&T Issues

Americans' support for the development of alternative sources of energy increased in the 2000s. Assessments of environmental hazards from pollution, nuclear power, and climate change were largely stable between 1993 and 2010.

- A majority of Americans said the government spends too little on developing alternative energy sources, and most favor providing incentives for using solar and other alternative energy sources.
- In 2010 and 2011, about one-third of Americans (34%) said they worry about environmental quality "a great deal," following an increase from 2006 to 2008. More Americans considered water pollution as "very" or "extremely dangerous" to the environment than they did several other potential problems.
- Climate change continues to divide opinion. In a 22-nation survey, respondents from the United States, China, and the UK were less likely to consider climate change a "very serious problem" than those in a number of other countries. Respondents from only two nations (Poland and Pakistan) were less likely than Americans to consider climate change a "very serious problem."
- Support for the use of nuclear power to generate electricity increased from 53% in 2007 to 62% in 2010. However, a substantial minority says that nuclear power plants are not safe—a proportion that may increase after the 2011 earthquake and tsunami in Japan.

A majority of Americans favor medical research that uses human embryonic stem cells. However, Americans are overwhelmingly opposed to reproductive cloning and wary of innovations using "cloning technology."

- Support for embryonic stem cell research has increased since 2004, with 62% in favor of embryonic stem cell research in 2010. A higher proportion (71%) favors stem cell research when it does not involve human embryos.
- More than three-quarters of Americans oppose human cloning.

Americans remain largely unfamiliar with nanotechnology, despite increased funding and a growing numbers of products on the market that use nanotechnology.

- Public awareness of nanotechnology remains limited. Even among respondents who had heard of nanotechnology, knowledge levels are not high.
- Those who have heard "a lot" or "some" about nanotechnology are more likely to say the benefits of such technology will outweigh any harms than to say the harmful results will outweigh the benefits.
- Europeans are split, on average, over whether nanotechnology use in consumer products should be encouraged or not (44% to 35%, respectively, with 22% holding no opinion).

Introduction

Chapter Overview

Science and technology (S&T) affect all aspects of American life, including work, leisure, family, and civic activities. In the workforce, Americans use technology to improve productivity in ways that could not have been imagined a generation ago, applying recently invented tools and applications. In their leisure time, they entertain themselves with high technology electronic products and make friends, communicate, and stay informed about the world through the Internet and social media. As citizens, they may engage in discussions on climate change, stem cell research, and nuclear power—issues about which atmospheric scientists, microbiologists, and nuclear engineers have formal training and expertise—or benefit from advances in new technologies.

It is increasingly difficult for Americans to be competent workers, consumers, and citizens without some degree of competency in S&T. How the American public collectively deal with S&T-related issues may, in turn, affect what kinds of S&T development the United States will support. Therefore, this chapter presents not only indicators about media sources, information, and knowledge of S&T, but indicators of people's attitudes about S&T-related issues as well. To put U.S. data in context, this chapter examines trend indicators for past years and comparative indicators for other countries.

Chapter Organization

This chapter is divided into four main sections. The first section includes indicators of the public's sources of information about, level of interest in, and active involvement with S&T. The second section reports indicators of public knowledge, including measures of factual knowledge of science and engineering and people's understanding of the scientific process. When possible, American adults' understanding of science is compared to that of American students. The third and fourth sections of the chapter describe public attitudes toward S&T. The third section presents data on attitudes about S&T in general, including support for government funding of basic research, confidence in the leadership of the scientific community, perceptions of the prestige of S&E occupations, and opinions about how much influence science and scientists should have on public affairs. The fourth section addresses public attitudes on issues in which S&T plays an important role, such as the environment, climate change, nuclear power, the quality of science and math education, and the use of animals in scientific research. It also includes indicators of public opinion about several emerging lines of research and new technologies, including stem cell research, cloning, genetically modified (GM) food, nanotechnology, and synthetic biology.

A Note About Data and Terminology

This chapter emphasizes trends over time, patterns of variation within the U.S. population, and international patterns. It reviews survey data from national samples with sound representative sampling designs. The emphasis in the text is on the trends and patterns presented in the data. All survey data are subject to numerous sources of error; interpretation of the data should be mindful of the limits of survey data. Caution is especially warranted for data from surveys that omit significant portions of the target population, have low response rates, or have topics that are particularly sensitive to subtle differences in question wording. (See sidebars, "U.S. Survey Data Sources" and "International Survey Data Sources.") Most of the international comparisons involve identical questions asked in different countries. However, language and cultural differences can affect how respondents interpret questions and can introduce numerous complexities, so international comparisons require careful consideration.

Throughout this chapter, the terminology used in the text reflects the wording in the corresponding survey question. In general, survey questions asking respondents about their primary sources of information, interest in issues in the news, and general attitudes use the phrase "science and technology." Thus, "S&T" is used when discussing these data. Survey questions asking respondents about their confidence in institutional leaders, the prestige of occupations, and their views on different disciplines use terms such as "scientific community," "scientists," "researchers," and "engineers," so "S&E" is used when examining issues related to occupations, careers, and fields of research. Although science and engineering are distinct fields, national survey data that make this distinction are scarce.

Information Sources, Interest, and Involvement

Americans' awareness and understanding of S&T are dependent, in part, on how much they monitor new S&T developments throughout their adult life. Because S&T are relevant to so many aspects of daily life and are often changing and evolving, information about S&T can help Americans make informed decisions and more easily navigate the world around them. Interest in and involvement with S&T can lead Americans to acquire more information and achieve greater understanding.

This section reviews the sources of information about S&T that are available to and used by the public, interest in and attention to media reports about S&T, and the amount of S&T news available from traditional and new media sources. It concludes with indicators of behavioral involvement in S&T through visits to museums and other cultural institutions.

U.S. Survey Data Sources

Sponsoring Organization	Title	Years Used	Information Used	Data Collection Method	Respondents *(n)*; Margin of Error of General Population Estimates
National Science Foundation (NSF)	Public Attitudes Toward and Understanding of Science and Technology (1979–2001); University of Michigan Survey of Consumer Attitudes 2004	1979–2001, 2004	Information sources, interest, informal science institution visits, general attitudes, government spending attitudes, science/math education attitudes, animal research attitudes	Telephone interviews	*n* = 1,574–2,041; ± 2.47%–3.03%
NORC at the University of Chicago	General Social Survey (GSS)	1973–2010	Government spending attitudes, confidence in institutional leaders	Face-to-face interviews	Government spending (2000–10): *n* = 1,358–4,901; ± 2.7%–3.9% Confidence in institutional leaders, (1973–2010): *n* = 876–3,278; ± 1.3%–3.3%
NORC at the University of Chicago	GSS environment module	1993–94, 2000, 2010	Environmental dangers attitudes	Face-to-face interviews	*n* = 1,276–1,557; ± 2.5%–3.3%
NORC at the University of Chicago	GSS S&T module	2006, 2008, 2010	Information sources, interest, informal science institution visits, general attitudes, government spending attitudes, science/math education attitudes, animal research attitudes, nanotechnology awareness and attitudes, science knowledge	Face-to-face interviews	*n* = 1,864–2,021; ± 2.5%–3.3%
ABC News/Planet Green/Stanford University	ABC News/Planet Green/ Stanford University Poll	2008	Environmental problem attitudes	Telephone interviews	*n* = 1,000; ± 3.0%
CBS News/*New York Times*	CBS News/*New York Times* Poll	2008	Genetically modified food awareness and attitudes	Telephone interviews	*n* = 1,065; ± 3.0%
American Association for the Advancement of Science (AAAS)	AAAS Project 2061 (unpublished results, 2008)	2007 (middle school students)	Science knowledge	Paper questionnaires	*n* = 2,047 middle school students; *n* = 1,597 (follow-up question)
Department of Education, National Center for Education Statistics (NCES)	National Assessment of Education Progress (NAEP)	2000 (grade 8), 2005 (grades 4 and 8)	Science knowledge	Paper questionnaires	2000 (independent national sample): *n* = 15,955 8th graders; ± 2.2% (one question used) 2005 (combined national/ state sample): *n* = 147,700 4th graders; ± 1.0% (one question used) *n* = 143,400 8th graders; ± 0.8%–1.2% (three questions used)
The Gallup Organization	Various ongoing surveys	2001–11	Federal priorities, environmental protection, climate change, global warming, nuclear power, alternative energy, animal research, stem cell research, quality of science/math education in U.S. public schools attitudes	Telephone interviews	*n* = ~1,000; ± 3.0–4.0%
Harris Interactive	The Harris Poll	1977–2009	Occupational prestige attitudes	Telephone interviews	*n* = ~1,000 (~500 asked about each occupation)
Pew Initiative on Food and Biotechnology, The Pew Charitable Trusts	Poll on consumer attitudes toward genetically modified foods and genetic engineering	2001–06	Genetically modified foods attitudes	Telephone interviews	*n* = 1,000; ± 3.1%
Pew Internet & American Life Project, Pew Research Center	Pew Internet & American Life Survey	2006, 2010	Information sources, interest, involvement, Internet use	Telephone interviews	2006: *n* = 2,000; ± 3.0% 2010: *n* = 2,252; ± 2.4%
Pew Research Center for the People and the Press	Biennial News Consumption Survey	2008, 2010	Information sources, interest, credibility of information sources, top stories, time spent following the news	Telephone interviews	2008: *n* = 3,615; ± 2.0% 2010: *n* = 3,006; ± 2.5%
Pew Research Center for the People and the Press	General Public Science Survey, separate survey of AAAS scientists	2009	Public's and scientists' beliefs about S&T-related issues, benefits of science to well-being of society, animal research attitudes	Telephone interviews (survey of general public) Internet (survey of scientists)	Public: *n* = 2,001; ± 2.5% Scientists: *n* = 2,533; ± 2.5%
Pew Research Center for the People and the Press	News Interest Index Survey	2010–11	Top stories, nuclear power and offshore oil drilling attitudes	Telephone interviews	*n* = ~1,000; ± 4.0%

U.S. Survey Data Sources—continued

Sponsoring Organization	Title	Years Used	Information Used	Data Collection Method	Respondents *(n);* Margin of Error of General Population Estimates
Pew Research Center for the People and the Press	Political Survey (various)	2008–11	Information sources, Internet use, national policy attitudes (environment, global warming, energy, stem cell research), government spending for scientific research attitudes	Telephone interviews	*n* = ~1,300–2,250; ± 2.5%–3.5%
Virginia Commonwealth University (VCU)	VCU Life Sciences Survey	2001–08, 2010	Interest, science and government spending for scientific research attitudes, energy sources, animal research, stem cell research, cloning technology attitudes	Telephone interviews	*n* = ~1,000; ± 3.0%–3.8%
The Woodrow Wilson International Center for Scholars, conducted by Peter D. Hart Research Associates	Synthetic Biology Project	2010	Synthetic biology awareness and attitudes	Telephone interviews	*n* = 1,000; ± 3.1%

International Survey Data Sources

Sponsoring Organization	Title	Years Used	Information Used	Data Collection Method	Respondents *(n);* Margin of Error of General Population Estimates
BBVA Foundation (Fundacion BBVA)	BBVA Foundation International Study on Attitudes To Stem Cell Research and Hybrid Embryos	2007/2008 combined	Stem cell research knowledge, awareness, and attitudes	Face-to-face interviews	*n* = 1,500 for each of 15 countries; ± 2.6%
British Council, Russia	Survey of Public Attitudes Toward Science and Technology in Russia	2003	Various knowledge and attitude items	Paper questionnaires	*n* = 2,107
Canadian Biotechnology Secretariat	Canada–U.S. Survey on Biotechnology	2005	Biotechnology, nanotechnology, genetically modified foods, and other technology attitudes (includes U.S. data on specific issues)	Telephone interviews	(Canada): *n* = 2,000; ± 2.19% (United States): *n* = 1,200; ± 2.81%
Chinese Association for Science and Technology (CAST), China Research Institute for Science Popularization (CRISP)	Chinese National Survey of Public Scientific Literacy	2001, 2007	Various knowledge and attitude items, interest, occupational prestige, informal science institution visits	Face-to-face interviews	2001: *n* = 8,350 2007: *n* = 10,059; ± 3.0%
European Commission	Special Eurobarometer 224/ Wave 63.1: *Europeans, Science and Technology* (2005)	2005	Knowledge, trust in scientists, public support for basic research, other attitudes, informal science institution visits	Face-to-face interviews	(EU total) *n* = 26,403; (Germany) 1,507; (UK) 1,307; (Slovakia) 1,241; (19 other countries) ~1,000; (3 other countries) ~500
	Special Eurobarometer 224/ Wave 64.3: *Europeans and Biotechnology in 2005: Patterns and Trends* (2006)	2005	Biotechnology attitudes		(EU total) *n* = ~25,000; (each member country/state) ~1,000
	Special Eurobarometer 300/ Wave 69.2: *Europeans' Attitudes Towards Climate Change* (2008)	2008	Climate change attitudes		(EU total) *n* = ~26,661; (Germany) 1,534; (UK) 1,306; (22 other countries) ~1,000; (3 other countries) ~500
	Special Eurobarometer 340/ Wave 73.1: *Science and Technology Report* (2010)	2010	S&T attitudes and interest, support for basic research, animal research attitudes		(EU total) *n* = ~26,671; (Germany) 1,531; (UK) 1,311; (22 other countries) ~1,000; (3 other countries) ~500
	Special Eurobarometer 341/ Wave 73.1: *Europeans and Biotechnology in 2010: Winds of change?* (2010)	2010	Nuclear energy, nanotechnology, emerging biotechnologies, synthetic biology, and genetically modified foods attitudes		(EU total) *n* = ~26,676; (Germany) 1,531; (UK) 1,316; (22 other countries) ~1,000; (3 other countries) ~500

International Survey Data Sources—continued

Sponsoring Organization	Title	Years Used	Information Used	Data Collection Method	Respondents *(n);* Margin of Error of General Population Estimates
India National Council of Applied Economic Research	National Science Survey	2004	Various knowledge and attitude items, informal science institution visits	Face-to-face interviews	*n* = 30,255
Japan National Institute of Science and Technology Policy, Ministry of Education, Culture, Sports, Science and Technology	Survey of Public Attitudes Toward and Understanding of Science & Technology in Japan	2001	Various knowledge and attitude items, informal science institution visits	Face-to-face interviews	*n* = 2,146
Korea Foundation for the Advancement of Science and Creativity (KOFAC, formerly Korea Science Foundation)	Survey of Public Attitudes Toward and Understanding of Science and Technology	2004, 2006, 2008	Interest, various knowledge and attitude items, informal science institution visits	Face-to-face interviews	*n* = 1,000; ± 3.1%
Malaysian Science and Technology Information Center (MASTIC), Ministry of Science, Technology and Innovation	Survey of the Public's Awareness of Science and Technology: Malaysia	2008	Interest, awareness, various knowledge and attitude items, informal science institution visits	Face-to-face interviews	*n* = 18,447; ± 1.0%
Ministry of Science and Technology (MCT) of Brazil	Public Perceptions of Science and Technology	2006, 2010	Interest, informal science institution visits	Face-to-face interviews	*n* = ~ 2,000; ± 2.2%
Pew Global Attitudes Project, Pew Research Center	Global Attitudes Survey	2010	Climate change concerns	(Varies by country) Face-to-face interviews Telephone interviews	(United States) *n* = 1,002; ± 4.0%; (21 other countries) *n* = 700–3,262; ± 2.5%–5.0%
Samuel Neaman Institute for Advanced Studies in Science and Technology (Israel)	Survey of attitudes of Israeli public toward science and technology	2006	Prestige of science careers	Telephone interviews	*n* = 490
U.S. Department of Education, NCES	Trends in International Mathematics and Science Study (TIMSS)	2003 (grade 8)	Science knowledge	Paper questionnaires	(United States) *n* = 8,912; ± 1.4% (for all TIMSS questions); (44 other countries) *n* = 2,943–8,952; ± 1.0%–2.4% (for all TIMSS questions)
WorldPublicOpinion.org/ The World Bank, managed by Program on International Policy Attitudes at University of Maryland	WorldPublicOpinion.org Poll	2009	Attitudes toward climate change as government priority	(Varies by country) Face-to-face interviews Telephone interviews	*n* = 18,578 in 19 nations comprising 60% of world's population; ± 3.0%–4.0%

EU = European Union; UK = United Kingdom

NOTES: All surveys are national in scope and based on probability sampling methods. Statistics on number of respondents and margin of error are as reported by the sponsoring organization. When a margin of error was not cited, none was given by the sponsor.

S&T Information Sources

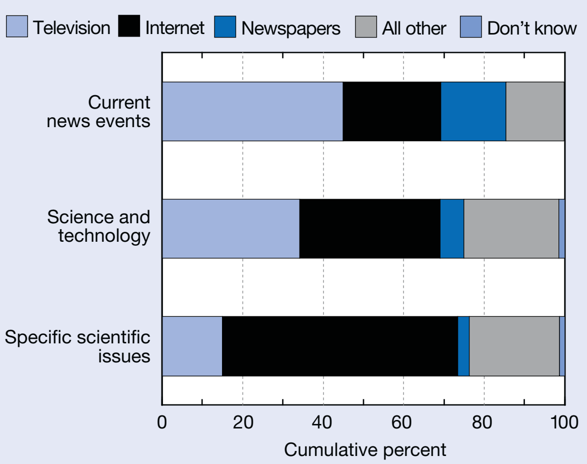
U.S. Patterns and Trends

The media environment has been changing over the past decade. Although a plurality of Americans say that television is their primary source of news about current events, fewer said that they relied on television news for S&T information in 2010 than in previous years. Also, a majority turn to the Internet as their primary source of information on specific scientific issues such as global climate change, stem cell research, GM foods, and nuclear power.

For news about current events, television is the primary source of information for 45% of Americans. Substantial percentages report that most of their current event news comes from the Internet (24%) or newspapers (16%) (figure 7-1; appendix table 7-1). The proportion of Americans getting information about current events from the Internet has increased considerably since the 1990s, and the proportion using newspapers for current events has declined (figure 7-2). Newspaper readership has strongly declined over the past decade (Project for Excellence in Journalism, PEJ 2010e). Patterns of reported media use over time are complicated by the fact that some of the readership for newspapers has shifted to online news sources by the same organizations that produce print newspapers.[1] Thus, the separation between print and online news sources is often blurred. (Also see sidebar, "The Blending of Print and Online Sources of Science News.")

For news about S&T, Americans are about equally likely to rely on the Internet as on television. According to the 2010 General Social Survey (GSS), 35% of Americans cite the Internet as their primary source of S&T information, up from 29% in 2008. The proportion citing the Internet as their primary source of S&T information has grown steadily since

Figure 7-1
Primary source of information about current news events, science and technology, and specific scientific issues: 2010

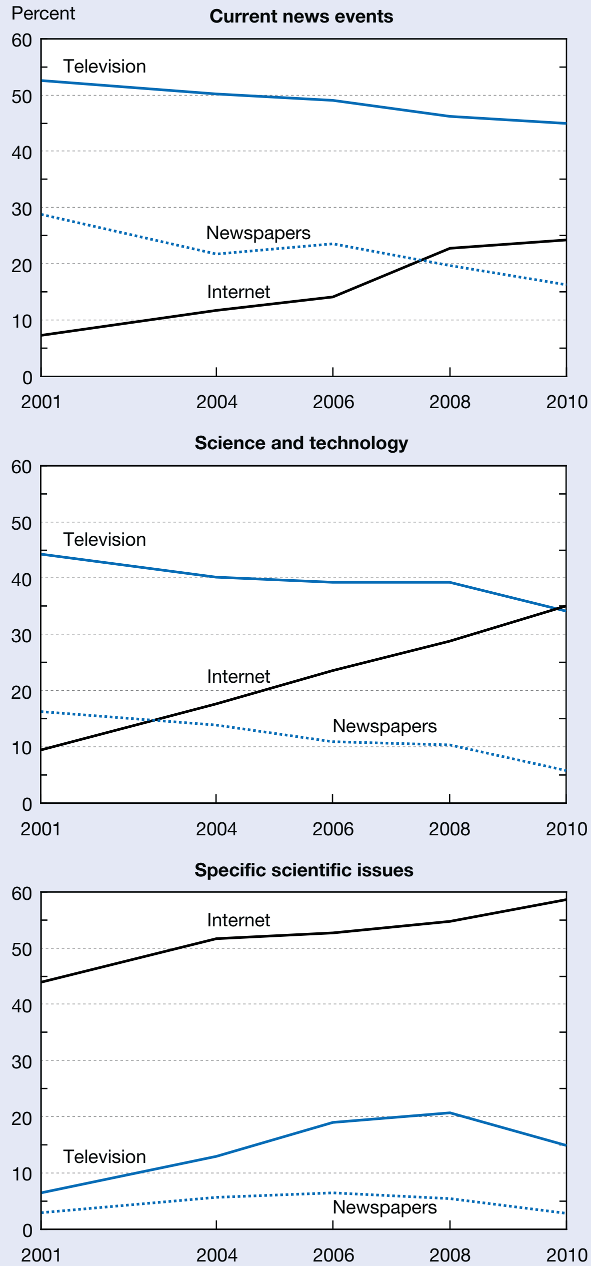


NOTE: "All other" includes radio, magazines, books, government agencies, family, and friends/colleagues.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2010). See appendix tables 7-1, 7-2, and 7-3.

Science and Engineering Indicators 2012

Figure 7-2
Primary source of information about current news events, science and technology, and specific scientific issues: 2001–10



SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (2001); University of Michigan, Survey of Consumer Attitudes (2004); University of Chicago, National Opinion Research Center, General Social Survey (2006, 2008, 2010). See appendix tables 7-1, 7-2, and 7-3.

Science and Engineering Indicators 2012

The Blending of Print and Online Sources of Science News

Internet news sites sometimes represent new providers of news and other times represent an alternative outlet for reporting done by print or broadcast media organizations. The 2010 General Social Survey asked half the sample a question with response options that distinguish between online and print-format sources for newspapers and magazines.

Print media organizations are more likely to serve as a primary source of Americans' information about current news events than they are about either S&T or specific scientific issues. When it comes to news about current events, a roughly equal proportion of Americans who primarily rely on the Internet do so via online venues of print media organizations and other online sources (12% and 11% of adults, respectively). Print media organizations are less dominant as sources of news about general S&T. Eleven percent of Americans rely on Internet sources for S&T news provided by print media organizations; nearly twice as many use other online sources (20%). A majority of Americans seeking information about specific scientific issues say the Internet would be their primary source, 12% would rely on online information from print media organizations, and 48% would rely on other online sources.

Table 7-A
Online and print information sources: 2010
(Percent)

Where do you get most of your information about…?	Current news events	Science and technology	Specific scientific issues
Online Sources			
Online newspapers	12	8	8
Online magazines	*	3	4
Other online sources	11	20	48
Print sources			
Print newspapers	16	7	3
Print magazines	1	8	3
Other sources	59	53	33
Don't know	*	1	1

* = <0.5% responded

NOTES: "Other sources" includes television, radio, books, family, friends/colleagues. Percentages may not add to 100% because of rounding.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2010).

Science and Engineering Indicators 2012

2001. Conversely, reliance on television has dropped; only 34% of Americans report that television is their primary source of S&T news, down from 39% in 2008 (figures 7-1 and 7-2; appendix table 7-2).[2]

When Americans are seeking specific information related to S&T, they turn to the Internet as the dominant resource.[3] Asked "If you wanted to learn about scientific issues such as global warming or biotechnology, where would you get information?" 59% of Americans cited the Internet, up slightly from 55% in 2008. Television ranked as a distant second at 15%, down from 21% in 2008 (figures 7-1 and 7-2; appendix table 7-3).

In general, use of the Internet for news and information, including S&T information, is greater among younger audiences and increases with education and income. Conversely, the use of television decreases with education and income and increases with age (appendix tables 7-1, 7-2, and 7-3). According to a recent Pew Research Center survey, the Internet now outranks television as the primary source of news about national and international issues among younger adults (ages 18–29) (Pew Research Center 2011b).[4] There is no reason to expect younger generations who grew up relying more heavily on the Internet to shift to traditional media as they age.

National data that address the processes through which Americans acquire and sort through S&T information are scarce. A Pew Internet and American Life Project survey examined how Americans use the Internet to acquire information about science (Horrigan 2006). It found that a clear majority of Internet users had engaged in some information search activities, including "look[ing] up the meaning of a particular scientific term or concept" (70%), "look[ing] for an answer to a question you have about a scientific concept or theory" (68%), and "learn[ing] more about a science story or scientific discovery you first heard or read about offline" (65%). In addition, just over half had used the Internet to "complete a science assignment for school, either for yourself or for a child" (55%) or to "check the accuracy of a scientific fact or statistic" (52%). Fewer had used the Internet to "download scientific data, graphs, or charts" (43%) or to "compare different or opposing scientific theories" (37%). How skillfully or how often Americans engage in the search for scientific information—whether on the Internet or elsewhere—remains unknown.

Using information effectively involves more than just finding it. In an information-saturated society, people often need to assess the quality of the information they encounter and determine its credibility. Survey data provide some indication of how Americans assess the credibility of public information. For the past 10 years, Americans have become more skeptical of the information they encounter in major broadcast and print media, but recently this trend has leveled off. Americans' judgments of media credibility are shaped by factors other than critical thinking skills and the quality of the information provided. For example, judgments of the credibility of particular mass media information sources are associated with political party affiliations (Pew Research Center 2010a).

Evidence about how Americans judge the credibility of S&T information in the media is scant. The 2006 Pew Internet and American Life Project study of how Americans acquire science information indicates that Internet users who seek science information online do not always assume that the information they find there is accurate. The vast majority (80%) reported they have checked information at least once, either by comparing it to other information they found online, comparing it to offline sources (e.g., science journals, encyclopedia), or looking up the original source of the information (Horrigan 2006). (For additional details, see NSB 2008.)

International Comparisons

Information sources in other countries depend, in part, on access to the Internet and the prevalence of Internet news sources (Internet World Statistics 2010). Internet access is currently greater in North America than in any other region of the world. In many other countries, television is the leading source of S&T information, newspapers generally rank second, and relatively fewer survey respondents cite the Internet as an important source of S&T information. In Malaysia, for example, 82% cite television as their leading source of S&T news and information, whereas 62% cite newspapers, and 25% cite the Internet (respondents could choose multiple sources of S&T information). Television is also the dominant source of S&T information in India, where about two-thirds of survey respondents in 2004 said it was their main information source (Shukla 2005). Radio (13%) and friends/relatives (12%) ranked ahead of print sources such as newspapers, books, and magazines, which together accounted for 9% of responses. India's relatively low literacy rate (144th of 176 countries in a 2005 ranking) may contribute to this reliance on non-printed sources. On the other hand, in more widely connected South Korea, a 2008 survey found that more respondents named the Internet (28%) as their primary source of S&T information than newspapers (16%) (KOFAC 2009).

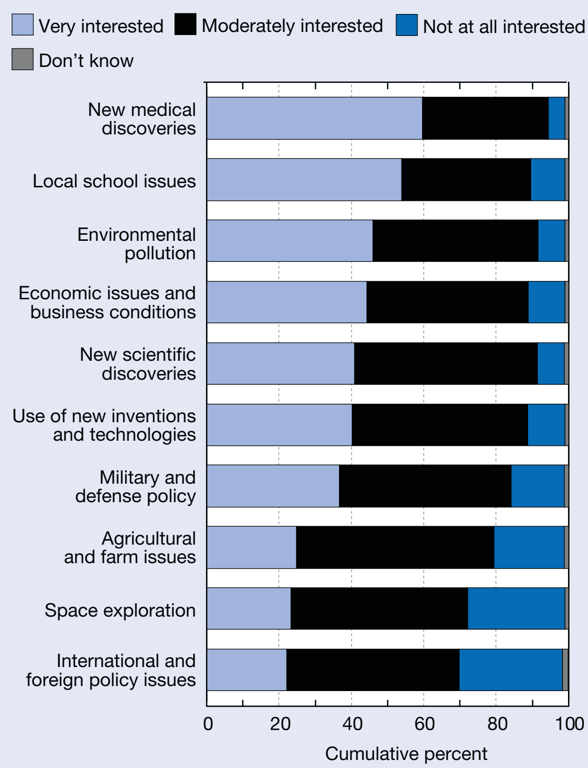
Public Interest in S&T

U.S. Patterns and Trends

Americans regularly express relatively high levels of interest in S&T news. More than four in ten Americans (41%) report being "very interested" in new scientific discoveries, half say they are "moderately interested," and just 8% are "not at all interested," according to the 2010 GSS survey (figure 7-3). The proportion of respondents "very interested" in new scientific discoveries in 2010 is about the same as in 2008 and down from 47% in 2001 (figure 7-4; appendix table 7-4).[5] Comparable data from Virginia Commonwealth University (VCU) show a stable trend in public interest in new scientific discoveries between 2001 and 2006; during this period, the proportion of Americans who said they had a lot of interest in new scientific discoveries fluctuated between 43% and 47% (VCU 2006). Interest in new scientific discoveries was greater among those with more formal education and more coursework in science and mathematics (appendix table 7-5).

Relative to other topics, however, the level of interest in S&T is not particularly high. Interest in new scientific discoveries and use of new inventions and technologies

Figure 7-3
Public interest in selected issues: 2010



NOTE: Responses to *There are a lot of issues in the news, and it is hard to keep up with every area. I'm going to read you a short list of issues, and for each one I would like you to tell me if you are very interested, moderately interested, or not at all interested.*

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2010). See appendix table 7-4.

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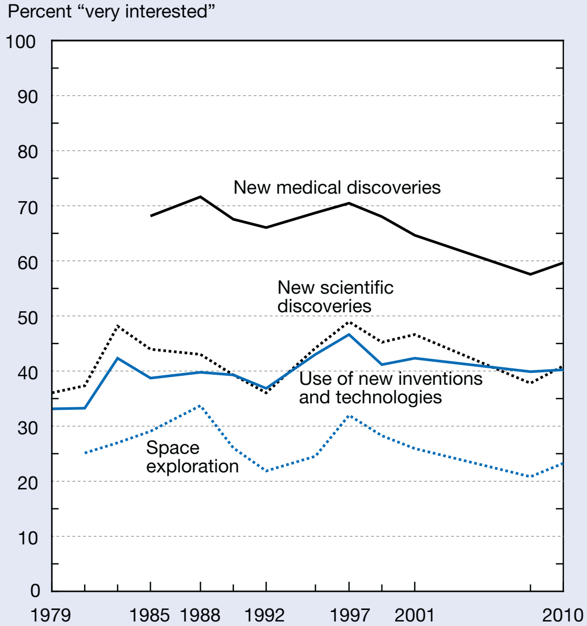
Figure 7-4
Public interest in selected science-related issues: 1979–2010



NOTES: Responses to *There are a lot of issues in the news, and it is hard to keep up with every area. I'm going to read you a short list of issues, and for each one I would like you to tell me if you are very interested, moderately interested, or not at all interested.* Figure shows only "very interested" responses. Figure includes all years for which data collected; other years extrapolated.

SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (1985–2001); University of Chicago, National Opinion Research Center, General Social Survey (2008, 2010). See appendix table 7-4.

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ranked in the middle among 10 areas considered on the 2010 GSS survey. Interest in S&T is roughly comparable to interest in economic issues and business conditions, and military and defense policy. It ranks well ahead of interest in agriculture and farming, space exploration, and foreign policy; and lags behind interest in new medical discoveries, environmental pollution, and local school issues (figure 7-3). Of course, a more inclusive concept of S&T might treat several of the topics on this list, such as space exploration and new medical discoveries, as part of the S&T category; furthermore, other topic areas often include substantial S&T content.[6]

Survey reports about attention to news show a smaller percentage of Americans paying close attention to news reports about S&T in 2008 relative to earlier years. In the 2008 Pew Research Center survey on media consumption, 13% of the respondents reported following S&T news "very closely." S&T news ranked 13th among 18 topics, tied with consumer news and ahead of entertainment, culture and the arts, celebrity news, and travel (table 7-1). As is the case for many other news topics, the percentage of Americans who said they follow S&T closely declined between 1996 and 2008. S&T's relative standing on the list of topics also slipped; it ranked ahead of seven topics in 1996, but ahead of only two of the same topics in 2008 (Pew Research Center 2008).

International Comparisons

International surveys often find similar or lower expressed interest in S&T, but few ask about interest levels using the exact same question wording, making direct comparisons difficult. In the 2010 European survey ("Eurobarometer"), 30% of respondents across all 27 European nations surveyed report being "very interested" in new scientific discoveries and technological developments, 49% are "moderately interested," and 20% are "not interested." Thus, expressed interest in S&T tends to be lower in the European Union (EU) than in the United States. The EU's average self-reported interest in S&T-related issues is about the same in 2010 as it was 2005,[7] but there is considerable variation among different countries. In both the United States and in Europe, men show more interest in S&T than women (EC 2010).[8]

About half of Chinese respondents (52%) report being interested in new scientific discovery; somewhat lower percentages are interested in new discovery and new technology (CRISP 2008).[9] Interest is lower in South Korea, where 24% of respondents were very interested in new scientific discovery (KOFAC 2009).

In other countries, the questions asked are not directly comparable to those asked in the United States. Brazilians showed a marked increase in interest about S&T in 2010 compared with 2006, along with a marked increase in interest about the environment (MCT of Brazil 2010). In Malaysia, interest toward S&T has been fairly stable between 1998 and 2008, whereas interest in environmental pollution has shown a gradual decline (MASTIC 2010).

Interest in medicine tends to be on a par with interest in S&T in Europe and China. Europeans are about equally likely to report being very interested in "new medical discoveries" as they are in "new scientific discoveries and technological development" (EC 2010). The Chinese are equally likely to report being interested in "new medical progress" and "new scientific discovery" (CRISP 2008). More Brazilians report being interested or very interested in medicine and health than in S&T (MCT of Brazil 2010); this pattern is consistent with U.S. survey data. The same pattern holds in Malaysia (MASTIC 2010).

Interest in space exploration has consistently ranked low in the United States and around the world, relative to other S&T topic areas. Surveys in Russia, China, and Japan have documented this general pattern in the past, though no recent data are available on this subject. In India, 19% of the public reported being "interested" in space exploration—lower than any other topic asked (Shukla 2005). Malaysia recently developed a space exploration program and put its own astronauts into space for the first time in 2007. In 2008, half of

Table 7-1
News followed "very closely" by American public: 1996–2008
(Percent)

Type of news	1996	1998	2000	2002	2004	2006	2008
Weather	NA	NA	NA	NA	53	50	48
Crime	41	36	30	30	32	29	28
Education	NA	NA	NA	NA	NA	NA	23
Community	35	34	26	31	28	26	22
Environment	NA	NA	NA	NA	NA	NA	21
Politics/Washington news	16	19	17	21	24	17	21
Local government	24	23	20	22	22	20	20
Health news	34	34	29	26	26	24	20
Sports	26	27	27	25	25	23	20
Religion	17	18	21	19	20	16	17
International affairs	16	16	14	21	24	17	16
Business and finance	13	17	14	15	14	14	16
Consumer news	14	15	12	12	13	12	13
Science and technology	20	22	18	17	16	15	13
Culture and arts	9	12	10	9	10	9	11
Entertainment	15	16	15	14	15	12	10
Celebrity news	NA	NA	NA	NA	NA	NA	7
Travel	NA	NA	NA	NA	NA	NA	6

NA = not available, question not asked

NOTES: Data reflect respondents who said they followed type of news "very closely." Table includes all years for which data collected.

SOURCE: Pew Research Center for the People and the Press, *Audience Segments in a Changing News Environment: Key News Audiences Now Blend Online and Traditional Sources* (17 August 2008), p. 39, Biennial News Consumption Survey (30 April–01 June 2008), http://people-press.org/reports/pdf/444.pdf, accessed 21 September 2009.

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Malaysians indicated they were "interested" or "very interested" in space exploration (MASTIC 2010).

Availability of S&T News in the Media

The sources of information Americans rely on for news about S&T are at least partly a function of the availability of S&T information from different venues and news media. Recent research on media coverage across a range of public policy domains found that the amount and prominence of media coverage is positively associated with public awareness of specific policy-related facts (Barabas and Jerit 2009). Thus, the amount and depth of media coverage of S&T could both reflect public interest in the topic and also influence the amount of public attention to and awareness of developments in S&T.

How much and what kinds of S&T news coverage are available in the media? The Project for Excellence in Journalism (PEJ 2010a) has conducted an extensive content analysis of media coverage since 2007 using a broad sample of about 50 outlets in the following media sectors: print, Internet, network television, cable television, and radio. Each week, stories are classified into 1 of 26 broad topic areas, including a category for S&T.[10]

These data show that S&T make up a small percentage of the total amount of news in the traditional media—less than 2% annually from 2007 to 2010 (table 7-2).[11] News coverage on the environment makes up a similarly small proportion of the news. By comparison, coverage of health and medicine makes up a greater proportion of the news but is also more variable, ranging from approximately 3% to 9% during the 4-year period.

Which stories about S&T are covered by the media? Within the S&T news coverage, stories on cyberspace issues are most common—about 27% in 2010 and 18% in 2009. Other stories compose a much smaller portion of the S&T news coverage in the media. In 2010, stories about the

Table 7-2
Traditional media coverage on science and technology, by topic area: 2007–10
(Percent)

Year	Number of stories	Science and technology	Environment	Health and medicine
2007	70,737	1.3	1.6	3.6
2008	69,942	1.1	1.3	2.7
2009	68,717	1.8	1.5	8.9
2010	52,613	1.5	1.6	5.0

NOTE: Data reflect percentage of news stories in each topic area based on content analysis of coverage by media outlets in five sectors: print, Internet, network TV, cable TV, and radio.

SOURCE: Project for Excellence in Journalism, News Coverage Index, special tabulations (21 March 2011), http://www.journalism.org/about_news_index/methodology, accessed 11 February 2011.

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NASA Space Shuttle mission accounted for 8% of the S&T news, roughly equal to the proportion of stem cell-related news in 2009 (table 7-3).

Analyses of the content on the three major broadcast networks (ABC, CBS, NBC) tell a similar story. The Tyndall Report has tracked the content of the three major broadcast networks for more than 20 years; the amount of air time on each nightly newscast is classified into 18 categories (Tyndall Report 2011a). Two categories with large science, engineering, and technology components are "science, space, and technology," and "biotechnology and basic medical research."[12] Neither category has ever occupied a large percentage of the approximately 15,000 minutes of annual nightly weekday newscast coverage on the networks. The airtime devoted to "science, space, and technology" averaged 339 minutes—about 2% of broadcast news—between 2000 and 2010, but fluctuated from 1% to 5% during this period (figure 7-5).[13] Time devoted to "biotechnology and basic medical research" was considerably lower, accounting for 1% or less of broadcast news (with some variation depending on the year).

The leading story on nightly news broadcasts in 2010 was the oil spill in the Gulf of Mexico (9% of the year's news). Although not classified as such, stories on the oil spill often included substantial attention to science and engineering issues (Tyndall Report 2011b). The most-covered stories on science, space, and technology in 2009 and 2010 focused on developments in the nation's space program and new developments in high technology products and tools for consumers, such as flat screen tablet computers and social networking websites (table 7-4). In the category of "biotechnology and basic medical research," cancer research garnered the most coverage, as it has done since 2006.

The media environment is rapidly changing, with *new media* and *social media* outlets continuing to proliferate and attract users. The Project for Excellence in Journalism conducts a new media content analysis focusing primarily on news-focused blogs and Twitter posts (PEJ 2010c). The analysis tracks the most-linked-to news subjects on a sample of blogs in order to capture the priorities of bloggers. The same procedure is used for Twitter posts.[14] This provides another indicator of interest in and availability of S&T news. In 2010, S&T stories composed 12% of the most-linked-to blog subjects in a given week; in 2009, that figure was 17%. On Twitter, S&T made up 38% of the most-linked-to subjects in a given week in 2010, down from 48% in 2009 (table 7-5).

Table 7-3
Leading traditional media story lines on science and technology, by topic area: 2009 and 2010
(Percent of news in each topic area)

Topic area/leading story line	2009	Topic area/leading story line	2010
Science, space, and technology (*n* = 1,212 stories)		Science, space, and technology (*n* = 796 stories)	
Cyberspace issues	17.6	Cyberspace issues	26.7
Stem cell research	8.6	NASA/shuttle missions	8.1
40th anniversary of Apollo space mission	6.4	Apple product and business news	8.0
Hubble Telescope	5.2	China	2.2
Space Shuttle Endeavour	4.4	Education	2.0
Moon bombing by NASA	3.2	Google	1.7
TV switch to digital	2.5	WikiLeaks	1.5
NASA/shuttle missions	2.5	Stem cell research	1.3
Global warming/climate change	1.9	Terror threats/homeland security	1.2
Texting and driving	1.7	Texting and driving	1.0
Environment (*n* = 1,007 stories)		Environment (*n* = 830 stories)	
Global warming/climate change	37.1	BP oil spill in Gulf of Mexico	42.2
Pollution/emissions/going green	18.9	Energy debate	15.4
Energy debate	13.8	Global warming/climate change	11.5
Economy	3.4	Pollution/emissions/going green	7.0
G8 Summit	2.7	China	1.0
Health and medicine (*n* = 6,101 stories)		Health and medicine (*n* = 3,271 stories)	
Health care reform debate in Congress	65.2	Health care reform debate in Congress	62.8
Swine flu outbreak	15.7	Egg recall	2.3
Government mammogram recommendations	1.5	2010 elections	1.4
Economy	0.8	Stem cell research	1.4
Chemotherapy refused by teen cancer patient	0.6	Avandia	1.3

NOTE: Data reflect story lines with greatest percentage of news in each topic area based on content analysis of coverage by media outlets in five sectors: print, Internet, network TV, cable TV, and radio.

SOURCE: Project for Excellence in Journalism, News Coverage Index, special tabulations (21 March 2011), http://www.journalism.org/about_news_index/methodology, accessed 11 February 2011. For methodology, see http://www.journalism.org/commentary_backgrounder/new_media_index_methodology, accessed 11 February 2011.

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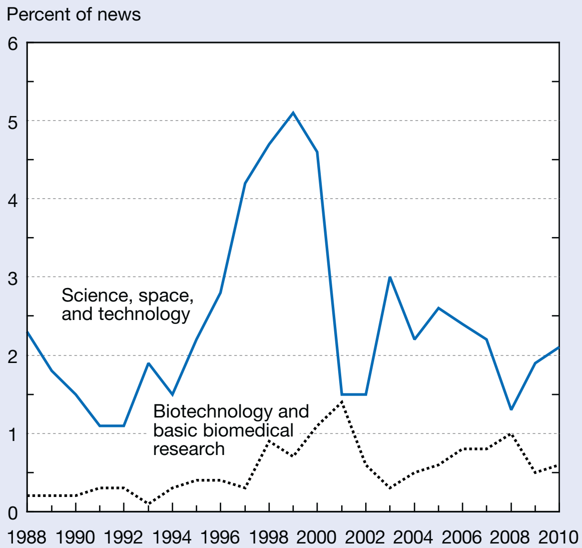
Figure 7-5
Network nightly news coverage of science and technology: 1988–2010



NOTES: Data reflect percentage of approximately 15,000 total annual minutes of weekday nightly newscasts on ABC, CBS, and NBC that were spent on science, space, and technology and on biotechnology and basic medical research. Excluded from science, space, and technology are forensic science and media content. Excluded from biotechnology and basic medical research are stories on clinical research and medical technology.

SOURCE: Tyndall Report, special tabulations (21 March 2011), http://www.tyndallreport.com, accessed 3 February 2011.

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What kinds of stories *go viral* on blogs and Twitter posts? There is no available quantitative measure of the most-linked-to science stories. Recent examples of most-linked-to blog stories on science include the discovery of a new kind of large rat in Papua New Guinea, news that a chemical found in blue M&Ms might have therapeutic qualities, and the discovery of a meat-eating plant (PEJ 2010d). Climate change and the controversy surrounding e-mails from a British researcher on the subject was one of the top five subjects covered by bloggers in December 2009 and made up a third of the weekly blog links 3 months later, shortly after a BBC interview on the subject (PEJ 2010b).

Involvement

Involvement with S&T outside the classroom in informal, voluntary, and self-directed settings—such as museums, science centers, zoos, and aquariums—is another indicator of the public's interest in S&T.[15] By offering visitors the flexibility to pursue individual curiosity, such institutions provide a kind of exposure to S&T that is well-suited to helping people develop further interest.[16]

In the 2008 GSS, 61% of Americans indicated that they had visited an informal science venue during the previous year (appendix table 7-6).[17] About half (52%) said they had visited a zoo or aquarium, and more than one-quarter had visited a natural history museum (28%) or an S&T museum (27%). One in three Americans had visited an art museum and 64% had visited a public library. These data are generally consistent with data collected by the Pew Internet and

Table 7-4
Leading nightly news story lines on science and technology, by topic area: 2009 and 2010
(Annual minutes of coverage)

Topic area/leading story line	2009	Topic area/leading story line	2010
Science, space, and technology		Science, space, and technology	
NASA Hubble Space Telescope repairs	40	Internet used for social networking: Facebook	34
Moon astronomy: NASA searches for evidence of water	20	Computer flatscreen table technology: iPad	20
NASA anniversary of Apollo manned moon missions	19	Cellular telephone/computer combination: iPhone	18
NASA Space Shuttle program	17	NASA manned space flights to be discontinued	18
Computer networks targeted by coordinated hackers	15	UFO speculation fascinates skywatchers	13
Internet used for social networking: Facebook	12	Internet classified ads posted online: Craigslist	11
Apple Computer CEO Steve Jobs returns to work	12	High-technology multitasking is distracting	9
Internet online commerce volume increases	12	Office copier machines have hard drive memories	9
NASA plans renewed manned missions to moon	11	Videostreams shared online in viral networks: YouTube	8
Videostreams shared online in viral networks: YouTube	6	China censors Internet access, e-mail traffic	8
Biotechnology/basic medical research		Biotechnology/basic medical research	
War on cancer/research efforts	37	War on cancer/research efforts	48
Human embryo stem cell biotechnology research	23	Human embryo stem cell biotechnology research	14
		Genetic DNA biotech analysis predicts disease	11
		Salmon genetically modified to accelerate growth	7
		Spinal cord injuries and paralysis research	5

NOTES: Data reflect annual minutes of story coverage on these topics by major networks ABC, CBS, and NBC, out of approximately 15,000 total annual minutes on weekday nightly newscasts. Shown are the story lines receiving at least 5 minutes of coverage in 2009 and 2010. Excluded from science, space, and technology are stories on forensic science and media content. Excluded from biotechnology/basic medical research are stories on clinical research and medical technology.

SOURCE: Tyndall Report, special tabulations (2 March 2011), http://www.tyndallreport.com, accessed 3 February 2011.

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Table 7-5
"Most-linked-to" subjects in the new media, by topic area: 2009 and 2010
(Percent)

Topic area	Blogs 2009 (*n* = 235)	Blogs 2010 (*n* = 256)	Twitter[a] 2009 (*n* = 132)	Twitter[a] 2010 (*n* = 255)
Science, space, and technology	17	12	48	38
Environment	4	4	4	2
Health and medicine	8	6	6	1

n = number of subjects coded

[a] Twitter content analysis for 2009 based on 6 months starting June 15; analysis for 2010 based on 12 months.

NOTE: Data reflect percentage of "most-linked-to" subjects in a given week, based on content analysis of news-focused blogs and social media sites.

SOURCE: Project for Excellence in Journalism, New Media Index, special tabulations (17 February 2011), http://www.journalism.org/commentary_backgrounder/new_media_index_methodology, accessed 11 February 2011.

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American Life Project and the Institute for Museum and Library Services. (For more detail on these surveys, see NSB 2008.) Among those who visited each of these institutions, the number of annual visits was highest for public libraries, which averaged about 15 visits per year.

The proportion of respondents who reported visiting either a zoo or aquarium, an S&T museum, and a public library is down slightly from the last time these questions were asked in 2001.[18] Respondents in households with children 18 or younger were more likely to visit a zoo or aquarium, a public library, and also a natural history museum. Minors in the household did not make a difference in the proportion of adults who visited an art museum or an S&T museum (appendix table 7-7).

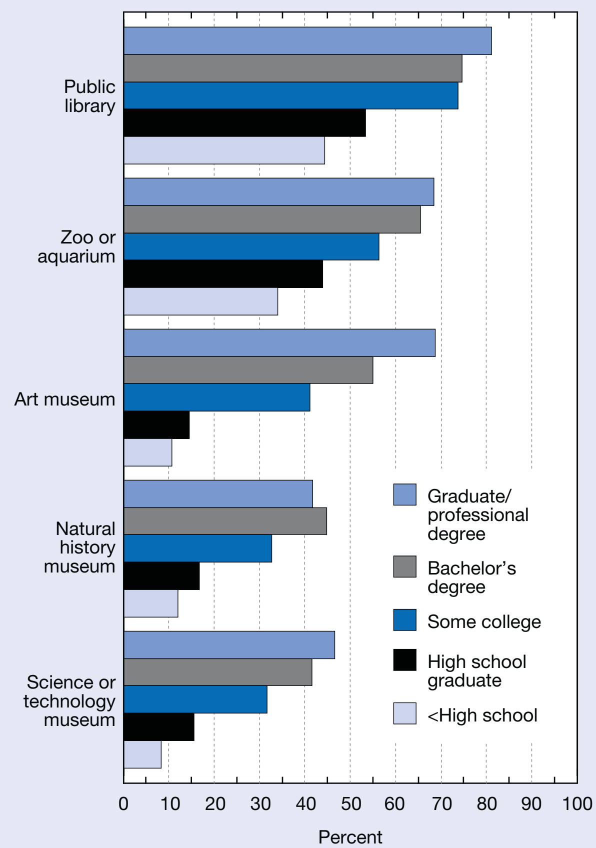
Americans with more years of formal education are more likely than others to engage in these informal science activities (figure 7-6; appendix table 7-7). Those in higher income brackets are more likely to have visited a zoo or aquarium, a natural history or S&T museum, or an art museum, but are just as likely as those in the lowest income bracket to have visited a public library. In general, visits to informal science institutions are less common among Americans who are 65 or older.

In addition, respondents who get most of their information about S&T from the Internet or use this medium to learn about scientific issues are more likely to have visited any informal science institution, even after controlling for expressed interest in scientific issues. This suggests that users experience these different sources of science information as complementing, rather than replacing, one another.

International Comparisons

Compared with the United States, visits to S&T museums are less common in China, Japan, South Korea, Malaysia, India, Europe, and Brazil (table 7-6). The proportion of respondents who indicate they have visited a zoo is similar in the United States, China, and Japan. Visiting a zoo is more common in the United States[19] than it is in South Korea, India, Malaysia, Europe, and Brazil. Unmeasured

Figure 7-6
Attendance at informal science and other cultural institutions, by institution type and education level: 2008



NOTES: Responses to *I am going to read you a short list of places and ask you to tell me how many times you visited each type of place during the last year, that is, the last 12 months.* Percentage indicates respondents who had attended the noted institution at least once.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2008). See appendix tables 7-6 and 7-7.

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Table 7-6
Visits to informal science and other cultural institutions, by country/region: Most recent year
(Percent)

Institution	United States (2008)	China (2007)	Japan (2001)	South Korea (2008)	India (2004)	Malaysia (2008)	EU (2005)	Brazil (2010)
Zoo/aquarium[a]	52	52	43	36	35	30	27	22
Natural history museum	28	14	19	NA	NA	NA	NA	NA
Science/technology museum[b]	27	17	12	11	12	11	16	8
Public library[c]	64	41	46	34	27	NA	34	29
Art museum[d]	34	18	34	34	22	30	23	14

NA = not available, question not asked

EU = European Union; data not available for Bulgaria and Romania

[a] "Zoo, aquarium, botanic garden" for China; "Zoo" for India, Malaysia, Brazil.
[b] "Science museum" for South Korea; "Science parks" for India; "National Science Centre" for Malaysia; "Science museums or technology museums or science centers" for EU.
[c] "Library" for India, Brazil.
[d] "Art museum or exhibition hall" for China; "Museum/art gallery" for South Korea; "Museum" for India, Malaysia.

NOTES: Responses to (United States, Japan, South Korea) *I am going to read you a short list of places and ask you to tell me how many times you visited each type of place during the last year, that is, the last 12 months* (percentage includes those who visited each institution one or more times); (China, EU, Brazil) *Which of the following have you visited in the last 12 months?* (multiple answers possible); (Malaysia) *In the past year, how many times did you visit the following places?* (percentage includes those who visited each institution one or more times); (India) *How frequently did you visit the following during the last 12 months?* (percentage includes those who visited each institution one or more times).

SOURCES: United States–University of Chicago, National Opinion Research Center, General Social Survey (2008); China–Chinese Association for Science and Technology/China Research Institute for Science Popularization, Chinese National Survey of Public Scientific Literacy (2007); Japan–National Institute of Science and Technology Policy/Ministry of Education, Culture, Sports, Science and Technology, Survey of Public Attitudes Toward and Understanding of Science and Technology in Japan (2001); South Korea–Korea Foundation for the Advancement of Science and Creativity (formerly Korea Science Foundation), Survey of Public Attitudes Toward and Understanding of Science and Technology (2008); India–National Council of Applied Economic Research, National Science Survey (2004); Malaysia–Malaysian Science and Technology Information Center/Ministry of Science, Technology and Innovation, Survey of the Public's Awareness of Science and Technology: Malaysia (2008); EU–European Commission, Eurobarometer 224/Wave 63.1: *Europeans, Science and Technology* (2005); Brazil–Ministry of Science and Technology of Brazil, Public Perceptions of Science and Technology (2010). See appendix table 7-6 for U.S. trends.

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differences in the prevalence and accessibility of informal science learning opportunities across countries prohibit attributing different visit patterns to differences in interest.

Public Knowledge About S&T

Knowledge and understanding of S&T can be relevant to public policy and the personal choices that people make. In developing measures for what is often termed *scientific literacy* across nations, the Organisation for Economic Co-operation and Development (OECD 2003) emphasizes that scientific literacy is a matter of degree and that people cannot be classified as either literate or not literate. The OECD noted that literacy had several components:

> Current thinking about the desired outcomes of science education for all citizens emphasizes the development of a general understanding of important concepts and explanatory frameworks of science, of the methods by which science derives evidence to support claims for its knowledge, and of the strengths and limitations of science in the real world. It values the ability to apply this understanding to real situations involving science in which claims need to be assessed and decisions made…
>
> Scientific literacy is the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity. (pp. 132–33)

A good understanding of basic scientific terms, concepts, and facts; an ability to comprehend how S&T generates and assesses evidence; and a capacity to distinguish science from pseudoscience are widely used indicators of scientific literacy. U.S. survey data indicate that many Americans provide multiple incorrect answers to basic questions about scientific facts and do not apply appropriate reasoning strategies to questions about selected scientific issues. Residents of other countries, including highly developed ones, appear to perform no better, on balance, when asked similar questions. However, in light of the limitations of using a small number of questions largely keyed to knowledge taught in school, generalizations about Americans' knowledge of science should be made cautiously.

Understanding Scientific Terms and Concepts

U.S. Patterns and Trends

One common indicator of public understanding about science comes from an index of factual science knowledge questions covering a range of science disciplines. Responses to nine questions are used in a combined scale as an indicator of general knowledge about S&T. In 2010, Americans, on average, were able to correctly answer 5.6 out of the 9 items, for an average percent correct of 63%.

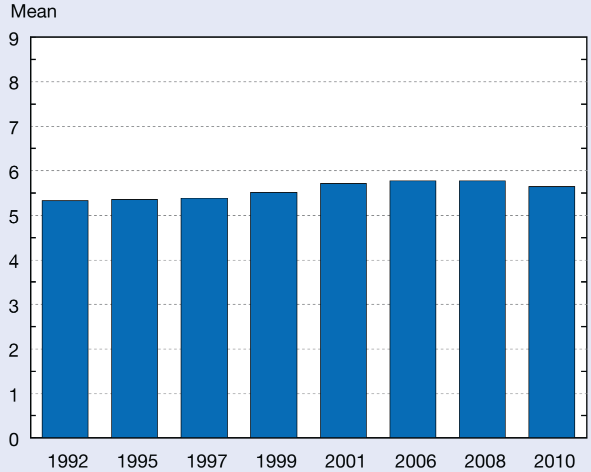
The public's level of factual knowledge about science has not changed much over the past two decades (figure 7-7). Since 2001, the average number of correct answers to a series of mostly true-false science questions in years for which fully comparable data were collected has ranged from 5.6 correct responses to 5.8 correct responses, although knowledge on individual questions has varied somewhat over time (appendix tables 7-8 and 7-9).[20] (Also see sidebar, "Measuring Factual Science Knowledge Over Time.")

Some individuals know more about science than others, of course. Factual knowledge of science is strongly related to people's level of formal schooling and the number of science and mathematics courses completed. Among those who have no more than a high school education, 49% of the questions were answered correctly, on average. Individuals who had attended college answered more items correctly; the average percent correct rose to 81% among those who had taken three or more science and mathematics courses in college (figure 7-8; appendix table 7-8).

Respondents age 65 and older are less likely than younger Americans to answer the factual science questions correctly (appendix table 7-8). Younger generations have had more formal education, on average, than Americans coming into adulthood some 50 years ago; these long-term societal changes make it difficult to know whether the association between age and factual knowledge is due primarily to aging processes, cohort differences in education, or other factors. An analysis of surveys conducted between 1979 and 2006 concluded that public understanding of science has increased over time and by generation, even after controlling for formal education levels (Losh 2009, 2011). (Also see Bauer 2009.)

Factual knowledge about science is also associated with sex. Men tend to answer more factual science knowledge questions correctly than do women. However, this pattern depends on the science domain referenced in the question. In the factual questions included in NSF surveys since 1979, men

Figure 7-7
Mean number of correct answers to trend factual knowledge of science scale: 1992–2010



NOTES: Mean number of correct answers to nine questions included in trend factual knowledge of science scale; see appendix table 7-8 for explanation, list of questions, and percentage of questions answered correctly. See appendix tables 7-9 and 7-10 for responses to individual questions. Table includes all years for which data were collected.

SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (1992–2001); University of Chicago, National Opinion Research Center, General Social Survey (2006, 2008, 2010).

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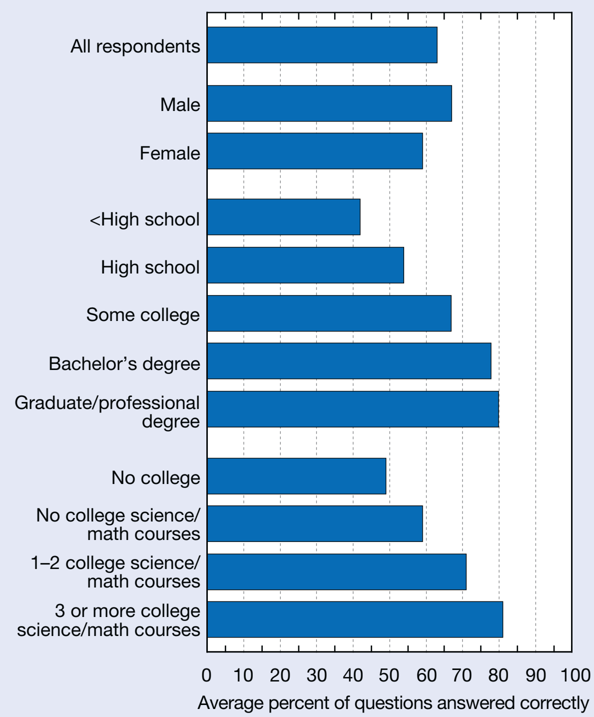
Figure 7-8
Correct answers to trend factual knowledge of science scale, by respondent characteristic: 2010



NOTES: Data reflect average percentage of nine questions answered correctly. "Don't know" responses and refusals to respond counted as incorrect. See appendix table 7-8 for explanation, list of questions, and additional respondent characteristics. See appendix tables 7-9 and 7-10 for responses to individual questions.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2010).

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Measuring Factual Science Knowledge Over Time

How to measure factual knowledge about science over time is a difficult puzzle, in part because the generally accepted principles and facts of scientific fields are constantly in flux. The items in the factual knowledge index were first developed in the 1970s and aimed to tap a selection of science facts that would likely withstand the "test of time" (Miller 1998, 2011). The index aims to measure the extent to which the public has a clear understanding of the factual aspects of major scientific fields in the biological and physical sciences. The proportion of the public that provides the correct answer on any one question is less important than the pattern of responses across the set of questions used in the factual knowledge index.

As science changes and public knowledge about science changes, the exact questions that best distinguish individuals who tend to know more about science from those who tend to know less are likely to vary over time. As a result, periodic review of indicators such as these is warranted. A number of studies and analyses have been commissioned by NSF for this purpose over the years. NSF is in the process of undertaking further review and experimentation with the factual knowledge questions.

Two items used in past versions of the index have received considerable scrutiny; one concerned the "big bang" and the other concerned evolution. In the 2010 GSS, 45% of Americans answered "true" that "the universe began with a huge explosion." There was some concern that the wording of this question erred too heavily on the side of using easily comprehensible language at the cost of scientific precision. This may prompt some highly knowledgeable respondents to think that the item blurs or neglects important distinctions, and in a few cases may lead respondents to answer the question incorrectly. The other item of some concern was "human beings, as we know them today, developed from earlier species of animals." In the 2010 GSS, half of Americans answered "true" to the question about evolution. As discussed elsewhere in the chapter, evidence from a 2004 survey-based experiment suggests that responses to these items reflect more than familiarity with the concepts. (Also see NSB 2008.)

As measures of science knowledge, these questions correlate with the overall index, but the correlations for other items are generally stronger. A statistical review conducted by the Research Triangle Institute on behalf of NSF in 2004 found that all the knowledge questions, including the evolution and "big bang" questions, reflect a single underlying dimension of factual knowledge (Bann and Schwerin 2004). Later analyses have replicated this finding over time. Thus, the social science foundation for using either 11 items or 9 items together in one scale is well-supported.

This chapter relies on the 9-item factual knowledge scale for analysis of trends in knowledge over time. Responses to the 9-item factual knowledge scale and an 11-item factual knowledge scale that includes responses to the questions on evolution and the "big bang" are highly correlated with each other. Whether or not these two questions are included in a scale of factual science knowledge has little bearing on the summary portrait of Americans' knowledge that the scale conveys. In addition, knowledge differences between population groups (e.g., men and women) are similar (appendix table 7-10). Table 7-B shows that, on average, respondents in the top quartile on the trend factual knowledge scale answered 87% of the questions on the 11-item version of the scale correctly and 59% of the two additional items correctly. Those in the lower quartiles on the trend factual knowledge scale answered fewer items correctly.

Table 7-B
Correct responses on trend factual knowledge of science scale by longer factual knowledge scale: 2010
(Average percent correct)

Respondent score[a]	Trend factual knowledge of science scale, 9 items	11-item scale[b]	2-item scale[c]
Top quartile	94	87	59
2nd quartile	73	68	47
3rd quartile	51	48	37
Bottom quartile	25	24	22

[a]Quartile based on correct answers to trend factual knowledge of science scale, 9 items.
[b]11-item scale that includes the same 9 items plus responses to 2 additional items.
[c]2-item scale consisting of responses to the evolution and "big bang" questions.

NOTES: Data reflect average percentage of questions in index answered correctly. "Don't know" responses and refusals to respond counted as incorrect.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2010).

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score higher than women on questions in the physical sciences, but not on questions in the biological sciences. Women tend to score at least equally as high as men on the biological science questions and often a bit higher (table 7-7).

Comparisons of Adult and K–12 Student Knowledge

The factual knowledge questions that have been repeatedly asked in U.S. surveys involve information that was being taught in grades K–12 when most respondents were young. Because science continually generates new knowledge that reshapes how people understand the world, scientific literacy requires lifelong learning so that citizens become familiar with terms, concepts, and facts that emerge after they complete their schooling.

The 2008 GSS included several different kinds of factual science knowledge questions; seven of those questions can be directly compared with national student assessments of science knowledge. Adult Americans received a higher or similar score to fourth and eighth grade students in five of the seven factual science knowledge questions where comparisons scores were possible (table 7-8).

Comparisons should be made cautiously because of the differences in circumstances in which students and adults responded to these science knowledge questions. Students' tests were self-administered on paper, whereas the majority of respondents in the GSS answered orally to questions asked by an interviewer. Also, elementary and middle school students had an advantage over adults in that classroom preparation preceded their tests. (For more details, see NSB 2010.)

Knowledge About Nanotechnology and the Polar Regions

New developments in S&T are always on the horizon. Indicators of factual science knowledge need to probe knowledge and understanding about newly emerging science topics, as well as more established topics. Recent GSS surveys included indicators of public understanding for one such emerging area—nanotechnology.

A small minority report having heard "a lot" about nanotechnology; 31% of Americans correctly indicate that "nanotechnology involves manipulating extremely small units of matter, such as individual atoms, in order to produce better materials" is true.[21] About two in ten (18%) Americans correctly indicate that "the properties of nanoscale materials often differ fundamentally and unexpectedly from the properties of the same materials at larger scales." (Also see "Public Attitudes About Specific S&T-Related Issues.")

Table 7-7
Correct answers to factual knowledge and process questions in physical and biological sciences, by sex: 1999–2010
(Average percent correct)

Science topic/sex	1999	2001	2004	2006	2008	2010
Physical science index[a]						
Male	72	73	73	74	74	73
Female	57	59	55	59	61	60
Biological science index[b]						
Male	59	61	62	63	60	62
Female	62	65	65	66	64	65

[a]Physical science index includes five questions:
- *The center of the Earth is very hot.* (True)
- *All radioactivity is man-made*. (False)
- *Lasers work by focusing sound waves*. (False)
- *Electrons are smaller than atoms*. (True)
- *The continents have been moving their location for millions of years and will continue to move.* (True)

[b]Biological science index includes six questions (questions 3 and 4 have two parts):
- *It is the father's gene that decides whether the baby is a boy or a girl.* (True)
- *Antibiotics kill viruses as well as bacteria.* (False)
- *A doctor tells a couple that their genetic makeup means that they've got one in four chances of having a child with an inherited illness.* (1) *Does this mean that if their first child has the illness, the next three will not?* (No); (2) *Does this mean that each of the couple's children will have the same risk of suffering from the illness?* (Yes) Data represent a composite of correct responses to both questions.
- *Two scientists want to know if a certain drug is effective against high blood pressure. The first scientist wants to give the drug to 1,000 people with high blood pressure and see how many of them experience lower blood pressure levels. The second scientist wants to give the drug to 500 people with high blood pressure and not give the drug to another 500 people with high blood pressure, and see how many in both groups experience lower blood pressure levels. Which is the better way to test this drug? Why is it better to test the drug this way?* (The second way because a control group is used for comparison.) Data represent a composite of correct responses to both questions.

NOTES: Data reflect average percentage of questions in index answered correctly. "Don't know" responses and refusals to respond counted as incorrect.

SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (1999, 2001); University of Michigan, Survey of Consumer Attitudes (2004); and University of Chicago, National Opinion Research Center, General Social Survey (2006, 2008, 2010). See appendix tables 7-9 and 7-10 for factual knowledge questions. See appendix tables 7-13 and 7-14 for scientific process questions (probability and experiment).

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Table 7-8
Comparison of correct answers given by adults and students to factual knowledge questions: Most recent year
(Percent)

			Adult	Student		
Question	Field of study	Concepts measured	United States	United States	International	Question source
1. *A farmer thinks that the vegetables on her farm are not getting enough water. Her son suggests that they use water from the nearby ocean to water the vegetables. Is this a good idea?*	Earth and space sciences	Water cycle; nature of the oceans and their effects on water and climate; location of water, its distribution, characteristics, and its effect and influence on human activity	84	61	NA	NAEP 2005, grade 4
2. *Traits are transferred from generation to generation through the…*	Life sciences	Reproduction and heredity	79	86	74	TIMSS 2003, grade 8
3. *How do most fish get the oxygen they need to survive?*	Life sciences	Change and evolution; adaptation and natural selection	75	78	NA	NAEP 2005, grade 8
4. *What property of water is most important for living organisms?*	Physical sciences	Matter and its transformations	68	76	NA	NAEP 2000, grade 8
5. *Which one of the following is NOT an example of erosion?*	Earth and space sciences	Composition of the Earth; forces that alter the Earth's surface; rocks: their formation, characteristics, and uses; soil: its changes and uses; natural resources used by humankind; and forces within the Earth	54	37	NA	NAEP 2005, grade 8
6. *Lightning and thunder happen at the same time, but you see the lightning before you hear the thunder. Explain why this is so.*	Physical sciences	Frames of reference; force and changes in position and motion; action and reaction; vibrations and waves as motion; electromagnetic radiation and interactions of electomagnetic radiation with matter	44	36	NA	NAEP 2005, grade 8
7. *A solution of hydrochloric acid (HCl) in water will turn blue litmus paper red. A solution of the base sodium hydroxide (NaOH) in water will turn red litmus paper blue. If the acid and base solutions are mixed in the right proportion, the resulting solution will cause neither red nor blue litmus paper to change color. Explain why the litmus paper does not change color in the mixed solution.*	Chemistry	Acids and bases	20	17	21	TIMSS 2003, grade 8

NA = not available, question not asked

NAEP = National Assessment of Educational Progress; TIMSS = Trends in International Mathematics and Science Study

NOTES: Questions appeared in 2008 General Social Survey; see appendix table 7-17 for complete questions. Original sources of questions are NAEP and TIMSS.

SOURCES: University of Chicago, National Opinion Research Center, General Social Survey (2008), see appendix table 7-18; NAEP, http://nces.ed.gov/nationsreportcard/itmrls/startsearch.asp, accessed 22 September 2009; TIMSS, http://nces.ed.gov/timss/results03.asp, accessed 22 September 2009.

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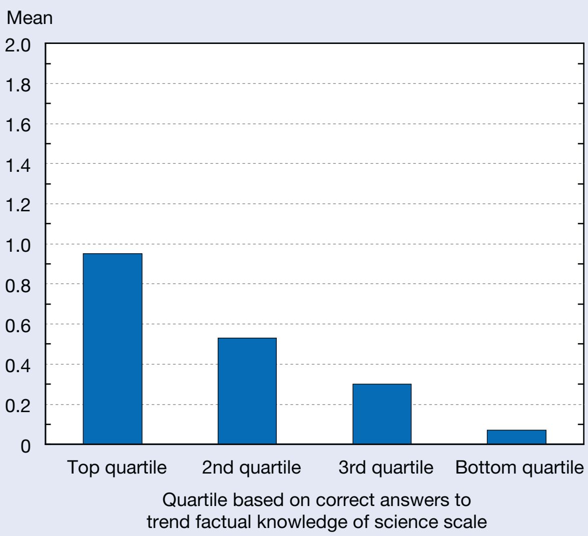
Those who scored higher on the general factual knowledge scale were also more likely to answer the two questions about nanotechnology correctly (figure 7-9).[22] Likewise, the educational and demographic characteristics associated with higher scores on the trend factual knowledge questions are also associated with higher knowledge of nanotechnology (appendix table 7-11). These data suggest that the trend factual knowledge scale, although focused on the kind of scientific facts and principles learned in school, is a reasonable indicator of factual science knowledge in general, including knowledge on newly emerging topics acquired later in life.

The 2006 and 2010 GSSs included a series of knowledge questions about the polar regions. Knowledge about the polar regions was measured using a 4-item scale of true-false questions. In 2010, Americans answered 60% of the four items correctly, on average, up from 55% in 2006. Increased knowledge about the polar region was indicated especially by two of the four questions: "The North Pole is on a sheet of ice that floats on the Arctic Ocean" (from 41% in 2006 to 48% in 2010), and "Hunting is more likely than climate change to make polar bears become extinct" (from 36% in 2006 to 44% in 2010) (appendix table 7-12). It is possible that this increase in knowledge stems, in part, from increased attention to the polar regions during the 2007–2008 International Polar Year.

Figure 7-9
Mean number of correct answers to nanotechnology questions, by correct answers to trend factual knowledge of science scale: 2010



NOTES: Mean number of correct responses to two factual questions on nanotechnology. Respondents saying they had heard "nothing at all" about nanotechnology were not asked questions; these respondents count as zero (0) correct. See appendix table 7-11 for responses to nanotechnology questions. Trend factual knowledge of science scale includes nine questions; see appendix table 7-8 for explanation and list of questions.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2010).

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However, there may be other reasons for the change including increased public attention to global climate change and its implications for the polar regions.

International Comparisons on Factual Knowledge Questions

Adults in different countries and regions have been asked identical or substantially similar questions to test their factual knowledge of science. Knowledge scores for individual items vary from country to country, and no country consistently outperforms the others. For the physical science and biological science questions reported in table 7-9, knowledge scores are relatively low in China, Russia, and Malaysia. Compared to the United States and the EU, scores in Japan are also relatively low.[23]

Science knowledge scores vary considerably across Europe, with northern European countries, led by Sweden, scoring the highest on a set of 13 questions. For a smaller set of 4 questions that were administered in 12 European countries in 1992 and 2005, each country performed better in 2005. In contrast, U.S. data on science knowledge do not show upward trends over the same period. In Europe, as in the United States, men, younger adults, and more highly educated people tend to score higher on these questions.

Reasoning and Understanding the Scientific Process

Another indicator of public understanding of science focuses on understanding of how S&T generates and assesses scientific evidence, rather than knowledge of particular facts. Past NSF surveys have used questions on three general topics—probability, experimental design, and the scientific method—to assess trends in Americans' understanding of the process of scientific inquiry. One set of questions tests how well respondents apply the principles of probabilistic reasoning to a series of questions about a couple whose children have a one in four chance of suffering from an inherited disease.[24] A second set of questions deals with the logic of experimental design, asking respondents about the best way to design a test of a new drug for high blood pressure. A third, open-ended question probes what respondents think it means to "study something scientifically." Because probability, experimental design, and the scientific method are all central to scientific research, these questions are relevant to how respondents evaluate scientific evidence. These measures are reviewed separately and then as a combined indicator of public understanding about scientific inquiry (table 7-10; appendix table 7-13).

In 2010, two-thirds of Americans correctly responded to two questions about probability of a child's genetic inheritance of illness. Understanding of probability has been fairly stable over time, with the percentage giving a correct response ranging from 64% to 69% since 1999. About half (51%) of Americans correctly identified the concept of using an experimental design or control group in the context of a medical study in 2010. This represents a marked increase in

Table 7-9
Correct answers to factual knowledge questions in physical and biological sciences, by country/region: Most recent year
(Percent giving correct answer)

Question	United States[a] (2010) (*n* = 1,932)	South Korea (2004) (*n* = 1,000)	EU (2005) (*n* =16,029)	Japan (2001) (*n* = 2,146)	Malaysia (2008) (*n* = 18,447)	India (2004) (*n* = 30,255)	China (2007) (*n* = 10,059)	Russia (2003) (*n* = 2,107)
Physical science								
The center of the Earth is very hot. (True)	84	87	86	77	66	57	49	NA
The continents have been moving their location for millions of years and will continue to move. (True)	80	87	87	83	44	32	44	40
Does the Earth go around the Sun, or does the Sun go around the Earth? (Earth around Sun)	73	86	66	NA	72	70	78	NA
All radioactivity is man-made. (False)	67	48	59	56	14	NA	40	35
Electrons are smaller than atoms. (True)	51	46	46	30	33	30	22	44
Lasers work by focusing sound waves. (False)	47	31	47	28	16	NA	20	24
The universe began with a huge explosion. (True)	38	67	NA	63	NA	34	22	35
Biological science								
The cloning of living things produces genetically identical copies. (True)	80	NA	68	NA	53	NA	NA	NA
It is the father's gene that decides whether the baby is a boy or a girl.[b] (True)	61	59	64	25	40	38	55	22
Ordinary tomatoes do not contain genes, while genetically modified tomatoes do.[c] (False)	47	NA	41	NA	NA	NA	NA	22
Antibiotics kill viruses as well as bacteria. (False)	50	30	46	23	8	39	21	18
Human beings, as we know them today, developed from earlier species of animals. (True)	47	64	70	78	NA	56	69	44

NA = not available, question not asked

EU = European Union; data not available for Bulgaria and Romania

[a]See appendix table 7-9 for U.S. trends.
[b]China and Europe surveys asked about "mother's gene" instead of "father's gene."
[c]Russia survey asked about "ordinary plants" instead of "ordinary tomatoes."

SOURCES: United States–University of Chicago, National Opinion Research Center, General Social Survey (2010); South Korea–Korea Science Foundation (now Korea Foundation for the Advancement of Science and Creativity), Survey of Public Attitudes Toward and Understanding of Science and Technology (2004); EU–European Commission, Eurobarometer 224/Wave 63.1: *Europeans, Science and Technology* (2005), and Eurobarometer 224/Wave 64.3: *Europeans and Biotechnology in 2005: Patterns and Trends* (2006); Japan–National Institute of Science and Technology Policy/Ministry of Education, Culture, Sports, Science and Technology, Survey of Public Attitudes Toward and Understanding of Science and Technology in Japan (2001); Malaysia–Malaysian Science and Technology Information Centre/Ministry of Science, Technology and Innovation, Survey of the Public's Awareness of Science and Technology: Malaysia (2008); India–National Council of Applied Economic Research, National Science Survey (2004); China–Chinese Association for Science and Technology/China Research Institute for Science Popularization, Chinese National Survey of Public Scientific Literacy (2007); Russia–Gokhberg L and Shuvalova O, *Russian Public Opinion of the Knowledge Economy: Science, Innovation, Information Technology and Education as Drivers of Economic Growth and Quality of Life,* British Council, Russia (2004).

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understanding from 38% in 2008 (table 7-10; appendix table 7-13).[25] Understanding of what it means to study something scientifically is considerably lower, at 18% in 2010. Correct responses on this question are lower, in part, because the task of expressing a concept in one's own words is more difficult than recognizing a correct response to a multiple-choice style closed-ended survey question. Correct responses on these questions have ranged from a low of 18% in 2010 to a high of 26% in 2001.

Taken together, 42% of Americans exhibit an understanding of scientific inquiry in 2010, up from 36% in 2008.[26] As was found for factual science knowledge, public understanding of scientific inquiry is strongly associated with people's level of formal schooling and the number of science and mathematics courses completed. Among those who have no more than a high school education, 23% are able to provide a correct response on the measure of understanding scientific inquiry. Understanding of scientific inquiry is somewhat higher among college attendees who did not take college-level science or mathematics courses. However, it is notably higher (71% correct) among individuals who completed at least three science and mathematics courses in college (figure 7-10; appendix table 7-14).

Americans age 65 and older score lower than younger adults on the scientific process measures. The differences are greatest on understanding of an experimental or control group design and on the open-ended questions about the meaning of scientific study. These differences may be related to the lower levels of formal education among older generations in the United States. The same pattern was found for factual science knowledge.

Unlike the patterns found on factual knowledge, particularly on facts related to the physical sciences, men and women obtain similar scores on understanding of scientific inquiry (figure 7-10; appendix table 7-14).

Comparisons of Adult and K-12 Student Understanding

The 2008 GSS included several additional questions on the scientific process that provide an opportunity to examine Americans' understanding of experimental design in more detail. From 29% to 57% of Americans responded correctly to questions measuring the concepts of scientific experiment and controlling variables, only 12% responded correctly to all the questions on this topic, and nearly 20% of Americans did not respond correctly to any of them (appendix table 7-15). These data raise questions about how well Americans can reliably apply a generalized understanding of experimental design across different situations.

Table 7-10
Correct answers to scientific process questions: Selected years, 1999–2010
(Percent)

Question	1999 (*n* = 1,882)	2001 (*n* = 1,574)	2004 (*n* = 2,025)	2006 (*n* = 1,864)	2008 (*n* = 2,021)	2010 (*n* = 1,454)
Understanding of scientific inquiry scale[a]	32	40	39	41	36	42
Components of understanding scientific inquiry scale						
Understanding of probability[b]	64	67	64	69	64	66
Understanding of experiment[c]	34	40	46	42	38	51
Understanding of scientific study[d]	21	26	23	25	23	18

[a]To be classified as understanding scientific inquiry, survey respondent had to (1) answer correctly the two probability questions stated in footnote b and (2) either provide "theory-testing" response to open-ended question about what it means to study something scientifically (see footnote d) or correct response to open-ended question about experiment, i.e., explain why it is better to test a drug using a control group (see footnote c).

[b]To be classified as understanding probability, survey respondent had to answer correctly *A doctor tells a couple that their genetic makeup means that they've got one in four chances of having a child with an inherited illness.* (1) *Does this mean that if their first child has the illness, the next three will not have the illness?* (No); and (2) *Does this mean that each of the couple's children will have the same risk of suffering from the illness?* (Yes).

[c]To be classified as understanding experiment, survey respondent had to answer correctly (1) *Two scientists want to know if a certain drug is effective against high blood pressure. The first scientist wants to give the drug to 1,000 people with high blood pressure and see how many of them experience lower blood pressure levels. The second scientist wants to give the drug to 500 people with high blood pressure and not give the drug to another 500 people with high blood pressure, and see how many in both groups experience lower blood pressure levels. Which is the better way to test this drug?* and (2) *Why is it better to test the drug this way?* (The second way because a control group is used for comparison.)

[d]To be classified as understanding scientific study, survey respondent had to answer correctly (1) *When you read news stories, you see certain sets of words and terms. We are interested in how many people recognize certain kinds of terms. First, some articles refer to the results of a scientific study. When you read or hear the term scientific study, do you have a clear understanding of what it means, a general sense of what it means, or little understanding of what it means?* and (2) (If "clear understanding" or "general sense" response) *In your own words, could you tell me what it means to study something scientifically?* (Formulation of theories/test hypothesis, experiments/control group, or rigorous/systematic comparison.)

NOTES: Data reflect percentage giving a correct response to each concept. "Don't know" responses and refusals to respond counted as incorrect and not shown. See appendix table 7-13 for more detail on probability questions and for years prior to 1999.

SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (1999, 2001); University of Michigan, Survey of Consumer Attitudes (2004); and University of Chicago, National Opinion Research Center, General Social Survey (2006, 2008, 2010).

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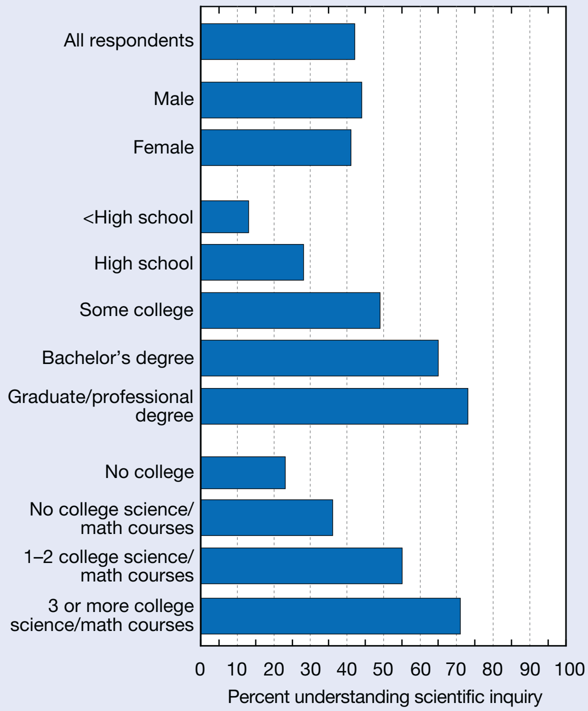
Figure 7-10
Understanding scientific inquiry, by respondent characteristic: 2010



NOTES: See appendix table 7-13 for explanation of understanding scientific inquiry and questions included in the index. See appendix table 7-14 for additional respondent characteristics.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2010).

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These questions allow a comparison between adults' understanding of experimentation and that of middle school students tested on the exact same questions. Out of the three experimental knowledge questions where direct comparison is possible, adults' scores are similar to a national sample of middle school students on one question, but lower on two others (appendix table 7-16).

Other Indicators of Public Knowledge and Understanding About S&T

The trend factual knowledge and process understanding questions are both indicators used to gauge public knowledge and understanding about S&T over time. These are but two of the potential indicators that might be useful, however (Miller 1998). A handful of other approaches have been used in recent years. These are reviewed briefly below. One provides an alternative measure of factual public knowledge about science that is rooted in national standards for what students are expected to know about science. Other approaches include indicators of understanding about statistics and the interpretation of charts, as well as indicators of the ability to distinguish between science and pseudoscience. Taken together, these approaches provide a more complete portrait of public understanding about S&T. Other approaches are currently being developed that seek to add indicators of the understanding of science as it applies to everyday life and measure public understanding of institutions and how they influence the development of S&T. (See sidebar, "Public Understanding of Science and Its Role in Everyday Life.")

National Standards and Applying Science Knowledge to Specific Problems

Recently devised measures developed in light of national standards for what students should know about scientific topics provide additional information about public knowledge and understanding. These standards go beyond the factual knowledge questions that have been used to measure trends in public knowledge of science on NSF surveys since 1979 and often include the ability to apply science knowledge to specific problems. Questions of this kind were administered as part of the 2008 GSS and were reported in NSB 2010. The 2008 GSS questions were selected from Project 2061, an initiative by the American Association for the Advancement of Science (AAAS) that develops assessment materials aligned with current curricular standards, and from three national exams administered to students.[27] The series of questions included nine factual questions, two questions that measured chart reading and the statistical concept of a "mean," and five questions that tested reasoning and understanding of the scientific process. Two of the 16 questions were open-ended and the rest were multiple-choice. (For details on the measures, see appendix table 7-17.[28])

Respondents who answered these additional factual knowledge questions correctly (on the "scale 2" index reflecting national standards) also tended to answer the trend factual knowledge questions correctly. This suggests that the trend factual knowledge questions are a reasonable indicator of the type of knowledge students are tested on in national assessments (appendix table 7-18).

Understanding of Statistics and Charts

Americans encounter basic statistics and charts in everyday life. Many media reports cite studies in health, social, economic, and political trends. Understanding statistical concepts is important to understanding the meaning of these studies and, consequently, to scientific literacy (Crettaz von Roten 2006). One test of these concepts included on the 2008 GSS found that 74% of Americans could read a simple chart correctly and 66% understood the concept of "mean" in statistics. Understanding these two concepts was associated with both formal education and the number of math and science courses taken. Older respondents were less likely than younger adults to respond correctly to these two questions. Men and women were about equally likely to answer these questions correctly (appendix table 7-15).

Public Understanding of Science and Its Role in Everyday Life

Indicators of public understanding about S&T can serve many purposes. NSF held two workshops in fall 2010 with social science experts from multiple disciplines and backgrounds to review how best to conceptualize and measure public understanding of science and engineering (Guterbock et al. 2010; Toumey et al. 2010). The workshop participants endorsed the past measures reported by NSF as useful indicators of public understanding and suggested approaches for developing additional or improved indicators. The workshop participants also endorsed the need to monitor and evaluate all indicators on an ongoing basis so that adjustments to the indicators can be implemented when needed.

The NSF-sponsored workshops identified three key functions of public knowledge about S&T. First, knowledge facilitates civic engagement with science, particularly when technologies raise emerging issues that intersect science and society. Examples of these kinds of situations include public debates at the local, state, or national levels about nuclear power and nuclear waste disposal, and debates about the role and funding of embryonic stem cell research. Second, knowledge facilitates decisionmaking in everyday life, particularly when S&T intersects with citizens' work, home, and leisure activities. Some examples include knowledge about antibiotic medications and their appropriate usage, and the principles of heat and electricity as they relate to home use. A third function of science knowledge is broadly framed as knowledge for the sake of knowing more about the world and how it works, addressing human curiosity in ways that go beyond instrumental needs for practical knowledge. This three-part framework for the role and function of public knowledge about S&T helps inform the standards against which one can judge the kinds of knowledge that are important for citizens to hold and whether the public knows "enough" about science for these three purposes.

Three different types of knowledge were identified: factual science knowledge, knowledge of scientific processes and standards for evaluating scientific evidence, and knowledge about the institutions that play a role in scientific development and how those institutions operate (also see Shen 1975). NSF surveys have included measures of both factual science knowledge and understanding of scientific processes for a number of years. Indicators of how well the public understands the workings of institutions engaged in S&T development have not been included in past NSF surveys. Research by Bauer, Petkova, and Boyadjieva (2000) developed one set of measures along these lines in surveys of the British and Bulgarian publics.

Apart from evaluating the purposes and function of the NSF indicators of public knowledge, the workshops also raised additional questions for social scientists to explore, such as research on the kinds of things that motivate greater learning about S&T and a better understanding of how such adult learning occurs.

Pseudoscience

Another indicator of public understanding about S&T comes from measuring the public's capacity to distinguish science from pseudoscience. One such indicator, on astrology, is available over time on the NSF surveys conducted since 1979. Recent surveys show a downward trend toward fewer Americans considering astrology as scientific. In the 2010 GSS, 62% of Americans indicated that they believe that astrology is "not at all scientific," 28% said that it is "sort of scientific," and just 6% considered it "very scientific." Respondents with more years of formal education were less likely to perceive astrology to be at all scientific. In 2010, 78% of college graduates indicated that astrology is "not at all scientific," compared with 58% of high school graduates. Those who scored highest on the factual knowledge measures were less likely to perceive astrology to be at all scientific (79%) than those who scored lowest (52%). Respondents who correctly understood the concept of scientific inquiry were more likely to say that astrology is "not at all scientific" (73%) than those who did not understand the concept (54%). However, the youngest age group (18–24) was less likely to say astrology is "not at all scientific" (46%) and more likely to say it is "very" or "sort of scientific" (54%) (appendix table 7-19).[29]

Public Attitudes About S&T in General

Public support for S&T can make a difference in many ways. Public openness to technological change can give U.S. businesses opportunities to build a domestic customer base, create a foundation for worldwide technological competitiveness, and foster the national advantages that flow from pioneering innovations. Broad public and political support for long-term commitments to S&T research, especially in the face of pressing immediate needs, facilitates ambitious proposals for sustained federal S&T investments to reach fruition. Public confidence that S&E community leaders are trustworthy, S&T research findings are reliable, and S&E experts bring valuable judgment and knowledge to bear on public issues encourages reliance on scientific knowledge in practical affairs. In addition, positive public perceptions of S&E occupations encourage young people to pursue S&E careers.

This section presents general indicators of public attitudes and orientations toward S&T in the United States and other countries. It covers views of the promise of S&T and reservations about science, overall support for government funding of research, confidence in scientific community leaders, perceptions of the proper influence of scientists on controversial public issues about which the research community claims expertise, and views of S&E as occupations.

Promise and Reservations About S&T

A majority of Americans see science as having, on balance, a positive effect on society and regard scientists and engineers as contributing to the well-being of society. At the same time, a majority of Americans also express reservations about the role of S&T in society.

NSF surveys dating back to 1979 show that roughly seven in ten Americans see the effects of scientific research, in general, as more positive than negative for society. In 2010, 46% of GSS respondents said the benefits of scientific research strongly outweigh the harmful results, and 23% said that benefits slightly outweigh harms. Only 9% of respondents said the harms either slightly or strongly outweigh the benefits. Of the remaining respondents, 14% volunteered that the two are about equal and 8% gave no response. These numbers are generally consistent with earlier surveys; those saying the benefits strongly or slightly outweigh the harmful results ranged from 68% to 79% over the 30-year survey period (figure 7-11; appendix table 7-20). In practically any major American social grouping, few individuals express strong doubt about the benefits of science.

Americans overwhelmingly agree that S&T will foster "more opportunities for the next generation" (appendix table 7-21). Agreement with this statement has been increasing moderately for more than a decade; nine in ten Americans agreed in 2010.[30]

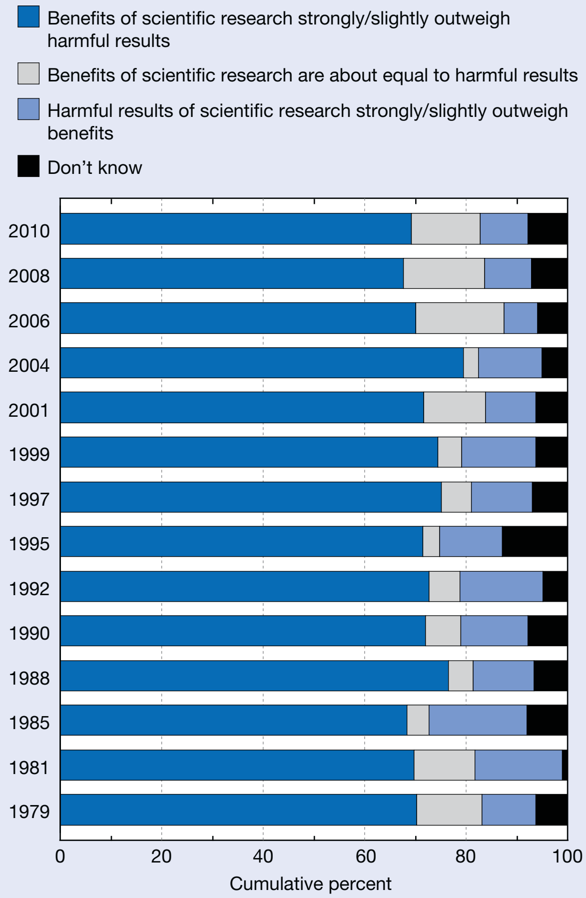
The annual VCU Life Sciences Surveys show similar results. The percentage of Americans who agreed that "developments in science helped make society better" ranged from 83% to 87% over the past decade, with about half of the public (48%) saying that science helped make society "a lot" better in 2010 and 34% saying it made society "somewhat better." Similarly, between 2002 and 2010, the surveys asked respondents whether they believed that "scientific research is essential for improving the quality of human lives" and found that agreement ranged between 87% and 92% (VCU 2010). During the same period, between 88% and 92% of respondents agreed that "new technology used in medicine allows people to live longer and better."

A survey conducted by the Pew Research Center for the People and the Press (2009a) also demonstrates a strong public regard for the benefits to society from S&E. Respondents considered a series of occupational groups and rated each in terms of their contribution to the well-being of society. Seven in ten Americans said that scientists contribute "a lot" to the well-being of our society; 64% said the same about engineers. Medical doctors were evaluated similarly, with 69% of respondents saying they contribute a lot to society. Only the military and teachers were considered by more Americans to contribute a lot to society (table 7-11).

What kinds of contributions do Americans have in mind? The Pew Research Center survey asked respondents to express, in their own words, some of the ways science has had a positive effect on society. More than half of all responses referred to medical contributions: 32% of responses referred to general improvements in healthcare and medicine and 24% referred to specific vaccines and disease research. Other responses were less common. These included space exploration (8% of responses), the environment (7% of responses), and communication and computer technologies (7% of responses).

Americans who have more years of formal education and score higher on measures of science knowledge express

Figure 7-11
Public assessment of scientific research: 1979–2010



NOTES: Responses to *People have frequently noted that scientific research has produced benefits and harmful results. Would you say that, on balance, the benefits of scientific research have outweighed the harmful results, or have the harmful results of scientific research been greater than its benefits?* In this figure, "benefits outweigh harmful results" and "harmful results outweigh benefits" each combine responses of "strongly outweigh" and "slightly outweigh." Figure includes all years for which data collected. Detail may not add to total because of rounding.

SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (1979–2001); University of Michigan, Survey of Consumer Attitudes (2004); University of Chicago, National Opinion Research Center, General Social Survey (2006, 2008, 2010). See appendix tables 7-20 and 7-23.

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Table 7-11
Public perceptions of various groups' contributions to the well-being of society: 2009
(Percent)

Occupational group	A lot	Some	Not very much	Nothing at all	Don't know
Members of the military	84	11	3	1	1
Teachers	77	17	3	1	2
Scientists	70	23	3	2	3
Medical doctors	69	24	4	1	2
Engineers	64	25	4	2	5
Clergy	40	37	10	5	9
Journalists	38	41	13	4	4
Artists	31	43	15	7	4
Lawyers	23	46	18	9	5
Business executives	21	43	22	9	5

NOTES: Responses to *Thinking about some different professions, how much do you think the following contribute to the well-being of our society? Do [people in occupational group] contribute a lot, some, not very much, or nothing at all to the well-being of our society?* Detail may not add to total because of rounding.

SOURCE: Pew Research Center for the People and the Press, *Public Praises Science: Scientists Fault Public, Media* (9 July 2009), http://people-press.org/report/528/, accessed 6 January 2011.

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more favorable attitudes about S&T. A review of numerous surveys from around the world found—other things being equal—a weak but consistent relationship between greater knowledge of science and more favorable attitudes toward science. This relationship was stronger in the United States than in any of the other countries in the study (Allum et al. 2008). (For more details, see NSB 2008.)

Americans also express reservations about S&T. The VCU Life Sciences Surveys found that a majority of Americans agree that "scientific research these days doesn't pay enough attention to the moral values of society." In 2010, 58% of respondents agreed with this statement and 35% disagreed; however, the percentage that agreed has dropped substantially, from a high of 73% in 2001. Majorities or near majorities agree with statements expressing reservations about science in other surveys, as well. For example, in the 2010 GSS, about half (51%) agreed that "science makes our way of life change too fast"; 47% disagreed. Men and women are about equally likely to express reservations about science. Those expressing fewer reservations about science on this statement tend to have more formal education, more science and math education, and more factual knowledge of science (appendix table 7-22).

International Comparisons

International surveys also indicate strong public support for S&T. Although data from other countries are not entirely comparable, they appear to indicate that Americans hold at least equally or somewhat more positive attitudes about the benefits of S&T than Europeans, Russians, and Japanese. Attitudes in China and South Korea are comparable with the United States; on some questions, attitudes are even more favorable, but reservations about science are somewhat higher in China and South Korea as well (appendix table 7-23). Attitudes about S&T have grown increasingly positive in Malaysia over recent years; in 2008, 74% of Malaysians agreed that scientific research has more positive than negative effects, up from 45% in 1998. In all of the countries and regions where survey data exist, statements about the achievements and promise of science elicit substantially more agreement than disagreement.

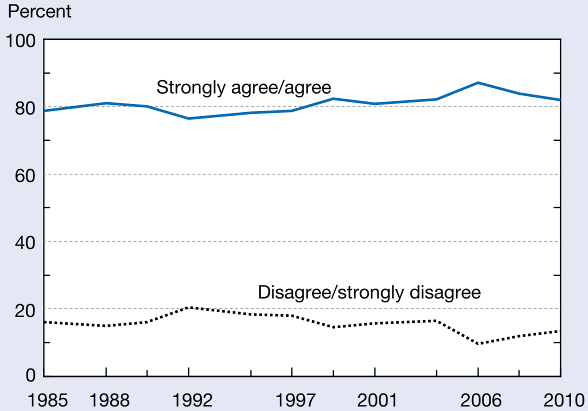
As in the United States, respondents abroad also express reservations about S&T. Numerous international surveys have asked for agreement or disagreement with a statement that "science makes our way of life change too fast" (appendix table 7-23). Levels of agreement with this statement appear to be lower in the United States than in several other countries, although there are large differences of viewpoint across European nations.

Federal Funding of Scientific Research

U.S. public opinion consistently and strongly supports federal spending on basic research. Since 1985, NSF surveys have asked Americans whether, "even if it brings no immediate benefits, scientific research that advances the frontiers of knowledge is necessary and should be supported by the federal government." In 2010, 82% agreed or strongly agreed with this statement; 14% disagreed. Agreement with this statement has ranged from a low of 76% in 1992 to a high of 87% in 2006 (figure 7-12; appendix tables 7-24 and 7-25).

The 2009 Pew Research Center Survey found that nearly three-quarters of Americans express support for federal spending on S&E. Asked whether government investments "usually pay off in the long run," or are "not worth it," 73% said spending on basic scientific research "usually pays off in the long run"; 74% said the same about engineering and technology. Furthermore, six in ten Americans said "government investment in research is essential for scientific

Figure 7-12
Public opinion on whether government should fund basic scientific research: 1985–2010



NOTES: Responses to *Even if it brings no immediate benefits, scientific research that advances the frontiers of knowledge is necessary and should be supported by the federal government. Do you strongly agree, agree, disagree, or strongly disagree?* Responses of "don't know" not shown. Survey results in 1985, 1988, 1990, 1992, 1995, 1997, 1999, 2001, 2004, 2006, 2008, and 2010; other years extrapolated.

SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (years through 2001); University of Michigan, Survey of Consumer Attitudes (2004); University of Chicago, National Opinion Research Center, General Social Survey (2006, 2008, 2010). See appendix tables 7-24 and 7-25.

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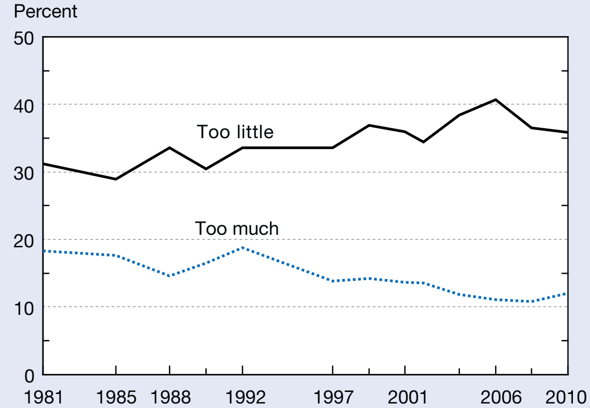
Figure 7-13
Public assessment of amount of government spending for scientific research: 1981–2010



NOTES: Responses to *We are faced with many problems in this country, none of which can be solved easily or inexpensively. I'm going to name some of these problems, and for each one, I'd like you to tell me if you think that the government is spending too little money on it, about the right amount, or too much: [scientific research].* Responses of "right amount" and "don't know" not shown. Survey results in 1981, 1985, 1988, 1990, 1992, 1997, 1999, 2001, 2002, 2004, 2006, 2008, and 2010; other years extrapolated.

SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (1981–2001); University of Chicago, National Opinion Research Center, General Social Survey (2002–10). See appendix table 7-26.

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progress," 29% said "private investment will ensure that enough scientific progress is made, even without government investment," and the remainder gave no response.

Another indicator, the proportion of Americans who thought the government was spending too little on scientific research, increased from 1981 to 2006, fluctuating between 29% and 34% in the 1980s, between 30% and 37% in the 1990s, and between 34% and 41% in the 2000s. In 2010, 36% of respondents said government spending on scientific research was "too little," 47% said it was "about right," and 12% said it was "too much" (figures 7-13 and 7-14; appendix table 7-26). Support for increased government spending is greater for a number of other program areas, with the highest support for spending on education (74%). About six in ten Americans say government should spend more on developing alternative energy sources (61%), assistance to the poor (61%), health (58%), and environmental protection (57%). Support for increased spending in other areas is lower. Support for increased spending on scientific research (36%) is roughly comparable to that for spending on improving mass transportation (40%) and parks and recreation (32%). Still, based on the proportion of the U.S. population favoring increased spending, scientific research garners more support than spending in national defense (25%), space exploration (16%), and assistance to foreign countries (8%).[31]

A more recent survey by the Pew Research Center (2011a) suggests that the economic downturn of recent years and other factors have dampened Americans' appetite for increased government spending in a number of areas. In the Pew Research Center survey, public support for increasing spending on scientific research was 36%, down from 39% in 2009; support for decreasing scientific research spending was 23% in 2011, up from 14% in 2009.

International Comparisons

In other countries where similar though not precisely comparable questions have been asked, respondents also express strong support for government spending on basic scientific research. In 2010, 72% of Europeans agreed that "even if it brings no immediate benefits, scientific research which adds to knowledge should be supported by government," and only 9% disagreed. In 2007, 74% of Chinese agreed to a similar statement. These percentages may be lower because of a difference in question wording, however. Both the European survey and the Chinese survey offered a middle option ("neither agree nor disagree"), whereas no middle category was offered in the United States (appendix table 7-23). Agreement in South Korea, Malaysia, Japan, and Brazil is comparable to that in the United States and Europe.

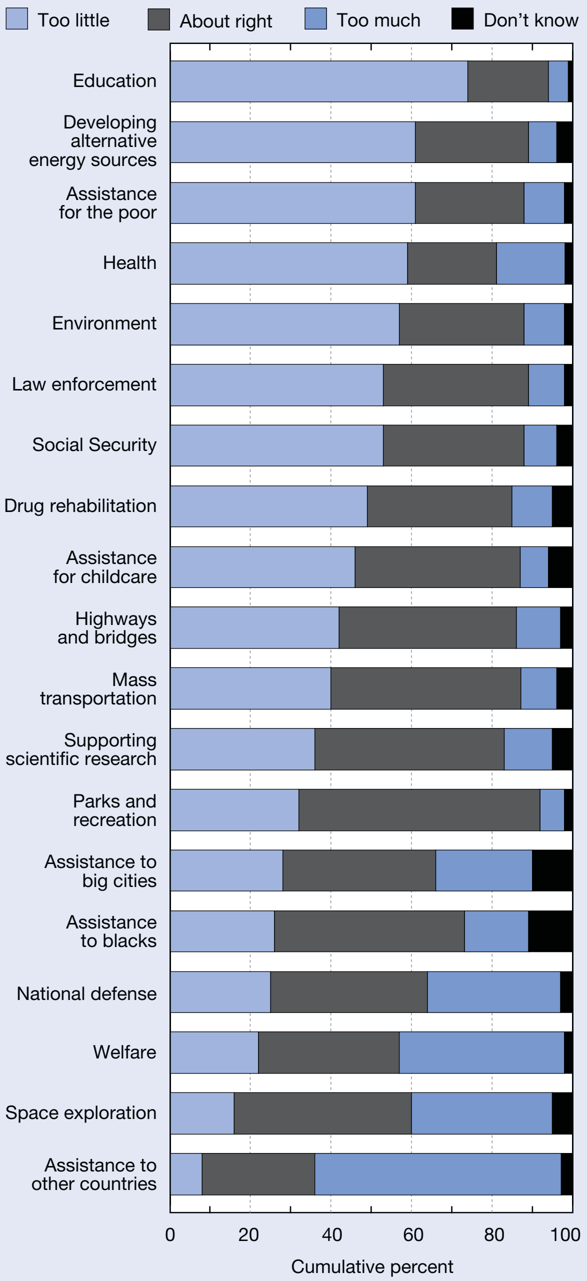
Confidence in the Science Community's Leadership

For the science-related decisions that citizens face, a comprehensive understanding of the relevant scientific research would require mastery and evaluation of a great deal of evidence. In addition to relying on direct evidence from scientific studies, citizens who want to draw on scientific evidence may consult the judgments of leaders and other experts who they believe can speak authoritatively about the scientific knowledge that is relevant to an issue.

Public confidence in leaders of the scientific community is one indicator of public willingness to rely on science. Since 1973, the GSS has tracked public confidence in the leadership of various institutions, including the scientific community. The GSS asks respondents whether they have "a great deal of confidence," "only some confidence," or "hardly any confidence at all" in the leaders of different institutions. In 2010, four in ten Americans expressed "a great deal of confidence" in leaders of the scientific community, nearly half (49%) expressed "some confidence," and fewer than one in ten (7%) expressed "hardly any confidence at all" in the scientific community (figure 7-15; appendix table 7-27).

About the same proportion expressed "a great deal of confidence" in leaders of the medical community (41%) as in leaders of the scientific community. The military was the

Figure 7-14
Public attitudes toward government spending in various policy areas: 2010



NOTE: Responses to: *We are faced with many problems in this country, none of which can be solved easily or inexpensively. I'm going to name some of these problems, and for each one I'd like you to tell me if you think that the government is spending too little money on it, about the right amount, or too much.*

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2010). See appendix table 7-26.

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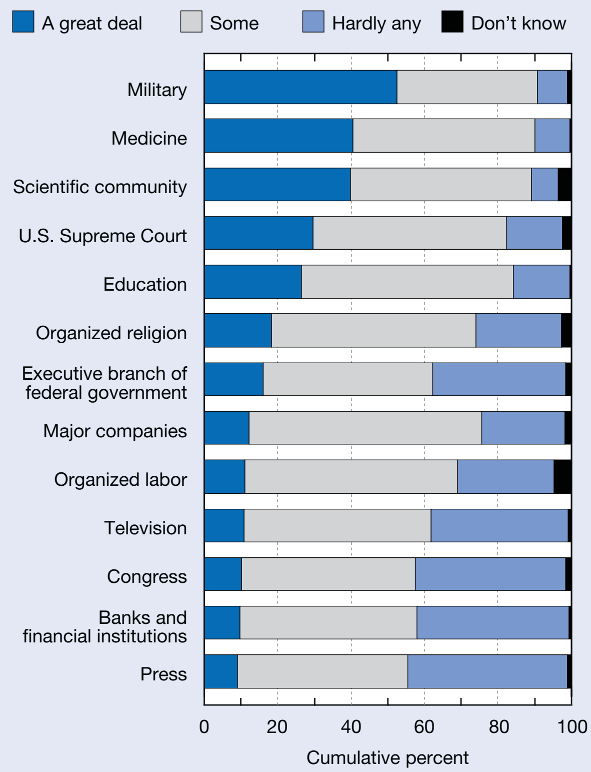
Figure 7-15
Public confidence in institutional leaders, by type of institution: 2010



NOTE: Responses to *As far as the people running these institutions are concerned, would you say that you have a great deal of confidence, only some confidence, or hardly any confidence at all in them?*

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2010). See appendix table 7-27.

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only institution with higher levels of expressed confidence (52%). This pattern is consistent with past surveys where science usually ranked second or third in public confidence, with medicine or the military ranking first. The consistently high confidence in the leadership of the scientific community contrasts with views of other institutional leaders over the years. For example, confidence in the military has fluctuated more widely over the past three decades. The medical community has seen a long-term decline in confidence during the 1970s and 1980s. More than half of Americans expressed a great deal of confidence in medical leaders in the mid-1970s, compared to about 40% in recent years. Thirty years ago, confidence in the medical community was higher than confidence in scientific leaders. However, during the past decade, the public was about equally likely to express confidence in medical and scientific leaders.

Influence of Scientific Experts on Public Issues

Government support for scientific research derives partly from the notion that science can support policymakers in shaping many public decisions. Science can play this role more effectively if the general public supports the use of scientific knowledge in such decisions and shares the view that science is relevant.

In 2006 and 2010, the GSS asked about the appropriate influence of science on four public policy issues to which scientific research might be considered relevant. In 2010, those issues were global climate change,[32] research using human embryonic stem cells, federal income taxes, and nuclear power.[33] In 2006, those issues included GM foods but not nuclear power. Survey respondents were asked how much influence a group of scientists or engineers with relevant expertise (e.g., medical researchers, economists, nuclear engineers) should have in deciding about each issue, how well the experts understood the issue, and to what extent each would "support what is best for the country as a whole versus what serves their own narrow interests." The same questions were asked about elected officials and either religious leaders (for stem cell research) or business leaders (for the other issues). Thus, the questions allow a comparison among leadership groups at a single point in time as well as a comparison of perceptions about occupational groups over time.

The GSS data indicate that most Americans believe that scientists and engineers should have either a "great deal" or "a fair amount" of influence on these public decisions. Relative to other groups, more say that scientists and engineers should have a great deal of influence about these issues than say the same about other groups when it comes to global warming, stem cell research, nuclear power, and GM foods (table 7-12).

The only exception to that pattern was found on tax issues. When it comes to decisions about reducing federal income taxes, 18% said that economists should have "a great deal" of influence and 23% said the same about elected officials. Both the 2006 GSS and the 2010 GSS found the same patterns in Americans' preferences about each group's influence on these public issues (see appendix table 7-28).

Americans also gave scientists relatively high marks for understanding each issue, a pattern that underscores the perception of scientists and engineers as experts in these areas (table 7-13). The GSS asked respondents to rate each leadership group's understanding of a largely factual aspect of each issue on a 5-point scale ranging from "very well" to "not at all." For the issues dealing with biological or geophysical phenomena, the differences in perceived understanding were significant: between 27% and 58% of the public placed the relevant S&E group in the top category of understanding, whereas only 3% to 16% placed any of the other groups in that category. The contrast among groups was smallest for the tax issue, with economists (27%) ranking ahead of business leaders (16%) and elected officials (10%) as understanding the likely effects of reducing federal income taxes "very well." The same patterns were found in 2006 and 2010 (see appendix table 7-29).

Perceptions of impartiality in judgments about these issues may also influence preferences about the role of leadership groups in public issue debates and decisions. When asked which groups would "support what is best for the country as a whole versus what serves their own narrow interests," the patterns were similar, with more Americans saying the relevant S&E group would support what is best for the country than saying the same about other leadership groups. For all issues, S&E groups were more likely to be seen as supporting what is best for the country than other leadership groups (table 7-14; appendix table 7-30).

One factor that may limit the influence of scientific knowledge and the scientific community on public issues is the perception that significant scientific disagreement exists, making scientific knowledge uncertain (Krosnick et al. 2006). GSS respondents were asked to rate the degree of scientific consensus on a largely factual aspect of each of the issues using a 5-point scale ranging from "near complete agreement" to "no agreement at all." The degree of perceived consensus was highest for medical researchers on "the importance of stem cells for research" (58% rated this group at one of the two points nearest the "complete agreement" scale point.) A 53% majority also saw nuclear engineers as at or near complete agreement about "the risks and benefits of using nuclear power to generate electricity." About four in ten (38%) gave the same level of rating for perceived consensus to environmental scientists on "the existence and causes of global warming." Lower proportions of respondents chose one of these two points when asked about the extent to which medical researchers agree on "the risks and benefits of genetically modified foods" in 2006 (28%), or economists on "the effects of reducing federal income taxes" in 2010 (21%) (table 7-15; appendix table 7-31). (See sidebar, "Differences Between Scientists and the Public on S&T-related Issues," for more perceptions of scientific consensus.)

Table 7-12
Public preferences about various groups' influence on decisions about public issues: 2010 or most recent year
(Percent and mean score)

Public issue/group	Preferred degree of influence					
	A great deal	A fair amount	A little	None at all	Don't know	Mean score
Global warming: deciding what to do about global warming policy						
Environmental scientists	48	37	9	3	3	3.3
Elected officials	12	35	34	17	3	2.4
Business leaders	8	22	40	27	3	2.1
Genetically modified (GM) foods: deciding whether to restrict the sale of GM foods						
Medical researchers	41	40	10	3	5	3.3
Elected officials	7	30	37	21	5	2.2
Business leaders	3	16	41	35	5	1.9
Stem cell research: deciding about government funding for stem cell research						
Medical researchers	41	39	11	5	4	3.2
Elected officials	9	32	34	21	4	2.3
Religious leaders	7	18	36	35	4	2.0
Nuclear power: deciding whether to expand the use of nuclear power						
Nuclear engineers	38	41	11	4	6	3.2
Elected officials	10	38	35	11	6	2.5
Business leaders	5	27	42	21	5	2.2
Federal income taxes: deciding whether to reduce federal income taxes						
Economists	18	55	18	4	6	2.9
Elected officials	23	39	24	9	5	2.8
Business leaders	11	41	33	10	5	2.6

NOTES: Responses to *How much influence should each of the following groups have in deciding: what to do about global warming policy; what to do about government funding for stem cell research; whether to reduce federal income taxes; whether to expand the use of nuclear power; whether to restrict sale of genetically modified foods?* Responses on global warming, stem cell research, federal income taxes, and nuclear power are for 2010. Responses on genetically modified foods are for 2006. Mean preferred influence score based on 4-point scale, where 4 = a great deal of influence, 3 = a fair amount, 2 = a little influence, and 1 = none at all. Detail may not add to total because of rounding.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2006, 2010). See appendix table 7-28.

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With a few exceptions, responses to these questions do not differ markedly among demographic groups. Americans with more education and more science knowledge tend to have more favorable perceptions of the knowledge, impartiality, and level of agreement among scientists.

Views of S&E Occupations

Data on public esteem for S&E occupations are an indicator of the attractiveness of these occupations and their ability to recruit talented people into their ranks. Such data may also have a bearing on the public's sense that S&E affects the nation's well-being in the future.

For more than 30 years, the Harris Poll (Harris Interactive 2009) has asked about the prestige of a large number of occupations, including scientists and engineers (table 7-16). In 2009, 57% of Americans said that scientists had "very great prestige," and 39% expressed this view about engineers. Most occupations in the surveys were rated well below engineers.[34]

The percentage of survey respondents attributing "very great prestige" to scientists has fluctuated narrowly between 52% and 57% since 2003. More Americans rated scientists as having "very great prestige" than did so for almost any other occupation considered in the Harris surveys. In recent years, their rating was comparable to that of nurses, doctors, firefighters, and teachers, and ahead of military and police officers. In 2009, it was second only to firefighters.

Engineers' standing is comparable to occupations clustered just below the top group of occupations rated (including clergy, military officers, farmers, and police officers). A plurality of Americans said engineers have "very great prestige"; this figure has fluctuated between a low of 28% in 2003 and a high of 40% in 2008, and was about the same in 2009, at 39%.

The relative ratings of each occupation are, of course, dependent on the set of occupations considered on the surveys. Prestige appears to reflect perceived service orientation and public benefit more than high income or celebrity; for

Table 7-13
Public perceptions of various groups' understanding of public issues: 2010 or most recent year
(Percent and mean score)

Public issue/group	Degree of understanding (on scale of 1 to 5): Very well 5	4	3	2	Not at all 1	Don't know	Mean score
Nuclear power: understand the likely effects of using nuclear power to generate electricity							
Nuclear engineers	58	18	11	4	3	5	4.3
Elected officials	5	11	32	33	15	5	2.6
Business leaders	5	11	32	30	17	5	2.5
Stem cell research: understand stem cell research							
Medical researchers	49	26	14	3	2	5	4.2
Elected officials	4	7	34	28	24	5	2.4
Religious leaders	5	6	27	28	29	5	2.3
Global warming: understand the causes of global warming							
Environmental scientists	40	20	21	10	6	4	3.8
Elected officials	5	10	28	26	26	4	2.4
Business leaders	4	9	29	28	26	4	2.3
Genetically modified foods: understand the risks posed by genetically modified foods							
Medical researchers	32	32	18	8	5	6	3.8
Elected officials	3	6	24	33	29	5	2.2
Business leaders	4	7	24	31	28	6	2.2
Federal income taxes: understand the likely effects of reducing federal income taxes							
Economists	27	21	31	8	6	7	3.6
Elected officials	10	18	32	18	17	6	2.8
Business leaders	16	24	31	14	9	7	3.3

NOTES: Responses to *How well do the following groups understand: causes of global warming; stem cell research; likely effects of reducing federal income taxes; likely effects of using nuclear power to generate electricity; risks posed by genetically modified foods?* Responses on global warming, stem cell research, federal income taxes, and nuclear power are for 2010. Responses on genetically modified foods are for 2006. Mean understanding score based on 5-point scale, where 5 = understands very well and 1 = understands not at all. Detail may not add to total because of rounding.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2006, 2010). See appendix table 7-29.

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instance, fewer than two in ten Americans attributed "very great prestige" to entertainers or actors (table 7-16).

International Comparisons

Elsewhere, S&E occupations are also highly regarded. Among the Chinese in 2008, science (40%) rated close to medicine (41%) and teaching (43%) as an occupation that survey respondents hoped their children would pursue (CRISP 2008). In 2006, the majority of Israelis said they would be pleased if their children became scientists (77%), engineers (78%), or physicians (78%) (Yaar 2006). On at least one measure, Americans rated scientific careers more positively than was the case in at least some other countries. In 2004, a little more than 50% of South Koreans said they would feel happy if their son or daughter wanted to become a scientist. In the United States, 80% of those surveyed in 2001 expressed positive views regarding their children becoming scientists.

Public Attitudes About Specific S&T-Related Issues

Public attitudes can affect the speed and direction of S&T development. When science plays a substantial role in a national policy controversy, more than the specific policies under debate may be at stake. The policy debate may also shape public opinion and government decisions about investments in general categories of research. Less directly, a highly visible debate involving S&T issues may shape overall public impressions of either the credibility of science or the proper role of science in other, less visible public decisions.

Likewise, public attitudes about emerging areas of research and new technologies may have an influence on innovation. The climate of opinion concerning new research areas can influence levels of public and private investment in related technological innovations and, eventually, the adoption of new technologies and the growth of industries based on these technologies.

Table 7-14
Public perceptions of various groups' impartiality in making policy recommendations about public issues: 2010 or most recent year
(Percent and mean score)

	Extent to which group would support (on scale of 1 to 5)						
Public issue/group	What is best for country 5	4	3	2	Own narrow interests 1	Don't know	Mean score
Global warming							
Environmental scientists	42	22	18	7	7	4	3.9
Elected officials	11	10	25	22	28	4	2.5
Business leaders	6	4	24	27	34	4	2.2
Genetically modified foods							
Medical researchers	34	29	19	7	6	5	3.8
Elected officials	6	10	32	25	21	5	2.5
Business leaders	2	4	25	32	32	5	2.1
Stem cell research							
Medical researchers	30	28	21	9	7	5	3.7
Elected officials	6	10	25	26	29	4	2.4
Religious leaders	9	10	24	24	27	6	2.5
Nuclear power							
Nuclear engineers	27	28	22	9	8	6	3.6
Elected officials	8	16	32	22	17	6	2.7
Business leaders	6	9	28	28	23	6	2.4
Federal income taxes							
Economists	19	27	28	11	9	6	3.4
Elected officials	10	11	27	22	24	6	2.6
Business leaders	5	11	23	29	27	6	2.4

NOTES: Responses to *When making policy decisions about [public issue], to what extent do you think [group] would support doing what is best for the country as a whole or what serves their own narrow interests?* Responses on global warming, stem cell research, federal income taxes, and nuclear power are for 2010. Responses on genetically modified foods are for 2006. Mean impartiality score based on 5-point scale, where 5 = best for the country and 1 = own narrow interests. Detail may not add to total because of rounding.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2006, 2010). See appendix table 7-30.

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Table 7-15
Public perceptions of scientific consensus on public issues: 2010 or most recent year
(Percent and mean score)

	Degree of consensus (on scale of 1 to 5)						
Group/public issue	Near complete agreement 5	4	3	2	No agreement at all 1	Don't know	Mean score
Medical researchers on importance of stem cells for research	28	30	26	6	4	7	3.8
Nuclear engineers on risks and benefits of nuclear power to generate electricity	19	34	28	6	3	11	3.7
Environmental scientists on existence and causes of global warming	15	23	35	11	10	6	3.2
Medical researchers on risks and benefits of genetically modified foods	9	19	41	11	7	13	3.1
Economists on effects of reducing federal income taxes	5	16	38	14	15	12	2.8

NOTES: Responses to *To what extent do [people in group] agree on [public issue]?* Responses on global warming, stem cell research, federal income taxes, and nuclear power are for 2010. Responses on genetically modified foods are for 2006. Mean consensus score based on 5-point scale, where 5 = near complete agreement and 1 = no agreement at all. Detail may not add to total because of rounding.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2006, 2010). See appendix table 7-31.

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Table 7-16
Public perceptions of prestige of various occupations: Selected years, 1977–2009
(Percent saying "very great prestige")

Occupation	1977	1982	1992	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Firefighter	NA	NA	NA	NA	NA	NA	NA	NA	55	48	56	63	61	57	62
Scientist	66	59	57	51	55	56	53	51	57	52	56	54	54	56	57
Doctor	61	55	50	52	61	61	61	50	52	52	54	58	52	53	56
Nurse	NA	NA	NA	NA	NA	NA	NA	NA	47	44	50	55	50	52	54
Teacher	29	28	41	49	53	53	54	47	49	48	47	52	54	52	51
Military officer	NA	22	32	29	34	42	40	47	46	47	49	51	52	46	51
Police officer	NA	NA	34	36	41	38	37	40	42	40	40	43	46	46	44
Priest/minister/clergy	41	42	38	45	46	45	43	36	38	32	36	40	42	40	41
Engineer	34	30	37	32	34	32	36	34	28	29	34	34	30	40	39
Farmer	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	36	41	41	36
Architect	NA	NA	NA	NA	26	26	28	27	24	20	27	27	23	28	29
Member of Congress	NA	NA	24	23	25	33	24	27	30	31	26	28	26	28	28
Lawyer	36	30	25	19	23	21	18	15	17	17	18	21	22	24	26
Business executive	18	16	19	16	18	15	12	18	18	19	15	11	14	17	23
Athlete	26	20	18	21	20	21	22	21	17	21	23	23	16	20	21
Journalist	17	16	15	15	15	16	18	19	15	14	14	16	13	18	17
Union leader	NA	NA	12	14	16	16	17	14	15	16	15	12	13	18	17
Entertainer	18	16	17	18	19	21	20	19	17	16	18	18	12	15	17
Banker	17	17	17	15	18	15	16	15	14	15	15	17	10	15	16
Actor	NA	NA	NA	NA	NA	NA	NA	NA	13	16	16	12	9	16	15
Stockbroker	NA	NA	NA	NA	NA	NA	NA	NA	8	10	8	11	12	10	13
Accountant	NA	13	14	18	17	14	15	13	15	10	13	17	11	15	11
Real estate agent/broker	NA	NA	NA	NA	NA	NA	NA	NA	6	5	9	6	5	6	5

NA = not available, question not asked

NOTES: Responses to *I am going to read off a number of different occupations. For each, would you tell me if you feel it is an occupation of very great prestige, considerable prestige, some prestige, or hardly any prestige at all?* Data reflect responses of "very great prestige."

SOURCE: Harris Interactive, Firefighters, Scientists, and Doctors Seen as Most Prestigious Occupations: Real Estate Brokers, Accountants, and Stockbrokers Are at the Bottom of the List. *The Harris Poll* (#86, 4 August 2009), http://www.harrisinteractive.com/vault/Harris-Interactive-Poll-Research-Pres-Occupations-2009-08.pdf, accessed 7 February 2011.

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For these reasons, survey responses regarding controversies over policies involving science, specific research areas, and emerging technologies are relevant. In addition, responses about relatively specific matters provide insight into the practical decisions through which citizens translate more general attitudes into actions, although, like all survey responses, how these responses relate to actual behavior remains uncertain. More generally, even in democratic societies, public opinion about new S&T developments does not translate directly into actions or policy. Instead, it filters through institutions that selectively measure what the public believes and either magnify or minimize the effects of divisions in public opinion on public discourse and government policy (Jasanoff 2005). Public attitudes about specific S&T issues can differ markedly from the views of scientists. (See sidebar, "Differences Between Scientists and the Public on S&T-related Issues.")

Public attitudes toward policy issues involve a multitude of factors, not just knowledge or understanding of relevant science. Values, morals, judgments of prudence, and numerous other factors can come strongly into play; judgments about scientific fact are often secondary. In assessing the same issue, different people may find different considerations relevant.

This section discusses data on environmental issues, including global climate change, nuclear power, and energy development; cloning and stem cell research; teaching evolution in schools; agricultural biotechnology (i.e., GM food); and attitudes toward recent and novel technologies, including nanotechnology and medical biotechnology. It concludes with recent data on attitudes toward scientific research on animals and toward science and mathematics education.

Environment, Climate Change, and Energy Development

Environmental issues, such as climate change, and the closely related issue of sustainable energy sources, have become of increased salience in national policy debates and international meetings such as those at the United Nations Climate Change Conference, held in Copenhagen, Denmark in December 2009. For Americans, the April 2010 oil spill in the Gulf of Mexico further increased the salience of environmental issues—particularly the environmental hazards of offshore oil drilling—with long-running media coverage and sustained public attention (Pew Research Center 2010c).

Differences Between Scientists and the Public on S&T-related Issues

Directly comparable data on the degree to which public attitudes align with those of scientists is scarce. A study conducted by the Pew Research Center in 2009 asked the same questions of a sample of scientists belonging to the AAAS and a representative sample of the general public. The study found a striking difference between the groups across a number of specific issues including climate change, nuclear power, embryonic stem cell research, evolution, and animal research.

The public tends to underestimate the degree of consensus among scientists about evolution. Six in ten said that scientists generally agree that humans have evolved over time, and 28% said they do not generally agree about this. The survey of scientists found that 97% of scientists say that humans and other living things have evolved over time.

The public also tends to underestimate the degree of consensus among scientists about climate change; 56% said that scientists generally agree that the earth is getting warmer because of human activity, and 35% said scientists do not generally agree about this. The survey of scientists found 84% of scientists say that "the earth is getting warmer mostly because of human activity such as burning fossil fuels." A survey of earth scientists by Doran and Zimmerman (2009) also found strong consensus among scientists that the earth's temperature is rising and that human activity is "a significant contributing factor in changing mean global temperatures."

Table 7-C
Comparison of general public's and scientists' attitudes toward specific S&T-related issues: 2009
(Percent)

S&T-related issue	Scientists[a]	General public[b]
Climate change		
The earth is getting warmer due to human activity	84	49
Climate change is due to natural changes in the atmosphere	10	36
No solid evidence earth is warming	4	11
Don't know/no answer	2	4
Nuclear power		
Favor building more nuclear power plants to generate electricity	70	51
Oppose building more nuclear power plants to generate electricity	27	42
Don't know/no answer	3	7
Embryonic stem cell research		
Favor federal funding for embryonic stem cell research	93	58
Oppose federal funding for embryonic stem cell research	6	35
Don't know/no answer	1	7
Evolution		
Humans and other living things evolved over time	97	61
Humans and other living things always existed in present form	2	31
Don't know/no answer	1	8
Animal research		
Favor use of animals in scientific research	93	52
Oppose use of animals in scientific research	5	43
Don't know/no answer	2	6

[a]Survey of scientists based on sample survey of AAAS members conducted by Internet, 1 May–14 June 2009 (*n* = 2,533).
[b]Survey of general public conducted by landline and cellular telephone, 28 April–12 May 2009 (*n* = 2,001).

SOURCE: Pew Research Center for the People and the Press, 9 July 2009.

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Surveys taken shortly after the oil spill in the Gulf found increased willingness to trade off energy production for environmental protection when compared with surveys conducted before the oil spill (Jones 2010). In addition, there was decreased public support for offshore oil drilling shortly after the spill; since that time, public support has returned to previous levels (Pew Research Center 2010b).

Concern About Environmental Quality

The Gallup Organization's annual survey on environmental issues indicates that Americans were somewhat less concerned about environmental quality in 2010 and early 2011, after an increase in expressed concern between 2006 and 2008. The 2011 Gallup Poll found 34% of Americans worry "a great deal" about the environment, 34% worry "a fair amount," and 31% worry "only a little" or "not at all" (Saad 2011a).[35] The percentage saying they worry "a great deal" was the same in 2010 (figure 7-16). Relative to other concerns, environmental quality ranked lower on the list than a number of other concerns including the economy (71%) and federal spending and the budget deficit (64%).

Environmental concerns are infrequently mentioned in response to open-ended questions about the most important problems facing the nation. Only about 2% of Americans mentioned the environment or pollution in an open-ended question asking "What do you think is the most important problem facing this country today?" (Jones 2011c).

Climate Change

Climate change (often colloquially referred to as *global warming*), has become a prominent environmental issue for the American public. In a 2008 survey asking Americans to report, in their own words, the "single biggest environmental problem the world faces at this time," the most common response was climate change (25%), followed by pollution (24%), energy problems (11%), and toxic substances in the environment (6%) (ABC News 2008).

Other surveys, using structured questions, also show evidence of widespread awareness of the issue of climate change. The Gallup Polls registered gradual increases in the percentage of Americans who say they understand the "global warming" issue "very well" or "fairly well," from 68% in 2004 to 82% in 2010 (The Gallup Organization 2010).

Public debate about climate change has centered on both the existence of climate change and the likely causes of any change occurring. Gallup surveys found a decline in the percentage of Americans who consider climate change to be primarily due to human activities. When asked whether "the increases in the earth's temperature over the last century" are largely the result of human activities rather than natural changes, half of Americans said human activities in 2010, down 8 points from 2008, and 46% said natural changes (Newport 2010).[36]

A large number of surveys have been conducted about climate change, both in the United States and abroad. The Pew Global Attitudes survey conducted in 2010 among 22 nations found 37% of Americans consider global climate change a "very serious problem," one third said it was "somewhat serious," and a minority said it was "not too serious" (15%) or "not a problem" (13%). The percentage of Americans saying climate change is "very serious" decreased 10 points from 47% in 2007. Americans express less concern about climate change than individuals in a number of other countries where majorities consider climate change a very serious problem: Germany, Japan, South Korea, India, Kenya, Argentina, Brazil, Mexico, Lebanon, and Turkey. Half or near half of the citizens in Spain, Jordan, and Indonesia say the same. The Chinese and British are about equally likely as Americans to say climate change is a very serious problem (41% and 40%, respectively). The only publics with lower concern than Americans about climate change were those in Poland (31%) and Pakistan (22%). A World Public Opinion survey conducted in 2009 in 15 nations found a similar pattern, with Americans, Russians, and Chinese least likely to consider climate change a "very serious" problem.

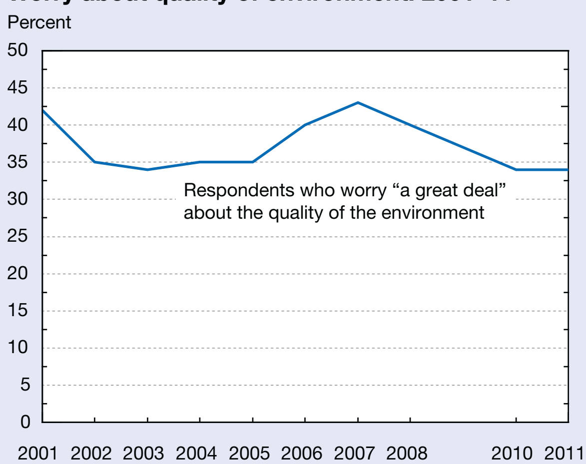
Assessment of Potential Problems

Public assessments of the degree to which potential hazards pose a threat to the environment have been surprisingly stable over the past two decades. A series of questions on the GSS surveys conducted in 1993, 1994, 2000, and 2010 show that Americans consider pollution of America's rivers, lakes, and streams to be more dangerous to the environment than any of several other potential problems; in 2010, 69% considered water pollution to be very or extremely dangerous. Air pollution caused by industry was considered very or extremely dangerous to the environment by 63%, whereas air pollution caused by cars was less likely to be considered very or extremely dangerous to the environment (43%) (table 7-17).

Furthermore, 48% of Americans considered the "rise in temperature caused by climate change" to be very or extremely dangerous to the environment, according to the 2010 GSS. A decade earlier, that figure was 40%. The percentage saying that climate change was not very or not at all dangerous to the environment rose during the same period, from 11% in 2000 to 18% in 2010. The percentage holding no opinion decreased during the same period.

Nuclear power stations were considered very or extremely dangerous to the environment by 45% of Americans in 2010. Perceptions of environmental danger from nuclear power stations were about the same as when this question

Figure 7-16
Worry about quality of environment: 2001–11



NOTES: Responses to the following: *How much do you personally worry about the quality of the environment: a great deal, a fair amount, only a little, or none at all?* Figure shows only responses for "a great deal." Poll conducted annually in March.

SOURCE: Saad L, Americans' worries about economy, budget top other issues, The Gallup Poll (21 March 2011), http://www.gallup.com/poll/146708/Americans-Worries-Economy-Budget-Top-Issues.aspx, accessed 22 March 2011.

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Table 7-17
Public assessment of potential environmental problems: 1993–2010
(Percent)

Potential problem/opinion	1993	1994	2000	2010
Pollution of America's lakes, rivers, and streams				
Extremely/very dangerous	66	61	66	69
Somewhat dangerous	27	29	23	24
Not very/not dangerous	4	5	5	4
Don't know	3	5	7	2
Air pollution caused by industry				
Extremely/very dangerous	61	53	62	63
Somewhat dangerous	30	37	29	31
Not very/not dangerous	4	5	2	4
Don't know	4	5	6	2
Pesticides and chemicals used in farming				
Extremely/very dangerous	37	33	45	52
Somewhat dangerous	48	49	39	37
Not very/not dangerous	11	13	8	8
Don't know	4	5	7	3
Rise in temperature caused by climate change[a]				
Extremely/very dangerous	41	35	40	48
Somewhat dangerous	34	35	33	27
Not very/not dangerous	14	16	11	18
Don't know	12	14	15	6
Nuclear power stations				
Extremely/very dangerous	40	41	NA	45
Somewhat dangerous	34	35	NA	30
Not very/not dangerous	16	15	NA	19
Don't know	9	9	NA	7
Air pollution caused by cars				
Extremely/very dangerous	48	43	45	43
Somewhat dangerous	38	42	41	46
Not very/not dangerous	7	9	6	8
Don't know	7	7	8	3
Modifying the genes of certain crops				
Extremely/very dangerous	NA	NA	21	25
Somewhat dangerous	NA	NA	32	33
Not very/not dangerous	NA	NA	25	26
Don't know	NA	NA	22	16

NA = not available, question not asked

[a]Wording was changed from "the greenhouse effect" to "climate change" in 2010.

NOTES: Responses to *In general, do you think that [potential problem] is extremely dangerous for the environment, very dangerous, somewhat dangerous, not very dangerous, or not dangerous at all for the environment?* Table includes all years for which data collected. Detail may not add to total because of rounding.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (1993–2010).

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was first asked in 1993. However, it is important to note that these data were collected prior to concerns about the risk to human health and the environment from damage to nuclear energy plants in the aftermath of the earthquake and tsunami in Japan in March 2011.

Assessments of environmental dangers changed substantially on only one issue—pesticides and chemicals used in farming. About half of Americans (52%) called these very or extremely dangerous to the environment in 2010, up from 45% in 2000 and 37% in 1993.

Concern about environmental dangers from GM crops appears to be modest. In the 2010 GSS, a quarter of Americans said modifying the genes of crops is very or extremely dangerous to the environment, and a roughly equal portion

(26%) said this is not very or not at all dangerous to the environment. Another 16% of Americans held no opinion about the dangers of GM crops, suggesting that the public has a more limited awareness or understanding of this issue.

Nuclear Power and Other Energy Sources

Public debate about energy sources in recent years has emphasized the need for lessened U.S. reliance on imported oil and more focus on alternative, renewable energy sources. A Gallup/*USA Today* poll conducted in early 2011 found more than eight in ten (83%) Americans favor legislation that "provides incentives for using solar and other alternative energy sources," and 15% are opposed. Two-thirds favor legislation that "expands drilling and exploration for oil and gas" (Jones 2011b). These findings are in keeping with public preferences on government spending in the 2010 GSS survey; 61% of Americans said the government is spending "too little" on developing alternative sources of energy.

Support for nuclear energy has varied over the past 15 years. American public opinion was fairly evenly divided in the late 1990s and support increased in the late 2000s. According to the 2010 GSS, about six in ten (61%) Americans favor or strongly favor increasing the use of nuclear energy to generate electricity in the United States, about three in ten (28%) oppose or strongly oppose, and the remainder gave no opinion. Similarly, the proportion of Americans who favor the use of nuclear power as "one of the ways to provide electricity" ranged from 57% to 62% between 2009 and early 2011 on Gallup surveys (Jones 2011a). The 2011 survey was conducted prior to damage to nuclear energy plants in Japan stemming from the earthquake and tsunami in March 2011. A Pew Research Center survey conducted shortly after the disaster in Japan suggests that Americans' support for nuclear power declined, but the long-term effect on Americans' attitudes toward nuclear power is unknown at this time (Pew Research Center 2011c). A substantial minority of Americans (42%) said nuclear power plants are not safe in a 2009 Gallup Poll, and prior surveys indicate that three out of five Americans oppose the construction of a nuclear energy plant in their local communities (Jones 2009).[37]

International Comparisons

In 2010, Europeans were divided about whether or not nuclear energy will "improve our way of life" (39%) or "make things worse" (39%). The remainder said nuclear energy will have no effect (10%) or held no opinion (13%). Assessments of nuclear energy were more negative when this question was first asked in 1999, and have been increasingly divided since that time (EC 2010). Support for nuclear energy varies a great deal among European countries. In general, citizens of countries that have operational nuclear power plants are considerably more likely to support nuclear energy than citizens of other countries (see NSB 2010).[38]

Stem Cell Research and Human Cloning

Unlike many issues involving scientific research, studies using embryonic stem cells have generated considerable public controversy. In the case of stem cell research, many people's attitudes are strongly related to their views about moral fundamentals. There is less reason to believe that this is the case for other S&T issues, such as nuclear power.

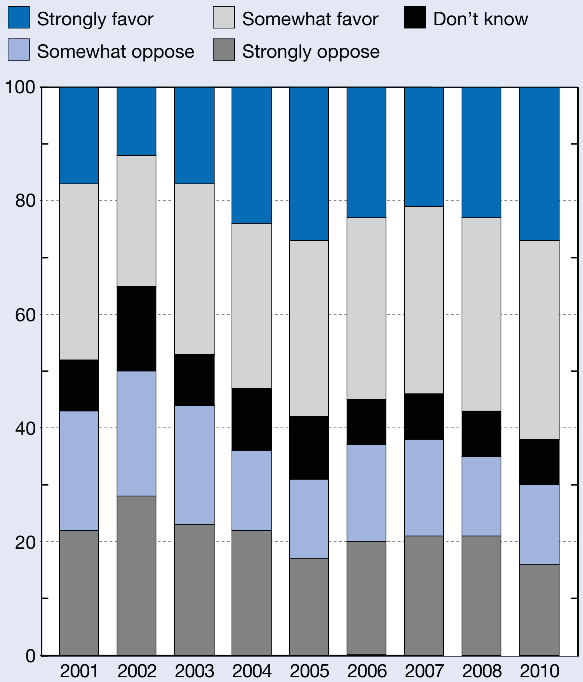
Public support for "medical research that uses stem cells from human embryos" grew over the past decade, from a low of 35% in favor in 2002. Since 2004, a majority of the public has favored stem cell research, with 62% favoring in 2010 and 31% opposed (VCU 2010) (figure 7-17). Annual Gallup Poll data draw a similar picture: the percentage of Americans who find stem cell research "morally acceptable" has fluctuated from a low of 52% in 2002 to a high of 64% in 2007; in 2011, 62% said it was "morally acceptable" and 30% said it was "morally wrong" (Saad 2011b).

Support for stem cell research is greater when the question posed asks about research that uses stem cells from sources that do not involve human embryos. About seven out of ten respondents (71%) favored this type of research in 2010, down slightly from 75% in 2007 (VCU 2010). Support is also greater when the question is framed as an emotionally compelling personal issue ("If you or a member of your family had a condition such as Parkinson's Disease, or a spinal cord injury, would you support the use of embryonic stem cells in order to pursue a treatment for that condition?") In this case, 70% of Americans support treatments that use stem cells and 21% do not (VCU 2006).

Americans are overwhelmingly opposed to human cloning when there is no mention of a medical purpose. In a 2010 survey, the idea of cloning or genetically altering humans was rejected by eight in ten Americans (VCU 2010). Opinions are more mixed when questions mention "cloning technology" that is used only to help medical research develop new treatments for disease; opinion about therapeutic cloning has been slowly growing more positive in recent years, with 55% in favor and 40% opposed in 2010 (table 7-18). The specter of reproductive cloning can generate apprehension about therapeutic cloning. Asked how concerned they were that "the use of human cloning technology to create stem cells for human therapeutic purposes will lead to a greater chance of human reproductive cloning," more than two-thirds of Americans said they were either very (31%) or somewhat (38%) concerned (VCU 2006).

Public attitudes toward cloning technology are not grounded in a strong grasp of the difference between reproductive and therapeutic cloning (see Glossary for definitions.) In the 2008 VCU survey, most Americans (64%) said they were "not very clear" or "not clear at all" about this distinction, with 26% saying they were "somewhat clear" and only 8% characterizing themselves as "very clear" about it. The number of Americans who professed greater comprehension in 2008 was lower than it was when VCU began asking this question in 2002. Additionally, self-assessed understanding of stem cell research declined between 2008 and 2010. In 2010, a 54% majority of Americans were "very clear" or "somewhat clear" about the difference between stem cells that come from human embryos, stem cells that come from adults, and stem cells that come from other sources, down from 64% in 2008 (VCU 2010).

Figure 7-17
Public attitudes toward stem cell research: 2001–10
Cumulative percent



NOTES: Responses to *On the whole, how much do you favor or oppose medical research that uses stem cells from human embryos?* Question most recently asked 12–18 May 2010. Survey not conducted in 2009. Detail may not add to total because of rounding.

SOURCE: Virginia Commonwealth University (VCU), VCU Life Sciences Survey (2010), http://www.vcu.edu/lifesci/images2/survey2010.pdf, accessed 4 March 2011.

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An international survey on attitudes toward stem cell research in a dozen European countries, the United States, Japan, and Israel found that awareness, knowledge, and attitudes about this type of research vary widely (Fundacion BBVA 2008). Overall, Americans were more aware of stem cell research than residents of most other countries and more often responded correctly to knowledge questions on this subject. All the same, Americans were somewhat more likely than residents of several countries in Europe to believe that stem cell research is immoral (appendix table 7-32).

Teaching Evolution in the Schools

In the United States, the topic of whether and how evolution should be taught in the school system has been a frequent source of controversy for almost a century. Public views about evolution and the role of teaching evolution in the schools have been relatively stable over the course of 30 years. In surveys sponsored by NSF between 1979 and 2010, many Americans appear skeptical of established scientific ideas about evolution. For example, when asked about the statement "human beings, as we know them today, developed from earlier species of animals" on the 2010 GSS survey, 38% considered this statement false and 47% said it was true (appendix table 7-10).

An experimental study included in the 2004 Michigan Survey of Consumer Attitudes suggests that survey responses to such questions reflect more than unfamiliarity with basic elements of science. Some of the survey respondents were asked a question that tested knowledge about evolution ("human beings, as we know them today, developed from earlier species of animals"). Other respondents were asked a question about what the theory of evolution asserts ("according to the theory of evolution, human beings, as we know

Table 7-18
Public opinion on medical technologies derived from stem cell research: 2010 or most recent year
(Percent)

Question	Favor	Oppose
1. *If you or a member of your family had a condition such as Parkinson's Disease, or a spinal cord injury, would you support the use of embryonic stem cells in order to pursue a treatment for that condition?* (Yes or no)	70	21
2. *Do you favor or oppose medical research that uses stem cells from sources that do NOT involve human embryos?* (Strongly favor, somewhat favor, somewhat oppose, or strongly oppose)	71	21
3. *How much do you favor or oppose using human cloning technology IF it is used ONLY to help medical research develop new treatments for disease?* (Strongly favor, somewhat favor, somewhat oppose, or strongly oppose)	55	40
4. *The technology now exists to clone or genetically alter animals. How much do you favor or oppose allowing the same thing to be done in humans?* (Strongly favor, somewhat favor, somewhat oppose, or strongly oppose)	15	80

NOTES: Question 1 asked during 7–21 November 2006. Questions 2, 3, and 4 asked during 12–18 May 2010. Detail does not add to total because "don't know" responses not shown.

SOURCE: Virginia Commonwealth University (VCU), VCU Life Sciences Survey (2006 for question 1; 2010 for questions 2, 3, and 4), http://www.vcu.edu/lifesci/images2/survey2010.pdf, accessed 4 March 2011.

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them today, developed from earlier species of animals"). Respondents were much more likely to answer correctly if the question was framed as being about scientific theories rather than as being about the natural world. When the question about evolution was prefaced by "according to the theory of evolution," 74% responded that the statement was true; conversely, only 42% considered the statement true when it was not prefaced as such. (For more details, see NSB 2008.) These differences may indicate that many Americans hold religious or other beliefs that cause them to be skeptical of certain established scientific ideas, even when they have some basic familiarity with those ideas.

When surveys ask for opinions about whether and how evolution should be taught in U.S. public schools, two key patterns emerge. First, when asked whether creation should be taught alongside of or in addition to evolution, a majority of Americans favor this pluralistic approach to education. Second, when asked whether creation should be taught instead of evolution—thereby replacing it in the science curriculum—a majority oppose this idea, while a sizeable minority favor it. In the most recent survey, 49% opposed teaching creation instead of evolution in the public schools and 38% favored it (Plutzer and Berkman 2008; Berkman and Plutzer 2010).

Genetically Modified Food

Although the introduction of GM crops has provoked much less public controversy in the United States than in Europe, U.S. public support for this application of biotechnology is limited. According to a 2008 CBS/*New York Times* poll, 44% of Americans indicate they have heard nothing or "not much" about GM ingredients added to foods to make them taste better and last longer (CBS-NYT 2008). However, 87% believe that these foods should be labeled and 53% expect that it is "not very likely" or "not at all likely" that they would buy food that is labeled as such.

Overall, these results are consistent with a series of five surveys conducted by the Pew Initiative on Food and Biotechnology between 2001 and 2006. These studies consistently found that only about one-fourth of U.S. consumers favor "the introduction of genetically modified foods into the U.S. food supply" (Mellman Group, Inc. 2006). The percentage of U.S. survey respondents reporting a negative reaction to the phrase "genetically modified food" (44%) was more than twice the 20% that reported a positive reaction (Canadian Biotechnology Secretariat 2005). Nonetheless, consumers in the United States express more favorable views than Europeans, with Canadians falling somewhere in between (Gaskell et al. 2006).

Although the FDA proposed guidelines for the approval process for genetically engineered animals in September 2008 (Maugh and Kaplan 2008), past surveys have generally found that U.S. residents are even more wary of genetic modification of animals than they are of genetic modification of plants (Mellman Group, Inc. 2005). Many express support for regulatory responses, but this support appears to be quite sensitive to the way issues are framed. Thus, whereas 29% expressed a great deal of confidence in "the Food and Drug Administration or FDA," only about half as many expressed the same confidence when the question was posed about "government regulators" (Mellman Group, Inc. 2006). (Additional findings from earlier U.S. surveys can be found in NSB 2006 and NSB 2008.)

Nanotechnology

Nanotechnology involves manipulating matter at unprecedentedly small scales to create new or improved products that can be used in a wide variety of ways. Nanotechnology has been the focus of relatively large public and private investments for almost a decade, and innovations based on nanotechnology are increasingly common. However, relative to other new technologies, nanotechnology is still in an early stage of development and the degree of risk remains uncertain (Chatterjee 2008, Barlow et al. 2009).

As noted earlier, public awareness and understanding of nanotechnology remains limited despite increased federal funding and more than 600 nanotechnology products already on the market (The National Academies 2008a).[39] According to the 2010 GSS, 24% of Americans report having heard "a lot" or "some" about nanotechnology, up four percentage points from 2008 and 2006. A plurality (44%) of Americans report having heard "nothing at all" about nanotechnology (appendix table 7-33). In 2010, among the minority of respondents who had heard "a lot" or "some" about this technology, 65% correctly indicated that "nanotechnology involves manipulating extremely small units of matter, such as individual atoms, in order to produce better materials," and 39% correctly indicated that "the properties of nanoscale materials often differ fundamentally and unexpectedly from the properties of the same materials at larger scales."

After receiving a brief explanation of nanotechnology, GSS respondents were asked about the likely balance between the benefits and harms of nanotechnology. Among all respondents to the 2010 GSS, regardless of their awareness of nanotechnology, 37% said the benefits will outweigh the harmful results, 11% expected the harms to predominate, and 43% held no opinion (appendix table 7-34). The balance of opinion was similar in 2006 and 2008.

In the GSS data, favorable attitudes toward and familiarity with nanotechnology are strongly associated. That is, Americans who say they are more familiar with nanotechnology are more likely to believe that its benefits will outweigh the risks. Among those who have heard "a lot" or "some" about nanotechnology, 65% said the benefits will outweigh the harms, 8% said harmful results will outweigh any benefits, 5% said benefits and harms would be about equal, and 22% had no opinion.[40] However, this association does not mean that when people become more familiar with nanotechnology their attitudes necessarily become positive (Cobb 2005; Lee, Scheufele, and Lewenstein 2005). Furthermore, recent research suggests that attitudes toward nanotechnology are likely to vary depending on the context in which it is applied, with energy applications viewed much more positively than those in health and human enhancements (Pidgeon et al. 2009).

International Comparisons

In Europe, 45% of survey respondents said they had heard of nanotechnology on the 2010 Eurobarometer, which described nanotechnology in terms of consumer product applications. Overall, 44% of Europeans agreed that nanotechnology should be encouraged, 35% disagreed, and 22% had no opinion about this issue (Gaskell et al. 2010).

Other Emerging Technologies

Opinions on other new and emerging technologies show an often receptive public, but one where opinion is likely to be fluid due to low levels of familiarity with the issue and any relevant concerns for public debate.

Synthetic biology, an emerging field that applies biologic science to design and construct new biological parts, organisms, or artificially engineered biological systems, provides one example. About one-quarter (26%) of Americans have heard "some" or "a lot" about synthetic biology, up from 9% in 2008 (Peter D. Hart Research Associates, Inc. 2010). When first asked to weigh the benefits and harms from synthetic biology, one-third thought the benefits and risks would be about equal, a similar percentage had no opinion, and the remainder was split about equally between those who felt the benefits would outweigh the risks and those who felt the risks would outweigh the benefits. After hearing a balanced description of the benefits and risks of synthetic biology, a greater proportion said the risks will outweigh the benefits than said the benefits will outweigh the risks.

International Comparisons

The 2010 Eurobarometer survey included an extensive series of questions about new and emerging biotechnologies. As in the United States, familiarity with synthetic biology tends to be limited. These data show that public familiarity with new technologies is often associated with opinions about the technology. In the case of nanotechnology, Europeans who are more familiar with the technology are more likely to see nanotechnology as safe and beneficial. In the cases of GM foods and animal cloning, greater familiarity with the technology is not associated with positive assessments of it (Gaskell, et al. 2010).

Animal Research

The medical research community conducts experimental tests on animals for many purposes, including to advance scientific understanding of biological processes and test the effectiveness of drugs and procedures that may eventually be used to improve human health.

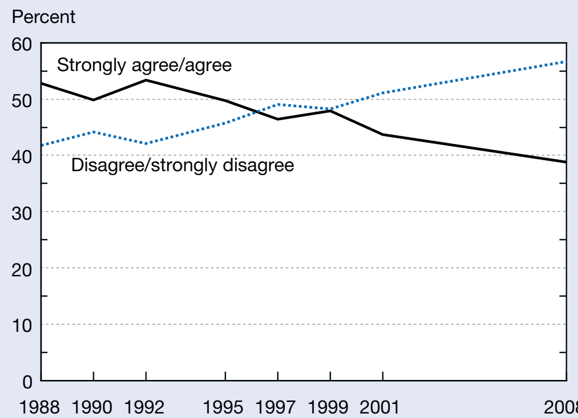
Most Americans support at least some kind of animal research. A 52% majority favors the use of animals in scientific research, whereas 43% are opposed, according to a 2009 Pew Research Center survey. Nearly two-thirds said they favor "using animals in medical research" (VCU 2007). Further, 55% of Americans consider "medical testing on animals" to be "morally acceptable," whereas 38% say it is "morally wrong," according to a 2011 Gallup survey (Saad 2011b). A 2008 Gallup survey also found a majority of respondents supported this kind of research; 64% opposed "banning all medical research on laboratory animals" and 59% opposed "banning all product testing on laboratory animals" (Newport 2008).

There is a sizeable gender gap in opinions about animal research. Women are less likely than men to support animal research; 42% of women favor the use of animals in research, compared with 62% of men (Pew Research Center 2009a). Similarly, women are less likely than men to say that medical testing on animals is "morally acceptable" (Saad 2010).

Opposition to using animals in research has grown in the past two decades. When asked whether scientists should be allowed to do "research that causes pain and injury to animals like dogs and chimpanzees if it produces new information about human health problems," between 42% and 45% of Americans disagreed in the early 1990s. This proportion increased to 51% in 2001 and 56% in 2008 (figure 7-18; appendix tables 7-35 and 7-36).[41]

Past NSF surveys suggest that the public is more comfortable with the use of mice in scientific experiments than the use of dogs and chimpanzees (NSB 2002). In 2001, 68% of

Figure 7-18
Public attitudes toward whether scientific research that causes pain to animals should be allowed: 1988–2008



NOTES: Responses to *Scientists should be allowed to do research that causes pain and injury to animals like dogs and chimpanzees if it produces new information about human health problems. Do you strongly agree, agree, disagree, or strongly disagree?* Responses of "don't know" not shown. Survey results in 1988, 1990, 1992, 1995, 1997, 1999, 2001, and 2008; other years extrapolated.

SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (1988–2001); University of Chicago, National Opinion Research Center, General Social Survey (2008). See appendix tables 7-35 and 7-36.

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Americans agreed that "scientists should be allowed to do research that causes pain and injury to animals like mice if it produces new information about human health problems," compared to 44% who expressed agreement when the question focused on dogs and chimpanzees (NSB 2002).

International comparisons on animal research are scarce. Half of Malaysians agree that "although research on animals may cause suffering, it has to be done for the sake of mankind." In Europe, two-thirds agree that "scientists should be allowed to do research on animals like mice if it produces new information about human health problems." A survey conducted by the Gallup Organization in 2003 showed that Americans and Canadians were more likely to tolerate scientific research on animals than the British. When asked, "Regardless of whether or not you think it should be legal, please tell me whether you personally believe that in general medical testing on animals is morally acceptable or morally wrong," the majority of adults in the United States and Canada believed it was morally acceptable (63% and 59%, respectively). In contrast, the majority of British respondents thought it was morally wrong (54%) (Mason Kiefer 2003).

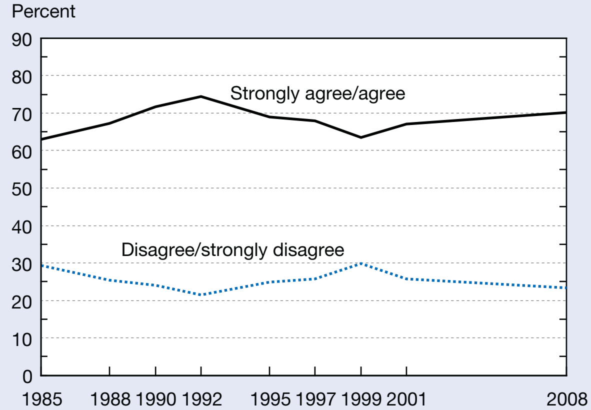
Science, Engineering, and Mathematics Education

In much of the public discourse about how Americans will fare in an increasingly S&T-driven world, quality education in science and mathematics is seen as crucial for both individuals and the nation as a whole.

In the 2008 GSS, the majority of Americans in all demographic groups agreed that the quality of science and mathematics education in American schools was inadequate (appendix tables 7-37 and 7-38). Their level of agreement increased with education, science knowledge, income, and age. Dissatisfaction with the quality of math and science education increased from 63% in 1985 to 70% in 2008, peaking at 75% in 1992 (figure 7-19). Further, about half of Americans said that their local public schools did not put enough emphasis on teaching science and math, an equal portion (48%) said the emphasis was about right, and just 2% said there was too much emphasis on teaching science and math in the local schools (Rose and Gallup 2007).

In addition, the proportion of Americans who said they believe the federal government is spending too little money on improving education in the biennial GSS surveys has remained greater than 70% since the early 1980s. This is consistently one of the top areas where the public feels government spending is too low (figure 7-14; appendix table 7-26).

Figure 7-19
Public assessment of whether the quality of science and mathematics education in America is inadequate: 1985–2008



NOTES: Responses to *The quality of science and mathematics education in American schools is inadequate. Do you strongly agree, agree, disagree, or strongly disagree?* Responses of "don't know" not shown. Survey results in 1985, 1988, 1990, 1992, 1995, 1997, 1999, 2001, and 2008; other years extrapolated.

SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (1985–2001); University of Chicago, National Opinion Research Center, General Social Survey (2008). See appendix tables 7-37 and 7-38.

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Conclusion

The portrait of public knowledge and attitudes concerning S&T depends, in part, on the standard used for judgment. One standard involves comparing a country's knowledge and attitudes with those recorded in other countries. When the data are examined using other countries as a benchmark, the United States compares relatively favorably. Compared with adult residents of other developed countries, American adults appear to know as much or more about science, and they express as much or more optimism about technology.

A second standard involves comparing Americans' knowledge and attitudes today with those of the past. By this standard, the survey data, while not showing marked improvements in public understanding, provide little or no evidence of declining knowledge. Relative to Americans in the recent past, today's American public scores as well on knowledge measures and tends to be more skeptical about scientific claims for pseudoscience, such as astrology. Additionally, younger Americans are more knowledgeable about S&T than older cohorts; this pattern suggests that the long-term outlook for public knowledge is promising.

Similarly, general U.S. attitudes about the promise and contribution of science to society remain strongly positive. Three decades of data consistently show that Americans endorse the past achievements and future promise of S&T and are favorably predisposed to continued government investment in science. When Americans compare science with other institutions, science's relative ranking is equally or more favorable than in the past. In addition, the prestige of the engineering profession has increased in recent years.

A third standard involves assessing what a technologically advanced society requires (either today or in the future) to compete in the world economy and enable its citizens to better take advantage of scientific progress in their own lives.

By this standard, there is more reason for concern. Trend data show that significant minorities of Americans cannot answer relatively simple knowledge questions about S&T, often express basic misconceptions about emerging technologies such as nanotechnology, and believe that relatively great scientific uncertainty surrounds the existence and causes of global climate change. Sizable proportions of the population express reservations about how the speed of technological change affects our way of life, and about the use of animals in medical research.

Regardless of the standard used in assessing public attitudes and understanding of S&T, one pattern in the data stands out: Americans who are more highly educated—particularly those who are college-educated and have completed college courses in science and mathematics—tend to know and understand more about S&T. Although it is not clear whether this association is causal, the pattern underscores the need for continued attention to the education system and the possible role of science, technology, engineering, and mathematics education in fostering public understanding of S&T.

Notes

1. Data from Pew show that the proportion of Americans who read the newspaper declined from 40% to 34% between 2006 and 2008, and that newspapers would have lost more readers if they did not have online versions. Most of the loss in newspaper readership since 2006 came from those who read the print version of the newspaper—in 2008, 27% said they had read only the print version of a daily newspaper the day before, compared to 34% in 2006. However, audiences are getting news from both traditional sources (television, print) and the Internet and blending these sources together, rather than choosing between one or the other (Pew Research Center 2008).

2. The 2010 GSS included two alternatives for distinguishing between print and online sources of information. The data in figure 7-1 are based on an approach that used followup questions asking whether references to newspapers, magazines, or the Internet included primarily print or online sources. An alternative approach offered response options that distinguish between online and print-format sources for newspapers and magazines, without branching into followup questions (see sidebar, "The Blending of Print and Online Sources of Science News"). Estimates of information sources for television, books, and other sources where there is no need to distinguish between print and online venues are comparable for both approaches to measurement. For most respondents, a response of newspapers appears to reflect reliance on print newspapers. Using the branched approach, the percentage indicating reliance on printed newspapers is similar to the percentage saying the same on the question with direct response options; less than 1% initially indicated a reliance on newspapers and then responded that they primarily relied on online newspapers in a followup question. When respondents are initially given options which distinguish between online newspapers and other online sources, however, somewhat fewer respondents indicate a reliance on any type of Internet source (31% vs. 35%).

3. The Internet is also a primary source of information for most Americans when they are seeking information on other topics, such as health. See Pew Internet and American Life Project surveys (Fox 2010; Jansen 2010).

4. Analyses that examine age differences in patterns of media use through repeated cross-sectional surveys hide considerable generational effects, because they only show a snapshot of a single point in time (Losh 2009).

5. In 2001, this question was part of a single-purpose telephone survey focused on S&T. In 2008, these data were collected as part of a face-to-face multipurpose survey covering a broad range of behavior and attitudes. It is unclear whether these differences in data collection or a change in public opinion account for the decline in interest observed between 2001 and 2008.

6. In interpreting survey data that use the phrase "science and technology," it is important to take into account the uncertainties surrounding its meaning and the different associations Americans make when they hear it.

7. Note that the Eurobarometer surveys include a different set of countries because the composition of the European Union changes over time. In 2010, the survey included 27 countries; in 2005, it included 25 countries.

8. The question asked on the Eurobarometer surveys has changed over time, making the data not always strictly comparable with previous Eurobarometer surveys or with U.S. data.

9. The China survey asked about interest levels on a 3-point scale with response options translated as "interested," "ordinary" interest level, and "not interested."

10. The analysis is based on a purposive selection of five media sectors, outlets within each sector, and specific programs or articles for study. The index is designed to capture the main news stories covered each week. Coding of programs and articles is limited to the first 30 minutes of most radio, cable, and network news programs, the front page of newspapers, and the top five stories on websites. Each selected unit of study is coded on 17 variables according to an established coding protocol. The team of individuals performing the content analysis is directed by a coding manager, a training coordinator, a methodologist, and a senior researcher. Intensive tests of intercoder reliability are conducted annually. For variables that require little or no inference, intercoder agreement was 97% in 2010. For variables requiring more inference, intercoder agreement ranged from 78% to 85% in 2010. Intercoder agreement was similar in earlier years. For more details, see http://www.journalism.org/about_news_index/methodology.

11. The total amount of news consists of the space devoted to news in print and online news sources and the time devoted to news on radio and TV sources.

12. "Science, space, and technology" includes stories on manned and unmanned space flight, astronomy, scientific research, computers, the Internet, and telecommunications

media technology. It excludes forensic science and telecommunications media content. "Biotechnology and basic medical research" includes stem cell research, genetic research, cloning, and agribusiness bioengineering, and excludes clinical research and medical technology. Stories often do not fall neatly into a single category or theme.

13. The peak in the coverage of the category "Science, space, and technology" in 1999 includes major network coverage of stories about the so-called Millennium Bug and business issues from the dot.com boom, such as the rise of Internet commerce and the browser antitrust wars.

14. The sample of news links on blogs and Twitter posts comes from two prominent Web-tracking sites, Icerocket and Tweetmeme, using the links to articles embedded on the sites as a proxy for the subject of the blog post or Tweet. The Web-tracking sites provide a list of the most-linked-to news stories based on the number of blogs, tweets, or other sites that link to each. Typically, the linked-to stories originate from traditional media sources. PEJ staff manually capture the list of most-linked-to stories each weekday, and the coding staff categorize the top five linked-to articles from this list of approximately 50 linked-to articles each week. The coding procedures are similar to those used for the News Coverage Index of traditional media sources. For more, see http://www.journalism.org/commentary_backgrounder/new_media_index_methodology.

15. People can become involved with S&T through many kinds of non-classroom activities. Examples of such activities include participating in government policy processes, going to movies that feature S&T, bird watching, and building computers. *Citizen science* is a term used for activities by citizens with no specific science training who participate in the research process through activities such as observation, measurement, or computation. Nationally representative data on this sort of involvement with S&T are unavailable.

16. Involvement in informal S&T activities is also thought to foster learning and knowledge about S&T (see Falk and Dierking 2010).

17. In the 2008 GSS, respondents received two different introductions to this question. Response patterns did not vary depending on which introduction was given.

18. In 2001, this question was part of a single-purpose telephone survey focused on science and technology. In 2008, these data were collected as part of a face-to-face multipurpose survey covering a broad range of behavior and attitudes. It is unclear whether these differences in data collection or a change in visit behavior account for the decline observed between 2001 and 2008.

19. In the United States, this measure included visits to a zoo or aquarium.

20. Survey items that test factual knowledge sometimes use easily comprehensible language at the cost of scientific precision. This may prompt some highly knowledgeable respondents to feel that the items blur or neglect important distinctions, and in a few cases may lead respondents to answer questions incorrectly. In addition, the items do not reflect the ways that established scientific knowledge evolves as scientists accumulate new evidence. Although the text of the factual knowledge questions may suggest a fixed body of knowledge, it is more accurate to see scientists as making continual, often subtle modifications in how they understand existing data in light of new evidence.

21. Respondents who say they know "nothing at all" about nanotechnology were not asked the two knowledge questions about this topic; they are classified as holding incorrect responses to both questions.

22. The two nanotechnology questions were asked only of respondents who said they had some familiarity with nanotechnology, and a sizable majority of the respondents who ventured a response different from "don't know" answered the questions correctly. To measure nanotechnology knowledge more reliably, researchers would prefer a scale with more than two questions.

23. In its own international comparison of scientific literacy, Japan ranked itself 10th among the 14 countries it evaluated (National Institute of Science and Technology Policy 2002).

24. Early NSF surveys used additional questions to measure understanding of probability. Bann and Schwerin (2004) identified a smaller number of questions that could be administered to develop a comparable indicator. Starting in 2004, the NSF surveys used these questions for the trend factual knowledge scale.

25. A change of this magnitude in a 2-year period is unusual. Because classification of knowledge on these items includes open-ended questions, it is possible that some of the change could stem from unknown differences in coding practices by the GSS staff over time.

26. Classification as understanding scientific inquiry is based on providing a correct response to the measure of understanding probability and providing a correct response to either the measure of understanding an experiment or the open-ended measure of understanding a scientific study.

27. The questions were selected from the Trends in Mathematics and Science Studies (TIMSS), National Assessment of Educational Progress (NAEP), practice General Educational Development (GED) exams, and AAAS Project 2061.

28. The scoring of the open-ended questions closely followed the scoring of the corresponding test administered to middle-school students.

For the NAEP question, "Lightning and thunder happen at the same time, but you see the lightning before you hear the thunder. Explain why this is so," the question was scored as follows:

1) Complete: The response provided a correct explanation including the relative speeds at which light and sound travel. For example, "Sound travels much slower than light so you see the light sooner at a distance."

2) Partial: The response addressed speed and used terminology such as thunder for sound and lightning for light, or made a general statement about speed but did not indicate

which is faster. For example, "One goes at the speed of light and the other at the speed of sound."
3) Unsatisfactory/Incorrect: Any response that did not relate or mention the faster speed of light or its equivalent, the slower speed of sound. For example, "Because the storm was further out," or "Because of static electricity."

For the TIMSS question, "A solution of hydrochloric acid (HCl) in water will turn blue litmus paper red. A solution of the base sodium hydroxide (NaOH) in water will turn red litmus paper blue. If the acid and base solutions are mixed in the right proportion, the resulting solution will cause neither red nor blue litmus paper to change color. Explain why the litmus paper does not change color in the mixed solution," the question was scored as follows:
1) Correct: The response had to refer to a neutralization or a chemical reaction that results in products that do not react with litmus paper. Three kinds of answers were classified as correct:
a. The response referred explicitly to the formation of water (and salt) from the neutralization reaction. For example, "Hydrochloric acid and sodium hydroxide will mix together to form water and salt, which is neutral."
b. The response referred to neutralization (or the equivalent) even if the specific reaction is not mentioned. For example, "The mixed solution is neutral, so litmus paper does not react.")
c. The response referred to a chemical reaction taking place (implicitly or explicitly) to form products that do not react with litmus paper (or a similar substance), even if neutralization was not explicitly mentioned. For example, "The acid and base react, and the new chemicals do not react with litmus paper."
2) Partially correct: The response mentioned only that acids and bases are "balanced," "opposites," "cancel each other out," or that it changes to a salt without mentioning the neutralization reaction. These answers suggest that the respondent remembered the concept but the terminology they used was less precise, or that the answer was partial. For example, "They balance each other out."
3) Incorrect: The response did not mention any of the above in a–c or is too partial or incomplete, and/or uses terminology that is too imprecise. For example, "Because they are base solutions—the two bases mixed together there is no reaction," or "There is no change. Both colors change to the other."

29. The pseudoscience section focuses on astrology because of the availability of long-term national trend indicators on this subject. Other examples of pseudoscience include the belief in lucky numbers, the existence of unidentified flying objects (UFOs), extrasensory perception (ESP), or magnetic therapy.

30. Methodological issues make fine-grained comparisons of data from different survey years suspect. For instance, although the question content and interviewer instructions were identical in 2004 and 2006, the percentage of respondents who volunteered "about equal" (an answer not among the choices given) was substantially different. This difference may have been produced by the change from telephone interviews in 2004 to in-person interviews in 2006 (though telephone interviews in 2001 produced results that are similar to those in 2006). More likely, customary interviewing practices in the three different organizations that administered the surveys affected their interviewers' willingness to accept responses other than those that were specifically offered on the interview form, including "don't know" responses.

31. This type of survey question asks respondents about their assessment of government spending in several areas without mentioning the possible negative consequences of spending (e.g., higher taxes, less money available for higher priority expenditures). A question that focused respondents' attention on such consequences might yield response patterns less sympathetic to greater government funding.

32. The GSS questions on global climate change used the term "global warming."

33. The 2010 GSS survey included ratings of nuclear engineers in addition to medical researchers, environmental scientists, and economists. As discussed below, the patterns of results were similar whether the group with relevant expertise was engineers or scientists.

34. There are many different types of specializations within occupations, and prestige may well vary within the same occupation or industry.

35. This survey was conducted prior to the earthquake and tsunami in Japan on March 11, 2011.

36. There is some evidence from a large scale experimental study that the wording used in such questions ("global warming" or "climate change") can have an effect on reported beliefs about global climate change (Schuldt, Konrath, and Schwarz 2011). Earlier studies suggested that such wording differences had little effect (EC 2008; Villar and Krosnick 2010).

37. The two questions from the 2009 Gallup survey were each asked to half of the sample (n = 500).

38. Countries with nuclear plants include Belgium, Bulgaria, the Czech Republic, Finland, France, Germany, Hungary, Lithuania, the Netherlands, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. Two exceptions to this pattern are Romania and Spain, both of which have operational nuclear power plants but where the level of support for nuclear energy is below the EU average. An earlier Eurobarometer study showed that respondents in Spain and Romania were less aware of the fact that their countries have nuclear power plants than respondents in other countries with nuclear plants in operation (EC 2008a). This low level of awareness regarding the operation of a nuclear plant in their country may lead to a less positive attitude about nuclear energy.

39. According to a report from The National Academies, more than 600 products involving nanotechnology are already on the market; most of them are health and fitness products such as skin care products and cosmetics (The National Academies, 2008b).

40. This pattern of data is consistent with findings from a meta-analysis of 22 studies conducted in the United States and elsewhere by Satterfield et al. (2009).

41. The increase in the proportion of respondents who disagree with this statement may be related to methodological issues, because of the changes in data collection. See note 5.

Glossary

Biotechnology: The use of living things to make products.

Climate change: Any distinct change in measures of climate lasting for a long period of time. Climate change means major changes in temperature, rainfall, snow, or wind patterns lasting for decades or longer. Climate change may result from natural factors or human activities.

EU: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

Genetically modified (GM) food: A food product containing some quantity of any genetically modified organism as an ingredient.

Global warming: An average increase in temperatures near the Earth's surface and in the lowest layer of the atmosphere. Increases in temperatures in the Earth's atmosphere can contribute to changes in global climate patterns. Global warming can be considered part of climate change along with changes in precipitation, sea level, etc.

Nanotechnology: Manipulating matter at unprecedentedly small scales to create new or improved products that can be used in a wide variety of ways.

Synthetic biology: An emerging field that applies biologic science to design and construct new biological parts, organisms, or artificially engineered biological systems.

Reproductive cloning: Technology used to generate genetically identical individuals with the same nuclear DNA as another individuals.

Therapeutic cloning: Use of cloning technology in medical research to develop new treatments for diseases; differentiated from human reproductive cloning.

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