Chapter 7.

Science and Technology: Public Attitudes and Understanding

Table of Contents

Highlights 7-3
Interest, Information Sources, and Involvement 7-3
Public Knowledge about S&T 7-3
Public Attitudes about S&T in General 7-3
Public Attitudes about Specific S&T-Related Issues 7-4
Introduction 7-6
Chapter Overview 7-6
Chapter Organization 7-9
A Note about Data and Terminology 7-9
Interest, Information Sources, and Involvement 7-19
Public Interest in S&T 7-19
Availability of S&T News in the Media 7-26
S&T Information Sources 7-31
Involvement 7-37
Public Knowledge about S&T 7-40
Understanding Scientific Terms and Concepts 7-41
Reasoning and Understanding the Scientific Process 7-51
Pseudoscience 7-55
Perceived Knowledge Importance 7-55
Public Attitudes about S&T in General 7-59
Promises and Reservations about S&T 7-59
Federal Funding of Scientific Research 7-65
Confidence in the Science Community's Leadership 7-70
Public Attitudes about Specific S&T-Related Issues 7-74
Environment 7-74
Climate Change 7-79
Energy 7-83
Genetically Engineered Food 7-86
Nanotechnology 7-87
Synthetic Biology 7-88
Stem Cell Research and Human Cloning 7-89
Animal Research 7-89
Science, Technology, Engineering, and Mathematics Education 7-90
Conclusion 7-91
Glossary 7-93
References 7-94

List of Sidebars

U.S. Survey Data Sources 7-11
International Survey Data Sources 7-13

Using Google Trends to Examine American Attention to Science and Technology 7-22
Scientists and Public Engagement 7-38
Survey-Based Experiments on Science Knowledge Question Format 7-46
Evaluation of the Human Evolution Question 7-47

List of Tables

Table 7-1. Leading nightly news story lines on science and technology, by topic area: 2013 and 2014 7-28
Table 7-2. Correct answers to factual knowledge and scientific process questions in physical and biological sciences, by sex: 1999–2014 7-45
Table 7-3. Correct answers to factual knowledge questions in physical and biological sciences, by country /region: Most recent year 7-49
Table 7-4. Correct answers to scientific process questions: Selected years, 1999–2014 7-51
Table 7-A. U.S. Survey Data Sources 7-11
Table 7-B. International Survey Data Sources 7-13

List of Figures

Figure 7-1. Key science and engineering knowledge and attitude indicators: 1981–2014 7-7
Figure 7-2. Key science and engineering indicators, by selected respondent education, sex, and age: 2014 7-8
Figure 7-3. Public interest in selected issues: 2014 7-20
Figure 7-4. Public interest in selected science-related issues: 1981–2014 7-21
Figure 7-5. Network nightly news coverage of science and technology: 1988–2014 7-28
Figure 7-6. Primary source respondents used to learn about current news events, science and technology, and specific scientific issues: 2014 7-33
Figure 7-7. Primary source respondents used to learn about current news events, science and technology, and specific scientific issues: 2001–14 7-35
Figure 7-8. Mean number of correct answers to trend factual knowledge of science scale: 1992–2014 7-42
Figure 7-9. Correct answers to trend factual knowledge of science scale, by respondent characteristic: 2014 .. 7-44
Figure 7-10. Understanding scientific inquiry, by respondent characteristic: 2014 7-54
Figure 7-11. Perceived importance of knowledge about science, by country/economy: 2014 7-57
Figure 7-12. Public assessment of scientific research: 1979–2014 7-60
Figure 7-13. Public assessment of belief in science versus faith and of whether science does more harm than good, by country/economy: 2014 7-63
Figure 7-14. Public opinion on whether government should fund basic scientific research: 1985–2014 7-66
Figure 7-15. Public assessment of amount of government spending for scientific research: 1981–2014 7-68
Figure 7-16. Public attitudes toward government spending in various policy areas: 2014 7-69
Figure 7-17. Public confidence in institutional leaders, by type of institution: 2014 7-71
Figure 7-18. Public confidence in institutional leaders, by selected institution: 1973–2014 7-72
Figure 7-19. Relation between the economy and concern over the environment: 1990–2014 7-75
Figure 7-20. Choose the environment over economic growth, by selected country/economy: Most recent year ... 7-77
Figure 7-21. Concern about specific environmental issues: 2001–15 7-79
Figure 7-22. Belief in global warming and confidence in that belief: 2008–15 7-81
Figure 7-23. Views on nuclear energy: 1994–2015 7-85
Figure 7-A. Google trend data for science, engineering, and technology searches: 2004–14 7-23
Figure 7-B. Google trend data for specific science and technology issues searches: 2004–14 7-25

Highlights

Interest, Information Sources, and Involvement

Four out of 10 Americans say they are "very interested" in new scientific discoveries, and 6 out of 10 say they are "very interested" in new medical discoveries.

- Other science-related issues also interest many Americans; these include environmental pollution and use of new inventions and technologies.
- Interest in environmental pollution has declined slowly since 1990, when more than 6 in 10 Americans said they were very interested in the topic. Only about 4 in 10 Americans gave this response in 2014.

The Internet remains Americans' primary source for science news and information seeking.

- Nearly half of Americans cited the Internet as their primary source of science and technology (S&T) information in 2014 compared with about one-tenth of Americans in 2001. Television and newspapers continue to be used less often as sources of science news and information.
- For those who say they use the Internet as their primary source of information, about 4 in 10 say they use a search engine (e.g., Google) to find science information. About 2 in 10 say they use online newspapers.

Public Knowledge about S&T

Americans correctly answered an average of 5.8 out of 9 factual knowledge questions in 2014, a score similar to those in recent years but high in terms of the overall historical trend.

- Americans with more formal education tend to provide a greater number of correct answers on science knowledge questions.
- Men tend to do better on questions focused on the physical sciences, whereas women do slightly better on questions focused on the biological sciences, for the specific questions asked.
- An experiment examined the standard question used to measure knowledge about evolution. This research found that a wording change substantially increased the percentage of correct responses and this change also improved correlation with knowledge of evolution and science more generally. Levels of factual scientific knowledge in the United States are comparable with those in Europe and are generally higher than levels in countries in other parts of the world.

Two-thirds of Americans could correctly answer two multiple-choice questions dealing with probability in the context of medical treatment, and about half could describe the best way to conduct a drug trial.

- The percentage of Americans providing correct responses to these questions is as high as it has ever been; nearly half of Americans correctly answered all of these scientific reasoning questions.

Public Attitudes about S&T in General

Americans perceive far more benefits than harms from science and want governments to fund research.

- About 7 in 10 Americans say that they believe the benefits from science are greater than the harms, and almost 9 in 10 agree that S&T will create more opportunities for future generations.
- However, Americans increasingly worry that science is making life “change too fast.” About half of Americans expressed this view in 2014, up from about one-third in 2004.
- About 4 in 10 Americans say we are spending “too little” to “support scientific research.” This number has stayed relatively steady for many years, although relatively few Americans (1 in 10) now say we spend “too much.”

Americans are more likely to have “a great deal of confidence” in leaders of the scientific community than in leaders of any group except the military.

- About 4 in 10 Americans express high levels of confidence in the scientific community. This ranks second only to the military, for which half of Americans say they have “a great deal of confidence.”
- Although the medical community remains one of the most respected groups in America, the percentage of Americans who express “a great deal of confidence” in the medical community has decreased since the 1970s and has tied with its previous low in 2002, with slightly fewer than 4 in 10 expressing high confidence.

Public Attitudes about Specific S&T-Related Issues

The wide range of survey data on Americans’ opinions on overall environmental protection yields conflicting findings.

- In 2015, about half of Americans said the environment should be made a priority over economic growth, up from about 3 in 10 in 2011. This level is still, however, below the nearly 6 in 10 who gave this response in 2001.
- Americans are, on average, less likely to choose the environment over the economy than residents of many other countries.
- About 4 in 10 Americans say they are “very interested” in environmental pollution news, down from about 6 in 10 in 1990.
- About 3 in 10 Americans say they worry “a great deal” about the quality of the environment, similar to the historic low in 2014.

Americans remain divided on the severity and nature of climate change.

- Slightly more than half of Americans say they worry about climate change, a percentage that is relatively low compared with surveys conducted since 1989. Fewer than 4 in 10 think it will pose a serious threat to their own way of life.
- Only about 6 in 10 Americans believe there is scientific consensus on the fact that climate change is occurring.

When given the choice, a majority of Americans say they would prefer to focus on non–fossil fuel alternatives.

- About 6 in 10 consumers say they would choose to prioritize conservation over fossil fuel development; the same proportion would focus on alternative energy over fossil fuel development.
- The vast majority of Americans (about 8 in 10) say they would like to see more emphasis on both fuel efficiency standards for vehicles and renewable energy development.

- Different surveys about how Americans feel about nuclear energy suggest that support may be as low as about 4 in 10 Americans or as high as about 6 in 10 Americans.

A minority of Americans think genetically engineered (GE) foods are safe.

- Three in 10 Americans see GE foods as "safe to eat," and a similar proportion believes that scientists understand the risks of these foods.

Most Americans view using stem cells from human embryos in medical research as "morally acceptable."

- Gallup research shows that more than 6 in 10 Americans see using stem cells from human embryos as acceptable. This percentage reached a historic high in 2014.

Most Americans think other countries are doing a better job on science, technology, engineering, and mathematics (STEM) education.

- In 2014, fewer than 1 in 10 Americans think that American kindergarten through grade 12 STEM education is among the best in the world.

Introduction

Chapter Overview

Science and technology (S&T) is central to American life. It shapes many of our daily activities, including how we interact at home, at work, and in our communities. Millions of Americans use S&T at work (see chapter 3), whereas others use these innovations to produce the goods and services that improve and reshape our lives. S&T gives us new opportunities to get healthy and stay healthy. It influences what and how we eat while providing technologies that keep us connected and entertained. S&T often enters our conversations about daily life decisions and may stimulate us intellectually and emotionally. The centrality of S&T to American life means that Americans' attitudes about and understanding of S&T may matter a great deal.

All technologies also involve risks and benefits, and technologies can embody risks that may take time to become apparent. S&T discussions may often center on potential risks and benefits, as well as moral issues raised by adopting scientific processes and technologies. Societies can do a better job of addressing potential concerns when the nature of these concerns is well understood and discussed (e.g., NRC 1996, 2008). Americans' desire to seek potential benefits from S&T and deal with potential risks may affect what kinds of S&T can be developed or used. For example, Americans must decide how much of society's resources to devote to scientific research, where to devote those resources, and whether to encourage or discourage the development of specific technologies. Individuals may also choose where to focus their careers based on both their personal interests and on where they believe they can make a meaningful contribution.

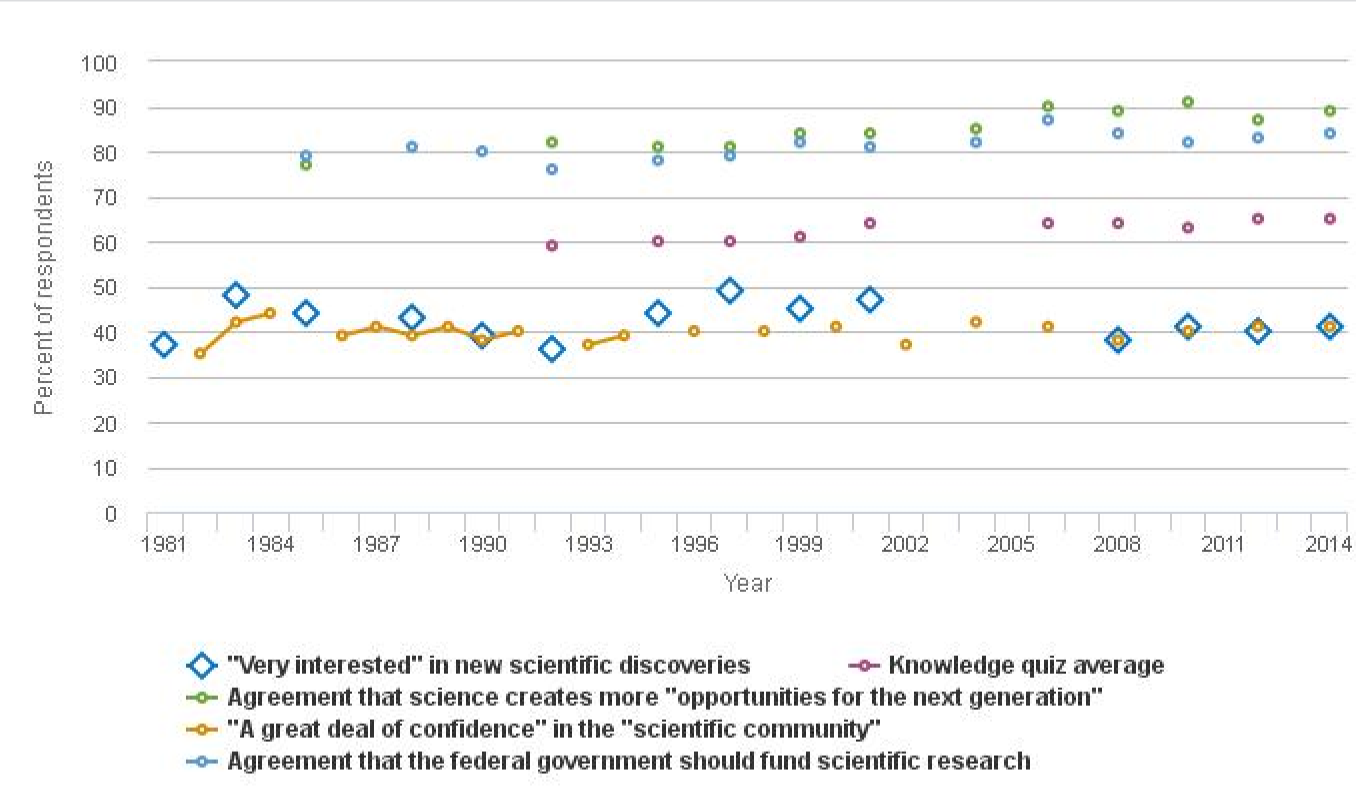
Given the centrality of S&T to life in the United States, this chapter presents indicators about interest in S&T news, where people encounter S&T in the media, trend data regarding knowledge of S&T, and indicators of people's attitudes about S&T-related issues. To put U.S. data in context, the chapter examines trend indicators for past years and comparative indicators for other countries, where such data are available.

A review of five key indicators in this chapter—interest in new scientific discoveries, basic scientific knowledge, belief that science creates opportunity, confidence in the scientific community, and support for science funding—indicates that Americans' overall attitudes about science are either stable or becoming more positive and that knowledge may be slowly increasing. The key indicators were chosen because data are available for a relatively long period for each indicator and because the indicators reflect the main themes raised in the chapter. Looking at these indicators together provides a sense of how Americans' overall attitudes and knowledge about S&T have changed over more than 30 years.

Specifically, the percentage of Americans agreeing that S&T creates new opportunities and that it is important to fund scientific research has been at relatively high levels in recent surveys compared with those from previous decades. Basic knowledge has also grown slightly with time. General confidence in the scientific community and the percentage of Americans saying that they are "very interested" in new scientific discoveries have been relatively stable in recent years (Figure 7-1). Also, as will be discussed in more detail subsequently, a key demographic factor associated with these indicators is overall education level. Science-specific education plays a role similar to overall education. In contrast, respondents' age and sex are either unrelated or weakly related to these types of key indicators (Figure 7-2).

Figure 7-1

Key science and engineering knowledge and attitude indicators: 1981–2014



NA = not available.

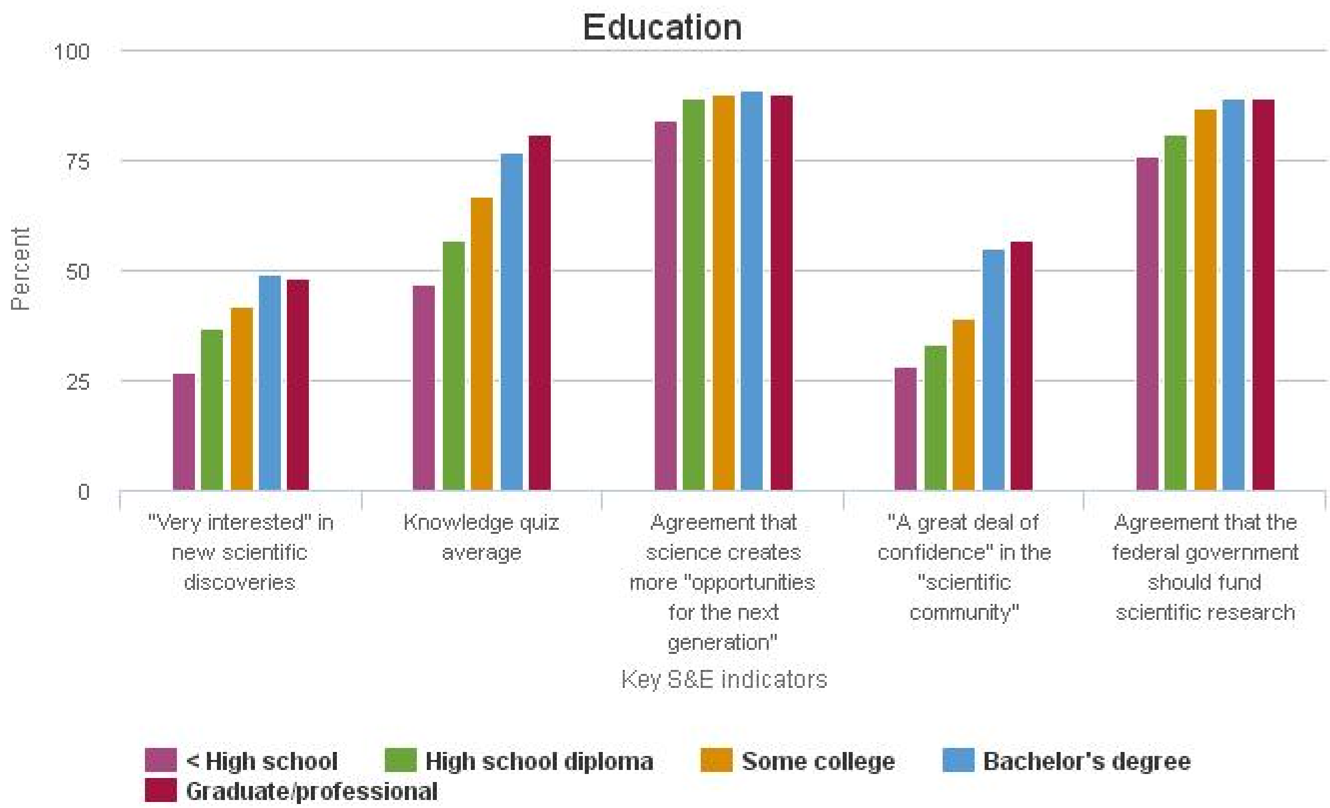
NOTE: Includes the responses "strongly agree" and "agree" to the following statements: *Agreement that science creates more "opportunities for the next generation"* and *Agreement that the federal government should fund scientific research.*

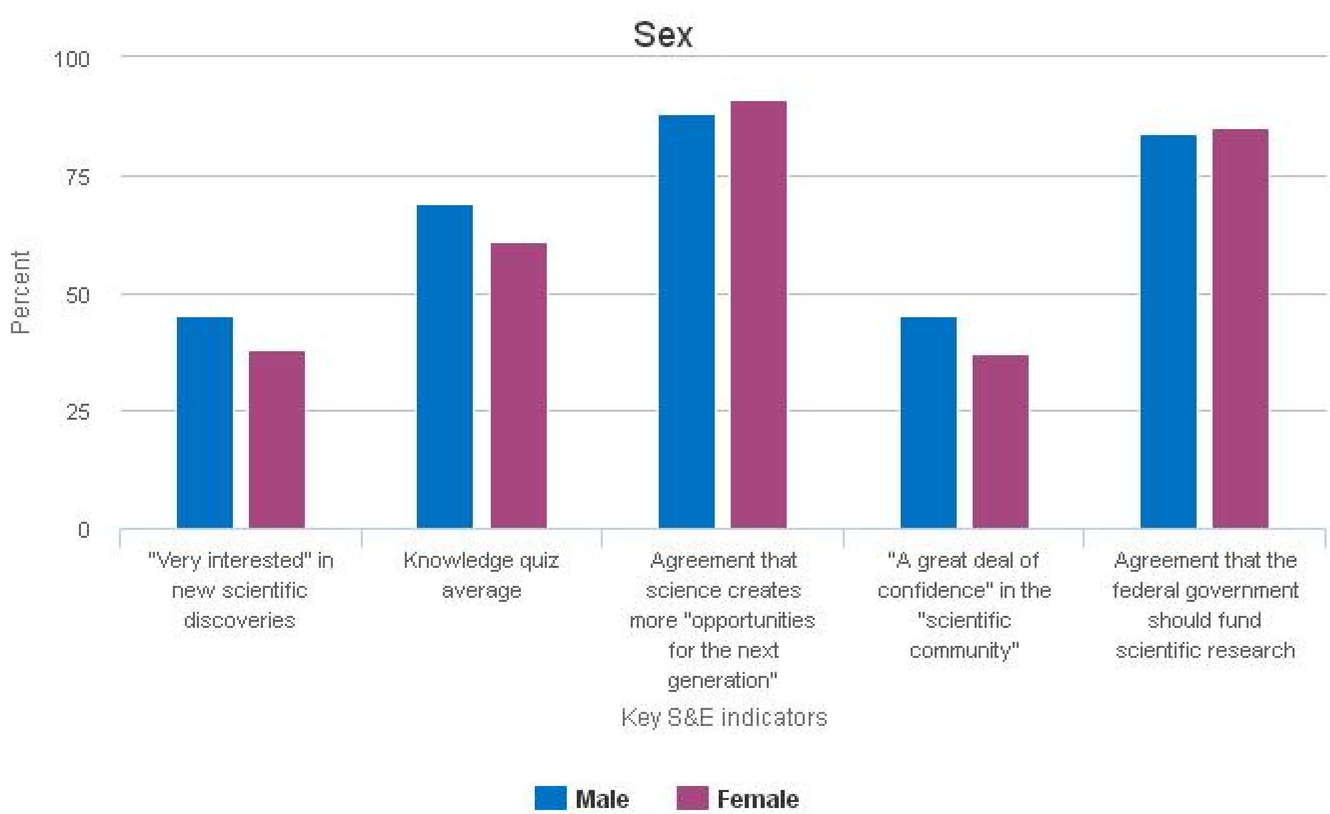
SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (1981–2001); University of Michigan, Survey of Consumer Attitudes (2004); University of Chicago, National Opinion Research Center, General Social Survey (2006–14). See appendix tables 7-1, 7-6, 7-15, 7-19, and 7-23.

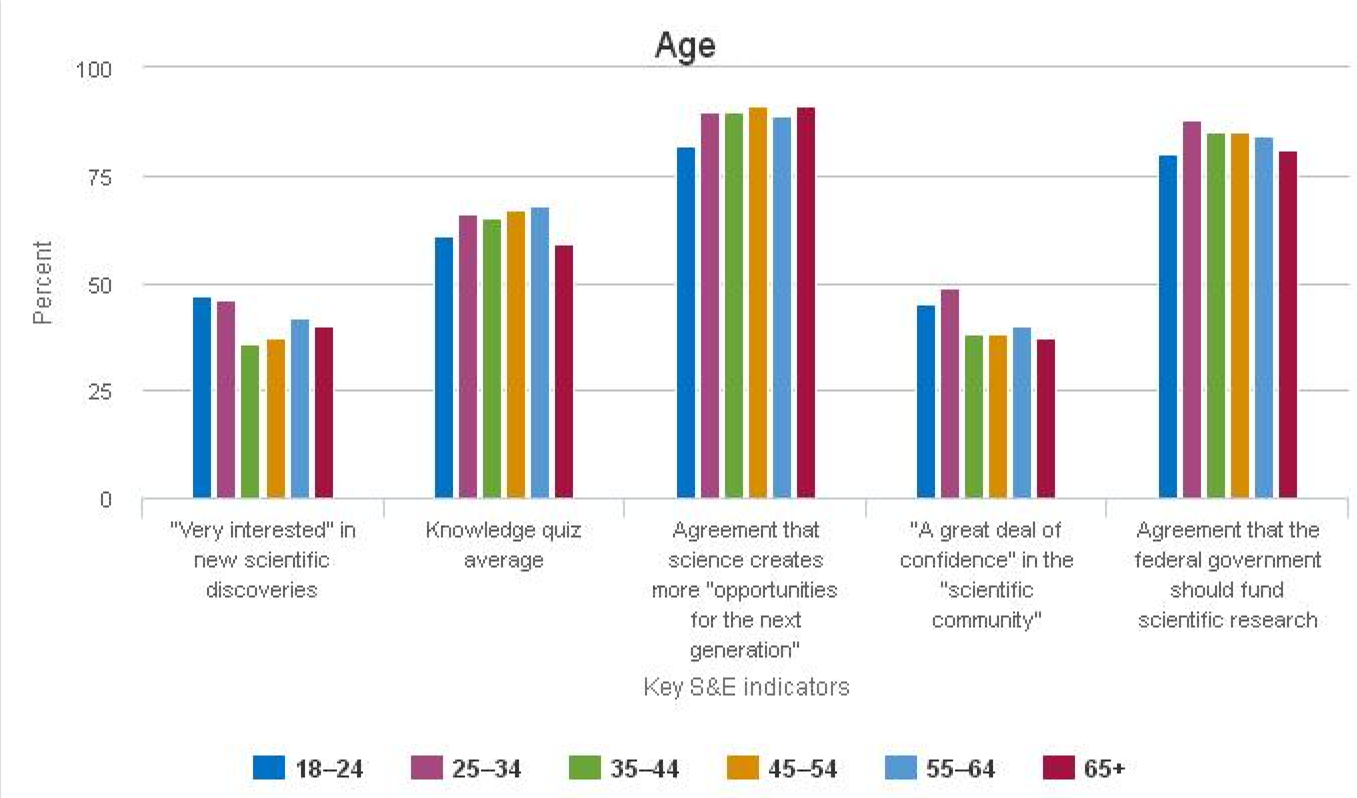
Science and Engineering Indicators 2016

Figure 7-2

Key science and engineering indicators, by selected respondent education, sex, and age: 2014







NOTE: Includes the responses "strongly agree" and "agree" to the following statements: *Agreement that science creates more "opportunities for the next generation"* and *Agreement that the federal government should fund scientific research.*

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2014). See appendix tables 7-1, 7-6, 7-15, 7-19, and 7-23.

Science and Engineering Indicators 2016

Chapter Organization

This chapter is divided into four main sections. The first includes indicators of the public's interest in S&T news, sources of information, and involvement in informal S&T activities. The second section reports on indicators of public knowledge, including trend measures of factual knowledge of S&E and people's understanding of the scientific process. This second section also includes results of survey experiments designed to better understand how question wording affects the accuracy of responses to knowledge questions. The third section presents data on attitudes about S&T in general, including support for government funding of basic research and confidence in the leadership of the scientific community. The fourth section addresses attitudes on public issues in which S&T plays an important role, such as the environment, climate change, energy, nuclear power, and the use of animals in scientific research. It also includes indicators of public opinion about several active lines of research and new technologies, including genetically engineered (GE) food, stem cell research, and cloning.

A Note about Data and Terminology

This chapter emphasizes trends over time, patterns of variation within the U.S. population, and comparisons between public opinion in the United States and in other countries or regions. It reviews survey data from national samples with sound, representative sampling designs. The text focuses on the trends and demographic patterns in the data. Where possible, the focus is on surveys released since the 2014 edition of *Science and Engineering Indicators* was written.

S&T-related questions asked in the biennial General Social Survey (GSS) on behalf of the National Science Foundation (NSF) are a major source of data for this chapter. The GSS is a high-quality, nationally representative survey focused on attitudes and behavior of the U.S. population. Questions about S&T information, knowledge, and attitudes have been included in the GSS since 2006 and have formed the basis of this chapter in *Indicators* since 2008. The GSS collects data primarily through in-person interviews. Comparable survey data collected between 1982 and 2004 by various survey providers contracted by NSF used telephone interviews. Before 1982, these data were collected via in-person interviews. Changes in data collection methods over these years, particularly before 2006 (i.e., the switch to the GSS and the return to face-to-face interviewing), may affect comparisons over time. Situations in which this may be an issue are highlighted in the text.

A range of other data sources are also used in the chapter, although only surveys involving probability-based samples are included. The primary sources of such data include Gallup, the Pew Research Center, and the World Values Survey (WVS). Like all survey data, the results reported in this chapter are subject to many sources of error (e.g., sampling error, response error) and random variation that should be kept in mind when interpreting the findings. Caution is especially warranted when interpreting results 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. The GSS typically uses face-to-face interviews, but most of the data from groups such as Gallup and the Pew Research Center use telephone samples (including both landlines and mobile phones) that inherently exclude those without telephones. The only Internet-based surveys used in the chapter are those collected by GfK, which chooses its panel based on techniques similar to the telephone samples used by other organizations. Nevertheless, face-to-face surveys are believed to be the best way to obtain high response rates and to maximize participation by respondents with low income or education who may be less likely to respond to other types of surveys (see sidebars, U.S. Survey Data Sources and International Survey Data Sources). The Eurobarometer, a major source of comparable European data, uses face-to-face surveys.

Another important limitation is that up-to-date, high-quality data are not always available. In some cases, there are only single surveys, large gaps between data collection years, or only a small number of questions on any given topic. This challenge is particularly acute when it comes to international data. There have been many surveys on S&T in Europe, but these are not conducted as regularly as the GSS. Data from Asia, even when they are collected, may not be made freely available to researchers. Data from Africa and South America are especially rare. As noted, the current chapter focuses on surveys that have become public after the preparation of the 2014 *Indicators* report. Earlier data can be found in past editions of *Indicators* (e.g., NSB 2014). Bauer, Shukla, and Allum (2012) also summarized relevant survey data up to 2006 from a range of countries and regions. Even in cases in which international comparisons attempt to compare identical questions, the responses may not be wholly comparable because of cultural differences in the meaning of the questions.

Throughout this chapter, the terminology used in the text reflects the wording in corresponding survey questions. 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 appropriate for 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. The term *Americans* is used throughout to refer to U.S. residents included in a national survey; equivalent terms (e.g., *Canadians*) are used for residents of other countries. However, not all respondents were citizens of the countries in which they were surveyed. When discussing data collected on behalf of NSF, the term *recent* is used to refer to surveys conducted since 2006, when data collection shifted to the GSS.

U.S. Survey Data Sources

Table 7-A below describes U.S. surveys utilized in this chapter.

Table 7-A U.S. Survey Data Sources

Sponsoring organization	Title	Years used	Questions used	Data collection method	Respondents (*n*); margin of error of general population estimates
National Science Foundation	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, visits to informal science institutions, general attitudes, government spending attitudes, science/mathematics education attitudes, animal research attitudes	Telephone interviews	*n* = 1,574–2,041; ± 2.47%–3.03%
National Opinion Research Center (NORC) at the University of Chicago	General Social Survey (GSS)	1973–2014	Government spending attitudes, confidence in institutional leaders	Face-to-face interviews, supplemented by telephone interviews	Government spending (2000–14): *n* = 1,434–2,256; ± 2.5%–3.9% Confidence in institutional leaders, (1973–2014): *n* = 876–3,278; ± 2.5%–4.4%

Sponsoring organization	Title	Years used	Questions used	Data collection method	Respondents *(n)*; margin of error of general population estimates
NORC at the University of Chicago	GSS science and technology module	2006, 2008, 2010, 2012, 2014	Information sources, interest, visits to informal science institutions, general attitudes, government spending attitudes, science/mathematics education attitudes, animal research attitudes, nanotechnology awareness and attitudes, science knowledge	Face-to-face interviews, supplemented by telephone interviews	*n* = 1,864–2,130; ± 2.5%–3.3%
National Survey of American Public Opinion on Climate Change	American Belief in Climate Change	2012	Climate change	Telephone interviews	*n* = 726; ± 4.0%
Gallup Organization	Various ongoing surveys	1982–2015	Federal priorities, environmental protection, climate change, global warming, nuclear power, alternative energy, animal research, stem cell research, quality of science /mathematics education in U.S. public schools attitudes	Telephone interviews	*n* = ~1,000; ± 3.0%–4.0%
Pew Internet & American Life Project, Pew Research Center	Pew Internet & American Life Survey	2006, 2012	Media use	Telephone interviews	2006: *n* = 2,000; ± 3.0% 2012: *n* = 2,252; ± 2.3%
Pew Research Center for the People and the Press	General Public Science Survey, separate survey of American Association for the Advancement of Science members	2014	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)	Public: *n* = 2,002; ± 3.1% Scientists: *n*- = 3,478; ± 1.7%

Sponsoring organization	Title	Years used	Questions used	Data collection method	Respondents (*n*); margin of error of general population estimates
Pew Research Center for the People and the Press	Media surveys (various)	1985–2015	Views of the news media, media believability	Telephone interviews	*n* = ~1,000–1,505; ± 3.4%–4.0%
Pew Research Center for the People and the Press	Political surveys (various)	2008–2015	Information sources, Internet use, national policy attitudes (environment, global warming, energy, stem cell research), government spending for scientific research attitudes	Telephone interviews	*n* = ~1,000–5,122; ± 1.6%–3.5%
Yale Project on Climate Change Communication and the George Mason University Center for Climate Change Communication	Climate Change in the American Mind	2008–2015	Climate change	Online (probability-based sample)	*n* = 1,263; ± 3.0%

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

International Survey Data Sources

Table 7-B below describes international surveys utilized in this chapter.

Table 7-B International Survey Data Sources

Sponsoring organization	Title	Years used	Questions used	Data collection method	Respondents *(n)*; **margin of error of general population estimates**
	BBVA Foundation International	2011	Media use, knowledge and attitudes	Face-to-face interviews	*n* = 1,500 for each of 15 countries; ± 2.6%

Sponsoring organization	Title	Years used	Questions used	Data collection method	Respondents *(n)*; **margin of error of general population estimates**
BBVA Foundation (Fundacion BBVA)	Study on Scientific Culture				
British Council, Russia	Survey of Public Attitudes Toward Science and Technology in Russia	2003	Various knowledge items	Paper questionnaires	*n* = 2,107
Council of Canadian Academies	Public Survey of Science Culture in Canada	2013	Various knowledge and attitude items, engagement, science skills	Landline and mobile phone (60%); Internet (40%)	*n* = 2,004; ± 2.2%
Chinese Association for Science and Technology, China Research Institute for Science Popularization	Chinese National Survey of Public Scientific Literacy	2001, 2007, 2010	Various knowledge and attitude items, interest, occupational prestige, visits to informal science institutions	Face-to-face interviews	2001: *n* = 8,350 2007: *n* = 10,059 2010: *n* = 68,416
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, visits to informal science institutions	Face-to-face interviews	(EU total) n = 26,403; Austria: 1,034 Belgium: 1,024 Cyprus: 504 Czech Republic: 1,037 Denmark: 1,013 Estonia: 1,000 Finland: 1,007 France: 1,021 Germany: 1,507 Greece: 1,000 Hungary: 1,000 Ireland: 1,008 Italy: 1,006 Latvia: 1,034 Lithuania: 1,003 Luxembourg: 518 Malta: 500 The Netherlands: 1005 Poland: 999 Portugal: 1009 Slovakia: 1241 Slovenia: 1,060 Spain: 1,036 Sweden: 1,023 United Kingdom: 1,307
		2005			

Sponsoring organization	Title	Years used	Questions used	Data collection method	Respondents *(n)*; **margin of error of general population estimates**
	Special Eurobarometer 224b/Wave 64.3: *Europeans and Biotechnology in 2005: Patterns and Trends* (2006)		Biotechnology attitudes		(EU total) *n* = ~25,000; Member States Austria: ~1,000 Belgium: ~1,000 Cyprus: ~1,000 Czech Republic: ~1,000 Denmark: ~1,000 Estonia: ~1,000 Finland: ~1,000 France: ~1,000 Germany: ~1,000 Greece: ~1,000 Hungary: ~1,000 Ireland: ~1,000 Italy: ~1,000 Latvia: ~1,000 Lithuania: ~1,000 Luxembourg: ~1,000 Malta: ~1,000 The Netherlands: ~1,000 Poland: ~1,000 Portugal: ~1,000 Slovakia: ~1,000 Slovenia: ~1,000 Spain: ~1,000 Sweden: ~1,000 United Kingdom: ~1,000
	Special Eurobarometer 300/Wave 69.2: *Europeans' Attitudes Towards Climate Change* (2008)	2008	Climate change attitudes		(EU total) *n* = ~26,661; Member States: Austria: 1,000 Belgium: 1,003 Bulgaria: 1,000 Cyprus: 504 Czech Republic: 1,014 Denmark: 1,005 Estonia: 1,006 Finland: 1,004 France: 1,040 Germany: 1,534 Greece: 1,000 Hungary: 1,000 Ireland: 1,004 Italy: 1,022 Latvia: 1,008 Lithuania: 1,021 Luxembourg: 501 Malta: 500 The Netherlands: 1,041 Poland: 1,000 Portugal: 1,001 Romania: 1,019 Slovakia: 1,085 Slovenia: 1,003 Spain: 1,033 Sweden: 1,007 United Kingdom: 1,306
	Special Eurobarometer 340/Wave 73.1: *Science and Technology Report* (2010)	2010	Science and technology attitudes and interest, support for basic research, animal research attitudes		(EU total) *n* = ~26,671; Member States: Austria: 1,000 Belgium: 1,012 Bulgaria: 1,009 Cyprus: 502 Czech Republic: 1,043 Denmark: 1,006 Estonia: 1,004 Finland: 1,001 France: 1,018 Germany: 1,531 Greece: 1,000 Hungary: 1,017 Ireland: 1,007 Italy: 1,018 Latvia: 1,013 Lithuania: 1,026 Luxembourg: 503 Malta: 500 The

Sponsoring organization	Title	Years used	Questions used	Data collection method	Respondents *(n)*; **margin of error of general population estimates**
					Netherlands: 1,018 Poland: 1,000 Portugal: 1,027 Romania: 1,060 Slovakia: 1,030 Slovenia: 1,004 Spain: 1,004 Sweden: 1,007 United Kingdom: 1,311
	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 engineered foods attitudes		(EU total) *n* = ~26,671; Member States: Austria: 1,000 Belgium: 1,012 Bulgaria: 1,009 Cyprus: 502 Czech Republic: 1,043 Denmark: 1,006 Estonia: 1,004 Finland: 1,001 France: 1,018 Germany: 1,531 Greece: 1,000 Hungary: 1,017 Ireland: 1,007 Italy: 1,018 Latvia: 1,013 Lithuania: 1,026 Luxembourg: 503 Malta: 500 The Netherlands: 1,018 Poland: 1,000 Portugal: 1,027 Romania: 1,060 Slovakia: 1,030 Slovenia: 1,004 Spain: 1,004 Sweden: 1,007 United Kingdom: 1,311
	Special Eurobarometer 401/wave 6: *Responsible Research and Innovation (RRI) Science and Technology* (2013)	2013	Research, innovation, science, and technology attitudes		(EU total) *n* = ~27,563 Member States: Austria: 1,022 Belgium:1,000 Bulgaria: 1,018 Croatia: 1,000 Cyprus: 505 Czech Republic:1,000 Denmark: 1,004 Estonia: 1,003 Finland: 1,003 France: 1,027 Germany: 1,499 Greece: 1,000 Hungary: 1,033 Ireland: 1,002 Italy: 1,016 Latvia: 1,006 Lithuania: 1,027 Luxembourg: 505 Malta: 500 The Netherlands: 1,019 Poland: 1,000 Portugal: 1,015 Romania: 1,027 Slovakia: 1,000 Slovenia: 1,017 Spain: 1,003 Sweden: 1,006 United Kingdom: 1,306
	Special Eurobarometer 419/wave 6: *Public Perceptions of*	2014	Science, research, and innovation public attitudes		(EU total) *n* = ~27,910 Member States: Austria: 1,005 Belgium:1,025 Bulgaria: 1,033 Cyprus: 503 Croatia: 1,010 Czech Republic: 1,100 Denmark: 1,004

Sponsoring organization	Title	Years used	Questions used	Data collection method	Respondents *(n)*; **margin of error of general population estimates**
	Science, Research, and Innovation (2014)				Estonia: 1,012 Finland: 1,017 France: 1,018 Germany: 1,511 Greece: 1,012 Hungary: 1,060 Ireland: 1,006 Italy: 1,014 Latvia: 1,016 Lithuania: 1,013 Luxembourg: 501 Malta: 501 The Netherlands: 1,030 Poland: 1,082 Portugal: 1,009 Romania: 1,020 Slovakia: 1,007 Slovenia: 1,034 Spain: 1,009 Sweden: 1,050 United Kingdom: 1,308
India National Council of Applied Economic Research	National Science Survey	2004	Various knowledge and attitude items, visits to informal science institutions	Face-to-face interviews	*n* = 30,255
Japan Science and Technology Agency, Research Institute of Science and Technology for Society	Survey of Scientific Literacy	2011	Various knowledge items	Internet Survey and interviews	*n* = 812–984
Korea Foundation for the Advancement of Science and Creativity (formerly Korea Science Foundation)	Survey of Public Attitudes Toward and Understanding of Science and Technology	2004, 2006, 2008	Interest, various knowledge and attitude items, visits to informal science institutions	Face-to-face interviews	*n* = 1,000; ± 3.1%
Malaysian Science and Technology Information Center,	Survey of the Public's Awareness of	2014	Interest, awareness, various knowledge and attitude items,	Face-to-face interviews	*n* = 2,653; ± 2.71%

Sponsoring organization	Title	Years used	Questions used	Data collection method	Respondents ***(n)*; margin of error of general population estimates**
Ministry of Science, Technology and Innovation	Science and Technology: Malaysia		visits to informal science institutions		
Pew Global Attitudes Project, Pew Research Center	Global Attitudes Survey	2013	Climate change concerns	(Varies by country) Face-to-face interviews Telephone interviews	(United States) *n* = 1,002; ± 3.5%; (38 other countries) *n* = 700–3,226; ± 3.1%– 7.7%
World Values Survey Association	World Values Survey Wave 6	2010-2014	Science, faith, environmental, and economics attitudes	Depending on country, face-to-face, mail, or online surveys; typically face-to-face	*n* = 1,000–2,500; ± 2.00%–3.20%

NOTES: EU = European Union; UK = United Kingdom.

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

Interest, Information Sources, and Involvement

Americans' understanding and attitudes about topics such as S&T depend, in part, on how much exposure they get to such content throughout their lives, as well as how much attention they pay to such content (Slater, Hayes, and Ford 2007). Exposure and attention to S&T can make residents more informed, shape their attitudes, and help them make decisions that are better for themselves, their families, and their communities. Media use itself may also foster a desire to seek and consider new information (Rimal, Flora, and Schooler 1999).

This section reviews overall expressed interest in media reports about S&T, the sources of material about S&T that are available to the public, and the type of S&T-related content the public uses. It concludes with indicators of personal involvement in S&T-related activities through visits to museums and other cultural institutions.

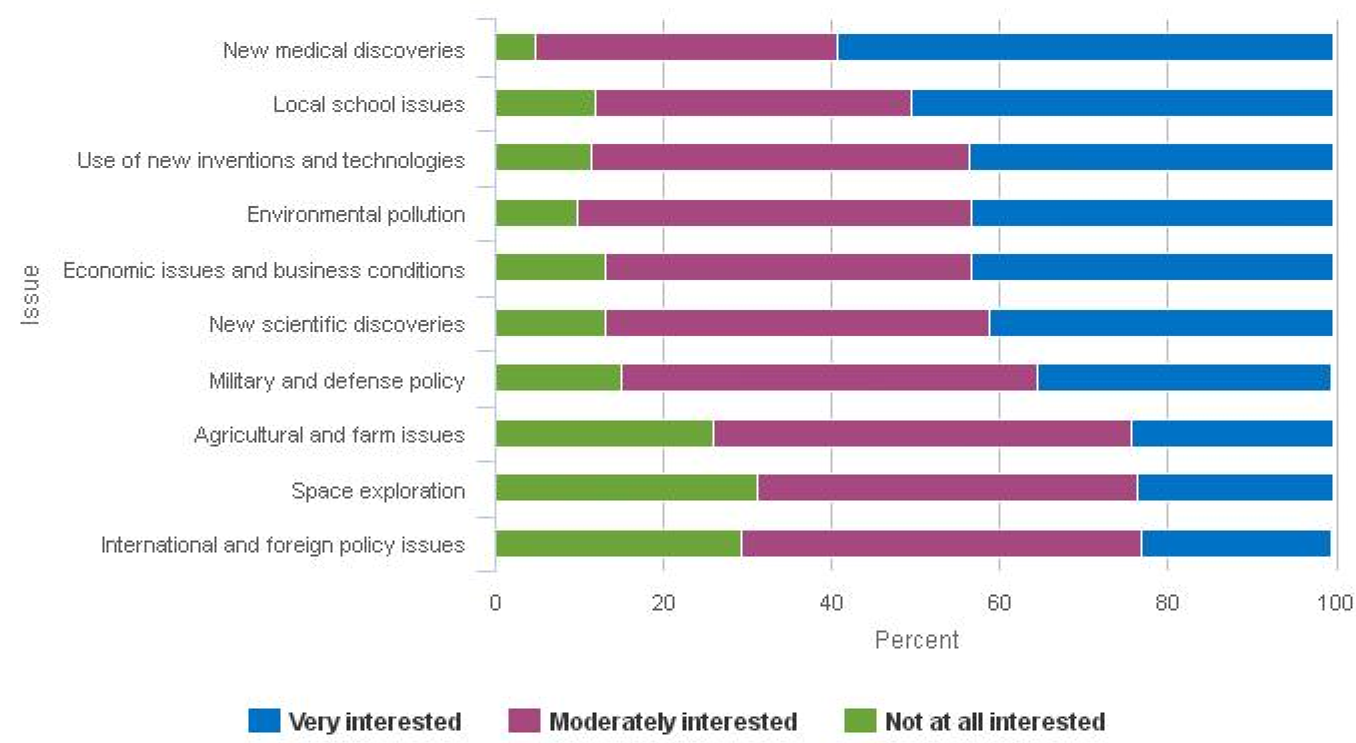
Public Interest in S&T

U.S. Patterns and Trends

Most Americans say they are interested in S&T. In 2014, 41% said they were "very interested" in new scientific discoveries, and 46% said they were "moderately interested" (Figure 7-3). Similarly, 43% said they were "very interested" in use of new inventions and technologies, and 59% said they were "very interested" in new medical discoveries. Medical discovery continues to be the subject included in the GSS in which Americans are most likely to express deep interest. About a quarter (24%) of respondents said they were "very interested" in space exploration. This puts space exploration near the bottom of the list of subjects asked about in the survey, similar to agricultural issues (24% "very interested" in 2014) and international policy (23% "very interested" in 2014).

Figure 7-3

Public interest in selected issues: 2014



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.* Responses of "don't know" are not shown.

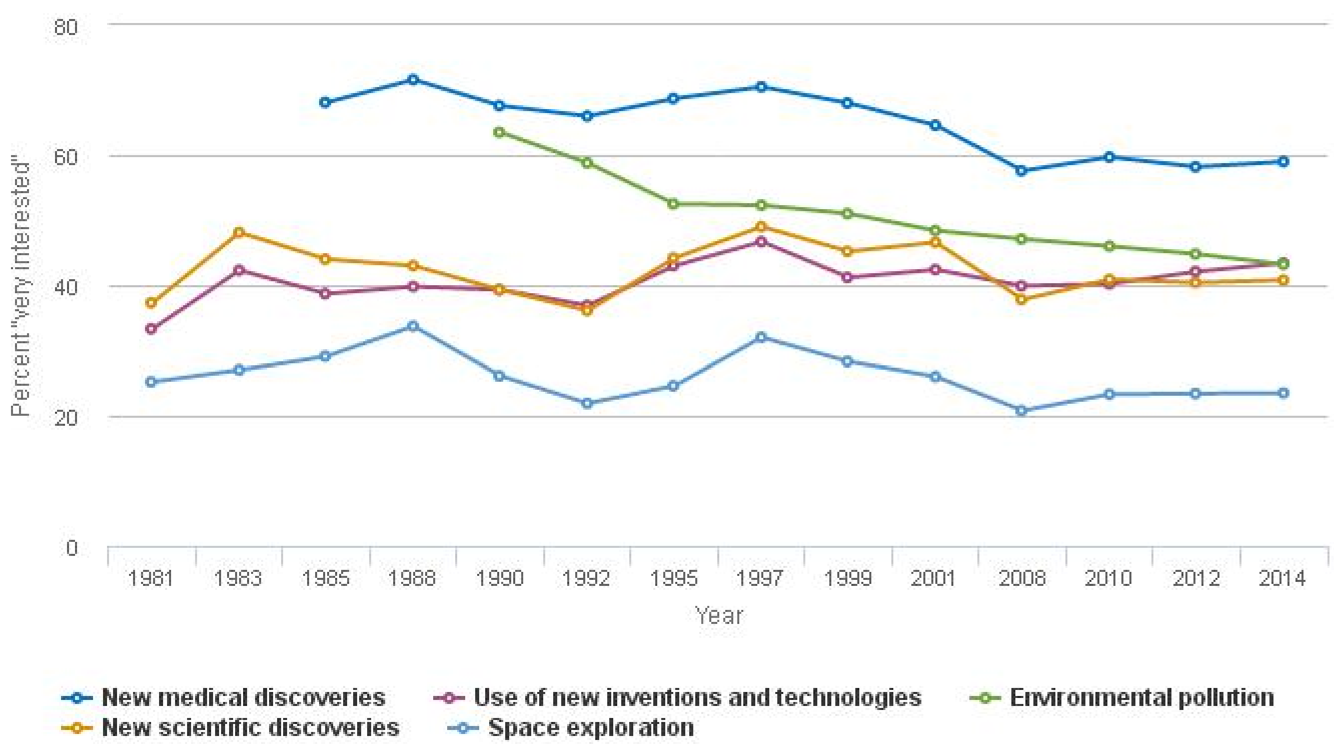
SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2014). See appendix table 7-1.

Science and Engineering Indicators 2016

Although sometimes down from previous highs, these figures have been fairly stable in recent years, with the exception of interest in "environmental pollution," which has declined (Figure 7-4). In 2014, 43% said they were "very interested" in the topic, which represents a decline from 64% in 1990, the first year for which there are data. Interest in medical discoveries is also lower than it was in previous decades, although it has been relatively stable in recent years (Appendix Table 7-1 and Appendix Table 7-2). It is not clear in the data why respondents have been less likely to express interest in "environmental pollution" over time. The discussion of specific environmental issues later in this chapter notes, however, that concern about the environment is relatively low in historical terms. The term *pollution* may also have become less salient as public discussion has turned to issues such as climate change.

Figure 7-4

Public interest in selected science-related issues: 1981–2014



NA = not available.

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. Survey results in 1981, 1983, 1985, 1988, 1990, 1992, 1995, 1997, 1999, 2001, 2008, 2010, 2012, and 2014.

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 (2008–14). See appendix table 7-1.

Science and Engineering Indicators 2016

Interest in the various science topics—and most other topics—is associated with education levels and mathematics and science course taking. Women tend to be more interested in medical discoveries, whereas men are more interested in S&T topics. There is little difference between the sexes on interest in the environment (Appendix Table 7-2).

Questions about interest may depend a great deal on the specific wording used to describe the subject and on the type of response that survey participants are allowed to select. Although "new scientific discovery" ranks in the middle of a group of issues in the GSS data (41% "very interested"), a public policy–focused survey by the Pew Research Center (2014c) found that 58% of respondents chose "science and technology" as a topic they were "interested in." The only topic selected more often was "health and medicine" (66%). "Events in your community" (57%) and "government and politics" (57%) were also of substantial interest. When required to select only three topics of interest, "health and medicine" (37%) and "government and politics" (36%) were selected the most, although "science and technology" (32%) was ranked as third most popular. A later science-focused survey found that 37% of respondents said they “enjoy keeping up with news about science” “a lot.” Another 35% said they get “some” enjoyment from keeping up with science news. About a quarter of Americans said they get either “not much” (18%) or no enjoyment “at all” (9%) from such coverage. These numbers were similar to those from a 2009 survey (Pew Research Center 2015b).

Another way that we can learn about what people think about S&T is to look at their behavior. New tools that allow users to explore online search habits, for example, can provide guidance on the topics that may be gaining or losing attention over time. The Using Google Trends to Examine American Attention to Science and Technology sidebar addresses this issue and provides two examples of what this type of data may be able to show those interested in how people are thinking about S&T.

Using Google Trends to Examine American Attention to Science and Technology

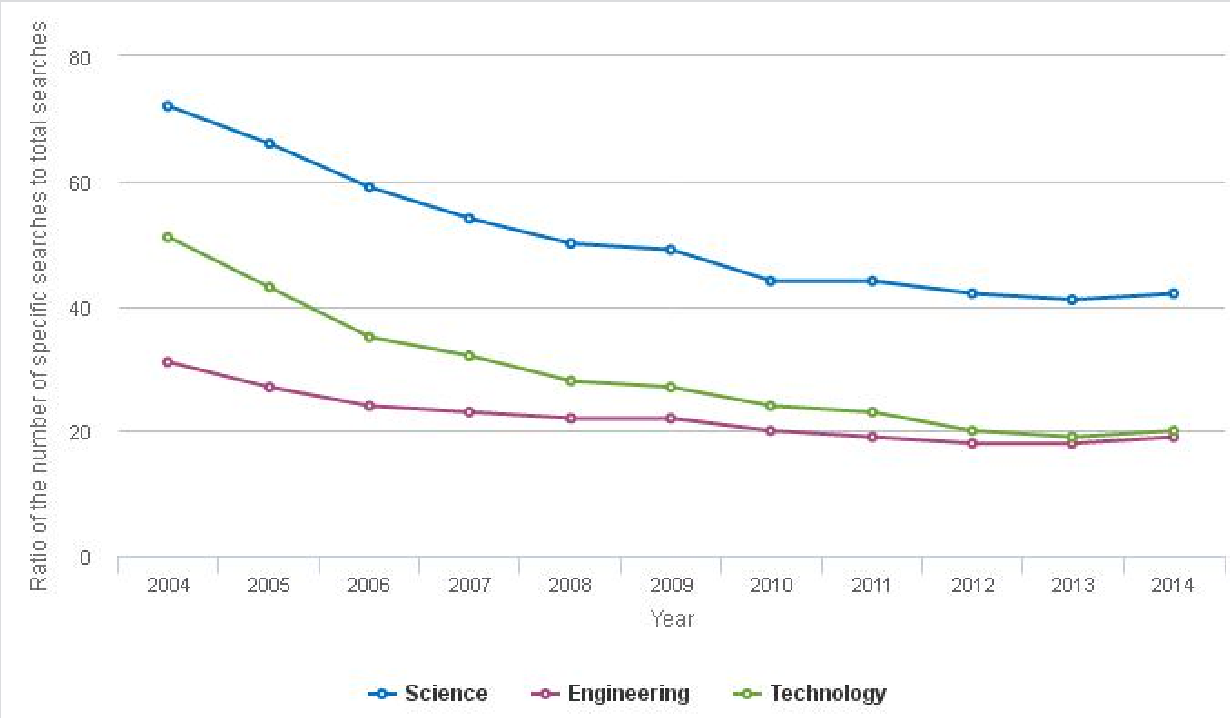
Another way to examine attention to science and technology (S&T) is to look at online search patterns using tools such as Google Trends (Segev and Baram-Tsabari 2012). Although specific data on the total number of searches for specific keywords are not publicly available, the Google Trends website provides data on Google search patterns back to 2004.

The findings for attention to S&T presented as follows are based on the number of Google searches for selected topics compared with the total number of Google searches at each time point. Therefore, a downward trend line means that the popularity of a search term is decreasing. It does not mean that the total number of searches for that search term is decreasing because the total number of Google searches has increased over time as the Internet has become more widely available. Google Trends also adjusts the search results so that the most popular time for a given keyword is always scored as 100, and other results are adjusted so that they represent comparisons with that high point (Google 2015). This means that results need to be described in relative terms. A wide range of searches might be used to provide guidance on interest in various S&T topics. The following two examples are provided.

First, a combined Google Trends search for how often people search for “science,” “engineering,” and “technology” in the United States shows that “science” is the most common of the searches and that there has been less relative focus on all three topics over time (Figure 7-A).* The downward sloping trend line for all three search terms suggests that each has become a relatively less common Google search since 2004. One potential explanation is that, as Internet use became more common, a smaller proportion of searches were focused on education or academic topics. In other words, entertainment or social uses might have become relatively more common during the period in question.

Figure 7-A

Google trend data for science, engineering, and technology searches: 2004–14



NOTE: The numbers reflect how many Google searches have been done for a particular term, relative to the total number of searches over time. The results are also normalized so that the highest score in any search is 100.

SOURCE: Google, Google Trends, http://www.google.com/trends/, accessed 6 January 2015.

Science and Engineering Indicators 2016

A second combined Google Trends search seeks to compare how often Google users searched the various topics discussed in the "Public Attitudes about Specific S&T-Related Issues" section of this chapter.[†] In this case, the results suggest that genetically engineered food, initially the least common search term, had become relatively common by 2014 (Figure 7-B). In contrast, there were declines in the relative amount of searching for issues related to the environment and stem cells. The pattern of searches for climate change shows a large spike around 2007, but relative searches have declined since. It is noteworthy that 2007 marked a high point in concern about climate change in the United States according to survey research on the topic (see the "Climate Change" section in this chapter and Kahn and Kotchen 2011). The relative amount of searching for nuclear energy has, in contrast, stayed stable, except for a brief spike in searches in 2011 at the time of the Fukushima Daiichi nuclear power plant accident in Japan.

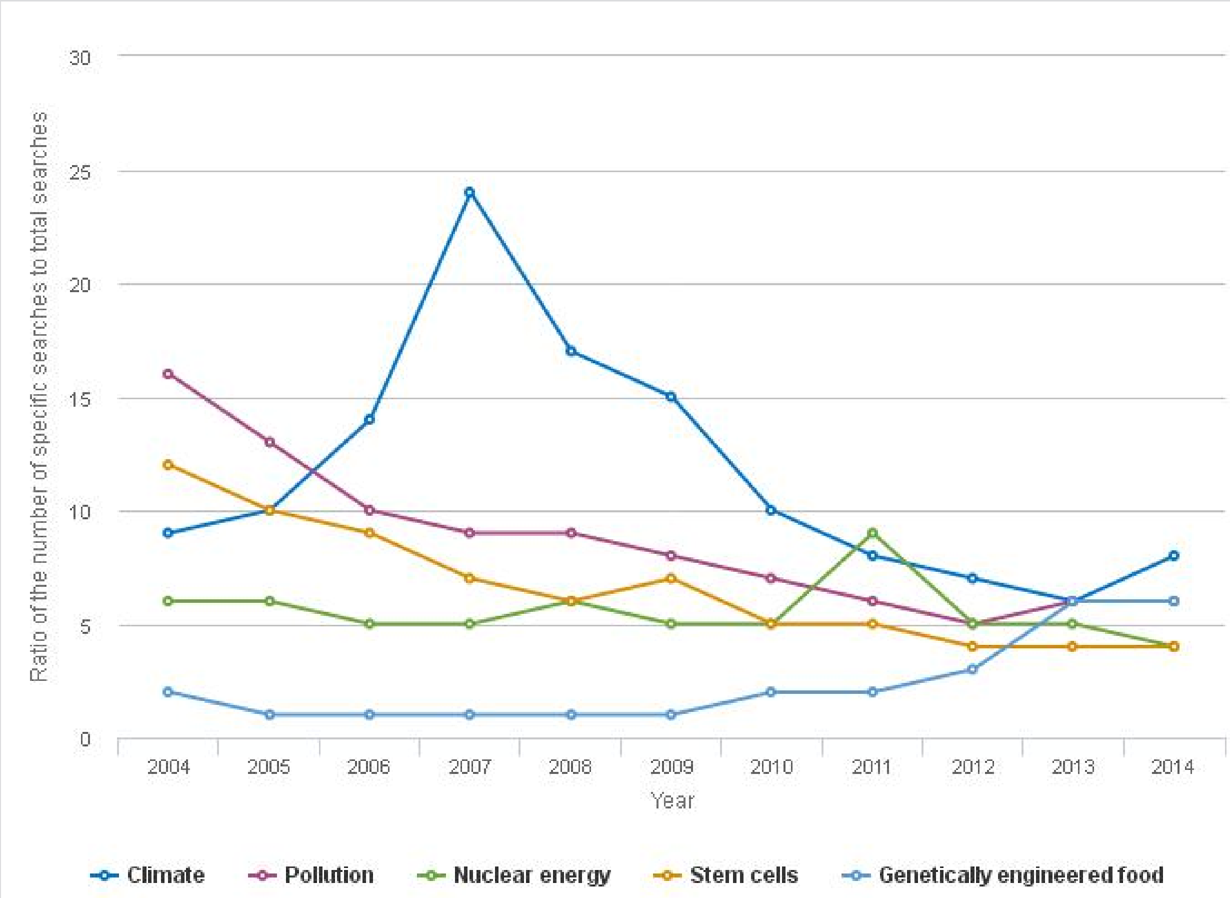
Tools such as Google Trends will likely become increasingly important to how we analyze behavior online. Other sources of online activity data from organizations such as Facebook or Twitter could also be used to assess interest in S&T topics, but data from such sources are not widely available. Google is a popular search engine in the United States; it accounted for about two-thirds (65%) of searches from desktop computers in January 2015 (comScore 2015). Focusing on these types of data, however, also means missing data on the behavior of those who are not online, including those with low levels of education and income. It will also become important to assess whether search patterns differ by language used (e.g., English versus Spanish). Although it is not shown here, the current Google Trends site also allows users to compare search patterns by location (e.g., country or state).

* Although various combinations were considered, the final search terms used were “science,” “engineering,” and “technology.” This search can be viewed, updated, or modified using the following link: http://www.google.com/trends /explore?q=#q=science%2C%20engineering%2C%20technology&geo=US&cmpt=q.

† Although various combinations were considered, the final search term used was: climate change +climate science +global warming +Kyoto protocol +UNFCC +Convention on Climate Change; pollution +environmental protection +environmental conservation +environmental issue; nuclear energy +nuclear power +nuclear reactor +nuclear plant +atomic energy +atomic power +atomic reactor +atomic plant; genetically engineered food +genetically engineered organism +genetically engineered crop +ge food +ge crop +genetically modified food +genetically modified organism +genetically modified crop +gm food +gm crop +gmo +agricultural biotechnology +agbiotech; STEM cell +STEM cells.”

Figure 7-B

Google trend data for specific science and technology issues searches: 2004–14



NOTE: The numbers reflect how many Google searches have been done for a particular term, relative to the total number of searches over time. The results are also normalized so that the highest score in any search is 100.

SOURCES: Google, Google Trends, http://www.google.com/trends/, accessed 6 January 2015.

Science and Engineering Indicators 2016

International Comparisons

Americans appear to report higher levels of interest in S&T issues than Europeans, although the level of expressed interest varies widely by country, and different question wordings require cautious comparisons. Overall, about 13% of Europeans said they were “very interested” in S&T in 2013, whereas another 40% said they were “fairly interested.” That is, 53% were “very” or “fairly” interested versus 87% of Americans who were “very” or “moderately” interested. The 27 European countries surveyed display a broad range of interest levels, with a high of 77% in Sweden and lows of 34% and 35% in the Czech Republic and Bulgaria, respectively (European Commission 2013). Another factor that makes these numbers difficult to compare is that 2013 Eurobarometer respondents were asked about only their general interest in S&T and not issues such as local schools or agriculture, whereas Americans were asked about interest in a wide range of issues (Figure 7-3).

Although data for countries beyond the United States and Europe are limited, previous surveys suggest that a sizable majority of residents of China, Japan, and South Korea report substantial interest in S&T. The varied questions and survey structures used, however, prevent direct comparisons with the United States. In 2010, 72% of Chinese respondents said they were interested in "new scientific discoveries," and 68% said they were interested in "new inventions and technologies" (CRISP 2010). In Japan, the percentage saying they were interested in "science and technology" climbed from 63% in January 2010 to 76% in July 2011, before and after the major earthquake that damaged the nuclear power plant in Fukushima. It dropped back to 65% in December 2011 (NISTEP 2012). In South Korea, a 2012 survey found that 48% of respondents said they had an interest in "new inventions and technologies," 48% said they had an interest in "new medical information and discoveries," and 50% said they had an interest in "new scientific discoveries." These levels are generally similar to 2008 and 2010 South Korean surveys (KOFAC 2013).

Availability of S&T News in the Media

Americans' knowledge and attitudes about S&T, particularly on topics in which research and discovery are ongoing, partially depend on the availability of S&T news. Media coverage often sets the public agenda (Soroka 2002) and frames the debate related to scientific issues (Nisbet and Scheufele 2009). A range of social processes associated with journalism, science, and public decision making determine which issues get attention from journalists during particular periods (Nisbet and Huge 2006). For example, natural or human disasters may increase the likelihood that relevant S&T issues are covered by the news while decreasing the likelihood that unrelated issues are covered. Quantity and prominence of coverage may also affect topical knowledge within society (Barabas and Jerit 2009). Other research suggests that different types of media have different effects on attitudes, with newspaper reading and Internet use being associated with more favorable attitudes than television (e.g., Dudo et al. 2011). Given the potential impact of media use, indicators that address how much and what kinds of S&T news coverage are available in the media can be important for understanding the development of views about S&T.

The amount of science-focused news programming on the three major broadcast networks (ABC, CBS, and NBC) appears to have been relatively low compared with that of previous years. The Tyndall Report has tracked the content of the three major broadcast networks for more than 20 years. Tyndall tabulates the amount of air time devoted to different topics using 18 different categories (Tyndall Report 2015). Two categories with substantial science, engineering, and technology components are "science, space, and technology" and "biotechnology and basic medical research."[i] Neither category has ever occupied a large percentage of the approximately 14,500–15,000 minutes of annual nightly weekday newscast coverage on the networks. The airtime devoted to "science, space, and technology" has averaged about 2% of broadcast news between 2000 and 2012 (Figure 7-5). Time devoted to "biotechnology and basic medical research" was even lower, almost always 1% or less of broadcast news.

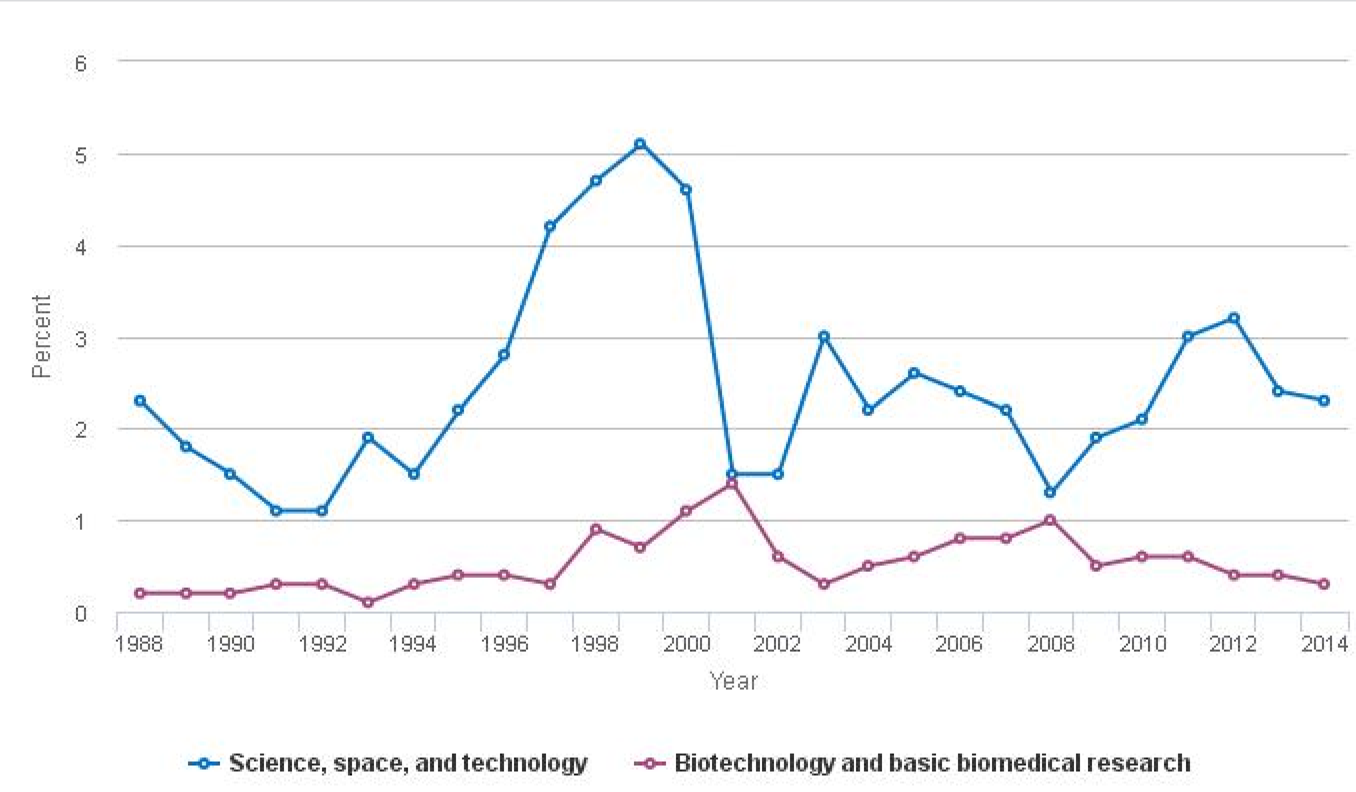
---

[i] "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. It excludes clinical research and medical technology. Stories often do not fall neatly into a single category or theme. The coverage of health research in the Tyndall television

data represents only a small percentage of the overall health coverage on television. The coding of these data is done by Andrew Tyndall. Intercoder agreement statistics are not provided because the coding is done by a single individual.

Figure 7-5

Network nightly news coverage of science and technology: 1988–2014



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 stories on forensic science. Excluded from biotechnology and basic medical research are stories on clinical research and medical technology.

SOURCE: Tyndall Report, special tabulations, http://tyndallreport.com, accessed 10 February 2015.

Science and Engineering Indicators 2016

It appears that, while the nature of science coverage varies from year to year, health coverage is relatively consistent. In 2013, the leading nightly news stories in the "science, space, and technology" category focused on the International Space Station and a Russian meteor strike. In 2014, the top stories were drone technology, space transportation, and space tourism. Cancer research garnered the most coverage in both 2013 and 2014 for the "biotechnology and basic medical research" category (Table 7-1). Since 2006, cancer research has received more attention than other medical research topics (NSB 2008, 2010, 2012, 2014).

Table 7-1 **Leading nightly news story lines on science and technology, by topic area: 2013 and 2014**

(Annual minutes of coverage)

Year and topic area/leading story line	Annual minutes of coverage
2013	

Year and topic area/leading story line	Annual minutes of coverage
Science, space, and technology	
International Space Station mission in orbit	38
Meteor explodes over Russia's Ural Mountains	25
Computer networks targeted by coordinated hackers	22
Drone technology: miniaturized, unmanned aircraft	19
Air safety: in-cabin use of electronic devices	18
Cellular telephone/computer combo: smart phones	15
Asteroids/astronomy: rocks pass close to Earth	12
Internet Twitter website makes public offering	9
Internet search engine Google monitors browsing	9
Science and mathematics education in schools	8
NASA *Voyager* probe is leaving solar system	8
Meteors are visible in night sky falling to Earth	8
NASA *Apollo* manned moon missions remembered	7
Solar-powered plane experiment has no engine	6
Mars astronomy: NASA *Curiosity* rover mission	6
Comet Ison may be heading for Earth	6
Internet used for social networking	6
Videogame title, design, development trends	6
BRAIN Initiative plans to map neurological activity	5
Computer systems are vulnerable to viruses, worms	5
Highway safety: drivers' cell phone use dangers	5
Space tourism planned by Virgin Galactic	5
Biotechnology and basic medical research	
War on cancer research efforts	36
Genetic DNA biotech analysis predicts diseases	9
Prosthetics technology for amputees goes bionic	5
2014	
Science, space, and technology	
Drone technology: miniaturized, unmanned aircraft	24
Space transportation uses privatized rockets	23
Space tourism planned by Virgin Galactic	21

Year and topic area/leading story line	Annual minutes of coverage
International Space Station mission in orbit	18
Comet astronomy: European satellite mission	18
Cellular telephone/computer combo: smart phones	15
Internet social networking: Facebook is popular	14
NASA manned missions to Mars planning	12
Wristwatch modernized: body-monitoring computer	11
Science and mathematics education in schools	10
Internet website security is vulnerable to hackers	9
Computer systems are vulnerable to viruses, worms	8
Video cameras miniaturized in HD by GoPro	8
Television broadcast networks' free signal diverted	8
Commercial bank databases targeted by hackers	7
Automobile research into smart-car technology	7
North Korea suffers cyberwarfare attack	6
Instant text messaging with worldwide WhatsApp app	6
Computer networks targeted by coordinated hackers	6
Internet account passwords hacked at Gmail	6
Highway safety: drivers' cell phone use dangers	5
Mars astronomy: NASA *Curiosity* rover mission	5
Asteroids/astronomy: rocks pass close to Earth	5
Bitcoin is virtual currency/commodity combination	5
Internet wireless networks targeted by hackers	5
Taxi fleet monopoly undercut by online services	5
Meteors are visible in night sky	5
Biotechnology and basic medical research	
War on cancer research efforts	12
Spinal cord injuries and paralysis research	10
Organs grown in laboratory for replacement implant	5

BRAIN = Brain Research through Advancing Innovative Neurotechnologies; HD = high definition; NASA = National Aeronautics and Space Administration.

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. Story lines receiving at least 5 minutes of coverage in 2013 or 2014 are shown. Excluded from science, space, and technology are stories on 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, http://www.tyndallreport.com, accessed 10 February 2015.

Beyond Tyndall, data on media coverage of S&T is relatively scarce. The Project for Excellence in Journalism (PEJ 2012) conducted an extensive content analysis of news media coverage between January 2007 and May 2012, using 52 outlets in the following media sectors: traditional publications that have print editions, publications that are available online only, network television, cable television, and radio. Each week, stories were classified into 1 of 26 broad topic areas, including S&T, the environment, and "health and medicine."[ii] Special tabulations of PEJ data showed that S&T coverage made up a small percentage of all news in the traditional media—less than 2% annually—between 2007 and 2012, similar to the Tyndall findings. News coverage of the environment made up a similarly small percentage of the news in the 2007–12 period, ranging from a low of 1.0% in 2011 to a high of 1.6% in both 2007 and 2010. Coverage of health and medicine consistently made up a greater percentage of the news, ranging from 3.1% in 2011 to 8.9% in 2009 (NSB 2012).

Entertainment television can also shape views, although summary data in this area are even more limited. One of the more recent studies showed that, between 2000 and 2008, portrayals of scientists represented just 1% of characters on prime-time network shows. Of these scientists, 7 out of 10 were men, and almost 9 out of 10 were white. Medical professionals were 8% of the characters. Generic "professionals" were the most common type of character (21%). In general, about 8 of 10 scientists were coded as being "good" and not a villain (Dudo et al. 2011).[iii] Video games may also be a source of depictions of scientists; one research project suggests that such depictions are generally positive (Dudo et al. 2014).

[ii] 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 was designed to capture the main news stories covered each week. Coding of programs and articles was 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 was coded on 17 variables, according to an established coding protocol. The team of individuals performing the content analysis was directed by a coding manager, a training coordinator, a methodologist, and a senior researcher. For variables that require little or no inference, intercoder agreement was 97% for 2010, the last year in which statistics were reported. 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.

[iii] In general, it is difficult to obtain information about S&T content within entertainment programming, although substantial evidence suggests that the entertainment people view shapes their attitudes about a range of issues, including S&T (Brossard and Dudo 2012).

S&T Information Sources

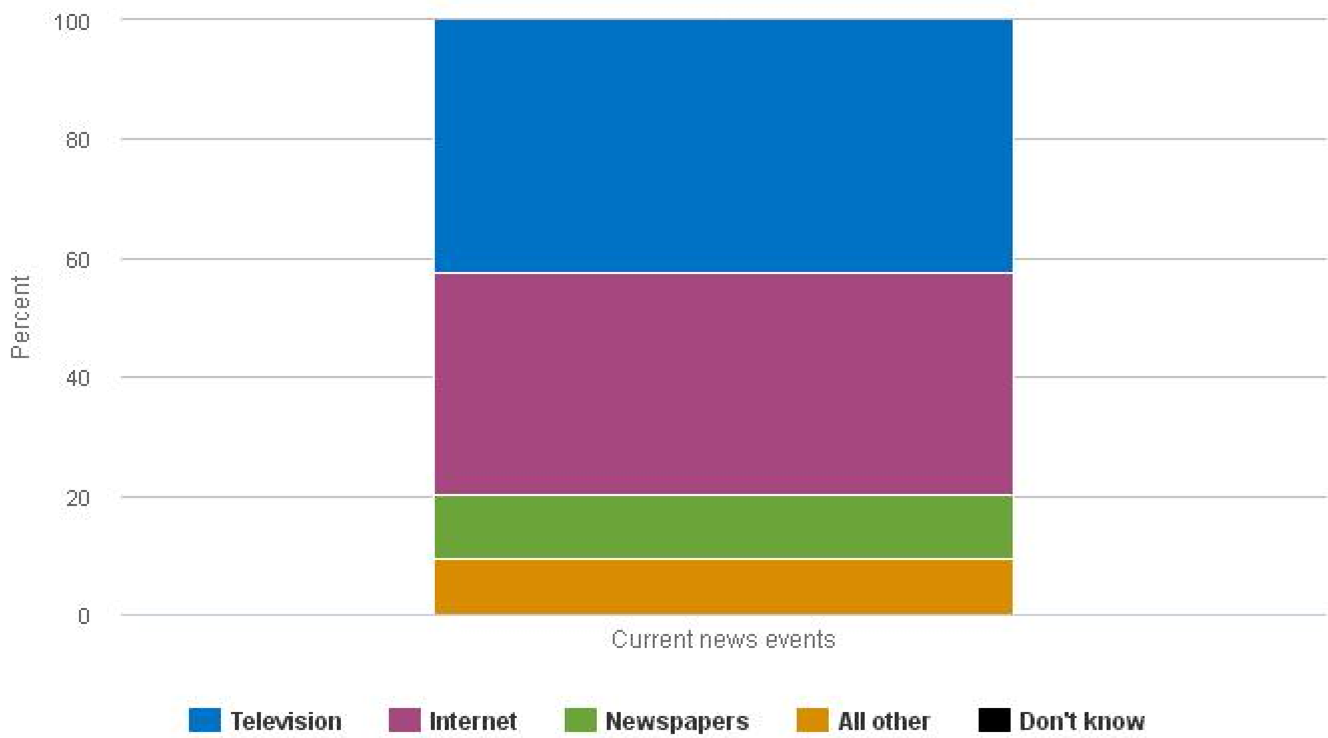
U.S. Patterns and Trends

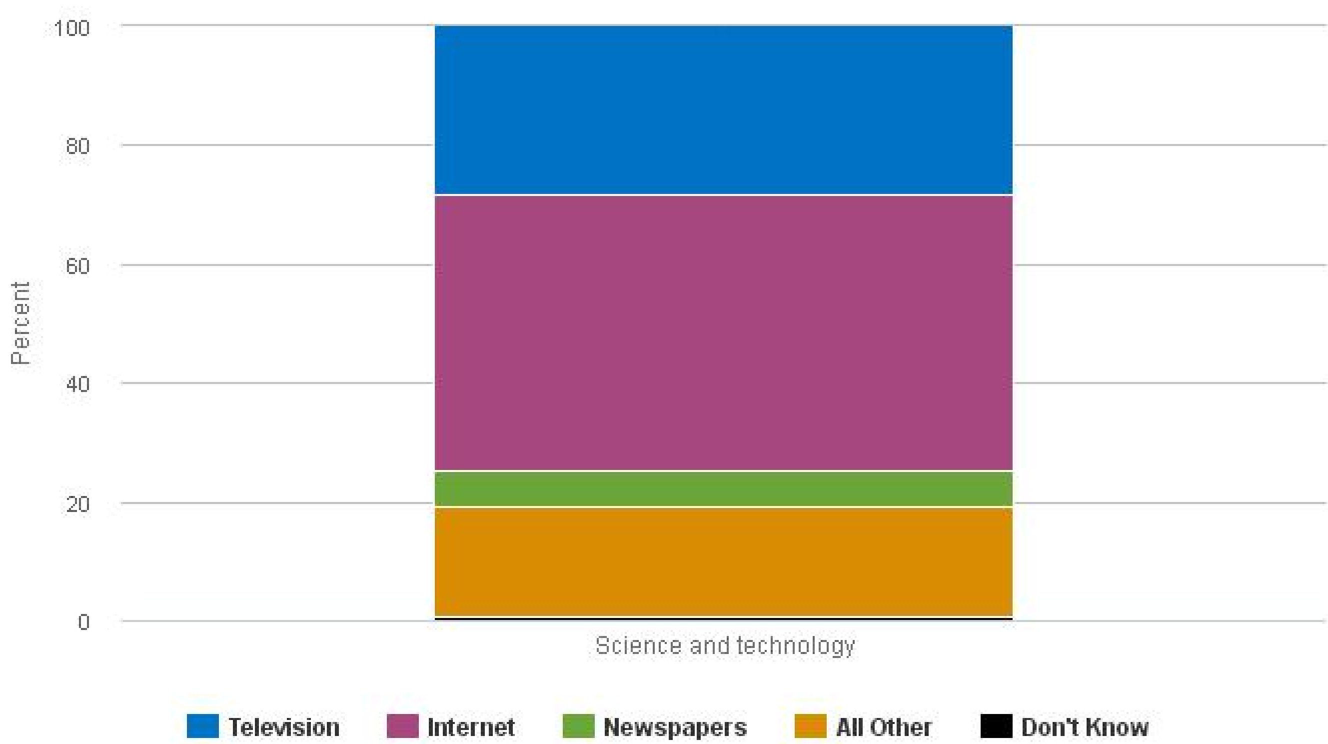
The news media environment continues to change as new organizations emerge; existing organizations disappear or merge; and journalistic routines change in response to economic, social, and technological forces. The available data show clear trends in what sources Americans say they use to get news about current events and S&T, as well as where they would look for new S&T information. The Pew Research Center (2012) previously reported that Americans said they spent a little more than an hour reading or watching the news per day in 2012. This figure was similar to that in previous years, but as the following data suggest, Americans are shifting to different media, increasingly spending time online. Caution is warranted when analyzing these results, however, because the distinction between news media is sometimes unclear. For example, as discussed subsequently, respondents may say they use newspapers for science information, but they use an online edition of the newspaper, or vice versa.

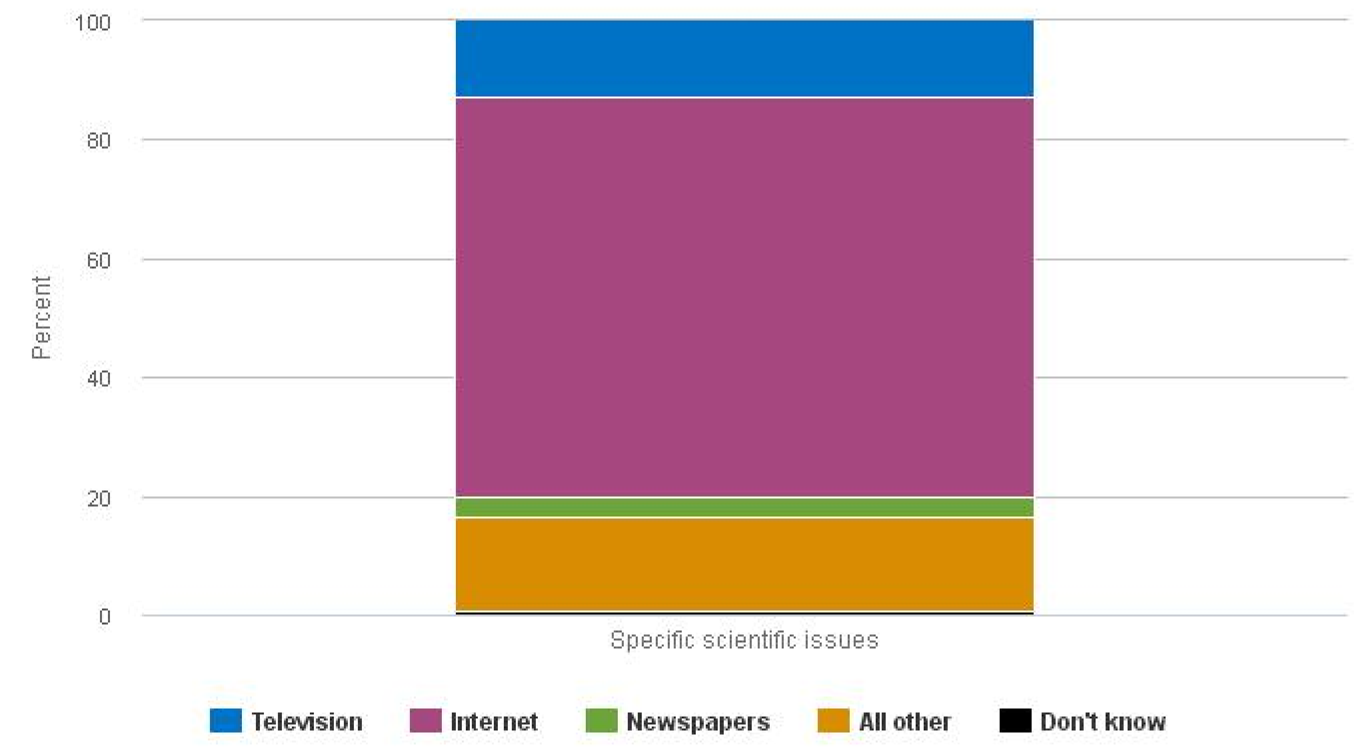
For news about general current events, television remains the primary source of information for 43% of Americans according to the GSS. Substantial percentages also reported in 2014 that their current event news comes primarily from the Internet (37%) or newspapers (11%) (Figure 7-6; Appendix Table 7-3). The percentage of Americans who report getting information about current events from the Internet has increased steadily since about 2001, and the percentages using newspapers and television for current events have declined (Figure 7-7).

Figure 7-6

Primary source respondents used to learn about current news events, science and technology, and specific scientific issues: 2014







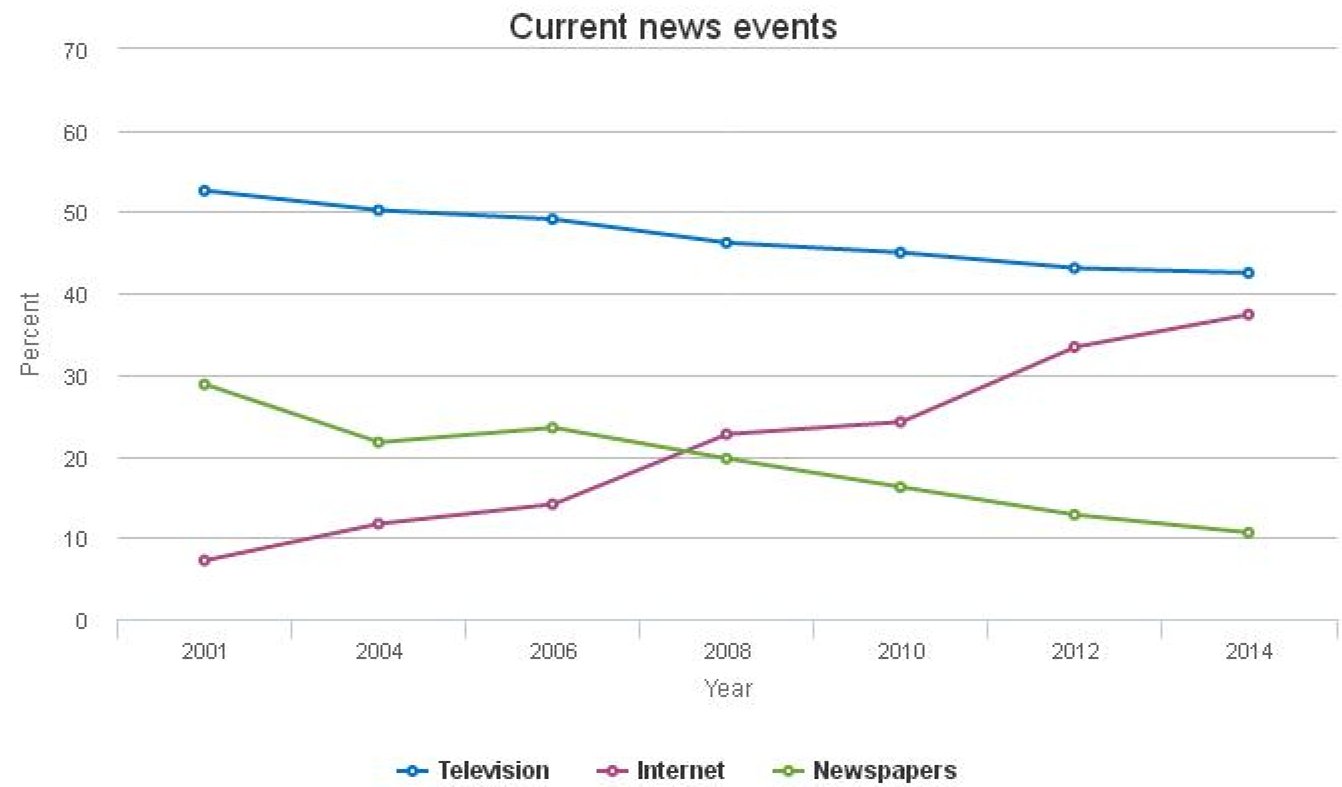
NOTE: "All other" includes radio, magazines, books, government agencies, family, and friends/colleagues.

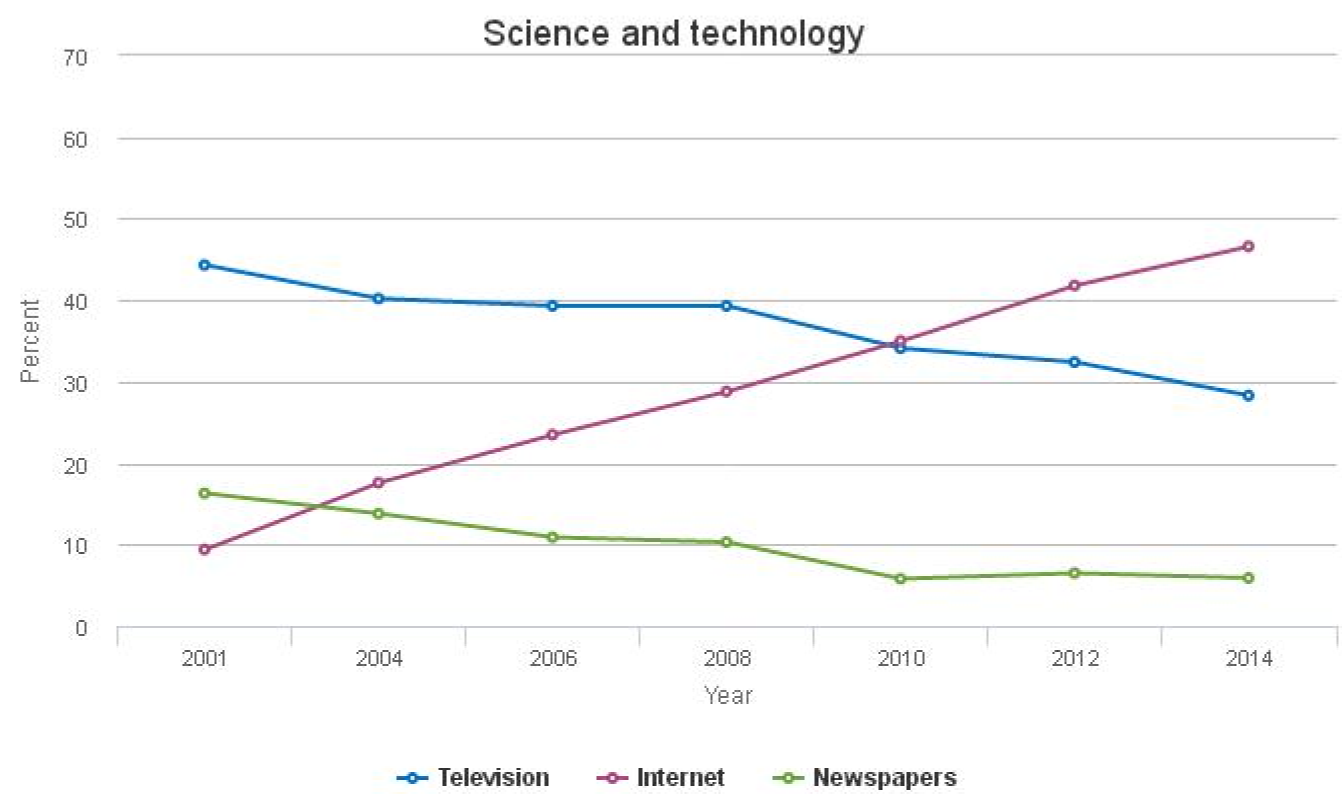
SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2014). See appendix tables 7-3–7-5.

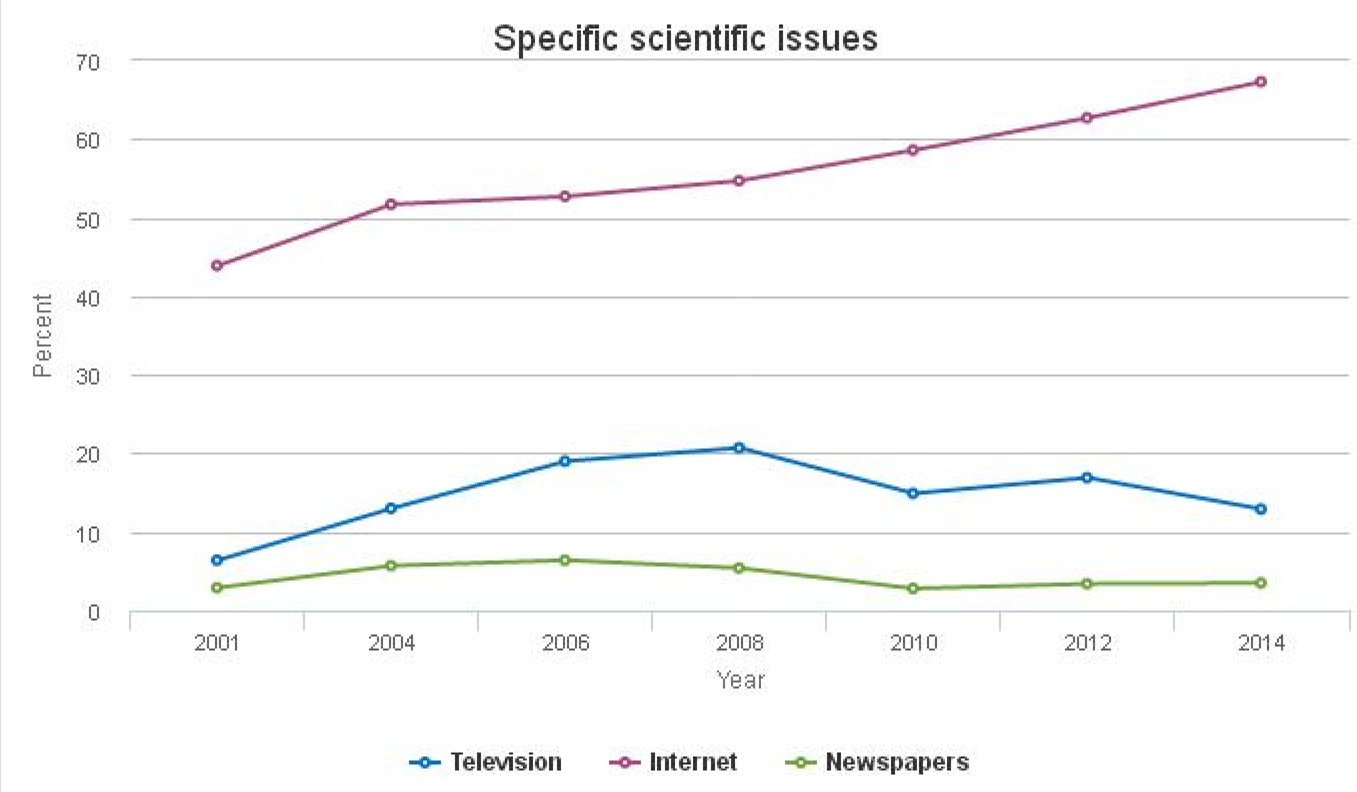
Science and Engineering Indicators 2016

Figure 7-7

Primary source respondents used to learn about current news events, science and technology, and specific scientific issues: 2001–14







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 (2006–14). See appendix tables 7-3–7-5.

Science and Engineering Indicators 2016

For news specifically about S&T, Americans are now more likely to rely on the Internet than on television. In 2014, 47% of Americans cited the Internet as their primary source of S&T information, up from 42% in 2012. This percentage has grown steadily since 2001 when 9% of respondents named the Internet as their primary source of S&T news. Conversely, reliance on television has dropped; about 28% of Americans reported that television was their primary source of S&T news in 2014, down from 32% in 2012. Some 6% said they get their S&T information from newspapers in 2014 (Figure 7-6 and Figure 7-7; Appendix Table 7-4). Of the 47% who go online for S&T information, 36% (i.e., 15% of all respondents) said that they use a search engine such as Google to seek information, whereas 45% said they use online newspapers (23%), online magazines (15%), or other online news sites (7%). Just 8% (3% of all respondents) said they rely on a science-focused site as their primary source of S&T news.

The Internet has also been the most common resource that respondents say they would use to seek information about specific scientific issues (Figure 7-6), and it has held this position since at least 2001 (Figure 7-7). In 2014, the highest ever percentage of Americans (67%) said they would go online to find information about a specific S&T issue. Another 13% said they would turn to television, and just 3% said they would use newspapers (Appendix Table 7-5).

Different subgroups of Americans tend to rely on different sources of information. Generally, higher levels of education and income are associated with relatively higher levels of Internet and newspaper use, whereas respondents with lower levels of education and income are more likely to say they rely on television. Newspaper reliance is more common for relatively older respondents, and Internet reliance is more common for relatively younger and higher-earning respondents. Television use is also somewhat less common for younger respondents, although the pattern is not nearly as pronounced (Appendix Table 7-3– Appendix Table 7-5).

International Comparisons

European and Asian patterns of media sources for news appear to differ from those in the United States, especially in the continuing importance of television. Television and traditional newspapers, in this regard, appear to remain the most commonly cited source for S&T news in many countries. However, many of the available data sources are several years old, and the rapid shift toward online sources seen in the United States suggests that older data, in particular, should be treated with caution.

Within Europe, a 2013 Eurobarometer survey found that television remains the dominant source of "information about developments in science and technology" (European Commission 2013). Overall, about 65% of Europeans said they "get information" from television, whereas 33% named newspapers, and 32% said "on websites." However, the way that the Eurobarometer survey asked this question allowed respondents to name multiple sources (whereas Americans select only one source in response to the similar GSS question).

Responses also vary substantially by country. Swedes were the most likely to say that they get S&T information from television (84%), newspapers (74%), magazines (51%), radio (45%), books (25%), and "social media or blogs" (23%). Swedes were also among the most likely to say they get S&T information "on websites" (54%), although Danes were slightly more likely to name websites as an information channel (57%). About one-third of residents of Portugal (34%) and a quarter of respondents in Malta (29%), Hungary (27%), Poland (27%), Italy (24%), and Ireland (24%) stated that they did not look for information about S&T. These countries were also typically among the least likely to name a specific channel for S&T information.

Outside of Europe and North America, older research has also suggested that television remains the leading source of S&T information; newspapers generally come in second, and relatively fewer survey respondents cite the Internet as an important source of S&T information. This was true in countries such as Malaysia (Malaysian Science and Technology Information Centre 2010) and India (Shukla 2005). A 2010 Chinese survey allowed respondents to choose up to three sources of information. About 88% of Chinese respondents indicated that television was a primary source of their S&T information, 59% said newspapers, and 27% said the Internet (CRISP 2010). However, in more widely connected South Korea, a 2012 survey found that, similar to 2010, a greater proportion of respondents named the Internet (21%) as their primary source of S&T information rather than newspapers (12%). About 58% said television was their primary source of S&T information (KOFAC 2013). Overall, it appears that, as Internet use has become more common, the Internet has also become an increasingly important source of S&T information.

Involvement

U.S. Patterns and Trends

As reported in 2012, U.S. residents may also come in contact with S&T through America's rich and diverse informal science and cultural institutions (Bell et al. 2009).[i] Some research suggests that informal science participation, along with media use, is a key source of perceived knowledge about S&T (Falk and Needham 2013). Although specific questions about informal science participation were not asked in the 2014 GSS, the 2012 GSS showed that reported attendance at informal science and cultural institutions was down slightly from 2008 (NSB 2014).[ii] In 2012, zoos and aquariums were the most popular type of informal science institutions, with 47% of Americans saying they had visited such an organization in the previous year. This represented a drop from 52% in 2008 and

58% in 2001. Americans with more years of formal education were more likely than others to engage in these informal science activities. Those in higher income brackets were also more likely to have visited a zoo or aquarium, a natural history or S&T museum, or an art museum, but they were 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 aged 45 or older.

---

[i] People become involved with S&T through many kinds of nonclassroom activities beyond attending informal science institutions. Examples of such activities include participating in government policy processes, going to movies that feature S&T, attending talks or lectures, 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.

[ii] In the 2008 GSS, respondents received two different introductions to this set of questions. Response patterns did not vary depending on which introduction was given.

Another important factor that affects citizens' ability to take part in informal science activities is the availability of relevant opportunities. Recent research has thus focused on how members of the scientific community think about engagement. The Scientists and Public Engagement sidebar addresses this issue.

International Comparisons

The available data—some of which are relatively dated—suggest that Americans are particularly active in the degree to which they use a range of informal science and cultural institutions. Within the available data, China and Japan are the only countries in which zoo and aquarium attendance levels are similar to those in the United States. China also has similar levels of S&T and natural history museum attendance. Chinese attendance at these types of institutions also appears to be growing, with average attendance up about an average of 8% from 2007 across the five types of cultural institutions measured (NSB 2012).

Scientists and Public Engagement

Scientists' willingness to get involved in informal science and technology (S&T) activities and engage with their fellow citizens on S&T topics represents an important way for the scientific community to communicate and broaden its contributions to society. Many science leaders have long called for such "public engagement" as a way to ensure that the scientific community stays connected with the broader community (e.g., Royal Society 1985; Leshner 2003). Recent research by the Pew Research Center (2015a) found that U.S.-based members of the American Association for the Advancement of Science (AAAS), the world's largest general scientific society and publisher of the influential academic journal *Science*, were broadly supportive of having scientists contribute to public discussions about scientific issues. This willingness is consistent with academic work that has also shown substantial willingness by scientists to engage the public (e.g., Peters et al. 2008; Dudo 2013).

Specifically, 87% of AAAS respondents said that scientists should "take an active role in public policy debates" related to S&T. In contrast, 13% said that scientists need to "focus on establishing sound scientific facts and stay out of public policy debates."*

Reported engagement itself was also common, with 86% of AAAS respondents saying that they "often" (37%) or "occasionally" (49%) talk with nonscientists about science or research findings. Furthermore, 21% say they "often" (3%) or "occasionally" (18%) speak with reporters about their work.

Online channels are also being used. About 23% of respondents said they "often" (7%) or "occasionally" (16%) use social media to talk about science, whereas 13% said they "often" (5%) or "occasionally" (8%) tweet about research in their specialty area. When it comes to blogging, 8% said they "often" (2%) or "occasionally" (6%) write blog posts about science, and identical numbers of respondents said that they write blog posts about their "research and specialty" area.

The data do not address how often AAAS members directly discuss S&T with policy makers.

The Pew Research Center (2015a) also reports that engagement is higher in fields in which respondents report feeling that there is more public debate in the news media and more interest among the public. For example, 44% of those AAAS respondents who said that there was "a lot" or "some" debate about their field said that they often talk with other citizens, whereas only 29% of respondents who said that they see "not too much" or "no debate" in the media said that they often talk to other citizens. Respondents who described their discipline as "earth science" (53%) and those with a focus on social science, history, or science policy (50%) were the most likely to say that they "often" talk with citizens about their work. Respondents from other disciplines, including those with a focus on physics or astronomy (40%), biomedical science (35%), engineering (34%), mathematics and computer science (32%), and chemistry (24%), also said that they talked with their fellow citizens to varying degrees.

[*]It is possible that members of AAAS could have unique views about public engagement inasmuch as the organization has an "advancement of science" mission. However, the AAAS is also the publisher of one of the world's highest impact journals, and the AAAS annual meetings often feature announcements of breaking science news. Also, because AAAS members tend to be relatively senior scholars, they might represent a key group whom other scientists might look to as examples.

Public Knowledge about S&T

Science and Engineering Indicators has been assessing Americans' knowledge about S&T since 1979. Initial questions focused on the proper design of a scientific study and whether respondents viewed pseudoscientific belief systems, such as astrology, as scientific. The questions also examined understanding of probability, and questions meant to assess an understanding of basic scientific facts were added in the late 1980s and early 1990s (Miller 2004). These later factual questions—called here the *trend factual knowledge questions*—remain the core of the best available data on trends in adult Americans' knowledge of science.

Although tracking knowledge trends is an important part of this chapter, it is also important to recognize that many researchers question the degree to which scientific literacy has a substantial impact on how people make decisions in their public and private lives (see, for example, NSB 2012:7–27; Bauer, Allum, and Miller 2007) and whether a short battery of questions can assess scientific literacy. Although all indicators have weaknesses and strengths, most evidence suggests that knowledge about science, as measured by the current GSS questions, has a small but meaningful impact on attitudes about science (Allum et al. 2008). It is also, however, clear that such knowledge need not result in accepting the existence of a scientific consensus or a policy position that such a consensus might suggest (Kahan et al. 2012). With regard to the limited number of questions included in the survey, adult responses to an expanded list of knowledge questions drawn from tests given to students nationwide indicate that people who "answered the additional factual questions accurately also tended to provide correct answers to the trend factual knowledge questions included in the GSS" (NSB 2010:7–20). This finding suggests that the trend questions used in this report represent a reasonable indicator of basic science knowledge, such as what might be needed to understand a newspaper science section (Miller 2004). At the same time, 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. Similar challenges confront attempts to study health literacy (Berkman, Davis, and McCormack 2010) and political literacy (Delli Carpini and Keeter 1996). Another issue is that, although the focus in *Indicators* is on assessing knowledge about scientific facts and processes, it could also be important to assess knowledge about the institutions of science and how they work—such as peer review and the role of science in policy discussions (Toumey et al. 2010). Others have similarly argued that the knowledge needed for citizenship might be different from what might be needed to be an informed consumer or to understand the role of science in our culture (Shen 1975, in Miller 2004).

More generally, 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. (OECD 2003:132–33)

The degree to which respondents demonstrate an 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 basic scientific literacy.

The 2014 GSS continues to show 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, rarely appear to perform better when asked similar questions**.**

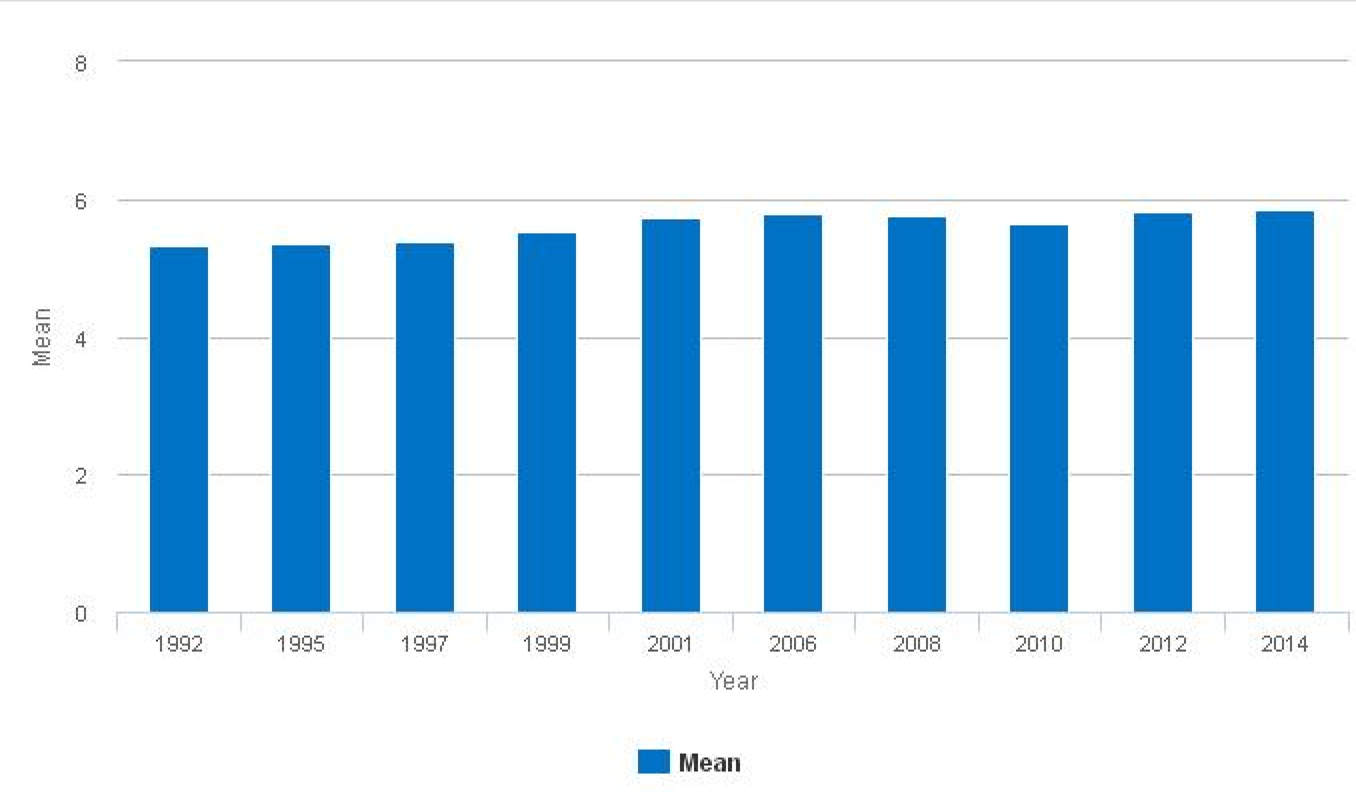
Understanding Scientific Terms and Concepts

U.S. Patterns and Trends

In 2014, Americans were able to correctly answer an average of 5.8 of the 9 items (65%) of NSF's factual knowledge questions. This score has remained nearly identical in recent years (Figure 7-8; Appendix Table 7-6). Two additional true-or-false questions about evolution and the big bang are also discussed subsequently.

Figure 7-8

Mean number of correct answers to trend factual knowledge of science scale: 1992–2014



NOTES: Mean number of correct answers to nine questions included in trend factual knowledge of science scale; see appendix table 7-2 for explanation and list of questions. See appendix table 7-6 for percentage of questions answered correctly. See appendix tables 7-7 and 7-8 for responses to individual questions.

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 (2006–14).

Science and Engineering Indicators 2016

The public's level of factual knowledge about science has not changed much over the past two decades. Since 2001, the average number of correct answers to a series of 9 questions for which fully comparable data have been collected has ranged from 5.6 to 5.8 correct responses, although scores for individual questions have varied somewhat over time (Figure 7-8; Appendix Table 7-7 and Appendix Table 7-8).[i] The Pew Research Center (2013c) used several of the same questions in a 2013 survey and received nearly identical results.

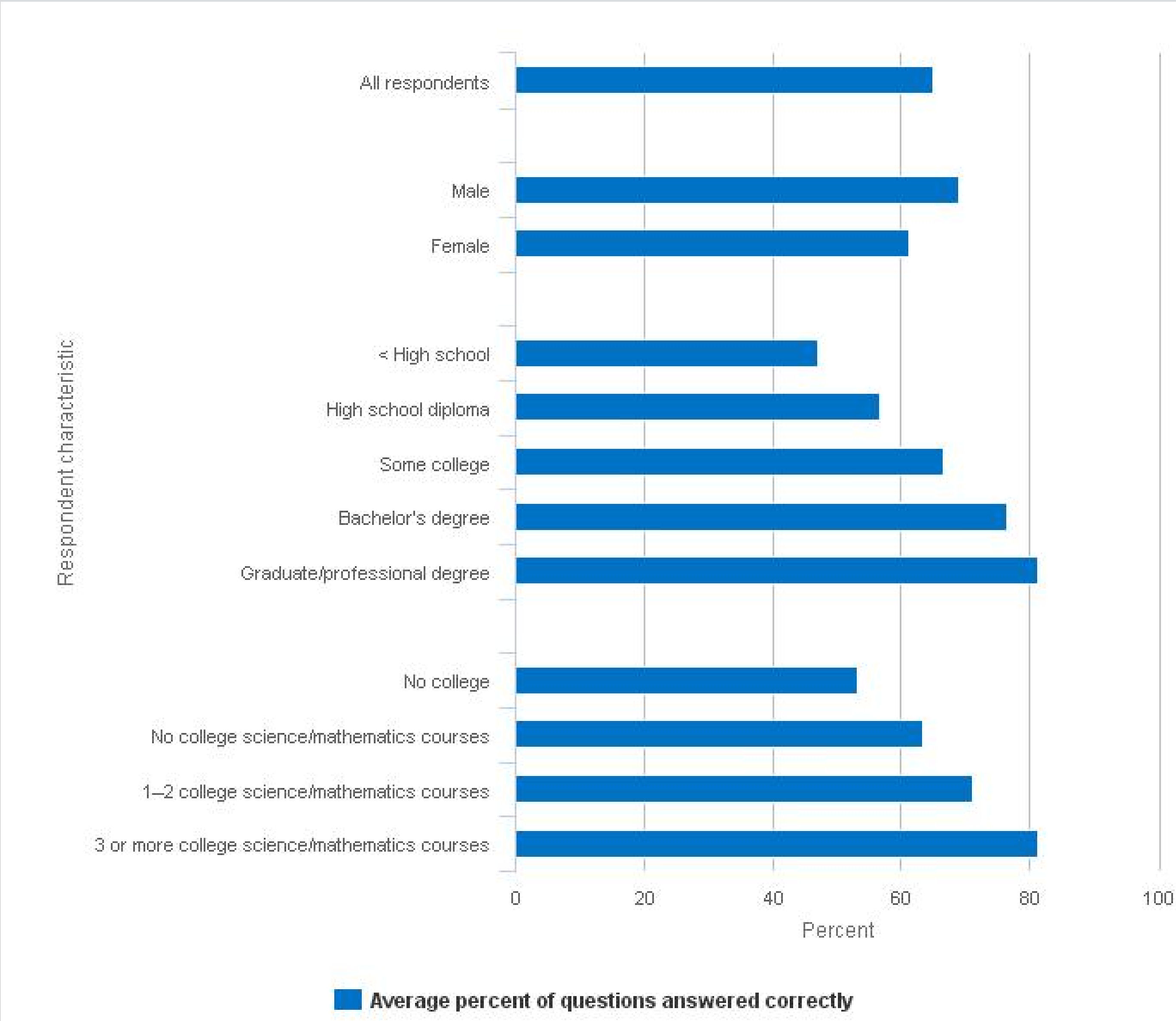
Within the GSS data, trend factual knowledge of science is strongly related to people's level of formal schooling and the number of science and mathematics courses completed (Appendix Table 7-6). For example, those who had not completed high school answered 47% of the nine questions correctly, whereas those for whom a bachelor's degree was their highest academic credential answered 77% of the questions correctly (Figure 7-9). The average percentage correct rose to 81% for those with a graduate degree. Similarly, Americans who took 5 or fewer high school or college science or mathematics courses answered 57% of the questions correctly, whereas those who had taken 9 or more courses answered 82% correctly. Those with higher verbal ability scores, a measure of cognitive ability (Miner 1961), also provided more correct responses. The 2014 version of *Indicators* (NSB 2014) showed that education is also associated with attending informal science institutions such as museums.

---

[i] 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 believe 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.

Figure 7-9

Correct answers to trend factual knowledge of science scale, by respondent characteristic: 2014



NOTES: Data reflect average percentage of nine questions answered correctly. “Don’t know” responses and refusals to respond counted as incorrect. See appendix table 7-6 for explanation, list of questions, and additional respondent characteristics. See appendix tables 7-7 and 7-8 for responses to individual questions.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2014).

Science and Engineering Indicators 2016

The current data also suggest interesting patterns in the relationship between age and science knowledge. Although there used to be a large gap in scientific knowledge between the top-performing age group and those in the older age groups, this gap has narrowed or disappeared (Appendix Table 7-6). For example, in 1992, those aged 25–34 answered 64% of the questions correctly, whereas those older than age 65 answered 47% of the questions correctly (a 17% gap). In 2014, those aged 25–34 answered 66% of the science questions correctly, whereas 59% of those older than age 65 answered the questions correctly (a 7% gap). The gap between those aged 55–64 and other high-performing groups had substantially declined by 2006. 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 primarily due to aging processes, cohort differences in education, or other factors. Analyses 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 2010, 2012).

Factual knowledge about science, at least as measured in the current GSS, is also associated with respondents' sex. Men (69%) tend to answer somewhat more factual science knowledge questions in the GSS correctly than women do (61%) (Figure 7-9). However, men's overall better average score depends on the specific science questions asked. Among the questions asked, men do better in physical science, whereas women do better in biology. Men have typically scored higher than women on questions in the physical sciences on the trend factual knowledge index. Women have tended to score at least equally as high as men on the biological science questions and often a bit higher (Table 7-2; Appendix Table 7-8); however, men did better than women on an expanded set of biology questions in the 2008 survey, which suggests that respondents' sex differences may depend on the specific questions asked. Some evidence also suggests that men might be more likely to guess, rather than say they do not know. This could partly account for men's slightly higher science knowledge score (Mondak 2004).

Table 7-2 Correct answers to factual knowledge and scientific process questions in physical and biological sciences, by sex: 1999–2014

(Percent)

Science topic/sex	1999	2001	2004	2006	2008	2010	2012	2014
Physical science index[a]								
Male	72	73	73	74	74	73	75	74
Female	57	59	55	59	61	60	61	63
Biological science index[b]								
Male	59	61	62	63	60	62	59	63
Female	61	65	65	66	64	64	62	67

[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 the average percentage of questions in the index answered correctly. "Don't know" responses and refusals to respond are 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); University of Chicago, National Opinion Research Center, General Social Survey (2006–14). See appendix tables 7-7 and 7-8 for factual knowledge questions. See appendix tables 7-9 and 7-10 for scientific process questions (probability and experiment).
	Science and Engineering Indicators 2016

Evolution and the Big Bang

The GSS includes two additional true-or-false science questions that are not included in the index calculation because Americans' responses appear to reflect factors beyond familiarity with basic elements of science. One of these questions is about evolution, and the other is about the origins of the universe. In 2014, 49% of Americans correctly indicated that "human beings, as we know them today, developed from earlier species of animals," and 42% correctly indicated that "the universe began with a big explosion" (Appendix Table 7-8). Both scores are relatively low compared with scores on the other knowledge questions in the survey.

To better understand Americans' responses, the 2012 GSS replicated an experiment first conducted in 2004 (NSB 2006). Half of the survey respondents were randomly assigned to receive the standard two questions focused on information about the natural world. The other half were asked the same questions with a preface that focused on conclusions that the scientific community has drawn about the natural world ("according to the theory of evolution, human beings, as we know them today, developed from earlier species of animals" and "according to astronomers, the universe began with a big explosion"). The results clearly showed that including the preface substantially improves scores (NSB 2014). This suggests that these items, as originally worded, may lead some people to provide incorrect responses based on factors other than their knowledge of what most scientists believe. The Survey-Based Experiments on Science Knowledge Question Format sidebar further examines whether the current response format for the science knowledge questions is as good as alternatives that have been suggested. An additional sidebar (Evaluation of the Human Evolution Question) presents survey experiment evidence regarding the soundness of the knowledge item question format in the *Indicators*.

Survey-Based Experiments on Science Knowledge Question Format

Researchers know that answers to survey questions are affected by the format of response options, raising the issue of whether *Indicators* science knowledge questions are being asked in the best possible way. For example, the true-or-false item "All radioactivity is man-made" can be reworded and tested as a so-called "forced-choice" item in which respondents are asked to select whether radioactivity is "All man-made" or "Some natural." Some researchers suggest that true-or-false items introduce more error because some respondents will reduce their effort by simply agreeing with most questions (Krosnick 1991, 1999; see also Krosnick and Presser 2010). However, this might not happen in this case because accurately answering brief factual science knowledge questions may take little effort.

Similarly, some researchers find that offering a "don't know" response encourages respondents to reduce their effort by selecting that option, increasing error in responding (Krosnick et al. 2002). Others, however, suggest that if respondents are sufficiently informed, a "don't know" option may reduce error (Tourangeau, Maitland, and Yan 2014).

Indicators science knowledge items are offered in a true-or-false format with "don't know" responses allowed and encouraged in instructions. To determine the soundness of this format, an Internet panel-based survey experiment tested alternative formats of these items.* It concluded that the format in use was as sound as, or better than, alternative formulations (for details, see Tourangeau, Maitland, and Yan forthcoming).

The knowledge items were asked with different response formats, and the researchers examined the relative strength of the correlations among the items in each of these formats. The formats that best capture respondents' knowledge of science, while reducing extraneous elements, should have items that are more strongly related to each other.

The strength of the correlations among questions in the true-or-false and forced-choice formats was about equal, suggesting that both formats are equally effective in capturing science knowledge.

The correlation among science knowledge questions was clearly higher for respondents encouraged to use "don't know," in contrast with those discouraged to do so. This indicates that the "don't know" encouraged condition results in responses that may better measure knowledge.

Varying both formats simultaneously suggests an advantage for the combination of forced choice with a "don't know" option over the currently used true-or-false option with "don't know." The advantage is modest, and the cost of changing to this option would include a break in a well-established time series.

The relationship of these alternative question formats was also examined against respondents' reported number of science courses taken in high school and college. Respondents who have taken more science courses should do better on tests of science knowledge, particularly those that better capture such knowledge. A question format that better captures this knowledge should therefore show a larger gap in the number of correct answers between those who have taken many and those who have taken few science courses. For the true-or-false and forced-choice formats, there was little difference in this gap (1.8 versus 1.9 additional correct answers). This is consistent with the previous finding that these formats are not appreciably different from each other in capturing knowledge.

For respondents encouraged to use "don't know," the difference between high- and low-scoring course takers was 2.5 additional correct answers. This contrasts with a substantially lower difference of 1.4 for those who were discouraged from responding "don't know." This is also consistent with the aforementioned finding that encouraging "don't know" responses is a superior technique because question responses are more correlated.

* Alternative response formats were tested using a survey experiment conducted in 2014 by Westat using GfK's online KnowledgePanel. Because of the limitations of the KnowledgePanel, findings here are meant to be suggestive rather than representative of the U.S. population. GfK KnowledgePanel seeks to be nationally representative and recruits participants using well-established methods. However, the ultimate response rate for a given survey, relative to all people in the population asked to participate in the panel, can be in the single digits. People drop out at various stages, may refuse to participate in the panel, and as panelists, may choose not to answer a particular survey. Whether this affects survey results depends on whether nonrespondents would give different responses to questions than respondents. A few prior studies on specific KnowledgePanel surveys indicated little difference between respondents and nonrespondents (see http://www.knowledgenetworks.com/ganp/docs/KnowledgePanelR-Statistical-Methods-Note.pdf).

Evaluation of the Human Evolution Question

U.S. respondents have scored lower than people in other developed countries on a true-or-false question about evolution: "Human beings, as we know them today, developed from earlier species of animals." Prior research provided tentative evidence that many U.S. respondents did poorly not because they did not know about the theory of evolution but because they did not believe in human evolution. If respondents' personal beliefs prevent them from giving the scientifically correct answer to this question about human evolution, then it is possible that the question may not have adequately captured people's general knowledge of science.

A 2014 survey experiment sought to provide more compelling evidence that personal belief reduced correct responses to the human evolution question. The experiment compared the human evolution item with an alternative item about the evolution of elephants (for details, see Maitland, Tourangeau, and Yan 2014; Maitland, Tourangeau, Yan, Bell, and Muhlberger 2014; Roos 2014 presents related findings). The elephant version of the evolution question received more correct responses than did the original version: 75% versus 52%. More correct responses are consistent with the supposition that the elephant version of the evolution question allows people who are skeptical about human evolution to reveal that they know about the theory of evolution.

The elephant version is also better correlated with general scientific knowledge, as measured by the nine-item *Indicators* knowledge battery. Among individuals who do not believe in human evolution, the elephant version is also better correlated with overall knowledge of evolution, measured by a battery of questions. This indicates that the elephant version ameliorates the effects of such disbelief.

Correct responding to the elephant version also turned out to be less related to whether respondents believed in human evolution. For the original version, the difference in correct responses between believers and nonbelievers was 78 percentage points, whereas for the elephant version, the difference was 41 percentage points.

The elephant version proves better than the original version in capturing scientific knowledge, evidently by permitting those who are personally skeptical of human evolution to show that they are aware of the theory of evolution. Adding the elephant version to the nine-item knowledge scale, however, improves the average knowledge score only marginally: from 73% to 76% correct. This improvement would come at the cost of a well-established time series.

These findings suggest that belief in human evolution is not a reliable indicator of general knowledge of evolution or science. That is, many people know basic facts about evolution and science without believing in human evolution.

International Comparisons

Knowledge scores for individual items vary from country to country, and it is rare for one country to consistently outperform others across all items in a given year (Table 7-3). One exception is a 2013 Canadian survey that has Canadians scoring as well as or better than Americans and residents of most other countries on the core science questions (CCA 2014). For the physical and biological science questions, knowledge scores are relatively low in China, Russia, and Malaysia. Compared with scores in the United States and the European Union overall, scores in Japan are also relatively low for several questions. Science knowledge scores have also varied across Europe, with northern European countries, led by Sweden, scoring the highest on a set of 13 questions.

Scores on a smaller set of four questions administered in 12 European countries in 1992 and 2005 show each country performing better in 2005 (European Commission 2005), in contrast to a flat trend in corresponding U.S. data. In Europe, as in the United States, men, younger adults, and more educated people tended to score higher on these questions (see also Wellcome Trust 2013).

Little international polling is done concerning evolution or the big bang. On evolution, the available evidence suggests that residents of other countries have typically been more likely than Americans to say they believe that "human beings, as we know them today, developed from an earlier species of animals." For example, although 49% of Americans gave the correct response to the evolution question in 2014, 70% of European respondents in 2005 (European Commission 2005), 74% of Canadian respondents in 2013 (CCA 2014), and 78% of Japanese respondents in 2011 (NISTEP 2012) gave this response (Table 7-3).

Table 7-3 **Correct answers to factual knowledge questions in physical and biological sciences, by country/region: Most recent year**

(Percent)

Question	United States [a] (2014)		Canada (2013)	China (2010)	EU (2005)	India (2004)	Japan[b] (2011)	Malaysia (2014)	Russia (2003)	South Korea (2004)
Physical science										
The center of the Earth is very hot. (True)	84		93	56	86	57	84	75	NA	87
The continents have been moving their location for millions of years and will continue to move. (True)	82		91	50	87	32	89	62	40	87
Does the Earth go around the Sun, or does the Sun go around the Earth? (Earth around Sun)	76		87	NA	66	70	NA	85	NA	86
All radioactivity is man-made. (False)	72		72	48	59	NA	64	20	35	48
Electrons are smaller than atoms. (True)	51		58	27	46	30	28	35	44	46

Question	United States [a] (2014)		Canada (2013)	China (2010)	EU (2005)	India (2004)	Japan[b] (2011)	Malaysia (2014)	Russia (2003)	South Korea (2004)
Lasers work by focusing sound waves. (False)	50		53	23	47	NA	26	30	24	31
The universe began with a huge explosion. (True)	42	c	68	NA	NA	34	NA	NA	35	67
Biological science										
It is the father's gene that decides whether the baby is a boy or a girl.[d] (True)	59		NA	58	64	38	26	45	22	59
Antibiotics kill viruses as well as bacteria.[e] (False)	55		53	28	46	39	28	16	18	30
Human beings, as we know them today, developed from earlier species of animals. (True)	49	f	74	66	70	56	78	NA	44	64

NOTES: NA = not available, question not asked.

EU = European Union.

See notes to table 7-2 for the full list of questions in the trend factual knowledge of science scale. EU data includes Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finalnd, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom, but does not include Bulgaria and Romania.

[a] See appendix table 7-7 for U.S. trends.

[b] Numbers for Japan are the average from two studies conducted in 2011.

[c] An experiment in the 2012 General Social Survey showed that adding the preface "according to astronomers" increased the percentage correct from 39% to 60% (NSB 2014).

[d] China and Europe surveys asked about "mother's gene" instead of "father's gene."

[e] Japan survey asked about "antibodies" instead of "antibiotics."

[f] An experiment in the 2012 General Social Survey showed that adding the preface "according to the theory of evolution" increased the percentage correct from 48% to 72% (NSB 2014).

SOURCES: United States—University of Chicago, National Opinion Research Center, General Social Survey (2014); Canada—Council of Canadian Academies, Expert Panel on the State of Canada's Science Culture, *Science Culture: Where Canada Stands* (2014); China—Chinese Association for Science and Technology/China

Research Institute for Science Popularization, Chinese National Survey of Public Scientific Literacy (2010); EU—European Commission, Eurobarometer 224/Wave 63.1: Europeans, Science and Technology (2005); India—National Council of Applied Economic Research, National Science Survey (2004); 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 (2011); Malaysia—Malaysian Science and Technology Information Centre/Ministry of Science, Technology and Innovation, Survey of the Public's Awareness of Science and Technology: Malaysia (2014); Russia—Gokhberg L, 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), Figure 7; 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).

Science and Engineering Indicators 2016

Reasoning and Understanding the Scientific Process

U.S. Patterns and Trends

Another indicator of the public understanding of science focuses on the public's understanding of how science generates and assesses evidence, rather than knowledge of particular science facts. Such measures reflect recognition that knowledge of specific S&T facts is conceptually different from knowledge about the overall scientific processes (Miller 1998), as well as the increased emphasis placed on process in science education (NRC 2012).

Data on three scientific process elements—probability, experimental design, and the scientific method—show 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 1 in 4 chance of suffering from an inherited disease. 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.

With regard to probability, 84% of Americans in 2014 correctly indicated that the fact that a couple's first child has the illness has no relationship to whether three future children will have the illness (Table 7-4; Appendix Table 7-9). In addition, about 74% of Americans correctly responded that the odds of a genetic illness are equal for all of a couple's children. Overall, 66% got both probability questions correct. The public's understanding of probability has been fairly stable over time, with the percentage giving both correct responses ranging from 64% to 69% since 1999, and has been no lower than 62% dating back to 1992 (Appendix Table 7-9 and Appendix Table 7-10).[i]

---

[i] Earlier NSF surveys used for the *Indicators* report 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. This scale does not include the questions aimed at studying scientific reasoning and understanding (e.g., questions about probability or the design of an experiment).

Table 7-4 **Correct answers to scientific process questions: Selected years, 1999–2014**

(Percent)								
Question	1999	2001	2004	2006	2008	2010	2012	2014
Understanding of scientific inquiry scale[a]	32	40	39	41	36	42	33	46
Components of understanding scientific inquiry scale								
Understanding of probability[b]	64	67	64	69	64	66	65	66
Understanding of experiment[c]	34	40	46	42	38	51	34	53
Understanding of scientific study[d]	21	26	23	25	23	18	20	26

[a] To be classified as understanding scientific inquiry, the survey respondent had to (1) answer correctly the two probability questions stated in footnote b, and (2) either provide a theory-testing response to the open-ended question about what it means to study something scientifically (see footnote d) or a correct response to the 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, the 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, the 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, the 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 the percentage of survey respondents who gave a correct response to each concept. "Don't know" responses and refusals to respond are counted as incorrect and are not shown. See appendix table 7-9 for more detail on the probability questions and for years before 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); University of Chicago, National Opinion Research Center, General Social Survey (2006–14).

Science and Engineering Indicators 2016

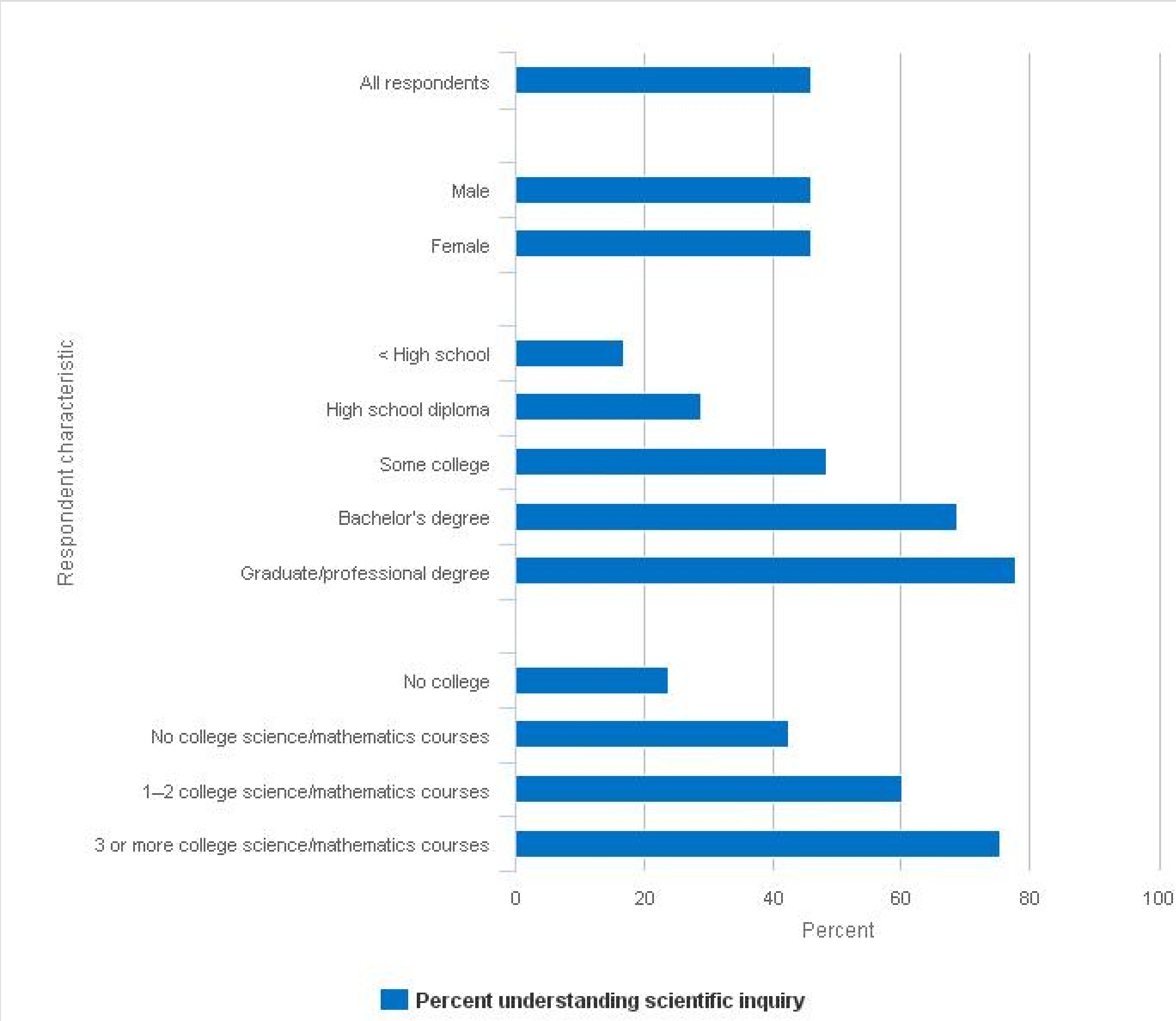
With regard to understanding experiments, more than half (53%) of Americans were able to answer a question about how to test a drug and then provide a correct response to an open-ended question that required them to explain the rationale for an experimental design (i.e., giving 500 people a drug while not giving the drug to 500 additional people, who then serve as a control group) (Table 7-4). The 2014 results are a substantial improvement over the unusually low 2012 results that had only 34% answering correctly. Indeed, the 2014 results are the highest they have ever been, although they are similar to the previous high (51%) seen in 2010 (Appendix Table 7-9). Also, although there has been an average increase in the percentage of correct responses over the previous two decades, there has also been substantial year-to-year variation. The changes observed for this question should be treated with particular caution because of the way these types of survey responses rely on human coders to categorize responses.[ii]

When all of the scientific reasoning questions are combined into an overall measure of "understanding of scientific inquiry" (Figure 7-10), the 2014 results were found to be the highest they have been for the 10 surveys for which NSF has data, dating back to 1995 (Appendix Table 7-9). About 46% of Americans could both correctly respond to the two questions about probability and provide a correct response to at least one of the open-ended questions about experimental design or what it means to study something scientifically (Table 7-4). The previous high was in 2010 when 42% correctly answered all of the questions. In general, respondents with more education, higher incomes, and greater verbal ability (Miner 1961) did better on the scientific inquiry questions. Men and women did equally well, whereas both younger and older age groups did relatively less well compared with those in the middle of the age range (Appendix Table 7-10).

[ii] Declines such as those seen in 2012 need to be regarded with caution. In that case, the percentage of Americans who correctly answered the initial multiple-choice question about how to conduct a pharmaceutical trial stayed stable between 2010 and 2012. It was only the follow-up question that asked respondents to use their own words to justify the use of a control group that saw a decline. For this question, interviewers record the response and then trained coders use a standard set of rules to judge whether the response is correct. Although the instructions and training have remained the same in different years, small changes in survey administration practices can sometimes substantially affect such estimates.

Figure 7-10

Understanding scientific inquiry, by respondent characteristic: 2014



NOTES: See appendix table 7-9 for explanation of understanding scientific inquiry and questions included in the index. See appendix table 7-10 for additional respondent characteristics.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2014).

Science and Engineering Indicators 2016

International Comparisons

Reasoning and understanding have not been the focus of surveys from most other countries in recent years. In Asia, a 2010 Chinese survey reported that 49% understood the idea of probability, 20% understood the need for comparisons in research, and 31% understood the idea of "scientific research" (CRISP 2010). In a July 2011

Japanese survey, 62% correctly answered a multiple-choice question on experiments related to the use of a control group, whereas 57% answered correctly in a follow-up December 2011 survey (NISTEP 2012). As noted previously, 66% of Americans provided a correct response to a similar question in 2014.

Pseudoscience

Another indicator of public understanding about S&T comes from a measure focused on the public's capacity to distinguish science from pseudoscience. One such measure, Americans' views on whether astrology is scientific, has been included in *Indicators* because of the availability of data going back to the late 1970s. Other examples of pseudoscience include the belief in lucky numbers, extrasensory perception, or magnetic therapy. Because astrology is based on systematic observation of planets and stars, respondents might believe that this makes it "sort of scientific." As such, the results on astrology should be interpreted with caution.[i]

In 2014, two-thirds of Americans (65%) said astrology is "not at all scientific," a value at the higher end of the historical range. A quarter (26%) said they thought astrology was "sort of scientific," and 6% said it was "very scientific." About 3% said they did not know. In contrast, the 2012 survey suggested that only 55% said that astrology is unscientific—a result that was relatively low in comparison with previous surveys. The percentage of Americans seeing astrology as unscientific has ranged between 50% (1979) and 66% (2004) since the NSF science survey began, with an increasing number of respondents saying astrology is "not at all scientific" and fewer saying that it is "sort of scientific."

Respondents with more years of formal education and higher income were less likely to see astrology as scientific. For example, in 2014, 84% of those with graduate degrees indicated that astrology is "not at all scientific," compared with 51% of those who did not graduate from high school. Age was also related to perceptions of astrology. Younger respondents, in particular, were the least likely to reject astrology, with only 48% of the youngest age group (18–24) saying that astrology is "not at all scientific" (Appendix Table 7-11).

---

[i] The fact that those with more formal education and higher factual science knowledge scores are consistently more likely to fully reject astrology suggests that this nuance has only a limited impact on results. Another problem is that some respondents may also confuse astrology with astronomy, and such confusion seems most likely to occur in some of the same groups (i.e., relatively lower education and factual knowledge) that might be predicted to get the question wrong. This could artificially inflate the number of wrong responses, although the fact that the question rebounded between 2012 and 2014 to within a more normal range also suggests that this question continues to assess something meaningful about how people perceive astrology. Also noteworthy is the fact that a Pew Forum on Religion & Public Life study (2009) using a different question found that 25% of Americans believe in "astrology, or that the position of the stars and planets can affect people's lives." Gallup found the same result with the same question in 2005 (Lyons 2005). In contrast, similar to 2014, the 2010 GSS found that 6% saw astrology as "very scientific," and 28% said they saw astrology as "sort of scientific" (34% total).

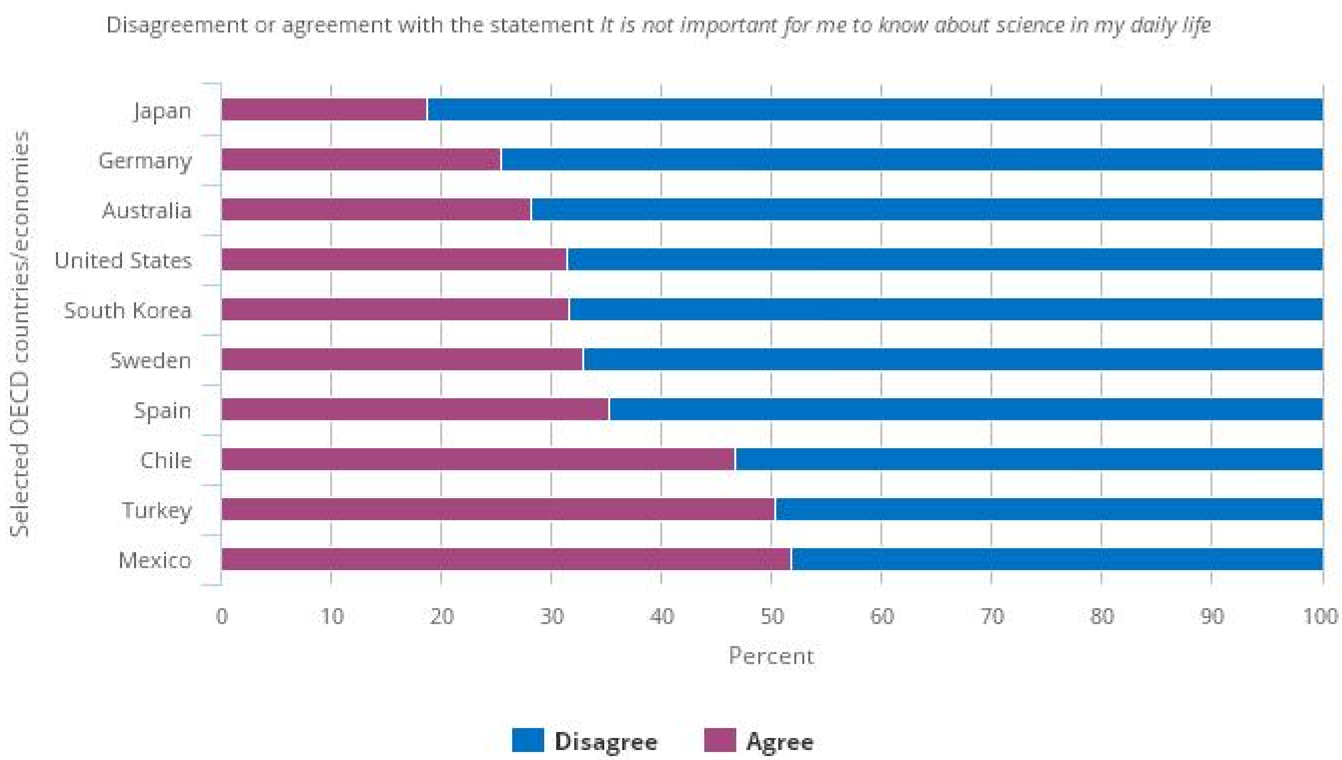
Perceived Knowledge Importance

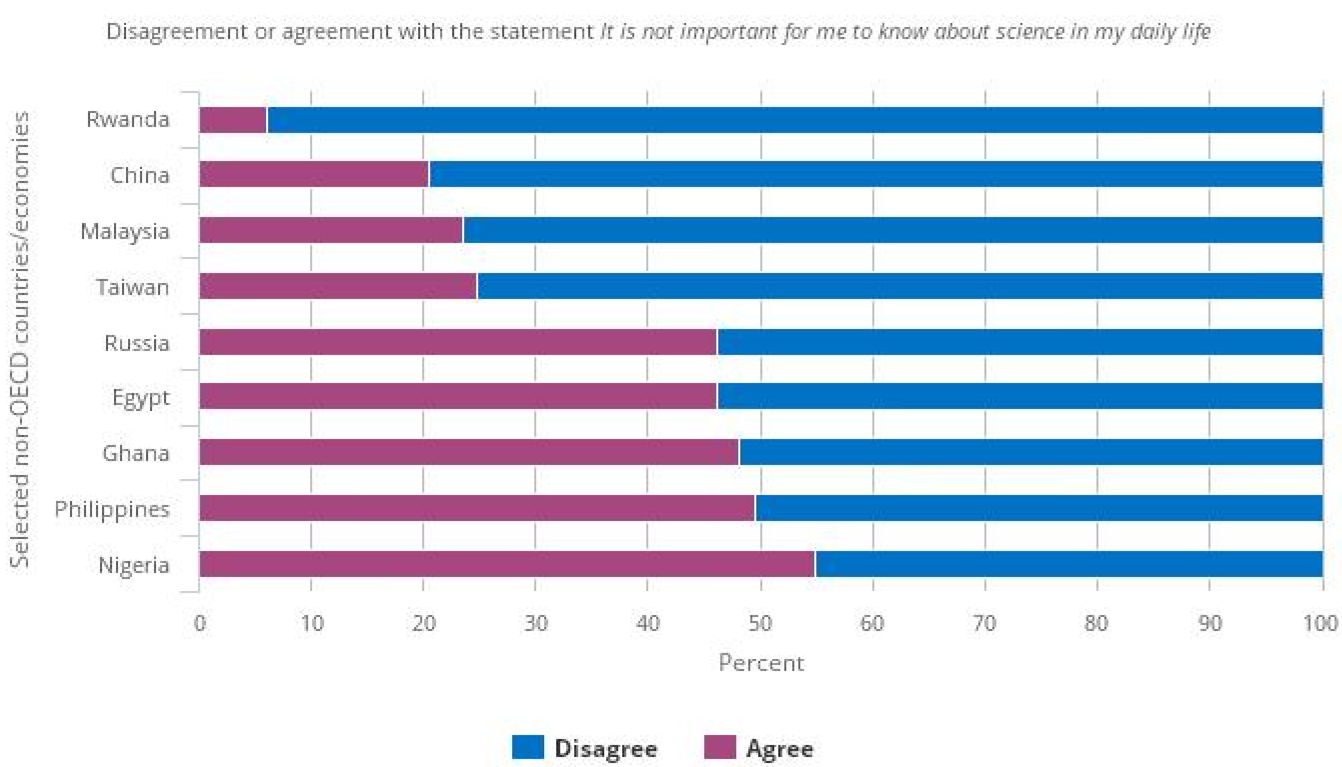
International Comparisons

A 2010–14 international survey also asked about people's perceptions of the importance of scientific knowledge to their daily lives. The study found that 32% of Americans said that it was "not important … to know about science in [his or her] daily life" by choosing between 6 and 10 on a 10-point scale where 1 represented complete disagreement and 10 represented complete agreement (WVS 2014). The United States is similar to many other OECD countries, although residents of Japan (19%) and Germany (26%) were less likely to agree that scientific knowledge is unimportant (Figure 7-11). Outside of the OECD, there were also countries in which relatively few residents indicated that they thought scientific knowledge was unimportant, including Rwanda (6%), China (21%), and Malaysia (24%). In general, about half of the residents of some OECD and non-OECD countries also said they thought scientific knowledge was unimportant.

Figure 7-11

Perceived importance of knowledge about science, by country/economy: 2014





OECD = Organisation for Economic Co-operation and Development.

NOTES: Responses to *It is not important for me to know about science in my daily life.* Respondents were asked to rate from 1 (completely disagree) to 10 (completely agree). Disagreement is the aggregation of responses from 1 to 5, agreement is the aggregation of responses from 6 to 10.

SOURCE: World Values Survey, WVS Wave 6 (2010–14), http://www.worldvaluessurvey.org/WVSDocumentationWV6.jsp, accessed 17 February 2015.

Science and Engineering Indicators 2016

Public Attitudes about S&T in General

Scientific knowledge is only one limited aspect of how people think about S&T. How people perceive science and scientists can also matter considerably. Such attitudes could affect the public's willingness to fund S&T through public investment (Miller, Pardo, and Niwa 1997; Muñoz, Moreno, and Luján 2012), as well as young people's willingness to enter into S&T training and choose jobs in S&T. Committing resources—whether time or money—to S&T means trusting that such commitments will pay off over the long term for individuals, families, and society. Such general views about S&T may also shape opinions about specific technologies and research programs that could enhance lives or pose new risks.

This section presents general indicators of public attitudes and orientations toward S&T in the United States and other countries. It covers perceptions of the promises and reservations about S&T, overall support for government funding of research, and confidence in scientific community leaders. Overall, the data make it clear that Americans support both S&T and the people involved in S&T.

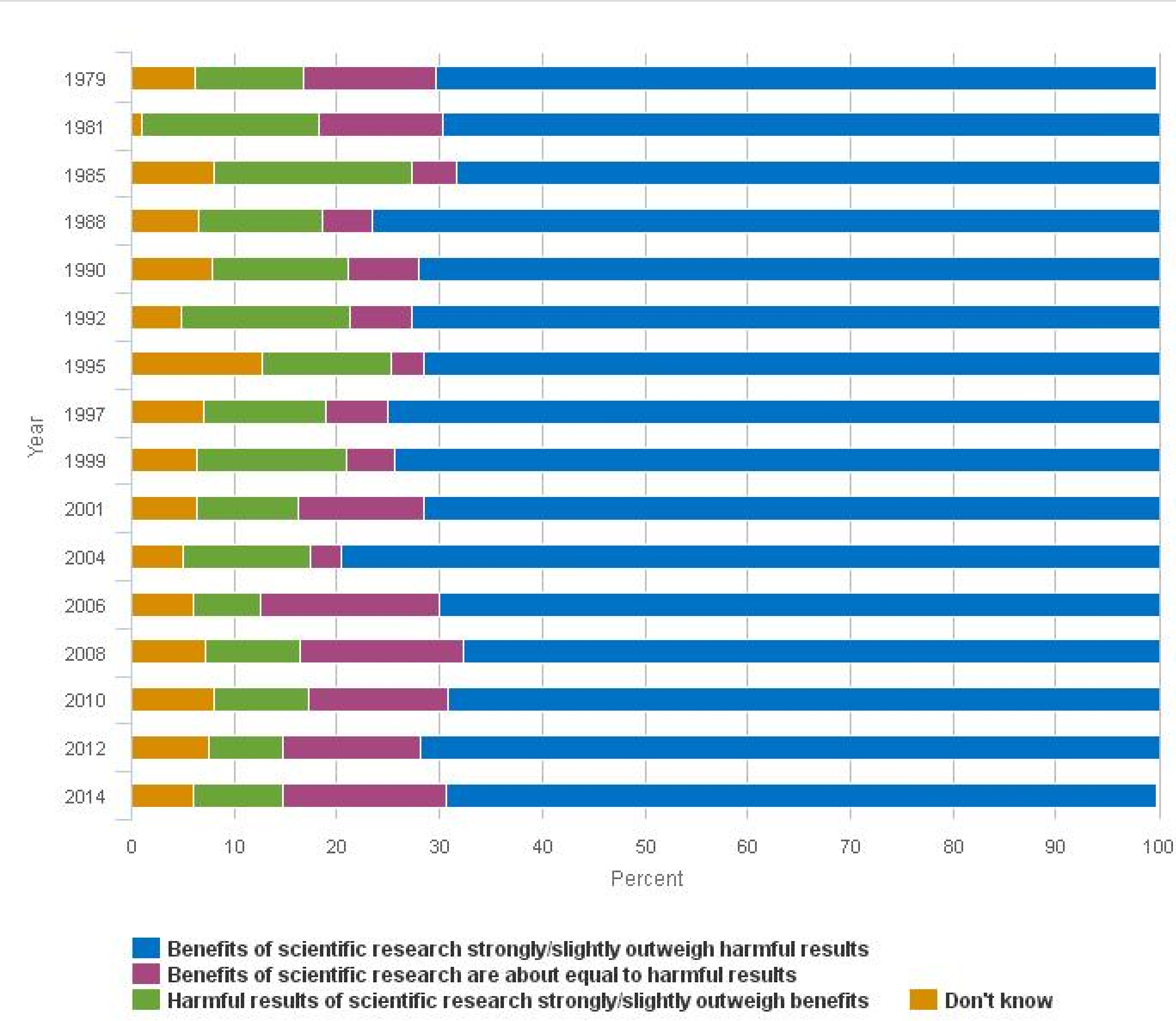
Promises and Reservations about S&T

U.S. Patterns and Trends

Overall, Americans remain strong believers in the benefits of S&T even while seeing potential risks. Surveys since at least 1979 show that roughly 7 in 10 Americans believe the effects of scientific research are more positive than negative for society (Figure 7-12; Appendix Table 7-12). In the 2014 GSS, this included 43% who said they believed the benefits "strongly" outweigh the negatives and 26% who said the benefits only "slightly" outweigh the potential harms (Appendix Table 7-13). Only 9% said science creates more harms than benefits, including 7% who indicated that they thought science caused "slightly" more harm and 2% who thought the balance was "strongly" toward harm. These numbers are generally consistent with earlier surveys; Americans saying the benefits strongly or slightly outweigh the harmful results have ranged from 68% to 80% since this question was initially asked in the 1970s.

Figure 7-12

Public assessment of scientific research: 1979–2014



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 were collected. Percentages 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 (2006–14). See appendix tables 7-12 and 7-13.

Science and Engineering Indicators 2016

Older respondents and those with more education, income, and scientific knowledge hold a stronger belief in the benefits of science than others (Appendix Table 7-12). For example, 44% of those who had not completed high school said they believe science does more good than harm, but 84% of those with bachelor's degrees and 91% of those with graduate degrees expressed this view. Similarly, 49% of those in the lowest income quartile expressed that they saw more benefits than harms from science as compared with 83% of those in the top income quartile. Men were more likely than women to say that benefits "strongly" outweigh harms (49% versus 38%), whereas women were more likely to indicate that the benefits "slightly" outweigh harms; overall, however, 70% of men and 68% of women agreed that science provided more benefits than harms.[i]

Americans also overwhelmingly agree that S&T will foster "more opportunities for the next generation." In the 2014 GSS, 89% of Americans "strongly agreed" (33%) or "agreed" (56%) that S&T will create more opportunities (Appendix Table 7-14). This is up slightly from 2012 but consistent with surveys between 2006 through 2010 during which time 89%–91% agreed about the relative value of S&T (Appendix Table 7-15). Pew Research Center (2015b) data further confirm that most Americans see science as having positive impacts in a range of areas. Overall, 79% of respondents to a 2014 survey by the organization said they thought science has "made life easier," whereas just 15% said they thought it has made life more difficult.

Although Americans may be generally positive about science, concern about the speed at which science may be changing "our way of life" is also close to high levels not seen in more than 30 years. In the 2014 GSS, 51% of Americans "strongly agreed" (11%) or "agreed" (40%) that "science makes our way of life change too fast," with demographic patterns corresponding to those found for the question addressing benefits and harms (Appendix Table 7-16). For example, those with less education and less income were more likely to express worry about the pace of change. Age, however, was not substantially associated with concerns about the pace of change. The current high level of concern is similar to that found in 1979 when 53% agreed that they were concerned about the pace of change. It is, however, difficult to know if there is an underlying trend because the main increase in concern occurred at the same time (between 2004 and 2008) that the underlying survey switched from a telephone survey to a face-to-face survey. Concern about the pace of change was, nevertheless, lower during much of the 1980s and 1990s (Appendix Table 7-17).

International Comparisons

The 2013 special Eurobarometer on S&T found that, across Europe, large majorities see substantial benefits from S&T. More than three-quarters (77%) of respondents said they felt that S&T had a "very" (60%) or "fairly" (17%) positive influence on society in their home country. There was near consensus in Sweden (94% positive) and in the Baltic countries of Estonia (91% positive) and Lithuania (90% positive). Even respondents in the least favorable countries—Romania (68% positive) and Portugal (69% positive)—agreed on the value of S&T (European Commission 2013). The 2013 Eurobarometer survey, along with the WVS, also included several questions that are nearly identical to those asked in the GSS.

For the Eurobarometer, Europeans were asked whether they believe S&T would "provide more opportunities for future generations." Three-quarters of Europeans (75%) agreed, and several northern European countries were again among the most favorable, led by the Netherlands (88%), Estonia (87%), Denmark (85%), and Sweden (85%). There were still substantial positive attitudes about S&T in countries in which residents were least likely to agree that S&T would provide future opportunities. The least positive attitudes were in Southern and Eastern Europe, including Slovenia (64%), Romania (67%), and Italy (67%). Belief in future benefits from science is also widespread, although Americans may be relatively less likely to say they see such benefits than residents of many other countries. In this regard, the 2010–14 WVS also included a question about perceived future opportunities from science. This question used a 10-point scale anchored by "completely disagree" to "completely agree" with no neutral response option (i.e., no middle category). Among OECD countries in the survey, the 79% of Americans who said they believe S&T will ensure more opportunities for future generations is similar to results from the Netherlands (84%), South Korea (80%), and Australia (74%). The OECD countries that see the most hope from S&T are Estonia (93%) and Poland (86%). Beyond the OECD, the countries in which there appears to be the most hope for S&T include Libya (97%), Qatar (93%), Uzbekistan (93%), and Armenia (91%) (WVS 2014). A separate 2013 survey indicated that 74% of Canadians agreed that S&T would create more opportunities (CCA 2014).

Another past GSS question used in the 2013 Eurobarometer survey on science asked respondents to consider the role of faith and science in society. A total of 39% of Europeans agreed that "we depend too much on science and not enough on faith." The highest proportion of agreement came from Southern and Eastern Europe, including Bulgaria (66%), Cyprus (66%), and Montenegro (64%), and the least amount of agreement came from the Netherlands (23%), Denmark (24%), and France (25%) (European Commission 2013). A 2013 Canadian survey found that Canadians' responses were similar (25% agreed) to those of respondents in the latter European countries (CCA 2014). About 41% of Americans agreed that "we depend too much on science and not enough on faith" when the question was last asked in the 2010 GSS (NSB 2014), similar to the European average.

The 2010–14 WVS also included a version of the faith versus science question, which used a 10-point scale anchored by "completely disagree" to "completely agree" described previously (WVS 2014). Among OECD countries, the WVS found that residents of Sweden (20%), Slovenia (21%), and the Netherlands (25%) were the least likely to agree that "we depend too much on science and not enough on faith" (i.e., give a response that was between 6 and 10 on the scale) (Figure 7-13). In contrast, Americans were evenly divided (50%). Beyond the OECD, the respondents least likely to say their society puts too much emphasis on science were from a group of Middle Eastern countries, including Yemen (20%) and Iraq (19%). Respondents from a group of Central and South American countries were among the most likely to agree that their society puts too much emphasis on science, including Ecuador (75%) and Colombia (70%).[ii]

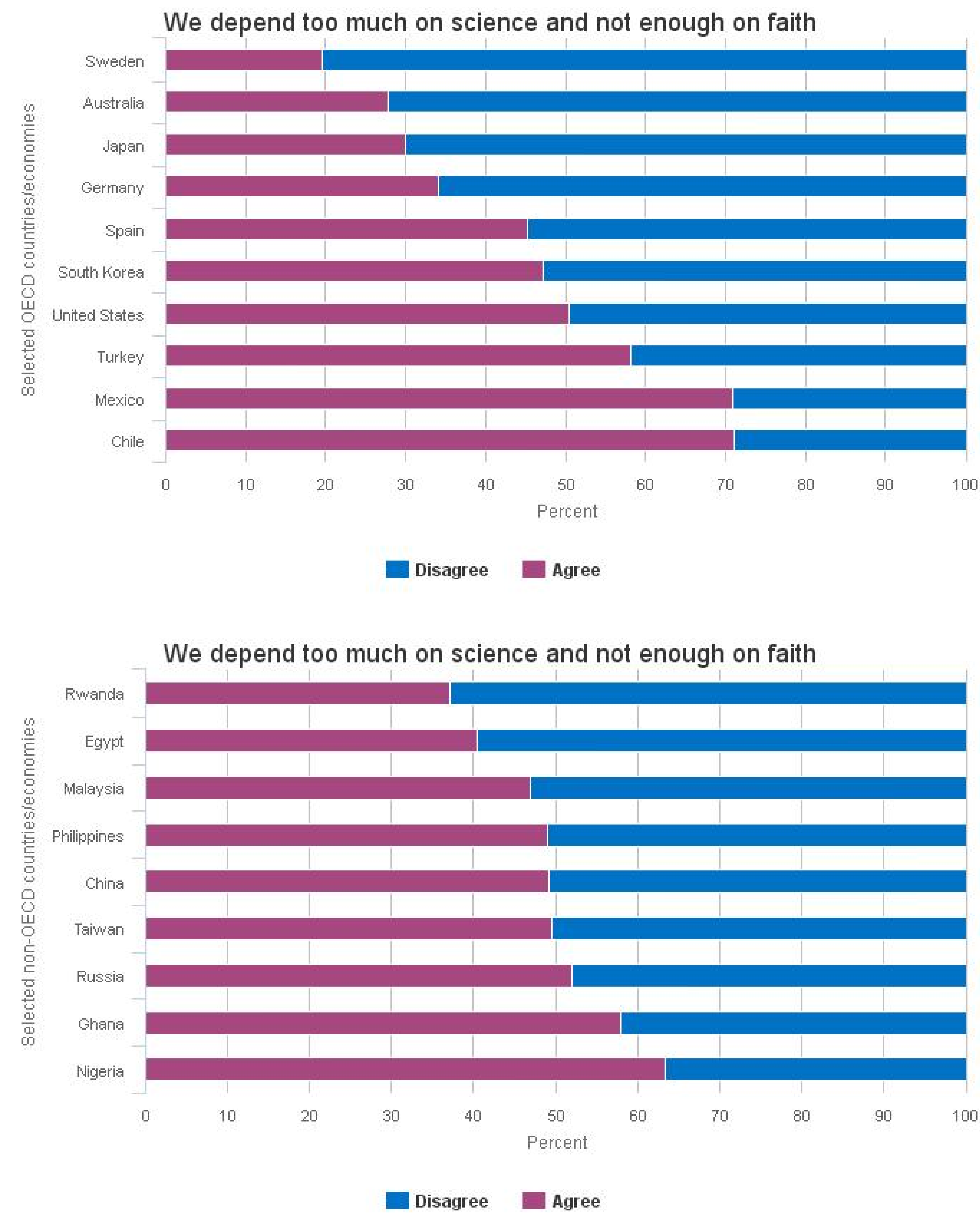
---

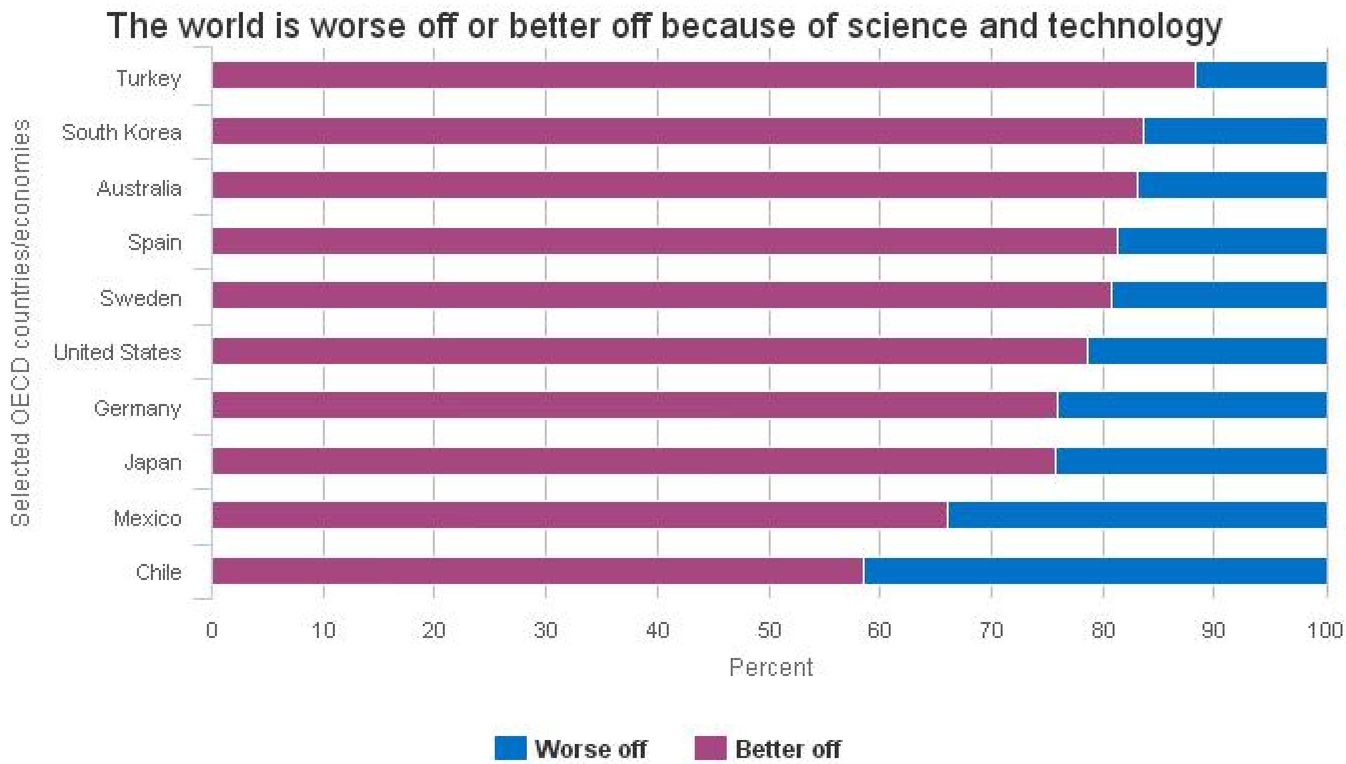
[i] Methodological issues make fine-grained comparisons of data from different survey years particularly difficult for this question. For example, although the question content and interviewer instructions were identical in 2004 and 2006, the percentage of respondents who volunteered "about equal" (an 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 (although 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.

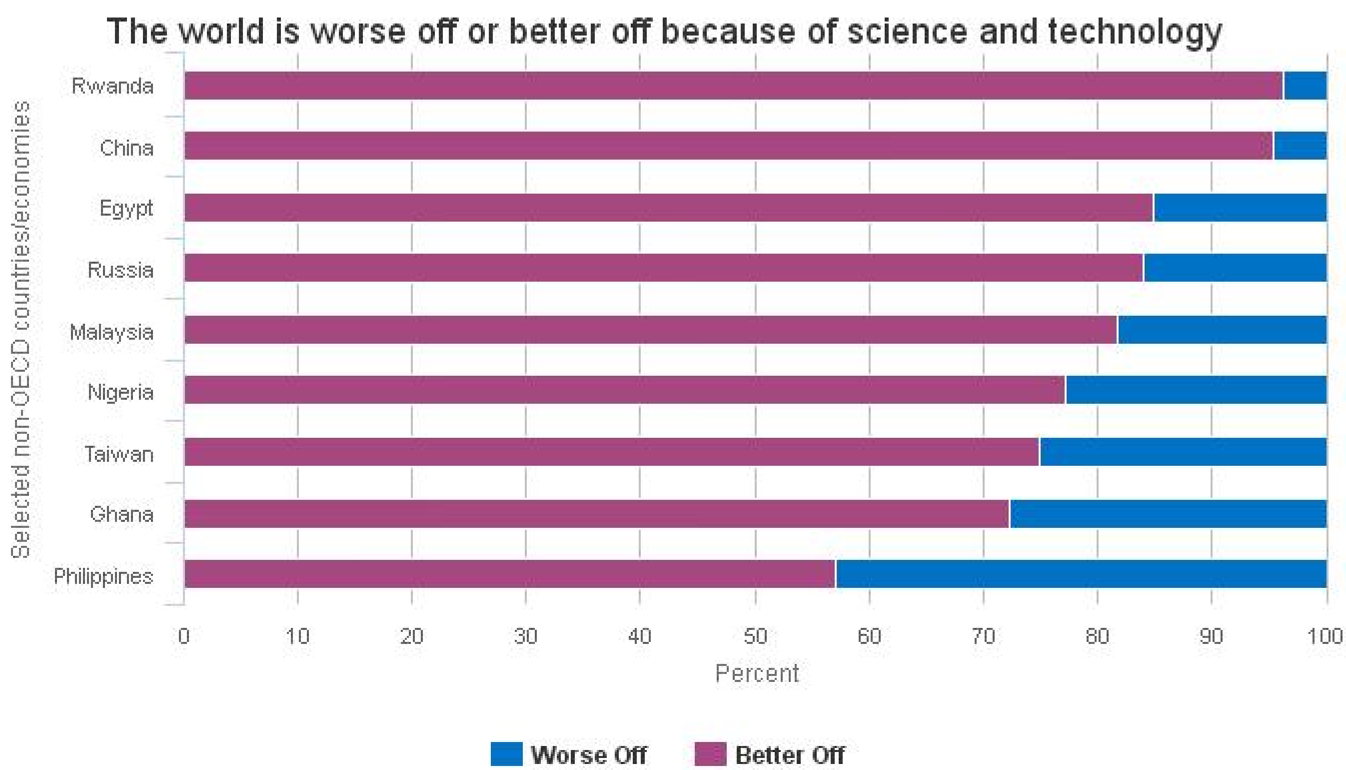
[ii] Interpreting this response is difficult because agreement could mean that a respondent thinks either that his or her country relies too much on science or not enough on science. For example, if the respondent felt that his or her country relied too much on faith, then he or she might disagree with the question. It should thus be understood that the respondent is unhappy with the current balance, not that he or she wants more emphasis on either faith or science. Also, the difference between the two data points from the United States is not readily interpretable because of the different response options provided to those taking the survey.

Figure 7-13

Public assessment of belief in science versus faith and of whether science does more harm than good, by country/economy: 2014







OECD = Organisation for Economic Co-operation and Development.

NOTES: Response to *We depend too much on science and not enough on faith.* Respondents were asked to rate from 1 (completely disagree) to 10 (completely agree). Disagreement is the aggregation of responses from 1 to 5; agreement is the aggregation of responses from 6 to 10. Response to *All things considered, would you say that the world is worse off, or better off, because of science and technology*. Respondents were asked to rate from 1 (Much worse off) to 10 (Much better off). Worse off is the aggregate of responses from 1 to 5; better off is the aggregate of responses from 6 to 10.

SOURCE: World Values Survey, WVS Wave 6 (2010–14), http://www.worldvaluessurvey.org/WVSDocumentationWV6.jsp, accessed 17 February 2015.

Science and Engineering Indicators 2016

Another WVS question addressing general views about S&T addressed whether respondents said they believed that science had made the world better off or worse off (again, using a 10-point scale). In this case, most respondents agreed that the world was "better off" because of science. Within the OECD, Turkey (88%), South Korea (84%), and Australia (83%) were the most likely to say the world was better off, although most residents of the United States (79%) also held this view (Figure 7-13). Within the OECD, residents of Chile (59%) and Mexico (66%) were the least likely to say that science has made the world better off. Outside of the OECD, residents of Rwanda (96%) and China (96%) were particularly likely to say that science had made the world better off. Residents of the Philippines (57%) were the least likely to give this view, although most non-OECD countries were positive about science.

A third GSS question that was included in the 2013 special Eurobarometer focused on whether respondents agreed or disagreed that "science makes our way of life change too fast." Although 51% of Americans agreed with this statement in 2014, about 62% of Europeans agreed, with residents of Cyprus (93%) and Greece (89%) being the most likely to agree and residents of the Netherlands (45%) and Denmark (45%) the least likely to agree (European Commission 2013). The 2013 Canadian survey suggested that just 35% of Canadians thought science makes life "change too fast" (CCA 2014).

Within Asia, different question wording makes comparisons difficult, but most respondents appeared to support S&T. In 2010, 75% of Chinese respondents "fully" or "basically" agreed that S&T brings more advantages than disadvantages, whereas only one-fifth (20%) said they thought that "we are too dependent on science such that we overlook belief" (CRISP 2010). In 2011, 54% of Japanese respondents said that S&T development has more advantages than disadvantages (NISTEP 2012). South Koreans were asked separate questions about the risks and benefits of S&T. In 2012, about 83% "agreed" or "somewhat agreed" that S&T promotes a healthy and convenient life, and 72% agreed that S&T "helps in everyday life." However, 60% also agreed that S&T "creates problems" (KOFAC 2013).

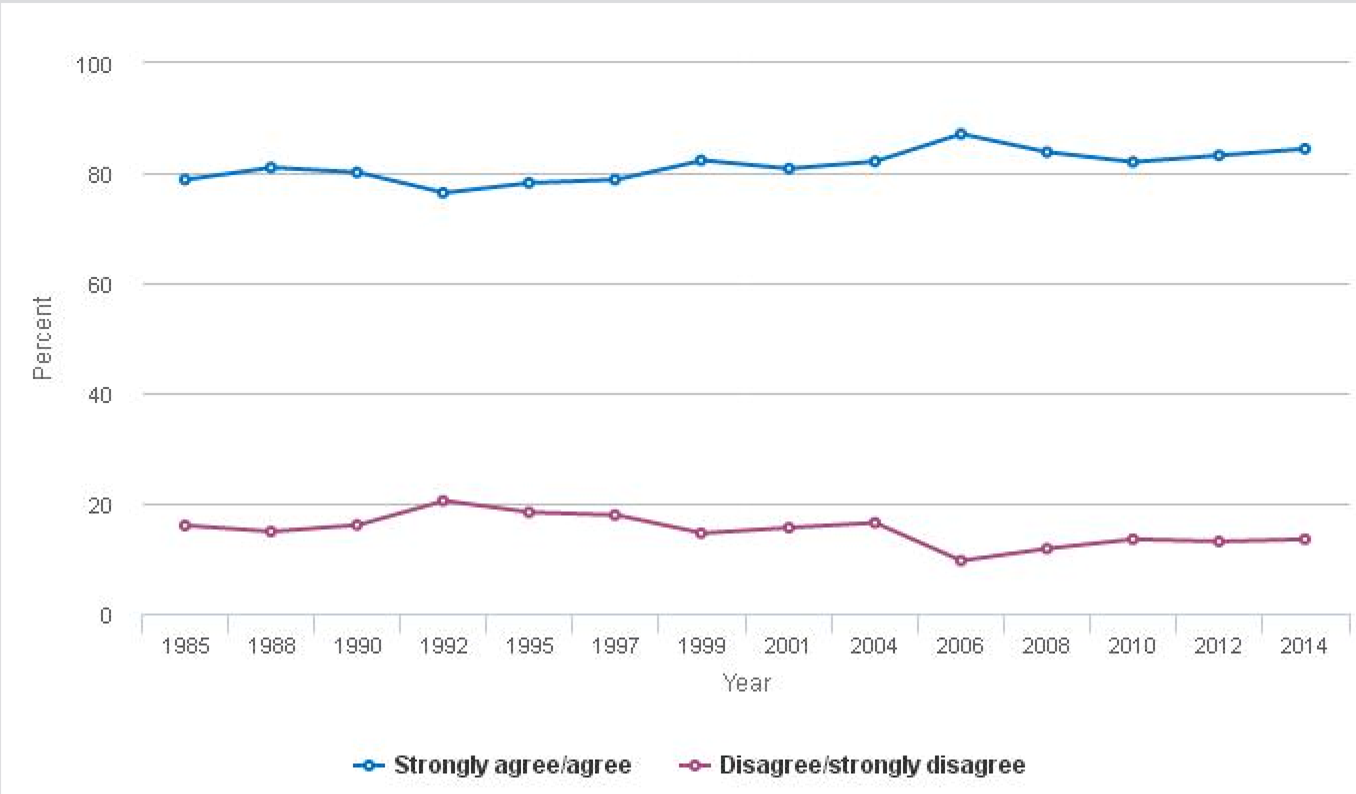
Federal Funding of Scientific Research

U.S. Patterns and Trends

U.S. public opinion has consistently and strongly supported federal spending on basic scientific research. In the 2014 GSS, 85% of Americans "strongly agreed" (25%) or "agreed" (60%) that "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" (Figure 7-14 and Appendix Table 7-18). This is similar to the percentage in recent years, although it has risen from that in the 1985–2001 NSF surveys, when the value ranged between 77% (1992) and 82% (1999) (Appendix Table 7-19).

Figure 7-14

Public opinion on whether government should fund basic scientific research: 1985–2014



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" are not shown.

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 Michigan, Survey of Consumer Attitudes (2004); University of Chicago, National Opinion Research Center, General Social Survey (2006–14). See appendix tables 7-18 and 7-19.

Science and Engineering Indicators 2016

Americans with relatively higher levels of education, more income, and more science knowledge are particularly likely to support funding scientific research. For example, 76% of those who had not completed high school agreed that funding was needed, but 90% of those with graduate degrees expressed this view (Appendix Table 7-18).

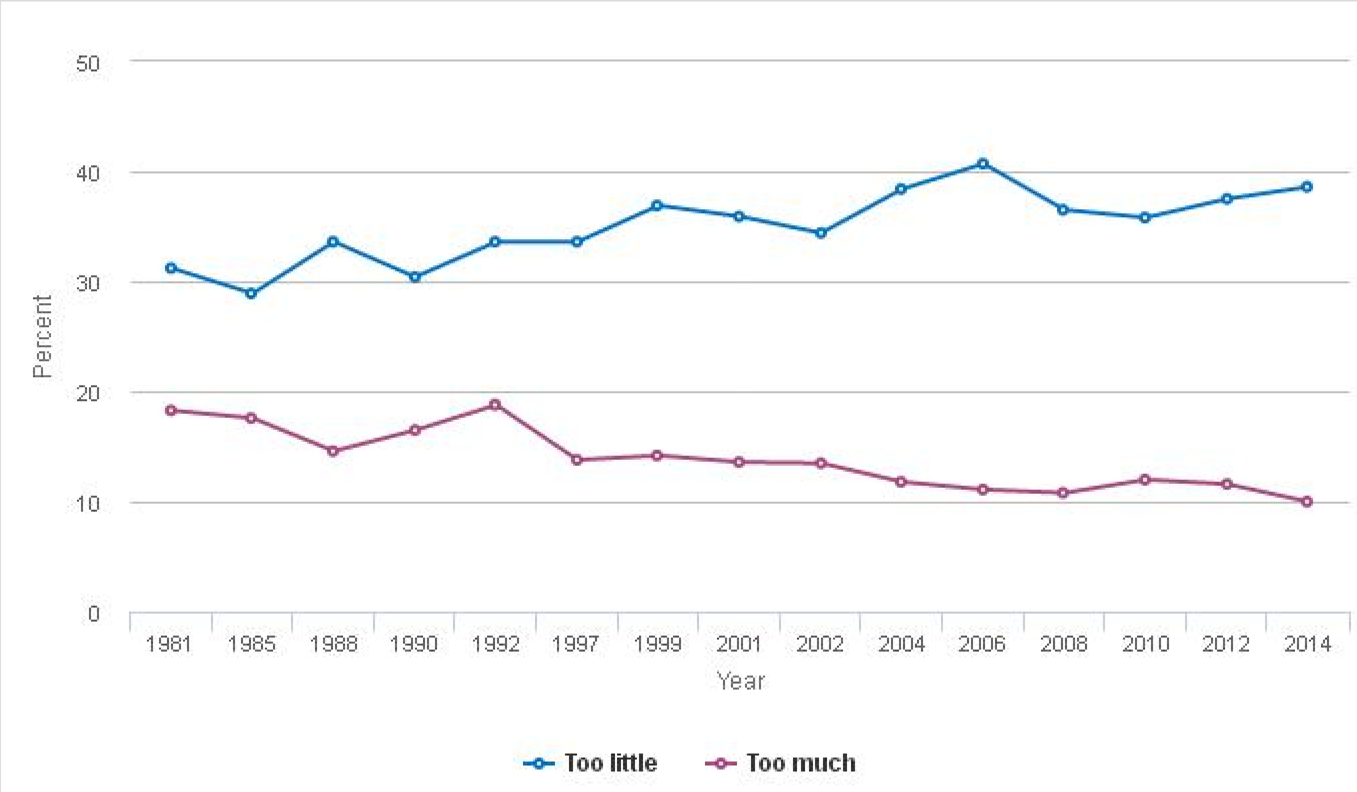
The Pew Research Center (2015b) also found that, in 2014, most Americans said they think that "government investments" in both basic scientific research (71%) and engineering and technology (72%) "pay off in the long run." Overall, 61% of Americans told the Pew Research Center that they thought "government investment in research is essential for scientific progress." These results were also similar to what the Pew Research Center found in 2009 (Pew Research Center 2015b).

Another indicator of views about S&T is the percentage of Americans who say they "think we're spending too little money" on "supporting scientific research." The 2014 GSS found that 39% of respondents said we are spending "too little," 45% said the amount was "about right," and 10% said it was "too much." In other words, 84% of Americans say they would like to see similar or increased funding for S&T in the years ahead, although the question does not specify who is responsible for this spending.

The percentage who said they thought we spend too little on science gradually increased from 1981 to 2006, fluctuating between 29% and 34% in the 1980s, between 30% and 37% in the 1990s, and then varying between 34% and 41% in the 2000s and 2010s (Figure 7-15; Appendix Table 7-20 and Appendix Table 7-21). Also, as noted previously, older residents, those with more education, and those with more income were more likely to say that they believe too little is being spent on science.

Figure 7-15

Public assessment of amount of government spending for scientific research: 1981–2014



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 we're 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.

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 Michigan, Survey of Consumer Attitudes (2004); University of Chicago, National Opinion Research Center, General Social Survey (2006–14). See appendix table 7-21.

Science and Engineering Indicators 2016

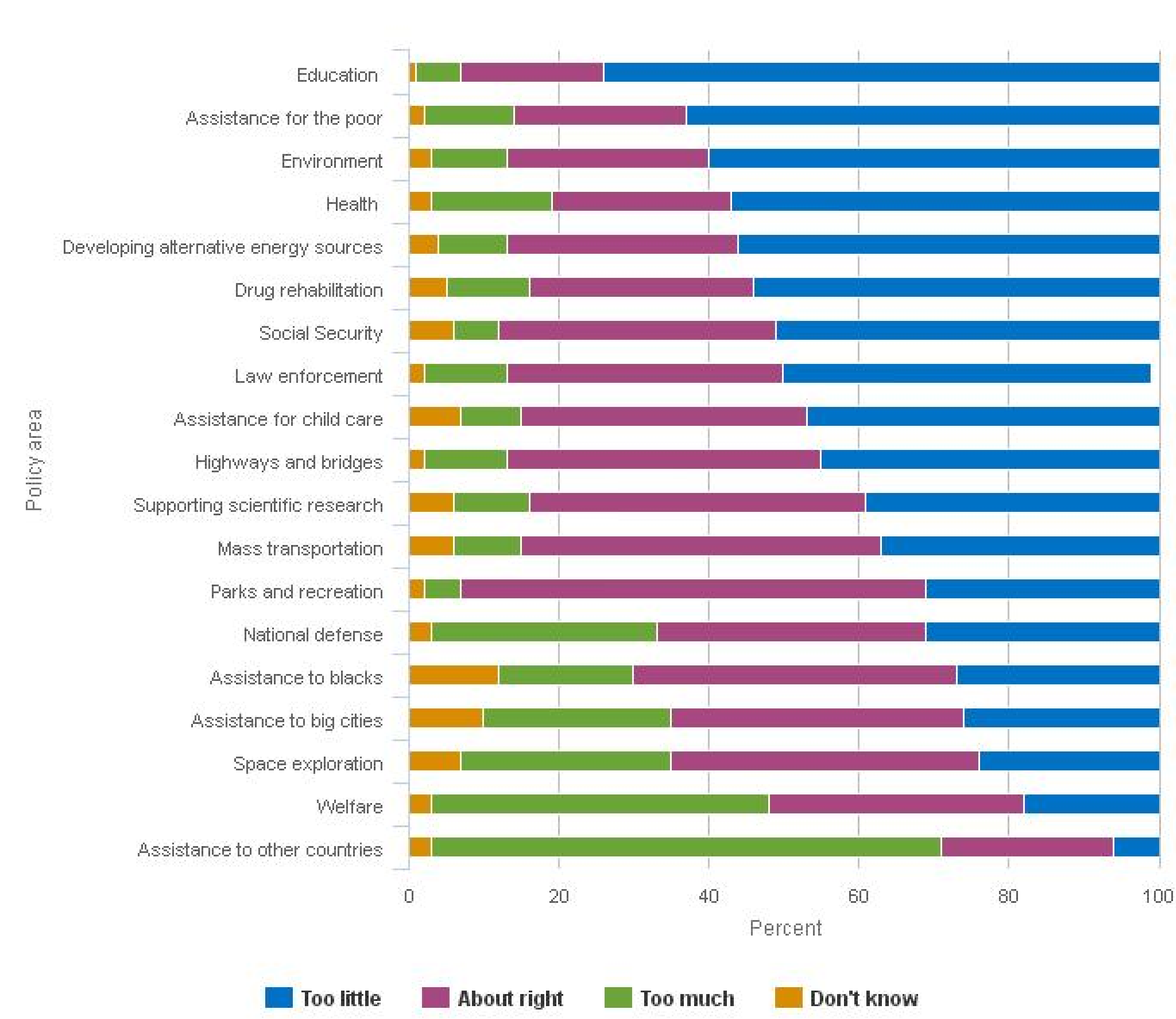
Compared with support for spending in other areas, however, support for spending on scientific research may not be especially strong. In the 2014 GSS, Americans were more likely to say several other policy domains need spending more than S&T (Figure 7-16). Although 39% of Americans say they would like more funding for scientific research, education has consistently been the domain that Americans are most likely to say receives too little funding, with 74% giving this response in 2014. Other S&T domains in which Americans consistently think there is too little spending according to the 2014 GSS include improving the environment (60%) and health (57%) (Appendix Table 7-21).[i]

---

[i] 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.

Figure 7-16

Public attitudes toward government spending in various policy areas: 2014



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 we're spending too little money on it, about the right amount, or too much.*

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2014). See appendix table 7-21.

Science and Engineering Indicators 2016

International Comparisons

Citizens of many other countries have also generally expressed strong support for spending on scientific research. In 2010, 72% of Europeans and 77% of Chinese agreed that scientific research should be supported even in the absence of immediate benefits (European Commission 2010a; CRISP 2010). A 2013 survey of Canadians similarly found that 76% of respondents said they thought government should support scientific research (CCA 2014). Levels of agreement in South Korea, Malaysia, Japan, and Brazil have also been similar to those in the United States and Europe (NSB 2012).

According to a 2014 Eurobarometer survey, Europeans also think that scientific and technological innovation will have positive impacts in the coming years in a range of policy domains. These include health and medical care (65%), education and skills (60%), transportation (59%), energy (58%), environmental protection (57%), climate change (54%), and housing (50%). Optimism was consistently higher in those who said they had studied S&T (European Commission 2014). In South Korea in 2012, 29% of respondents said they thought that the government and industry needed to invest more in S&T research; this percentage has fallen from 37% in 2008 and 35% in 2010 (KOFAC 2013). The South Korean survey asked about S&T topics only.

Confidence in the Science Community's Leadership

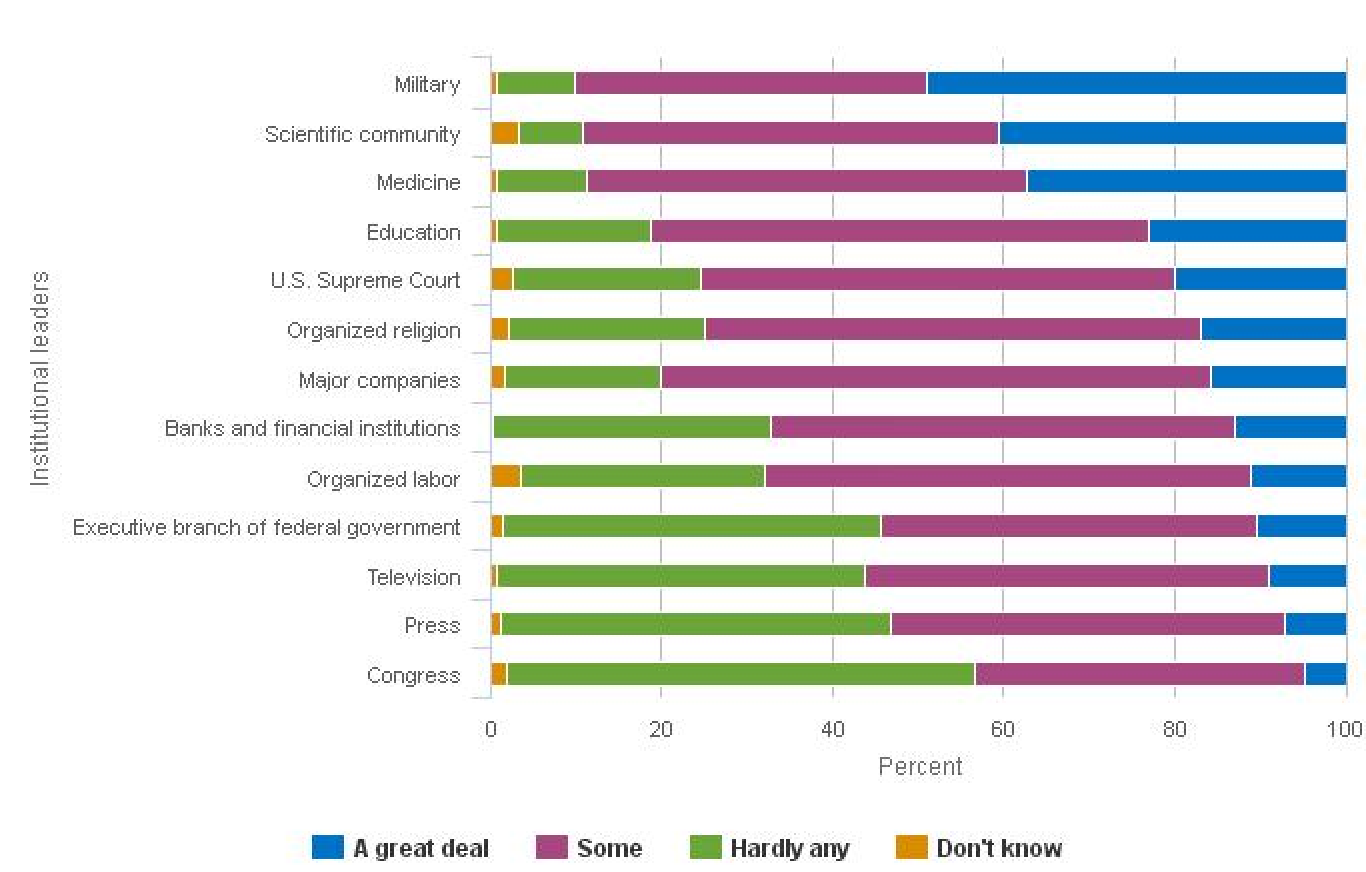
U.S. Patterns and Trends

Few members of the public have the background knowledge or resources to fully evaluate evidence related to scientific questions in the public sphere. People, therefore, often rely on how they perceive decision makers and other cues as decision aids (Fiske and Dupree 2014). Public confidence in leaders of the scientific community can therefore affect public acceptance of findings and conclusions based on scientific research.

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 2014, 41% of Americans expressed “a great deal of confidence” in leaders of the scientific community, 49% expressed “only some confidence,” and 8% expressed “hardly any confidence at all” (Figure 7-17). These results are nearly identical to 2012 and are similar to previous years (NSB 2014). In general, men (45%) are more confident in the scientific community than women (37%). Also, those with more education and income are more confident than those with less, and young respondents are more confident than older respondents (Appendix Table 7-22). Some recent research suggests that political views are increasingly related to confidence in science (Gauchat 2012; McCright et al. 2013).

Figure 7-17

Public confidence in institutional leaders, by type of institution: 2014



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?*

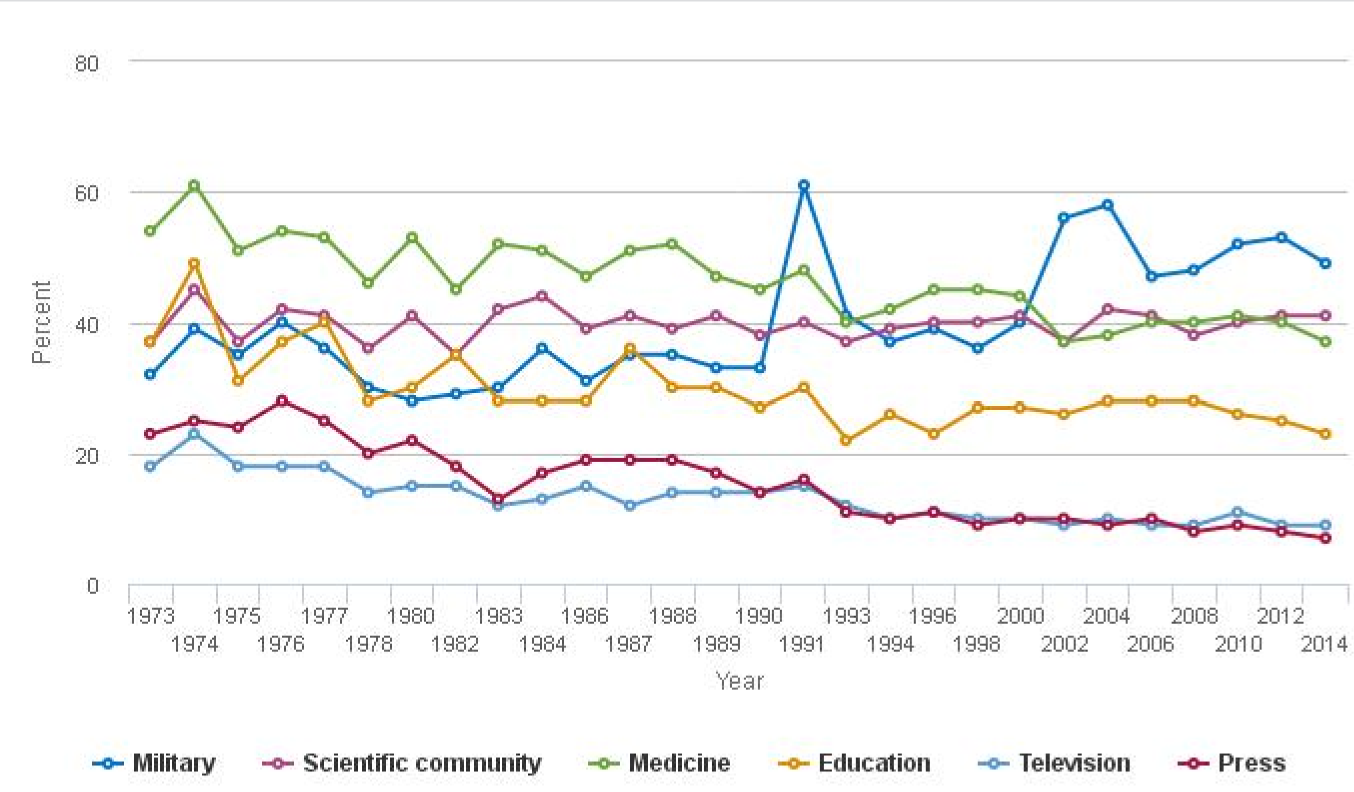
SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2014). See appendix table 7-23.

Science and Engineering Indicators 2016

These results also suggest that leaders of the scientific community compare well with leaders of other institutions in America. Only military leaders held greater public confidence in 2014, with 49% of Americans saying they had a "great deal of confidence" in them (Figure 7-18). In recent years, the percentage of Americans who express high levels of confidence in the scientific community (41%) has also remained similar to the percentage of Americans who have high confidence in the medical community (37%). However, whereas the percentage of Americans saying they place a "great deal of confidence" in the scientific community has been relatively stable since the 1970s, the percentage saying this about the medical community has fallen from consistently above 50% in the 1970s and 1980s to 37% in 2014 (for a discussion, see Zheng forthcoming) (Appendix Table 7-23).

Figure 7-18

Public confidence in institutional leaders, by selected institution: 1973–2014



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?* Figure shows only responses for "a great deal of confidence."

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (1973–2014). See appendix table 7-23.

Science and Engineering Indicators 2016

The GSS results are mostly consistent with a Pew Research Center (2013b) survey that showed that military leaders were the group that Americans were most likely to say contribute “a lot” to society (78%). Teachers were the second highest ranked (72%), followed by medical doctors (66%), scientists (65%), and engineers (63%). Americans were least likely to view lawyers (18%), business executives (24%), and journalists (28%) as contributing “a lot” to society. The survey also noted that opinions about most groups became less positive between 2009 and 2013, although this pattern was not universal. The percentage of Americans saying that scientists contribute “a lot” dropped somewhat from 70% to 66%, and medical doctors dropped from 69% to 66%. In contrast, engineers stayed essentially the same.

A later 2014 Pew Research Center (2015b) survey similarly found that most Americans think their country’s scientific achievements are relatively special, with 15% labeling them as among the “best in the world” and 39% labeling them as “above average”—that is, 54% viewed these achievements as at least “above average.” The military was again the only group seen more positively, with 76% seeing it as at least “above average” in the world. The quality of available “medical treatment” was ranked similarly to science—51% saw it as at least “above average.” The overall “healthcare” system, however, was ranked more poorly, with only 25% considering it as at least “above average.” Similarly, only about one-third of Americans rated America’s kindergarten through grade 12

(K–12) "science, technology, engineering, and math" (STEM) education "best in the world" (7%) or "above average" (22%). In all cases, these numbers declined from those in a 2009 survey. A companion survey of scientists found that scientists were much more likely than the general public to see America's scientific research as good, with 92% ranking it at least "above average." Scientists were also less likely to consider America's K–12 STEM education as successful, with just 16% ranking it as at least "above average."

International Comparisons

The 2013 special Eurobarometer on S&T examined views about scientists by asking residents to select up to three types of people from a list that they considered as "best qualified to explain the impact of scientific or technological development." University and government scientists (66%) were the most frequently selected group in every country, followed by corporate scientists (35%). Other groups were selected less frequently, including environmental protection associations (21%), television journalists (20%), consumer organizations (20%), medical doctors (19%), and newspaper journalists (15%). Near the bottom of the list were groups such as industry (9%), politicians (4%), and the military (3%). In Europe, perceptions about the top-ranked groups varied substantially by country. University and government scientists ranged from a high of 92% in Cyprus to a low of 54% in Portugal and 55% in Hungary. Similarly, corporate scientists ranged from a high of 57% in Cyprus to a low of 19% in Hungary. For environmental groups, the range was between 29% (Sweden) and 9% (Poland and Lithuania) (European Commission 2013).

Levels of reported trust varied in two Asian surveys that used different questions. A 2012 South Korean survey found that 36% "strongly agreed" or "agreed" that scientists can always be trusted (KOFAC 2013). In contrast, a 2011 survey in Japan found that 69% of respondents said scientists could be trusted or "somewhat trusted." Even more respondents (77%) said engineers could be trusted (NISTEP 2012).

Public Attitudes about Specific S&T-Related Issues

In addition to general views about S&T, people also develop views about specific issues and topics, and these views can shape behavior. Such specific attitudes are often based on general attitudes and knowledge, but this is not always the case. In the current context, attitudes about emerging areas of research and new technologies may influence innovation activity in important ways. For example, the climate of opinion about research areas such as biotechnology, energy, or other topics can shape public and private investment in these areas. Ultimately, such views might affect the individual or societal adoption of new technologies and the growth of industries based on these technologies.

Nevertheless, public opinion about new S&T developments rarely translates directly into actions or policy. Instead, institutions attempt to assess what the public believes and may magnify or minimize the effects of divisions in public opinion on policy (Jasanoff 2005). It is noteworthy that the public's attitudes about specific S&T issues such as climate change and biotechnology can differ markedly from the views of scientists (Pew Research Center 2015b). This is partly because attitudes toward S&T involve a multitude of factors, not just knowledge or understanding of the relevant science. Values, attitudes, and many other factors come into play, and judgments about scientific facts may become secondary or even shaped by those values or attitudes (Kahan, Jenkins-Smith, and Braman 2011).

This section describes views on environmental issues, including global climate change, nuclear power, and energy development; GE food; nanotechnology; synthetic biology; cloning and stem cell research; and teaching evolution in schools. It concludes with recent data on attitudes toward scientific research on animals and toward STEM education. As with the rest of *Indicators*, the focus is on descriptive statistics for key indicators, including trends and between-group differences. Where appropriate, academic research on the origins of opinions or their effects is cited to provide context.

Environment

Environmental issues—especially climate change and energy technologies—are often the subject of public policy debate and news interest. A review of general public views about the environment, specific environmental issues, energy technologies, and climate follows.

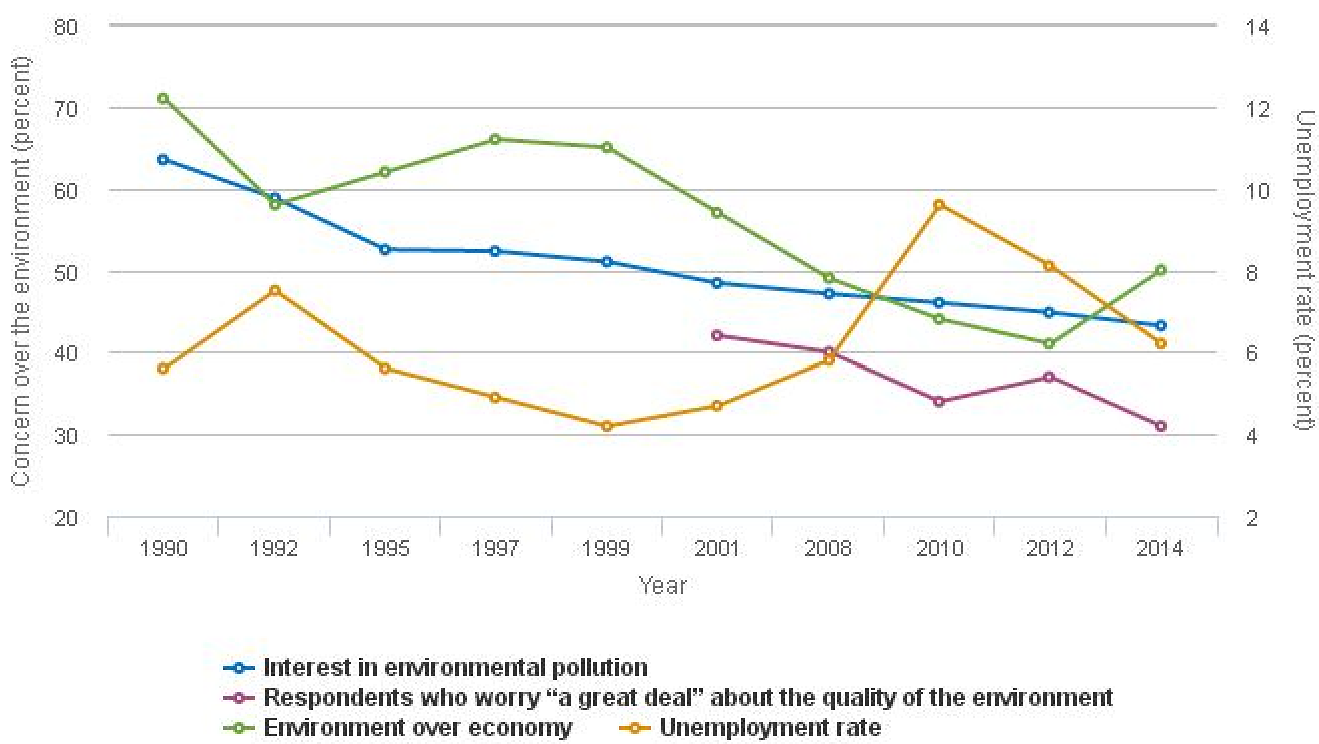
Overall Concern about Environmental Quality

U.S. patterns and trends. Annual Gallup surveys show that pro-environmental attitudes may be at a relative low point compared with historical averages. Nevertheless, environmental issues remain important to many Americans, with about half of the respondents expressing concern about the current state of the environment in the various questions discussed subsequently.

The proportion of Americans who say that they worry "a great deal" about the quality of the environment was at 34% in 2015 (Gallup 2015a), up slightly from the low point of 31% in 2014, but still low compared with other years since 2001 (Figure 7-19). As noted previously, the 2014 GSS also found that interest in environmental pollution is at a relative low, with 43% saying they are "very interested" in the subject in 2014, compared with 63% in 1990.

Figure 7-19

Relation between the economy and concern over the environment: 1990–2014



NA = not available; question not asked.

NOTES: Responses to the following:

• *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 responses for "very interested."

• *How much do you personally worry about the quality of the environment: a great deal, a fair amount, only a little, or not at all?* Figure shows only responses for "a great deal." Poll conducted annually in March.

• *With which one of these statements about the environment and the economy do you most agree: protection of the environment should be given priority, even at the risk of curbing economic growth (or) economic growth should be given priority, even if the environment suffers to some extent?*

SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (1990–2001); University of Chicago, National Opinion Research Center, General Social Survey (2008–14); Gallup, Climate Change: Environment, http://www.gallup.com/poll/1615 /environment.aspx#, accessed 10 August 2015; Bureau of Labor Statistics, Local Area Unemployment Statistics (various years).

Science and Engineering Indicators 2016

At the same time, however, Gallup data indicate that the proportion of Americans who say that the environment should be given priority over economic growth increased to 50% in 2014 and 46% in 2015 from a low of 36% in 2011. This is still below previous highs of 57% (2001) and 55% (2007) (Gallup 2015a). A similarly worded 2014 *New York Times*/CBS poll put the proportion choosing the environment at 58% (Dutton et al. 2014). The proportion who rated the country's environment as "only fair" (40% in 2015) or "poor" (9% in 2015), who think the country's environment is "getting worse" (51% in 2015), and who think the U.S. government does "too little" to protect the environment (48%) was either similar or down slightly in 2015 relative to recent years. This was, however, a decrease from higher levels of concern in the middle of the previous decade (i.e., 2007 and 2008) (Gallup 2015a).

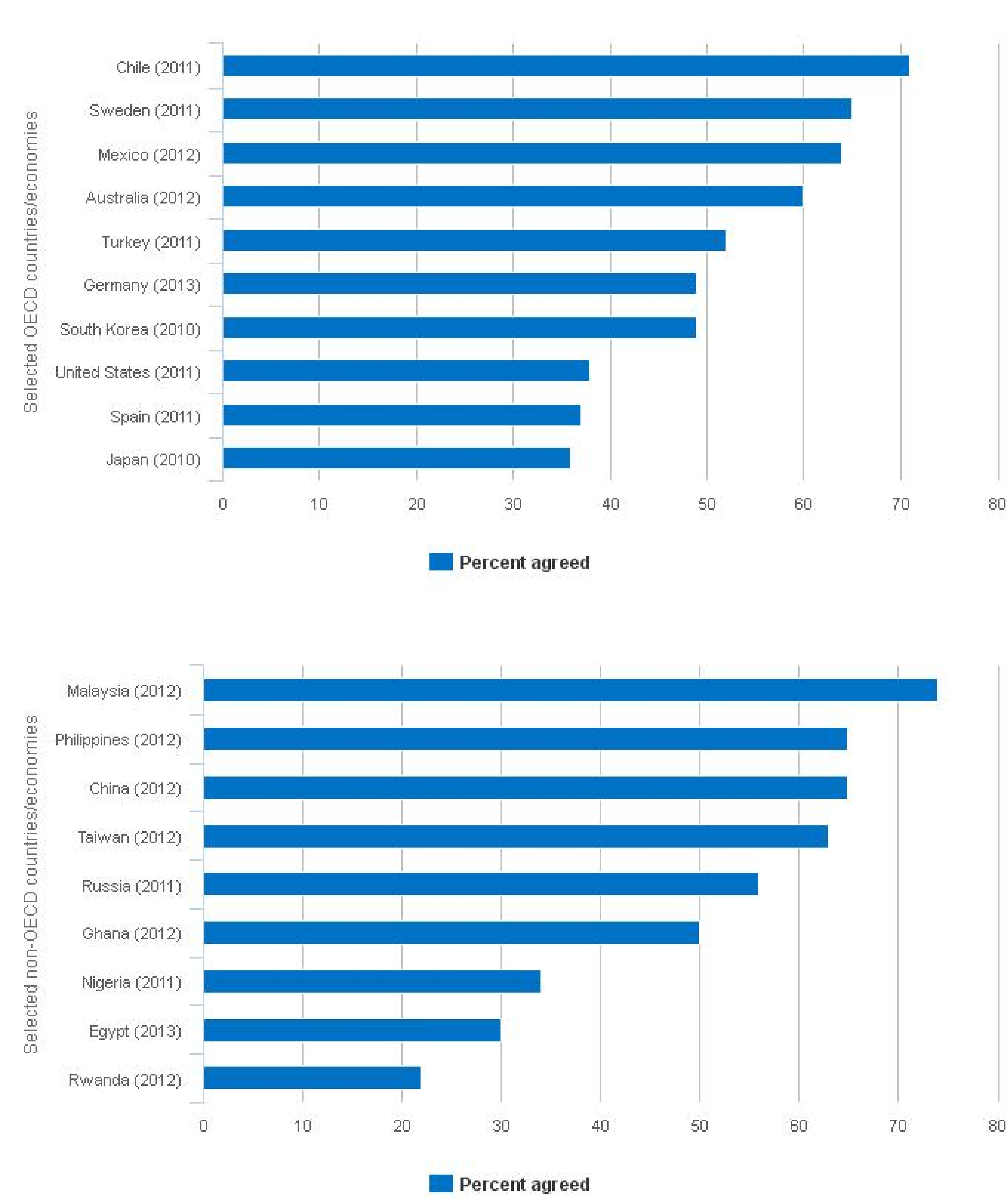
A series of Pew Research Center (2014b) surveys suggests a similar pattern of concern. Biennial pre-election surveys show that the proportion of respondents saying that "the environment" should be a "very important" election issue started at 55% in 2004 and climbed to a high of 62% in 2008 before falling back to 54% before the 2014 midterm election. This, nevertheless, put the environment relatively low on the list of issues about which respondents were asked. The economy (83%) and health care (77%) topped the list of issues that people said were important to them in the election.

Finally, although these numbers indicate that about half of Americans say they would choose the environment over the economy, recent polling consistently finds that less than 2% of respondents name the environment as the most important issue facing the nation when allowed to say what they think the most important problem facing the nation is in their own words. The economy, in contrast, is mentioned much more often. For example, 25% chose the economy or jobs as the most important problem in one recent survey focused on global warming (e.g., Dutton et al. 2014; see also Gallup 2015b).

International comparisons. The 2010–14 WVS allows for comparisons among countries and highlights wide variations in views around the globe. These data suggest that, in 2011 (the year Americans completed the WVS), about 38% of Americans said that "protecting the environment" should be a priority over economic growth (Figure 7-20) (WVS 2014). This was less than the average of 50% for the 50 countries included in the survey. Within the OECD, residents of Chile (71%), Sweden (65%), and Mexico (64%) were most inclined to give priority to the environment. Beyond the OECD, Malaysia (74%) and Uruguay (70%) were among the most likely to prioritize the environment. It should also be noted that, according to Gallup (2015a), the U.S. WVS data collection appears to have occurred at a point at which Americans were relatively less likely to choose the environment over economic growth.

Figure 7-20

Choose the environment over economic growth, by selected country/economy: Most recent year



OECD = Organisation for Economic Co-operation and Development.

NOTES: Respondents were asked to indicate which of two responses “comes closer to” their “own point of view.” These were: *Protecting the environment should be given priority, even if it causes slower economic growth and some loss of jobs* and *Economic growth and creating jobs should be the top priority, even if the environment suffers to some extent*. Some respondents also volunteered a different answer.

SOURCE: World Values Survey, WVS Wave 6 (2010–14), http://www.worldvaluessurvey.org/WVSDocumentationWV6.jsp, accessed 17 February 2015.

Science and Engineering Indicators 2016

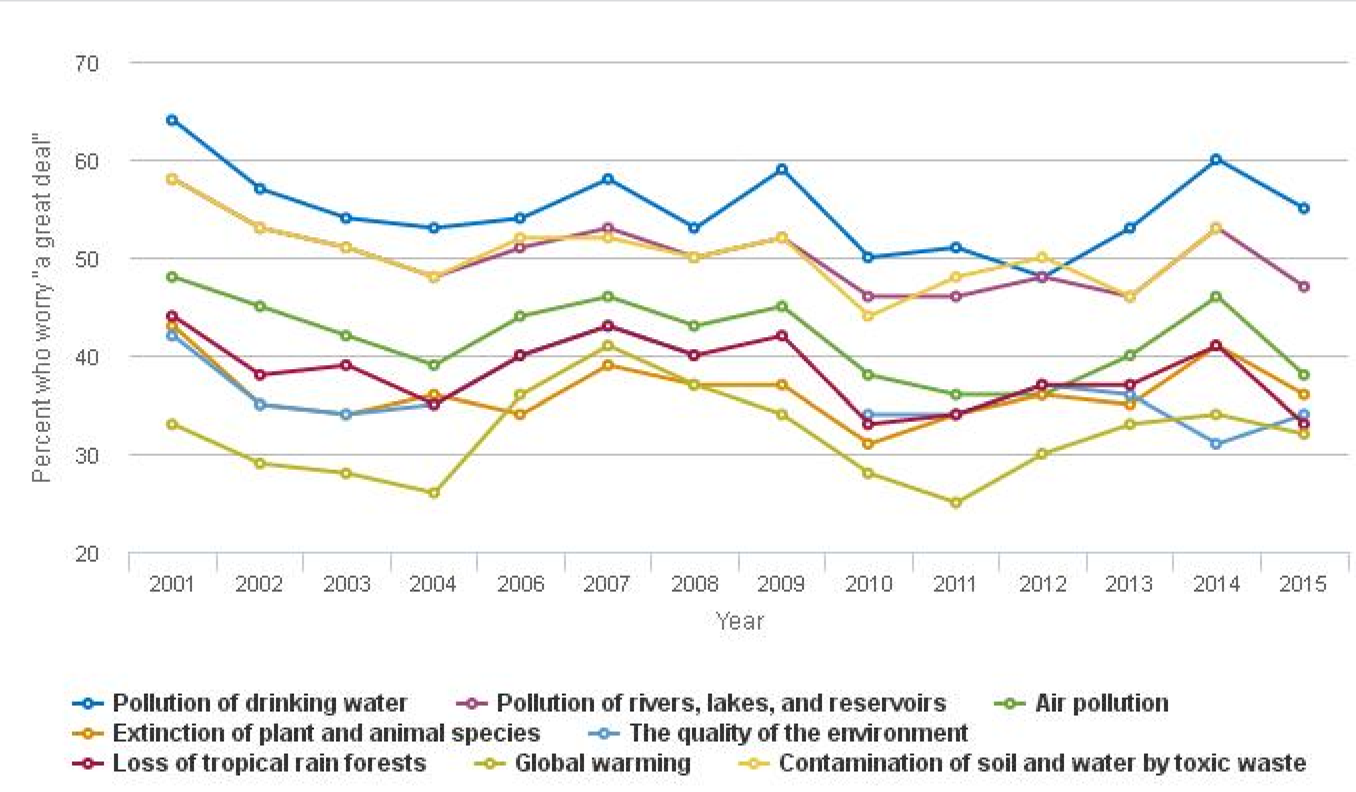
Within Europe, a 2014 Eurobarometer survey on the environment included a broad range of questions about attitudes and behavior. Overall, 95% of Europeans said that “protecting the environment” was “very important” (53%) or “fairly important” (42%), similar to 2011 (94%). About three-quarters of respondents (77%) also indicated that they “totally agreed” (35%) or “tend(ed)” to agree that “environmental issues have a direct impact” on their daily life. This was also stable from 2011 when 76% agreed. Respondents in southern European countries have the highest proportion of citizens with concerns about direct impacts. For example, residents of Cyprus (95%), Greece (93%), and Malta (90%) were the most likely to say they see an impact of environmental issues on their lives, whereas the least likely were residents of relatively affluent countries in Northern and Western Europe, including Denmark (56%), Austria (66%), the Netherlands (66%), Belgium (67%), and Germany (68%) (European Commission 2014). Although somewhat different from the Gallup and WVS questions that focused on overall economic versus environmental priorities, 59% of European respondents said that “public authorities” should favor “environmentally-friendly considerations over cost considerations” when “thinking about spending and investment.” Respondents in Slovenia (78%) and Cyprus (76%) were the most likely to prioritize the environment, whereas those in Poland (36%) and Romania (44%) were the least likely (European Commission 2014).

Assessment of Specific Environmental Problems

U.S. patterns and trends. Gallup (2015a) also asks about a wide range of specific environmental concerns as part of its annual survey on the environment. The 2015 data suggest a sharp drop in concern from the relatively high rates in 2014. This drop brings levels of concern back to where they have been in recent years but below historical averages. As in most previous years, drinking water pollution topped the list of issues about which Americans were most likely to “worry” a “great deal” about (55%) in 2015. Worry was also relatively high for “pollution of rivers, lakes, and reservoirs” (47%) (Figure 7-21). Smaller proportions expressed a “great deal” of worry about “air pollution” (38%), “extinction of plant and animal species” (36%), and the “loss of tropical rainforests” (33%). Americans expressed relatively low levels of concern about “global warming” (32%), a topic discussed in more detail subsequently. Within the available data, worry about environmental problems was greatest in 2000 and then fell and rose through the previous decade, reaching low points for most measures in about 2010 or 2011. Worries about different issues tend to move together.

Figure 7-21

Concern about specific environmental issues: 2001–15



NOTES: Responses to *How much do you personally worry about [specific environmental issues]: a great deal, a fair amount, only a little, or not at all?* Figure shows only responses for "a great deal." Poll conducted annually in March.

SOURCE: Gallup, Climate Change: Environment, http://www.gallup.com/poll/1615/environment.aspx# , accessed 2 August 2015.

Science and Engineering Indicators 2016

International comparisons. The 2014 Eurobarometer on the environment asked respondents to indicate the 5 "main" environmental issues that they were "worried about" from a list of 14. Although water pollution was the issue most worried about in the United States, "air pollution" (56%) was the most commonly named issue in Europe. In Europe, "air pollution" was followed by "water pollution" (50%), "the growing amount of waste" (43%), the health impact of "chemicals used in everyday products" (43%), and the "depletion of natural resources" (36%). Climate change was not included on the list because it was the focus of a separate report earlier in 2014.

Climate Change

U.S. Patterns and Trends

Climate change (often referred to as *global warming, especially in past decades*) remains a central, and often divisive, environmental issue for the American public. The importance of this issue to national and international debates means that it has also been the subject of widespread polling over more than two decades.[i]

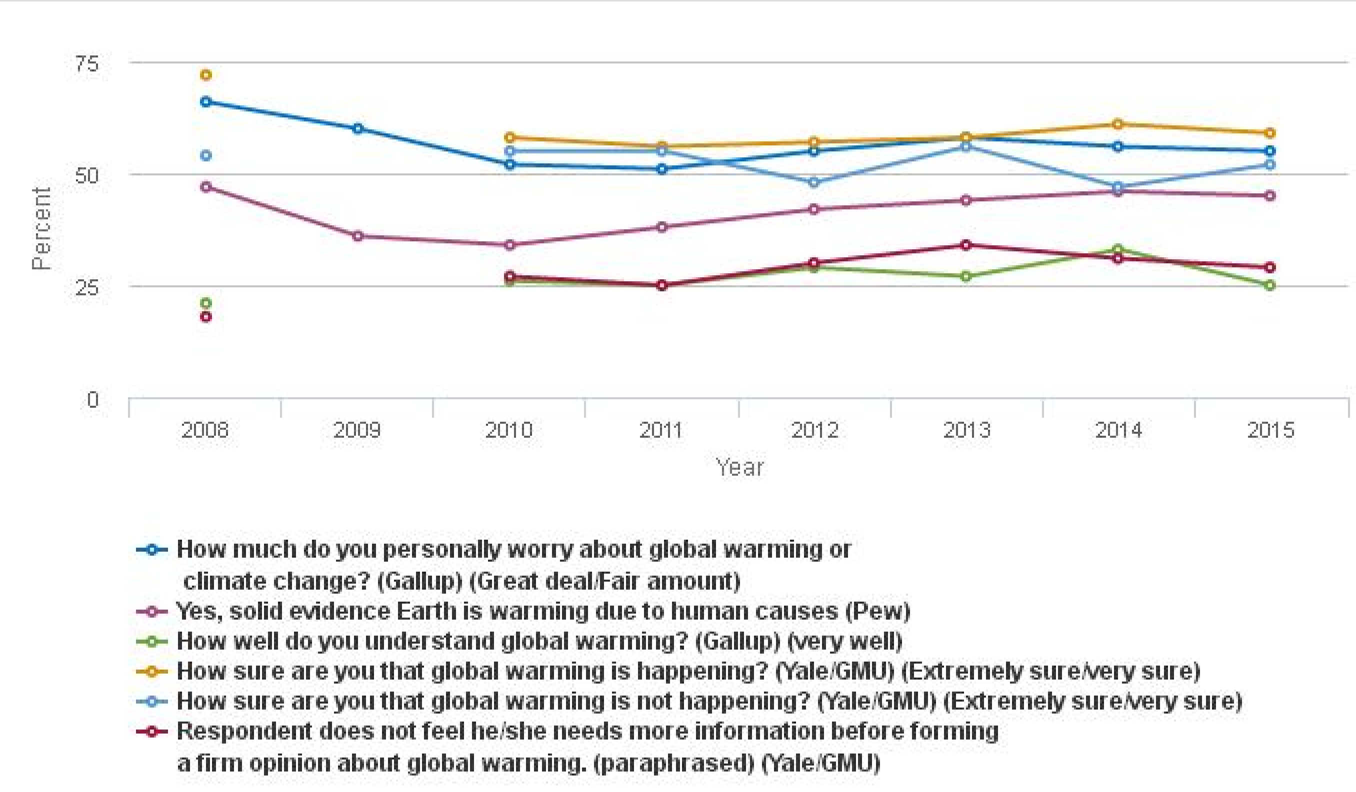
Gallup has polled on "global warming" since 1989, when it found that 63% of Americans worry a "great deal" (35%) or a "fair amount" (28%) about the issue (Saad 2015). In March 2015, the comparable statistic was 55%

(including 32% who worry a "great deal" and 23% who worry a "fair amount") (Figure 7-22). This indicator has fluctuated between a low of 51% (2004) and a high of 66% (2008) since 2001. Also, although more than half of Americans may say they worry about global warming, slightly more than one-third (37%) told Gallup in 2015 that they believed "global warming would pose a serious threat" to their "way of life" during their lifetime. As with the question about "worry," responses to this question have fluctuated over time, although it has stayed between 31% (2001) and 40% (2008) since 2001 (Jones 2014). Data from other sources show similar fluctuations. Researchers at Yale and George Mason University placed worry at 52% in early 2015 (Leiserowitz et al. 2015), whereas a survey from the *New York Times* and Stanford University (2015) indicated that 44% see "global warming" as a "very serious" future problem for the United States. Another 34% (78% in total) responded that the threat was at least "somewhat serious." Even more respondents (83%) said they thought global warming would be a threat to "the world."

[i] 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). Other studies, however, suggested that such wording differences have limited effect (Dunlap 2014; European Commission 2008; Villar and Krosnick 2010).

Figure 7-22

Belief in global warming and confidence in that belief: 2008–15



NA = not available, question not asked.

GMU = George Mason University.

NOTE: Dots indicate years with data.

SOURCES: Pew Research Center, *Public and Scientists' Views on Science and Society*, (2015), http://www.pewinternet.org /files/2015/01/PI_ScienceandSociety_Report_012915.pdf, accessed 25 March 2015; Pew Research Center, *Catholics Divided Over Global Warming,* (2015), http://www.pewforum.org/files/2015/06/Catholics-climate-change-06-16-full.pdf, accessed 11 August 2015; Gallup, Climate Change: Environment, http://www.gallup.com/poll/1615/environment.aspx#, accessed 17 January 2015; Leiserowitz A, Maibach E, Roser-Renouf C, Feinberg, G, and Rosenthal S, Climate Change in the American Mind: *March, 2015*. Yale University and George Mason University (2015), https://environment.yale.edu/climate-communication/files /Global-Warming-CCAM-March-2015.pdf, accessed 11 August, 2015.

Science and Engineering Indicators 2016

The Yale/George Mason work from 2014 also showed that about one-third (36%) of Americans said they believed that climate change would personally hurt them, 42% said they thought harm would come to their family, 43% said their community, 53% said other Americans or people in other industrialized countries, and 55% said people in developing countries (Leiserowitz et al. 2014). Researchers who study risk perceptions have long known that people often optimistically see risks as more likely to harm others than themselves (Spence, Poortinga, and Pidgeon 2012).

Many Americans also indicate that they believe in climate change but do not believe humans are exclusively to blame. Among Americans who believe the Earth is getting warmer, the survey from the *New York Times* and Stanford (2015) showed that about 40% said they believed it was because of “things people did,” whereas 18% thought the cause was natural. An additional 41% said they thought both human and natural processes deserved equal blame. June 2015 research by the Pew Research Center (2015c) without a "both" response option showed that 45% blame the climate change "mostly" on "human activity such as burning fossil fuels" (Figure 7-22), 18% believed that "mostly" "natural patterns" are the cause of the changes, and 5% said they did not know the cause. Another 25% said they did not believe change was occurring. Overall, the Pew Research Center's data suggest that the percentage attributing perceived change to human activity reached a high of 50% in July 2006 but declined to a low of 34% in October 2010.

Existing surveys also suggest varying degrees of certainty about climate change. In 2015, the Yale/George Mason surveys showed that 63% believe that "global warming is happening," and of these, 59% are "extremely" (27%) or "very" sure (32%). Similarly, of the 18% who do not believe in "global warming," 52% are "extremely" (21%) or "very sure" (31%) of their views (Leiserowitz et al. 2015). However, in 2015, just a quarter (25%) of Americans said they understood global warming "very well" (Gallup 2015a). A similar small percentage (29%) of Americans indicated that they felt they had enough information on the subject "to form a firm opinion" and that they therefore did not "need any more" (Leiserowitz et al. 2015) (Figure 7-22).

Despite widespread concern, the Pew Research Center (2015d) also reports that "dealing with global warming" has been at or near the bottom of the public's priorities for the president and Congress since at least 2007. About 38% of Americans said it should be a priority in 2015, although this is up from a low of 25% in 2012 and similar to the previous high of 38% in 2007. Rather than ask about priorities, Yale/George Mason researchers asked about whose responsibility it was to act in 2015 and found that most Americans say they want key social actors to do more to address global warming (Leiserowitz et al. 2015). Specifically, 68% of Americans said they thought "corporations and industry" "should be doing much more" or "more," and large percentages also wanted more from members of Congress (59%), local government officials (56%), state governors (55%), and the president (52%).

Only a small majority of Americans say they believe that scientists have reached a consensus on climate change. Gallup, for example, reported that 60% of Americans said that "most scientists believe that global warming is occurring" in 2014 (Dugan 2014). Their research also shows that the percentage saying a consensus exists rose from 48% in 1998 to a high of 65% in 2006 and 2008 before falling again. Several other surveys report similar findings, with the Yale/George Mason researchers placing belief in consensus at 52% in the first half of 2015 (Leiserowitz et al. 2015) and the Pew Research Center placing belief in consensus at 57% in 2014 (Pew Research Center 2015b). All of this research suggests that reported belief in consensus is related to belief in the threat of climate change.

A review of high-quality longitudinal studies from around the world concluded that negative economic trends are the most likely driver of widespread declines in environmental concern, including climate change, that began in about 2007 after several decades of rising concern (Scruggs and Benegal 2012; Capstick et al. 2015). This research also noted that political trends may also have played a role in some cases. One piece of evidence pointing to the central role of the economy is that the declines in support of climate change occurred in both Europe and the United States, two regions that were hit hard by the 2007–08 financial crisis and its immediate aftermath but that did not share the same political trends (Scruggs and Benegal 2012). It is also clear, however, that political views continue to shape opinion about climate change in the United States (e.g., Hart, Nisbet, and Myers 2015).

International Comparisons

The most recent internationally comparable, representative data on public views about climate change suggest that Americans are relatively less concerned about the issue than residents of most other countries (Pew Research Center 2013a). For example, in 2013, 40% of Americans told the Pew Research Center that they thought "global climate change" was a "major threat" to the United States, in contrast to 54% of both Canadians and Europeans. The views of those in the United States were similar to the views of respondents in Middle Eastern countries surveyed, where 42% of respondents saw climate change as a major threat. Latin American respondents (65%) were the most concerned, whereas respondents in Asia (56%) and Africa (54%) had views similar to respondents in Europe and Canada (Pew Research Center 2013a).

Energy

U.S. Patterns and Trends

Public opinion about energy has fluctuated in recent years in response to accidents such as the 2010 *Deepwater Horizon* oil spill in the Gulf of Mexico; the 2011 nuclear accident in Fukushima, Japan; changing energy prices; and the emergence of issues such as hydraulic fracturing (sometimes termed *fracking*) as a technique to obtain natural gas. The range of energy events and issues, however, means that, although specific events may have short-term effects, consistent long-term trends in public opinion about energy are rare. Overall, it appears that 2014 saw increased support for alternative energy compared with recent years.

Gallup (2015a) reported that, in 2015, Americans were about equally divided over whether "protection of the environment should be given a priority, even at the risk of limiting the amount of energy supplies—such as oil, gas, and coal—which the U.S. produces" or whether the "development of U.S. energy supplies … should be given priority, even if the environment suffers to some extent." About 49% of respondents chose the environment in 2015, up from a low of 41% in 2011. Environment was chosen by the highest percentage of respondents in 2007 (58%).

Gallup respondents were also previously asked how they thought the country should deal with "the nation's energy problems" and then were asked to choose between emphasizing production of "oil, gas and coal supplies" or "conservation by consumers." The percentage choosing to "emphasize conservation" rose to 57% in 2014 after hovering between 48% and 51% since 2010. The year in which the highest percentage of Americans chose conservation was also 2007 (64%) (Moore and Nichols 2014). An alternative question asked respondents to choose between fossil fuel production and "the development of alternative energy such as wind and solar power." With this question, Gallup found that 64% of Americans chose alternative energy in 2014, up from 59% in both 2012 and 2013 but similar to the 66% who chose alternative energy in 2011. A similar question asked by the Pew Research Center in recent years found that prioritizing alternative energy sources such as "wind, solar, and hydrogen" started at 63% in 2011 and then dipped to 47% in 2012 before climbing back to about 60% in late 2014, having reached a high of 65% in early 2014 (Pew Research Center 2014a).

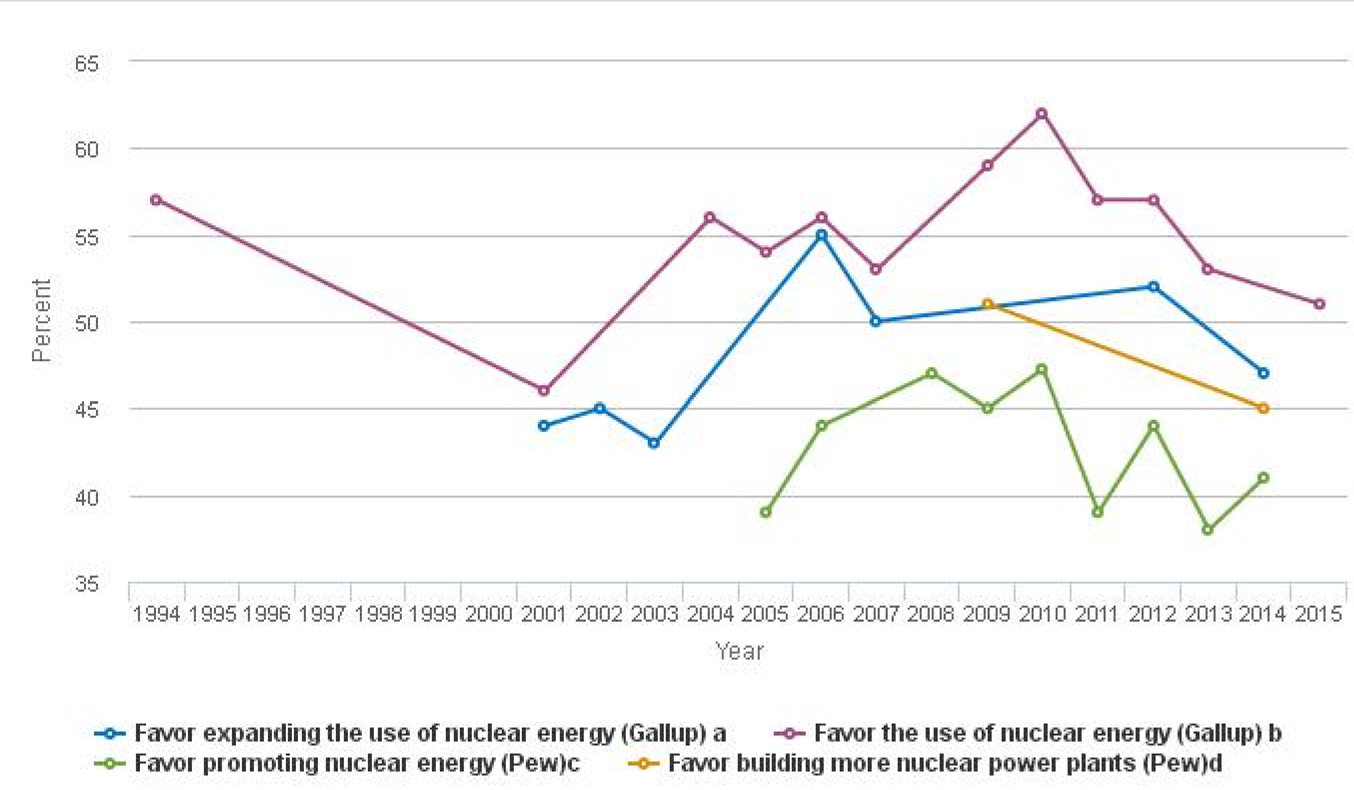
Alternative energy and conservation also do well when comparing questions that ask about specific energy options. For example, 81% of Americans favored "better fuel efficiency standards for cars, trucks, and SUVs" in 2014 (Pew Research Center 2014a), and 81% "strongly" (36%) or "somewhat" (45%) supported the need to "fund more research" on renewables in 2015 (Leiserowitz et al. 2015). The same study found that support for "tax rebates" for "energy efficient vehicles or solar panels" was equally high (80%) and that most Americans (67%) would support requiring utilities to produce a fifth of their electricity from renewable sources even if it cost consumers more (Leiserowitz et al. 2015). Gallup (Riffkin 2015) also found that many Americans would like to put "more emphasis" on "solar power" (79%) and "wind" energy (70%).

As in recent years, about half of Americans supported the use of nuclear energy in recent data (Figure 7-23). Gallup (2015a) reports that 51% of Americans said they "strongly" or "somewhat" favored nuclear energy in 2015. Support reached a high of 62% in 2010, just before the 2011 Fukushima Daiichi nuclear accident in Japan and has declined steadily since. A survey by the Pew Research Center (2014a) shows a similar decline. This search put the level of support for "promoting nuclear energy" at 41% in 2014 (down from a high of 52% in 2010, before

Fukushima, in surveys using the same question). A later 2014 survey found that 45% of Americans “favor building more nuclear power plants to generate electricity,” down from 51% in 2009 in a survey using the same question (Pew Research Center 2015b). Gallup (2015a) found that only about one-third (35%) of Americans said the government should put “more emphasis” on nuclear energy. A 2014 Pew Research Center (2015b) survey of members of the scientific community found, in comparison, that 65% of scientists favored building new nuclear power plants (down from 70% in 2009).

Figure 7-23

Views on nuclear energy: 1994–2015



[a] Responses to *I am going to read some specific environmental proposals. For each one, please say whether you generally favor or oppose it. How about [e]xpanding the use of nuclear energy?*

[b] Responses to *Overall, do you strongly favor, somewhat favor, somewhat oppose, or strongly oppose the use of nuclear energy as one of the ways to provide electricity for the U.S.?* Figure shows combined responses for "strongly favor" and "somewhat favor".

[c] Responses to *As I read some possible government policies to address America's energy supply, tell me whether you would favor or oppose each. [W]ould you favor or oppose the government promoting the increased use of nuclear power?* The 2010 data point is the average of responses to four surveys conducted that year. The 2011 data point is the average of responses to two survyes conducted that year.

[d] Responses to *Do you favor or oppose building more nuclear power plants to generate electricity?*

SOURCES: Gallup, Social Series: Environment, http://www.gallup.com/file/poll/168221/Energy_I_140402.pdf, accessed 28 May 2015; Gallup, Business: Energy, http://www.gallup.com/poll/2167/energy.aspx, accessed 28 May 2015; Pew Research Center, *December 2014 Political Survey*, http://www.people-press.org/files/2014/12/12-18-14-Energy-topline-for-release.pdf, accessed 28 May 2015; Pew Research Center, *General Public Science Survey, August 15-25, 2014, http://www.pewinternet.org/files/2015/07/2015-07-01_science-and-politics_TOPLINE.pdf,* accessed 28 May 2015.

Science and Engineering Indicators 2016

When it comes to fossil fuels, natural gas is clearly preferred over other options. According to Gallup (2015a) research, 55% said they would like to put more emphasis on this area, whereas only 41% wanted more attention to oil and 28% wanted more attention to coal. A Pew Research Center survey (2014a) found that about 56% of Americans would like to allow more "offshore oil and gas drilling." This percentage is similar to 2013 (58%), but the number has gone up and down several times since the question was first asked in 2008, reaching a high of 68% in 2009 and a low of 44% in 2010 after the *Deepwater Horizon* spill in the Gulf of Mexico. A separate 2014 set of science-focused surveys by the Pew Research Center (2015b) similarly found that 52% of Americans say they "favor" "offshore oil and gas drilling in U.S. waters," whereas 32% of members of the scientific community say they favor obtaining fossil fuels in this way.

One related subject that has received only limited polling attention but that is often in the news is the use of hydraulic fracturing, or "fracking," to help release natural gas from otherwise inaccessible deposits. Surveys by the Pew Research Center (2015b) found that the percentage of Americans who "favor" fracking declined from 48% in early 2013 to 44% in fall 2013 and then dropped again to 39% in mid-2014. A companion survey of members of the scientific community found that only 31% favored fracking. The Yale/George Mason researchers also conducted a fall 2012 survey and found that most Americans knew nothing (39%) or only "a little" (16%) about fracking. Most respondents (59%) who had heard something thought it was likely more "bad" than good. In contrast, however, 58% of all respondents said they did not know or were undecided as to whether they supported or opposed fracking. About one-fifth, "strongly" (10%) or "somewhat" (10%) opposed the use of fracking (Clarke, Boudet, and Bugden 2013).

International Comparisons

The European Commission (2013) conducted a short Eurobarometer on air pollution in 2012 that found broad support for renewable energy. The survey asked Europeans which "energy options" ought to be prioritized over the "next 30 years" and allowed up to two answers. Most (70%), however, chose only "renewable energy sources." The second highest was "energy efficiency" (26%), followed by nuclear energy (18%). A small number of Europeans said they thought the priority should be on producing natural gas from unconventional sources (i.e., fracking) (9%) or producing more conventional fossil fuels (8%). These responses varied widely across countries. For example, 82% of Portuguese respondents mentioned renewables, but only 45% of Bulgarians did so. Similarly, 44% of Czech respondents chose nuclear energy, whereas just 4% of Austrian and Cypriot respondents mentioned this potential priority. Prioritization of unconventional natural gas exploration was highest in Poland (32%) and lowest in Italy, Finland, and Sweden (all 3%). Conventional fossil fuel was mentioned most often in Latvia (19%) and least often in Sweden (3%).

The 2014 version of *Indicators* also reported the results of a 2010 international survey of a wide range of countries that suggested that the United States was relatively favorable toward nuclear energy (NSB 2014).

Genetically Engineered Food

U.S. Patterns and Trends

GE food—also sometimes called genetically modified (GM) food or genetically modified organisms (GMOs)—remains an active issue of public debate around the world as new products continue to enter the market. Some scholars point to the emergence of an anti-GE movement as something that proponents could have limited through better communication with the public during the early research and commercialization phases (Einsiedel and Goldenberg 2006). Surveys from across many years and studies, however, suggest that many Americans question the safety of genetic engineering of food, although it is not an issue on which there is evidence of substantial public knowledge.

Although there are limited national data from recent years, recent survey results are relatively consistent with findings from previous decades. A summary of surveys from the 1980s through 2000 (Shanahan, Scheufele, and Lee 2001) typically found that between one-third and one-half of Americans saw risks from genetic engineering, whereas a similar number saw benefits. This summary also found that few people felt that they knew a lot about the subject but that there was, nevertheless, broad support for labeling GE food.

Consistent with these past findings, a 2014 survey by the Pew Research Center (2015b) found that only 37% of Americans think that GE foods are "generally safe" to eat and only 28% think that "scientists have a clear understanding" of the "health effects of genetically modified crops." Similarly, a 2013 survey by the *New York Times* reported that 75% of Americans are "concerned" about the safety of GE foods (Kopicki 2013), and an ABC News survey found that 52% of Americans thought such foods were "unsafe" (Langer 2014).

There has also been active discussion on the question of how to address clear public opinion supporting mandatory labeling of food that contains GE ingredients despite arguments that such labeling would inappropriately suggest risks to buyers (McComas, Besley, and Steinhardt 2014). It seems clear, in this regard, that when directly asked, a substantial majority (93%) of Americans say they would like GE foods labeled, according to a 2013 poll for *The New York Times* (Kopicki 2013) and a similar 2014 poll for ABC News (Langer 2014).

It is also important to consider the limitations of the available data in this area. Given low knowledge, worldview and positive views about science and scientists (Frewer et al. 2013; McComas, Besley, and Steinhardt 2014) may play a central role in shaping views about genetic engineering. In other words, when many respondents answer questions about genetic engineering, they are likely reporting their general views about science or nature rather than fully answering based on consideration of genetic engineering. This recent research does not appear to have asked respondents how much they know about genetic engineering, although past work has tended to find that such knowledge is relatively low. For example, a 2001 survey found that only 13% said they had heard "a great deal" about the subject, and 47% said they had heard some. Another 29% said they heard "not much," and 11% said they had heard "nothing at all" (Hallman et al. 2002). The Pew Research Center (2015b) also reported that only 25% of Americans "always" look at labels to see whether food they are considering buying contains GE ingredients, and another 25% say they "sometimes" look. These responses, however, are difficult to reconcile with the fact that it is rare for products to include GE-related labels. Further, about 94% of U.S. soybeans and 93% of corn grown in the United States are genetically engineered (USDA 2014), and the products of both crops are used extensively in a wide variety of common food products. Also, several attempts to use referenda (e.g., in Colorado and Oregon in 2014) to require labeling of GE products have failed to receive enough votes to pass, although residents of one Hawaii county passed a ban on GE crops (Reuters 2014), and Vermont lawmakers passed a labeling law in 2014 (Strom 2014).

The reasons for using genetic engineering may also affect whether people report favorable views. When the Pew Research Center (2015b) asked about genetic modification to "create a liquid fuel replacement for gasoline," 68% of Americans and 78% of scientists said they would "favor" such a move.

International Comparisons

A recent analysis of articles on genetic engineering attitudes from around the world concluded that respondents were more opposed to animal modification than plant modification, that Europeans saw more risks and fewer benefits than Americans or Asians, and that moral concerns are highest in the United States and Asia (Frewer et al. 2013). The 2014 version of *Indicators* also reported the results of a 2010 international survey of a wide range of countries that suggested that the United States was relatively favorable toward genetic modification compared with other countries, with only 25% saying they thought such crops should be seen as "extremely dangerous to the environment." A number of other countries, including some European countries (e.g., Belgium, Norway, Denmark), were also relatively favorable toward the technology (NSB 2014). Some of the countries in which residents were least favorable to genetic engineering included Turkey, Chile, and Russia.

Nanotechnology

Nanotechnology involves manipulating matter at very small scales to create new or improved products that can be used in a variety of ways. Government and the private sector have made relatively large investments in this area in recent years, and innovations based on this work are increasingly common (Project on Emerging Nanotechnologies 2015).

Although recent data are limited, one 2014 survey conducted by researchers at the University of Wisconsin–Madison using the GfK KnowledgePanel found that 74% of respondents did not feel personally informed about "nanotechnology" and that 59% did not think the issue was "personally" important (Science, Media and the Public Research Group 2015). Despite low interest and low perceived knowledge, when asked, 45% of respondents said they thought nanotechnology was likely "risky for society as a whole," and 45% said they thought it was likely "beneficial for society as a whole." In both cases, however, more than a quarter (27% and 25%, respectively) said they were ambivalent. When the researchers combined the risk and benefit questions, they found that about slightly more than one-third (35%) indicated that they thought the risks outweighed the benefits and that a similar proportion (36%) indicated that they thought the benefits outweighed the risks. Ultimately, only 35% said they support the use of nanotechnology (25% neither agreed nor disagreed; 41% disagreed). A similar proportion (37%) said that they supported "federal funding of nanotechnology" (21% neither agreed nor disagreed; 42% disagreed). These data are largely consistent with earlier research featured in *Indicators* (NSB 2010) that found that only small portions of Americans said they had heard much about nanotechnology and that views about the relative risks and benefits were mixed.

As with the data on GE food, it is important to recognize that people's low levels of knowledge about nanotechnology likely mean that they are largely responding to questions about the issue based on such factors as their overall trust in science or their worldview. Additional factors such as the content or wording of the questions or the context of the survey may contribute to such processes.

Synthetic Biology

U.S. Patterns and Trends

Another topic for which the public may not have yet developed strong opinions but that survey researchers are beginning to study is synthetic biology, which involves using S&E to make new organisms such as bacteria to carry out specific tasks. These organisms would have genetic material that does not occur in nature. The specific tasks might include fighting diseases, cleaning up pollution, or manufacturing medicines or fuels (Woodrow Wilson International Center for Scholars 2015). Initial survey research on behalf of the Woodrow Wilson International Center for Scholars, part of the Smithsonian Institution, found that only a small number of Americans reported hearing "a lot" about the topic (Woodrow Wilson International Center for Scholars 2013). Nevertheless, this proportion steadily grew from 2% in 2008 to 6% in 2013, whereas the percentage who said they had heard "nothing at all" fell from 67% to 45% (another 30% said they heard just a little in 2013). As with genetic engineering and nanotechnology, the public is somewhat split on whether synthetic biology is likely to produce risks or benefits. In 2013, 40% said they thought that the risks and benefits would be about equal, whereas 18% saw more benefits than risks, and 15% saw more risks than benefits. The remaining 27% said they were not sure (Woodrow Wilson International Center for Scholars 2013). This project also included an effort to provide basic information about the subject and found that, once respondents heard such information, many tended to become more negative about the technology, whereas a few became more positive.

These results are largely consistent with a 2014 survey by university researchers (Akin et al. unpublished). This study found that 75% of Americans indicated they were "not informed" about synthetic biology (i.e., they responded between 0 and 4 on an 11-point scale anchored by "not at all informed" [0] and "very informed" [11]).

As with the Wilson Center research, the 2014 survey found that about equal numbers perceived risks and benefits, although the question structure was quite different. Overall, 25% perceived relatively high risks (i.e., they chose values between 8 and 11 on an 11-point scale anchored by "not at all risky" and "very risky"), and 22% perceived relatively high benefits (i.e., they chose values between 8 and 11 on an 11-point scale anchored by "not at all beneficial" and "very beneficial").

Stem Cell Research and Human Cloning

U.S. Patterns and Trends

Stem cell and cloning research focus on understanding how to use genetic material to produce living cells, tissues, and organisms. Such research creates opportunities for enhanced understanding of life and opportunities to develop new health care treatments. The intersection of health, human life, and the destruction of human embryos, however, raises ethical issues that have spurred public debate.

Most Americans appear to support the use of stem cells for medical research. Annual Gallup (Jones and Saad 2014) data showed that, in 2014, 65% of Americans saw using stem cells from human embryos in medical research as "morally acceptable." The percentage of those who saw such research as morally acceptable is up 5 points from 2013, although it is similar to the previous high of 64% found in 2007. In 2014, about 27% said it was "morally wrong." More generally, the percentage of Americans seeing the use of human embryos as morally acceptable climbed from 52% in 2002, when Gallup started polling on the issue, to the 65% high in 2014. The percentage of Americans viewing stem cell research as morally acceptable has ranged between 57% and 65% since 2007.

A minority of Americans support the cloning of humans and animals (Jones and Saad 2014). About 13% of Americans supported cloning of humans in 2014. This is identical to the level of support in 2013 and is the highest it has been since Gallup began asking about the subject in 2001. At that point, support stood at 7%.

International Comparisons

The last time a large sample of Europeans was asked about cloning was in 2010 when a Eurobarometer survey found that 63% of respondents across 27 European countries supported the use of stem cells from human embryos either with no special laws (12%) or "as long as this is regulated by strict laws" (51%). The use of adult stem cells, in contrast, was supported by 69% of Europeans, including 15% who saw no need for special laws and 54% who would approve if use was regulated by "strict laws." The survey did not address human cloning, but it included several questions about animal cloning, and the results suggested widespread disapproval of the technology. About 17% said that they saw it as "safe for future generations," and 70% of Europeans disagreed that "animal cloning in food production should be encouraged" (European Commission 2010b).

Animal Research

U.S. Patterns and Trends

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

Most Americans support at least some kinds of animal research, but this support has fallen in recent years. According to Gallup (Jones and Saad 2014), about 57% of Americans said they saw "medical testing on animals" as "morally acceptable" in 2014, similar to previous years but down from 65% in 2001 when Gallup first began asking the question in 2001 (Riffkin 2014). A different question by the Pew Research Center (2015b) found that, in 2014, 47% of Americans said they "favor" "the use of animals in scientific research," down from 52% in 2009.

International Comparisons

The most recent similar data from Europe are from a 2010 survey showing that, on average, Europeans oppose animal testing, but these views vary widely. Respondents were asked whether "scientists should be allowed to experiment on animals like dogs and monkeys if this can help sort out human health problems." About 44% of Europeans said they "totally" or "tend to" agree that such experiments should be allowed, whereas 37% said they "totally" or "tend to" disagree (European Commission 2010a).

Science, Technology, Engineering, and Mathematics Education

Formal education plays a central role in how people think about S&T and other factors such as involvement in informal education (e.g., museums) and media use. As noted previously, few Americans saw American STEM education as world class in 2014. Just 7% of Americans said they viewed U.S. K–12 STEM education as among the "best in the world," and just 22% said they thought it was "above average." About 39% saw it as "average," and 29% saw it as "below average." A companion survey of members of the scientific community was even more pessimistic, with just 1% seeing U.S. STEM education as among the "best in the world," and 15% seeing it as "above average." Most scientists said they thought U.S. K–12 STEM education was either "average" (38%) or "below average" (46%). In contrast, almost all of these same members of the scientific community said they thought "doctoral training in science and technology" was either the "best in the world" (46%) or "above average" (41%) (Pew Research Center 2015b).

Conclusion

Overall, the survey results presented above suggest that—for good or ill—attitudes and knowledge about S&T are relatively stable in the United States. As in previous years, Americans express relatively high interest in various S&T issues, with the one change being that they continue to shift their focus toward getting that information online. The results also show that many Americans know basic facts about science, although many still get the questions asked wrong. If change in basic science knowledge is occurring, it is occurring slowly. For attitudes, a substantial majority of Americans continue to see substantially more benefits than harms from science, have relatively high levels of confidence in the scientific community, and would like to see science supported. Views about specific scientific issues, including environmental, energy, and emerging technologies, are more varied. Although there are debates about issues such as climate change and GE food, many of the key trend lines discussed are either stable or gradually moving in favor of more positive views about science. International comparisons continue to show that Americans are often more interested in and positive about S&T than residents of many other countries. However, there are many countries around the world where S&T is also highly regarded, and residents of other countries often express more concern about the environment. From a historic standpoint, Americans' concern about the environment is no longer at historic lows, but concern is also not as high as it was in previous decades.

In reviewing this chapter, it is important to recall that the purpose of the types of indicators described here is to allow a fact-based discussion about what Americans think and know about topics related to science, technology, and engineering. The emphasis on between-group comparisons, over-time comparisons, and between-country comparisons is not to rank groups or countries but to provide the type of context that allows a discussion about where the United States may have had success and where there might be potential for improvement. For example, the finding that many Americans have, over time, lost confidence in the medical community, as well as groups such as those involved in education or journalism, suggests that longstanding confidence in the scientific community should not be taken as a given. Similarly, the fact that Americans appear to visit more S&T museums and centers than residents of many other countries might suggest an area of strength on which we might build. As an *Indicators* chapter, the current report, however, highlights the nature of and trends in public views without assessing why changes may have occurred. This leaves to others the challenge of determining the causes of the patterns and trends described.[i] Some of this literature is cited here, but the work of better understanding public attitudes and knowledge about science is ongoing.

Further, in reading the chapter, it is important to consider the overall mosaic that can be assembled from all of these indicators and to avoid putting too much emphasis on any specific statistic. As survey data, the indicators discussed are subject to random variation; as such, it is important to analyze long-term trends and multiple related questions before drawing strong conclusions. Another ongoing limitation of the available indicators is that many of the international comparison data come from Europe, with only limited recent data from the Asia-Pacific region, where there is a high level of S&T activity. Data from Africa and South America are even scarcer. Similarly, the questions asked vary by country in small and large ways. As such, international comparisons should be made with caution, and thoughtful consideration should be given to what we may know and what we do not know.

Despite such concerns, one pattern in the surveys reviewed continues to stand out. Year after year, Americans who have had more exposure to S&T—including those who are college educated and have completed college courses in science and mathematics—tend to understand more about S&T, see S&T in a more positive light, and engage with S&T more often. Although it is not clear whether this association is causal, the pattern underscores the potential role of formal STEM education in shaping how people think about S&T. It is also important, however, to recognize that Americans interact with science beyond formal education systems through channels such as museums, a range of media (television, websites), and daily interactions with others in their personal or professional lives. Data on these types of exposure pathways are not generally as available as data related to formal education.

Ultimately, those who would seek to change knowledge and attitudes about S&T appear to have an increasing range of formal and informal channels through which to reach Americans. Attracting young people to S&T professions and cultivating positive attitudes about the value of S&T will be important for the United States to remain a world leader in S&T. Efforts to engage with the public on such matters are occurring through a range of online tools and in the community (e.g., schools, museums, restaurants), workplaces, and homes. The challenge for S&T advocates is to ensure that current efforts to engage Americans of all ages on S&T topics are sufficient and having the desired effects.

---

[i] The GSS on which recent versions of this chapter are based is publicly available for online analysis or download at http://www3.norc.org/GSS+Website/.

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. Global warming is often the focus of climate change discussion.

Cloning: Reproductive cloning involves using technology to generate genetically identical individuals with the same nuclear DNA as another individual. Therapeutic cloning involves medical research to develop new treatments for diseases.

European Commission: The governance body for the European Union (EU) that is responsible for the Eurobarometer series of surveys. As of September 2015, the EU comprised 28 member nations: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. Unless otherwise noted data on the EU include all of these 28 members. In this regard, Eurobarometer data from earlier years often does not include recently added members.

Genetically engineered (GE) food: A food product containing some quantity of any GE organism as an ingredient. Also sometimes called genetically modified (GM) food, genetically modified organisms (GMOs), or agricultural biotechnology.

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, and so forth.

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

Organisation for Economic Co-operation and Development (OECD): Intergovernmental organization made up of most highly developed economies aimed at promoting policies to improve economic and social well-being.

Synthetic biology: Involves a combination of science and engineering to make or modify living organisms to carry out specific functions. The focus is on creating new genetic code that does not exist in nature.

References

Allum N, Sturgis P, Tabourazi D, Brunton-Smith I. 2008. Science knowledge and attitudes across cultures: A meta-analysis. *Public Understanding of Science* 17(1):35–54.

Akin H, Rose KM, Scheufele DA, Simis MJ, Brossard D, Xenos MA, Corley EA. Unpublished. Public attitudes on synthetic biology: Mapping landscapes and processes. Science, Media and the Public Research Group (SCIMEP), University of Wisconsin-Madison.

Bann CM, Schwerin MJ. 2004. *Public Knowledge and Attitudes Scale Construction: Development of Short Forms*. Research Triangle Park, NC: National Science Foundation, Division of Science Resources Statistics.

Barabas J, Jerit J. 2009. Estimating the causal effects of media coverage on policy-specific knowledge. *American Journal of Political Science* 53(1):73–89.

Bauer M, Allum N, Miller S. 2007. What can we learn from 25 years of PUS survey research? Liberating and expanding the agenda. *Public Understanding of Science* 16(1):79–95.

Bauer M, Shukla R, Allum N, editors. 2012. *The Culture of Science: How the Public Relates to Science Across the Globe*. New York, NY: Routledge.

Bell P, Lewenstein BV, Shouse AW, Feder M, editors. 2009. *Learning Science in Informal Environments*. Washington, DC: National Academies Press.

Berkman ND, Davis TC, McCormack L. 2010. Health literacy: What is it? *Journal of Health Communication* 15(Suppl. 2):9–19.

Brossard D, Dudo A. 2012. Cultivation of attitudes toward science. *In* Shanahan J, Signorielli N, editors, *Living with Television Now: Advances in Cultivation Theory and Research*, pp. 120–43. New York, NY: Peter Lang.

Capstick S, Whitmarsh L, Poortinga W, Pidgeon N, Upham P. 2015. International trends in public perceptions of climate change over the past quarter century. *Wiley Interdisciplinary Reviews: Climate Change* 6(1):35–61.

China Research Institute for Science Popularization (CRISP). 2010. *Chinese Public Understanding of Science and Attitudes towards Science and Technology*. Beijing, China: CRISP.

Clarke CE, Boudet HS, Bugden D. 2013. “Fracking” in the American mind: Americans’ views on natural gas drilling using hydraulic fracturing: September 2012. Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change Communication. http://www.climatechangecommunication.org/reports. Accessed 17 January 2015.

comScore. 2015. comScore releases January 2015 U.S. desktop search engine rankings. http://www.comscore.com/Insights/Market-Rankings/comScore-Releases-January-2015-US-Desktop-Search-Engine-Rankings. Accessed 6 March 2015.

Council of Canadian Academies (CCA). 2014. *Science Culture: Where Canada Stands*. Ottawa, Canada: Expert Panel on the State of Canada’s Science Culture, Council of Canadian Academies. http://www.scienceadvice.ca/uploads/eng/assessments%20and%20publications%20and%20news%20releases/science-culture/scienceculture_fullreporten.pdf. Accessed 17 January 2015.

Delli Carpini MX, Keeter S. 1996. *What Americans Know about Politics and Why it Matters*. New Haven, CT: Yale University Press.

Dudo AD. 2013. Toward a model of scientists' public communication activity: The case of biomedical researchers. *Science Communication* 35(4):476–501.

Dudo A, Brossard D, Shanahan J, Scheufele DA, Morgan M, Signorielli N. 2011. Science on television in the 21st century: Recent trends in portrayals and their contributions to public attitudes toward science. *Communication Research* 38(6):754–77.

Dudo A, Cicchirillo V, Atkinson L, Marx S. 2014. Portrayals of technoscience in video games: A potential avenue for informal science learning. *Science Communication* 36(2):219–47.

Dugan A. 2014. Americans most likely to say that global warming is exaggerated. http://www.gallup.com/poll/167960/americans-likely-say-global-warming-exaggerated.aspx. Accessed 16 June 2015.

Dunlap R. 2014. Global warming or climate change: Is there a difference? http://www.gallup.com/poll/168617/global-warming-climate-change-difference.aspx. Accessed 24 December 2014.

Dutton S, DePinto J, Salvanto A, Backus F. 2014. Americans weigh in on global warming's impact. http://www.cbsnews.com/news/americans-weigh-in-on-global-warmings-impact/. Accessed 17 January 2015.

Einsiedel EF, Goldenberg L. 2006. Dwarfing the social? Nanotechnology lessons from the biotechnology front. *In* Hunt G, Mehta M, editors, *Nanotechnology: Risk, Ethics, and Law*, pp. 213–21. London, United Kingdom: Earthscan.

European Commission. 2005. Special Eurobarometer 224: Europeans, science and technology. http://ec.europa.eu/public_opinion/archives/ebs/ebs_224_report_en.pdf. Accessed 23 May 2013.

European Commission. 2008. Special Eurobarometer 300: Europeans' attitudes towards climate change. http://ec.europa.eu/public_opinion/archives/ebs/ebs_300_full_en.pdf. Accessed 11 June 2013.

European Commission. 2010a. Special Eurobarometer 340: Science and technology. http://ec.europa.eu/public_opinion/archives/ebs/ebs_340_en.pdf. Accessed 20 February 2013.

European Commission. 2010b. Special Eurobarometer 341: Biotechnology. http://ec.europa.eu/public_opinion/archives/ebs/ebs_341_en.pdf. Accessed 20 February 2013.

European Commission. 2013. Special Eurobarometer 401: Responsible research and innovation (RRI), science and technology. http://ec.europa.eu/public_opinion/archives/ebs/ebs_401_en.pdf. Accessed 17 January 2015.

European Commission. 2014. Special Eurobarometer 419: Public perceptions of science, research and innovation. http://ec.europa.eu/public_opinion/archives/ebs/ebs_419_en.pdf. Accessed 17 January 2015.

Falk JH, Needham MD. 2013. Factors contributing to adult knowledge of science and technology. *Journal of Research in Science Teaching* 50(4):431–52.

Fiske ST, Dupree C. 2014. Gaining trust as well as respect in communicating to motivated audiences about science topics. *Proceedings of the National Academy of Sciences* 111(Suppl. 4):13593–97.

Frewer LJ, van der Lans IA, Fischer ARH, Reinders MJ, Menozzi D, Zhang X, van den Berg I, Zimmermann KL. 2013. Public perceptions of agri-food applications of genetic modification—A systematic review and meta-analysis. *Trends in Food Science & Technology* 30(2):142–52.

Gallup. 2015a. Climate change: Environment. http://www.gallup.com/poll/1615/environment.aspx#. Accessed 17 January 2015.

Gallup. 2015b. Trends A to Z: Most important problem. http://www.gallup.com/poll/1675/most-important-problem.aspx. Accessed 17 January 2015.

Gauchat G. 2012. Politicization of science in the public sphere: A study of public trust in the United States, 1974 to 2010. *American Sociological Review* 77(2):167–87.

Google. 2015. Trends help. https://support.google.com/trends#topic=4365599. Accessed 15 June 2015.

Hallman WK, Adelaja AO, Schilling BJ, Lang JT. 2002. *Public Perceptions of Genetically Modified Foods: Americans Know Not What They Eat*. Food Policy Institute Report No. RR-0302-001. New Brunswick, NJ: Rutgers, the State University of New Jersey, Food Policy Institute.

Hart PS, Nisbet EC, Myers TA. 2015. Public attention to science and political news and support for climate change mitigation. *Nature Climate Change* 5:541–5.

Jasanoff S. 2005. *Designs on Nature: Science and Democracy in Europe and the United States.* Princeton, NJ: Princeton University Press.

Jones J. 2014. In U.S., most do not see global warming as serious threat. http://www.gallup.com/poll/167879/not-global-warming-serious-threat.aspx. Accessed 17 January 2015.

Jones J, Saad L. 2014. Gallup poll social series: Values and beliefs. http://www.gallup.com/file/poll/170798/Moral_Acceptability_140530.pdf. Accessed 17 January 2015.

Kahan DM, Jenkins-Smith H, Braman D. 2011. Cultural cognition of scientific consensus. *Journal of Risk Research* 14(2):147–74.

Kahan DM, Peters E, Wittlin M, Slovic P, Ouellette LL, Braman D, Mandel G. 2012. The polarizing impact of science literacy and numeracy on perceived climate change risks. *Nature Climate Change* 2(10):732–5.

Kahn ME, Kotchen MJ. 2011. Business cycle effects on concern about climate change: The chilling effect of recession. *Climate Change Economics* 2(3):257–73.

Kopicki A. 2013. Strong support for labeling modified foods. http://www.nytimes.com/2013/07/28/science/strong-support-for-labeling-modified-foods.html?ref=science. Accessed 17 January 2015.

Korea Foundation for the Advancement of Science and Creativity (KOFAC). 2013. Survey of Public Attitudes towards and Understanding of Science and Technology 2012. Seoul, Korea: KOFAC.

Krosnick JA. 1991. Response strategies for coping with the cognitive demands of attitude measures in surveys. *Applied Cognitive Psychology* 5(3):213–36.

Krosnick JA. 1999. Survey research. *Annual Review of Psychology* 50:537–67.

Krosnick JA, Holbrook AL, Berent MK, Carson RT, Hanemann WM, Kopp RJ, Conaway M. 2002. The impact of “no opinion” response options on data quality: Non-attitude reduction or an invitation to satisfice? *Public Opinion Quarterly* 66(3):371–403.

Krosnick JA, Presser S. 2010. Question and questionnaire design. *In* Marsden PV, Wright JD, editors. *The Handbook of Survey Research*, 2nd ed., pp. 263–313. Bingley, UK: Emerald.

Langer G. 2014. Poll: Skepticism of genetically modified foods. http://abcnews.go.com/Technology/story?id=97567&page=1. Accessed 17 January 2015.

Leiserowitz A, Maibach EW, Roser-Renouf C, Feinberg G, Rosenthal S. Marlon J. 2014. Climate change in the American mind: October, 2014. Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change Communication. http://environment.yale.edu/climate-communication/files/Climate-Change-American-Mind-October-2014.pdf. Accessed 17 January 2015.

Leiserowitz A, Maibach EW, Roser-Renouf C, Feinberg G, Rosenthal S. Marlon J. 2015. Climate change in the American mind: March, 2015. Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change Communication. http://environment.yale.edu/climate-communication/files/Global-Warming-CCAM-March-2015.pdf. Accessed 13 May 2015.

Leshner AI. 2003. Public engagement with science [editorial]. *Science* 299:977.

Losh SC. 2010. Diverse digital divides in American society: 1983–2006. *In* Ferro E, Dwivedi YK, Gil-Garcia JR, Williams MD, editors, *Overcoming Digital Divides: Constructing an Equitable and Competitive Information Society, A Handbook of Research*, pp. 196–222. Hershey, PA: IGI Global.

Losh SC. 2012. Stereotypes about scientists over time among U.S. adults: 1983 and 2001. *Public Understanding of Science* 19(3)372:382.

Lyons L. 2005. Paranormal beliefs come (super)naturally to some. http://www.gallup.com/poll/19558/Paranormal-Beliefs-Come-SuperNaturally-Some.aspx?utm_source=astrology&utm_medium=search&utm_campaign=tiles. Accessed 9 June 2015.

Maitland A, Tourangeau R, Yan Y. 2014. NCSES Task Order 1: Experimentation with factual knowledge survey items. Final Report. Rockville, MD: Westat.

Maitland A, Tourangeau R, Yan Y, Bell R, Muhlberger P. 2014. The effect of question wording on measurement of knowledge about evolution. An examination of survey experiment data collected for the National Center for Science and Engineering Statistics.

Malaysian Science and Technology Information Centre (MASTIC), Ministry of Science, Technology and Innovation. 2010. The public awareness of science and technology Malaysia 2008. Putrajaya, Malaysia: MASTIC.

McComas KA, Besley JC, Steinhardt J. 2014. Factors influencing U.S. consumer support for genetic modification to prevent crop disease. *Appetite* 78:8–14.

McCright AM, Dentzman K, Charters M, Dietz T. 2013. The influence of political ideology on trust in science. *Environmental Research Letters* 8(4):044029.

Miller JD. 1998. The measurement of scientific literacy. *Public Understanding of Science* 7(1):203–23.

Miller JD. 2004. Public understanding of, and attitudes toward, scientific research: What we know and what we need to know. *Public Understanding of Science* 13(3):279–94.

Miller JD, Pardo R, Niwa F. 1997. Public perceptions of science and technology: A comparative study of the European Union, the United States, Japan, and Canada. Bilbao, Spain: Fundación BBVA.

Miner JB. 1961. On the use of a short vocabulary test to measure general intelligence. *Journal of Educational Psychology* 53(3):157–60.

Mondak JJ. 2004. Knowledge variables in cross-national social inquiry. *Social Science Quarterly* 85(3):539–58.

Moore B, Nicholls S. 2014. Americans still favor energy conservation over production. http://www.gallup.com/poll/168176/americans-favor-energy-conservation-production.aspx. Accessed 9 September 2015.

Muñoz A, Moreno C, Luján JL. 2012. Who is willing to pay for science? On the relationship between public perception of science and the attitude to public funding of science. *Public Understanding of Science* 21(2):242–53.

National Institute of Science and Technology Policy (NISTEP). 2012. Research on changes in public awareness of science and technology: The results of interviews and monthly internet surveys. Tokyo, Japan: Ministry of Education.

National Research Council (NRC). 1996. *Understanding Risk: Informing Decisions in a Democratic Society*. Washington, DC. National Academies Press.

National Research Council (NRC). 2008. *Public Participation in Environmental Assessment and Decision Making*. Washington, DC. National Academies Press.

National Research Council (NRC). 2012. *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Committee on a Conceptual Framework for New K-12 Science Education Standards. Washington, DC: National Academies Press.

National Science Board (NSB). 2006. *Science and Engineering Indicators 2006.* Two volumes (vol. 1, NSB 06-01; vol. 2, NSB 06-01A). Arlington, VA: National Science Foundation. Available at http://www.nsf.gov/statistics/seind06.

National Science Board (NSB). 2008. *Science and Engineering Indicators 2008.* Two volumes (vol. 1, NSB 08-01; vol. 2, NSB 08-01A). Arlington, VA: National Science Foundation. Available at http://www.nsf.gov/statistics/seind08.

National Science Board (NSB). 2010. *Science and Engineering Indicators 2010.* NSB 10-01. Arlington, VA: National Science Foundation. Available at http://www.nsf.gov/statistics/seind10.

National Science Board (NSB). 2012. *Science and Engineering Indicators 2012.* NSB 12-01. Arlington, VA: National Science Foundation. Available at http://www.nsf.gov/statistics/seind12.

National Science Board (NSB). 2014. *Science and Engineering Indicators 2014.* NSB 14-01. Arlington, VA: National Science Foundation. Available at http://www.nsf.gov/statistics/seind14.

New York Times, Stanford University. 2015. *The New York Times*/Stanford University/Resources for the future: Poll on global warming. http://www.nytimes.com/interactive/2015/01/29/us/politics/document-global-warming-poll.html. Accessed 30 January 2015.

Nisbet MC, Huge M. 2006. Attention cycles and frames in the plant biotechnology debate: Managing power and participation through the press/policy connection. *Harvard International Journal of Press/Politics* 11(2):3–40.

Nisbet MC, Scheufele DA. 2009. What's next for science communication? Promising directions and lingering distractions. *American Journal of Botany* 96(10):1767–78.

Organisation for Economic Co-operation and Development (OECD). 2003. The PISA 2003 assessment framework—Mathematics, reading, science and problem solving knowledge and skills. Paris, France: OECD.

Peters HP, Brossard D, de Cheveigné S, Dunwoody S, Kallfass M, Miller S, Tsuchida S. 2008. Science communication: Interactions with the mass media. *Science* 321(5886):204–5.

Pew Forum on Religion & Public Life. 2009. Many Americans mix multiple faiths. http://www.pewforum.org/files/2009/12/multiplefaiths.pdf. Accessed 7 May 2011.

Pew Research Center. 2012. In changing news landscape, even television is vulnerable. http://www.people-press.org/2012/09/27/in-changing-news-landscape-even-television-is-vulnerable/. Accessed 11 February 2015.

Pew Research Center. 2013a. Climate change and financial instability seen as top global threats. http://www.pewglobal.org/files/2013/06/Pew-Research-Center-Global-Attitudes-Project-Global-Threats-Report-FINAL-June-24-20131.pdf. Accessed 17 January 2015.

Pew Research Center. 2013b. Public esteem for military still high. http://www.pewforum.org/2013/07/11/public-esteem-for-military-still-high/. Accessed 17 January 2015.

Pew Research Center. 2013c. Public's knowledge of science and technology. http://www.people-press.org/2013/04/22/publics-knowledge-of-science-and-technology/. Accessed 29 April 2013.

Pew Research Center. 2014a. As U.S. energy production grows, public policy views show little change: Majority prioritizes developing alternative energy sources. http://www.people-press.org/files/2014/12/12-18-14-Energy-release.pdf. Accessed 17 January 2015.

Pew Research Center. 2014b. Deficit reduction declines as policy priority. http://www.people-press.org/2014/01/27/deficit-reduction-declines-as-policy-priority/1-25-2014_01/. Accessed 17 January 2015.

Pew Research Center. 2014c. Political polarization & media habits. http://www.journalism.org/2014/10/21/political-polarization-media-habits/ Accessed 13 January 2015.

Pew Research Center. 2015a. How scientists engage the public. http://www.pewinternet.org/files/2015/02/PI_PublicEngagementbyScientists_021515.pdf. Accessed 16 February 2015.

Pew Research Center. 2015b. Public and scientists' views on science and society. http://www.pewinternet.org/files/2015/01/PI_ScienceandSociety_Report_012915.pdf. Accessed 11 February 2015.

Pew Research Center. 2015c. Catholics divided over global warming. http://www.pewforum.org/2015/06/16/catholics-divided-over-global-warming/. Accessed 11 August 2015.

Pew Research Center. 2015d. Public's policy priorities reflect changing conditions at home and abroad: Fewer cite economy; more prioritize a strong military. http://www.people-press.org/files/2015/01/01-15-15-Policy-Priorities-Release.pdf. Accessed 11 February 2015.

Project for Excellence in Journalism (PEJ). 2012. Journalism.org. http://www.journalism.org. Accessed 30 April 2013.

Project on Emerging Nanotechnologies. 2015. Consumer product inventory: An inventory of nanotechnology-based consumer products introduced on the market. http://www.nanotechproject.org/cpi/. Accessed 8 May 2015.

Reuters. 2014. GMO labeling fails in Colorado, Oregon; GMO ban passes in Maui. http://www.nytimes.com/reuters/2014/11/05/us/politics/05reuters-usa-elections-gmo.html. Accessed 13 May 2015.

Riffkin R. 2014. New record highs in moral acceptability: Premarital sex, embryonic stem cell research, euthanasia growing in acceptance. http://www.gallup.com/poll/170789/new-record-highs-moral-acceptability.aspx. Accessed 17 January 2015.

Riffkin R. 2015. U.S. support for nuclear energy at 51%. http://www.gallup.com/poll/182180/support-nuclear-energy.aspx. Accessed 11 March 2015.

Rimal RN, Flora JA, Schooler C. 1999. Achieving improvements in overall health orientation: Effects of campaign exposure, information seeking, and health media use. *Communication Research* 26(3):322–48.

Roos JM. 2014. Measuring science or religion? A measurement analysis of the National Science Foundation sponsored science literacy scale 2006–2010. *Public Understanding of Science* 23(7):797–813.

Royal Society. 1985. The public understanding of science (the Bodmer report). London, UK: The Royal Society.

Saad L. 2015. U.S. views on climate change stable after extreme winter. http://www.gallup.com/poll/182150/views-climate-change-stable-extreme-winter.aspx. Accessed 13 May 2015.

Schuldt JP, Konrath SH, Schwarz N. 2011. "Global warming" or "climate change"? Whether the planet is warming depends on question wording. *Public Opinion Quarterly* 75(1):115–24.

Science, Media and the Public Research Group (SCIMEP). 2015. Public perceptions of nanotechnology. University of Wisconsin-Madison. Madison, WI: Department of Life Sciences Communication. http://scimep.wisc.edu/projects/reports/. Accessed 7 May 2015.

Scruggs L, Benegal S. 2012. Declining public concern about climate change: Can we blame the great recession? *Global Environmental Change* 22(2):505–15.

Segev E, Baram-Tsabari A. 2012. Seeking science information online: Data mining Google to better understand the roles of the media and the education system. *Public Understanding of Science* 21(7):813–29.

Shanahan J, Scheufele DA, Lee E. 2001. The polls—trends: Attitudes about agricultural biotechnology and genetically modified organisms. *Public Opinion Quarterly* 65(2):267–81.

Shen BSJ. 1975. Scientific literacy and the public understanding of science. *In* Day S, editor, *Communication of Scientific Information,* pp. 44–52. Basel, Switzerland: Karger.

Shukla R. 2005. India science report: Science education, human resources, and public attitude toward science and technology. New Delhi, India: National Council of Applied Economic Research.

Slater MD, Hayes AF, Ford VL. 2007. Examining the moderating and mediating roles of news exposure and attention on adolescent judgments of alcohol-related risks. *Communication Research* 34(4):355–81.

Soroka SN. 2002. Issue attributes and agenda-setting by media, the public, and policymakers in Canada. *International Journal of Public Opinion Research* 14(3):264–85.

Spence A, Poortinga W, Pidgeon N. 2012. The psychological distance of climate change. *Risk Analysis* 32(6):957–72.

Strom S. 2014. Vermont will require labeling of genetically altered foods. http://www.nytimes.com/2014/04/24/business/vermont-will-require-labeling-of-genetically-altered-foods.html. Accessed 13 May 2015.

Toumey C, Besley J, Blanchard M, Brown M, Cobb M, Ecklund EH, Glass M, Guterbock TM, Kelly AE, Lewenstein B. 2010. Science in the service of citizens & consumers: The NSF workshop on public knowledge of science, October 2010. National Science Foundation. http://www.nano.sc.edu/UserFiles/nanocenter/Documents/TOUMEY%20et%20al%202010%20SSCC%20%20NSF%20report.pdf. Accessed 7 May 2015.

Tourangeau R, Maitland A, Yan Y. Forthcoming. Assessing the scientific knowledge of the general public: The effects of question format and encouraging or discouraging don't know responses. *Public Opinion Quarterly*.

Tyndall Report. 2015. About the Tyndall Report website. http://tyndallreport.com/about/. Accessed 10 February 2015.

U.S. Department of Agriculture (USDA), Economic Research Service. 2014. Adoption of genetically engineered crops in the U.S. http://ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us.aspx. Accessed 23 March 2015.

Villar A, Krosnick JA. 2010. "Global warming" vs. "climate change": Does word choice matter? *Climatic Change* 105(1–2):1–12.

Wellcome Trust. 2013. Wellcome Trust Monitor: Wave 2. http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_grants/documents/web_document/wtp053113.pdf. Accessed 6 May 2015.

Woodrow Wilson International Center for Scholars. 2013. Awareness & impressions of synthetic biology. http://www.synbioproject.org/site/assets/files/1289/synbiosurvey2013.pdf? Accessed 11 May 2015.

Woodrow Wilson International Center for Scholars. 2015. Synthetic biology 101: What is synthetic biology? http://www.synbioproject.org/topics/synbio101/definition/. Accessed 11 May 2015.

World Values Survey (WVS). 2014. WVS Wave 6 2010–2014 Official Aggregate v.20150418. http://www.worldvaluessurvey.org/WVSDocumentationWV6.jsp. Accessed 17 February 2015.

Zheng H. Forthcoming. Losing confidence in medicine in an era of medical expansion? *Social Science Research*.