Public Attitudes

Science and Technology: Public Perceptions, Awareness, and Information Sources

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Executive Summary

Key takeaways:

- Public confidence in science and scientists has remained high for decades, with the majority of American adults reporting positive assessments of science and scientists. In 2022, 88% of U.S. adults agreed that scientific research that advances the frontiers of knowledge is necessary and deserves federal government support.
- A clear majority of U.S. adults—77% as of September 2022—expresses at least a fair amount of confidence in scientists to act in the best interests of the public.
- As recently as 2020, a small percentage of American adults reported any recent experience with various science activities—for example, participating in an online crowdsourcing activity for science data collection (3%) or helping a child with a science project either for school or outside of school (19%).
- Households with greater parent educational attainment or income report more exposure to science through children's activities, such as school projects, than do households with lower educational attainment or income.
- The majority of American adults (60%) report a basic understanding of scientific research principles such as the usefulness of a study control group for comparison with a treatment group, yet only half of U.S. adults (50%) could correctly identify a scientific hypothesis as of 2020.
- U.S. adults who demonstrate greater understanding of scientific logic tend to express more trust in scientists to act in the best interests of society than those who express less understanding.
- Public opinion research on emergent topics such as neurotechnology and artificial intelligence (AI) applications has been limited, and evidence on topics such as computer-assisted vehicles suggests such perceptions may fluctuate as Americans' experiences with technologies change.
- U.S. adults' support for scientific activities is not always contingent on research consensus: although a majority of U.S. adults in 2021 believed climate scientists had more to learn before those scientists would understand climate change mitigation "very well," 67% of U.S. adults in 2023 supported prioritizing development of energy sources (such as solar and wind) that are relevant to mitigation.

Data on Americans' understanding of science and technology (S&T) comprise at least three important dimensions: public perceptions of S&T, public familiarity with science research processes, and Americans' exposure to sources of science information and scientific activities. Both longitudinal assessments of perceptions and snapshots of sentiments offer insights relevant to those three dimensions. Data in this report reflect different moments in past decades rather than solely focusing on a single year, although researchers collected some of the data reported as recently as 2023. Insights reflect data drawn from national samples where possible and are constrained by data availability.

Researchers have measured understanding of S&T among American adults—meaning people at least 18 years old who live in a U.S. household—for decades and have noted a pattern of positive perceptions about science, scientists, and S&T professionals (such as engineers) over time. Americans generally have expressed confidence in science, scientists, and S&T professionals in recent decades, despite developments such as the COVID-19 pandemic. In recent years, 2020 data showed a brief uptick in confidence in scientists to act in the best interests of the public, which regressed to the level of 2016 perceptions by 2022.

Public understanding of specific science and engineering topics (such as AI and neurotechnology) is not uniform across topics, and perceptions can emerge and change over time as people gain more experience with technologies or concepts. Some evidence suggests widespread concern among American adults regarding neurotechnology, for example, but it is unclear how well they understand specific capabilities and planned future uses of such devices.

Perceptions of S&T and experiences with S&T also vary between people with different levels of educational attainment and income. Few American adults report recently participating in a science activity, such as making observations for a science research project or participating in an online crowdsourcing activity to identify animals, yet participation in science activities also varies. American adults with greater educational attainment or higher income report more science activity exposure.

How communication professionals present scientific developments also can shape public reactions. Their descriptions of how scientists conduct research can improve or discourage public acceptance of information resulting from that research. In addition, public perceptions of S&T may have shifted with recent developments such as the COVID-19 pandemic, the advent of new technologies, and media coverage of environmental news. Recent literature describes how changes in public perceptions of S&T can occur as people's experience with S&T changes. For example, personal experience with using automated technology and AI can positively affect trust perceptions over time. Trust in S&T also appears to be linked to Americans' comprehension of the processes of scientific research.

Introduction

Public perceptions of science and technology (S&T) in the United States affect many aspects of civic life. Those perceptions predict participation in formal science education (Graves et al. 2022; Vincent-Ruz and Schunn 2018), support for investment in S&T (Besley 2018; Muñoz, Moreno, and Luján 2012), and how people talk about scientific discoveries (Southwell and Torres 2006). Public encounters with, and understanding of, science can also help predict behavior toward scientific organizations and future patterns of science, technology, engineering, and mathematics (STEM) training (VanMeter-Adams et al. 2014).

Although measuring public perceptions of S&T has been a long-standing project for social science research, measurement itself has evolved as researchers have come to recognize the complexity of those perceptions. Earlier researchers tended to focus on deficits in science knowledge as a key criterion for evaluating public understanding of S&T, such as testing factual knowledge about antibiotics. More recently, however, researchers have turned to measuring public perceptions of science practice and scientific institutions. Those perceptions include a range of ideas and beliefs that may not always align neatly with knowledge of scientific facts (Allum et al. 2008; Miller 2004; NCSES 1985–2001). Patterns of public perception also evolve over time, suggesting that both cross-sectional and longitudinal data (meaning data captured at one point in time and data generated over time, respectively) are sometimes necessary to accurately track and evaluate public beliefs about S&T.

Some researchers view science as operating within larger social and cultural contexts—such as public discourse about values, the roles of institutions, and specific threats to health and quality of life—that must be acknowledged in thinking about how people perceive scientific research (Bauer 2009; Brossard and Lewenstein 2010; Lewenstein 1992). These changing considerations of science as an endeavor and of the roles of scientific institutions have coincided with long-term national measurement efforts that use stable indicators to track public perceptions of science over time. As a result, any effort to summarize public perceptions of science must address the tension between established measurement efforts that have not changed substantially over time and evolving conversations about what measures of public understanding of S&T are possible and appropriate.

This report presents indicators on three important dimensions of public perceptions and understanding: (1) Americans' perceptions of S&T in general and of specific S&T issues, (2) how well Americans understand scientific logic and research processes, and (3) where Americans encounter science and get scientific information. Reporting reflects available data. When possible, the discussion includes both aggregate U.S. data on public perceptions and data broken down by demographic characteristics. The report also includes some information comparing Americans' public perceptions of S&T with those of their counterparts in other countries with high levels of spending on S&T research and development (R&D).

Public Perceptions of Science and Technology

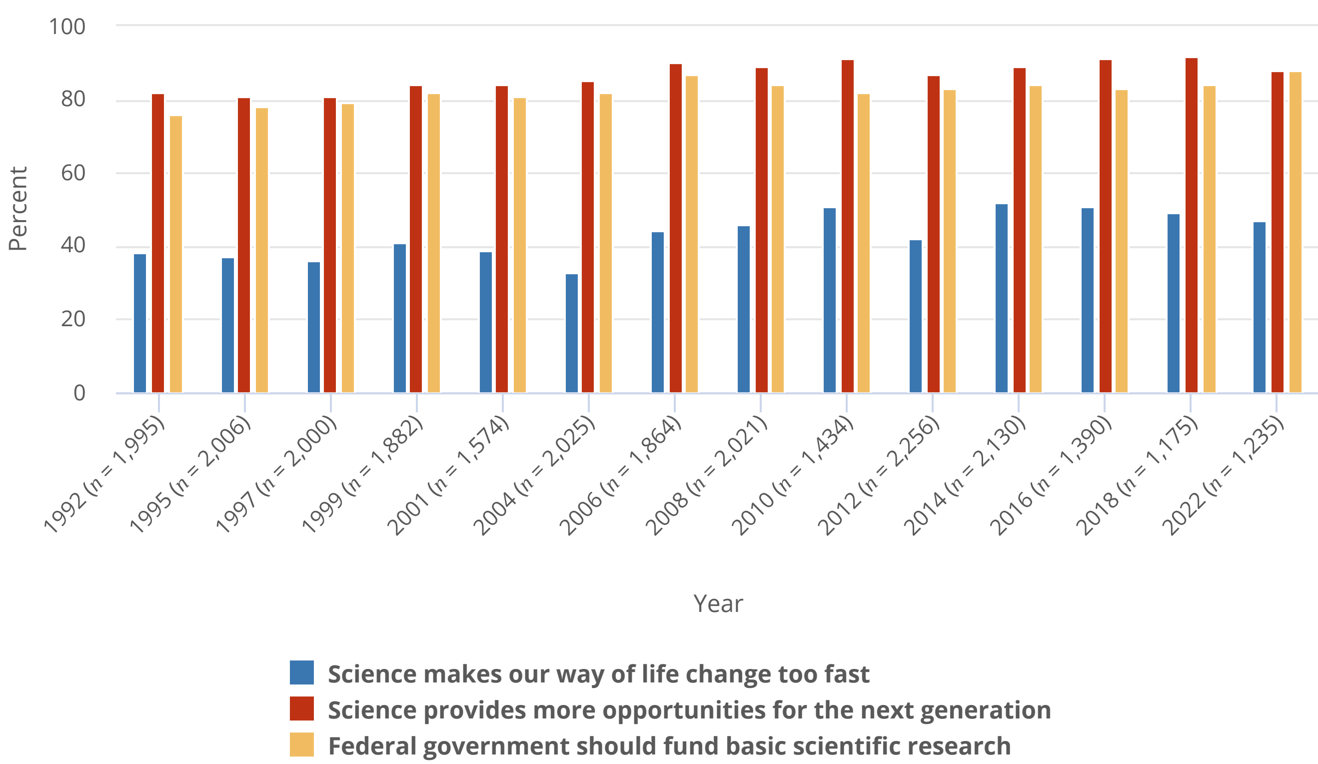
Public opinion on S&T includes beliefs about the general promise and benefits of scientific research for society. In addition, how people think about S&T is likely influenced by the extent to which U.S. adults are aware of specific topics addressed by scientific research and popular conceptualization of those topics. Examples of specific topics investigated by researchers in recent years that could influence future public opinion include artificial intelligence (AI), robotics, and automation technology; neurotechnology; climate change; and water contamination. Popular beliefs about STEM education in the United States also are relevant to discussion of the future of S&T in this country.

General Perceptions of S&T

Americans' support for S&T as a general enterprise has been consistently positive for at least four decades. Since the late 1970s, the General Social Survey (GSS)—a nationally representative survey of adults in the United States—has assessed Americans' perceptions of S&T (Smith et al. 2012–18). From 1979 to 2018, the GSS found a clear majority of American adults agreed that the benefits of scientific research strongly or slightly outweigh the harmful results (see *Indicators 2022* report "**Science and Technology: Public Perceptions, Awareness, and Information Sources**"). From 1992 to 2022, the GSS also found that most Americans surveyed believed that there would be more opportunities "for the next generation" because of S&T and that they supported federal funding for basic scientific research, even when they did not expect that research to produce immediate benefits (**Figure PPS-1**). In 2022, 88% of U.S. adults agreed that scientific research that advances the frontiers of knowledge is necessary and deserves federal government support.

Figure PPS-1

U.S. adults who agree that science makes our way of life change too fast, that science provides more opportunities for the next generation, and that the federal government should fund basic scientific research: Selected years, 1992–2022



Note(s):
This figure displays data for years when the question was proffered. Percentages may not add to 100% because of rounding. See Table SPPS-1 through Table SPPS-3 for standard errors. Responses are to the following: *Science makes our way of life change too fast. Because of science and technology, there will be more opportunities for the next generation. 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?* This figure displays the percentage of respondents who "strongly agree" or "agree" with the aforementioned statements.

Source(s):
Data are sourced from multiple surveys that used either identical or similar survey items: National Center for Science and Engineering Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (1992–2001); University of Michigan, Survey of Consumer Attitudes and Behavior (2004); NORC at the University of Chicago, General Social Survey (2006–22).

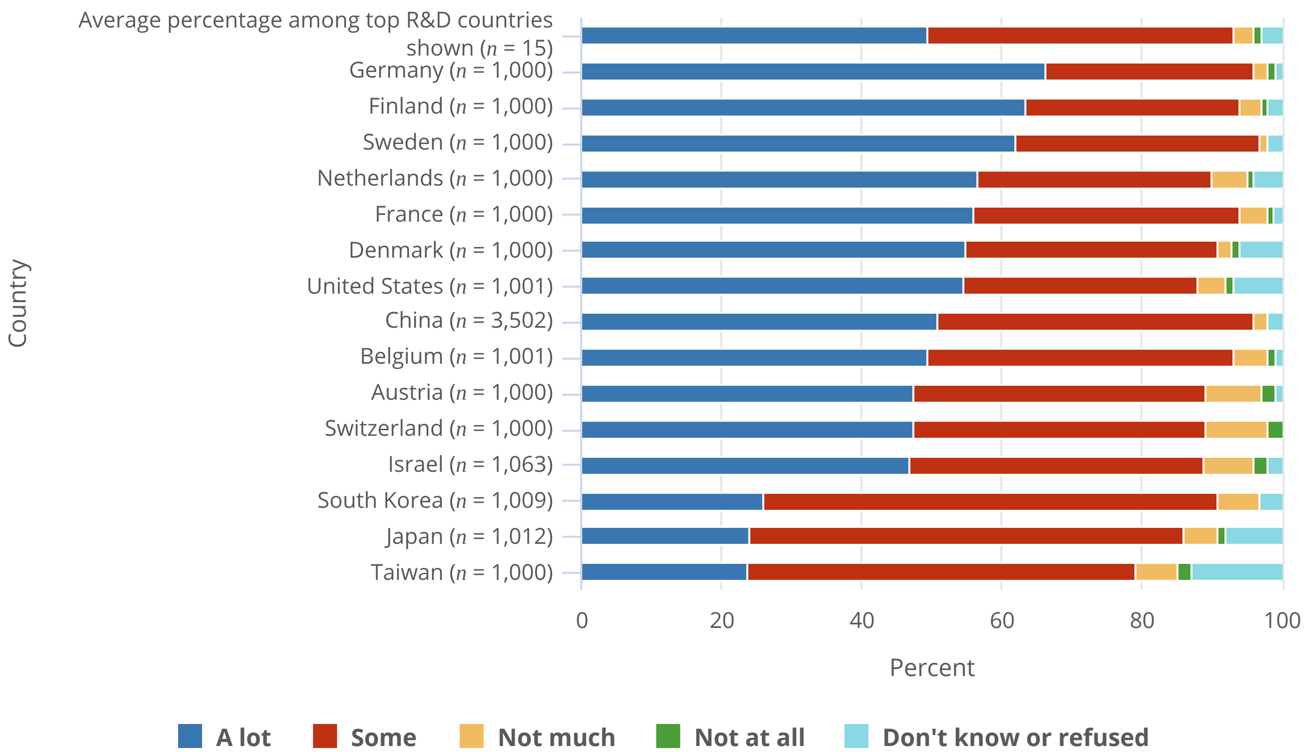
Science and Engineering Indicators

One exception to Americans' tendency to support S&T has been the perception that science makes life change too fast. In the last decade, Americans have been almost evenly split about the view that science has such a downside (**Figure PPS-1**). Since 2014, the GSS found that roughly half of respondents agreed or strongly agreed that "science makes our way of life change too fast," moving up from an average of 41% from 1995 to 2012 to an average of 50% from 2014 to 2022.

Americans also have tended to report that they trust science, a stance similar to that of residents of the other countries that spend the most on S&T R&D compared with the rest of the world. According to the Wellcome Global Monitor 2020 survey (Gallup 2021a)—the world's largest study on how people around the world think and feel about science and major health challenges—a majority of Americans surveyed (88%) reported that they trust science "some" or "a lot" (**Figure PPS-2**). This widespread prevalence of trust was largely consistent with the views of citizens in other countries that, like the United States, have invested substantially in R&D. Overall, 94% of adults in the top 15 countries included in the Wellcome Global Monitor with the largest gross domestic expenditures on R&D as a percentage of 2019 gross domestic product (GDP) reported trusting science "some" or "a lot" (**Figure PPS-2**).[1]

Figure PPS-2

Trust in science, by country: 2020



Note(s):
Percentages may not add to 100% because of rounding. See Table SPPS-4 for standard errors. Countries are those with top 16 gross domestic expenditures on R&D as a percentage of gross domestic product in 2019, listed in order from highest to lowest (see *Indicators 2022* report "Research and Development: U.S. Trends and International Comparisons"). Gallup adjusted each individual country total for nonresponse and population size. The average percentage shown in the figure is the mean across individual country percentages reported by Gallup. In 2019, Iceland was ranked in the top 16 but was not included in the Wellcome Global Monitor 2020 survey; therefore, only 15 of the top 16 countries are shown. Responses are to the following: *In general, would you say that you trust science a lot, some, not much, or not at all?*

Source(s):
Gallup. 2021. Wellcome Global Monitor 2020.

Science and Engineering Indicators

Despite Americans' general endorsement of science and the stability of their general perceptions of science over time, there are some notable differences in confidence in S&T between some groups. One source of those variations is the extent to which people understand how scientists conduct research and use the logic of science to generate evidence. This issue will be explored later in this report; see section **Public Familiarity with Science and Technology Research Processes**.

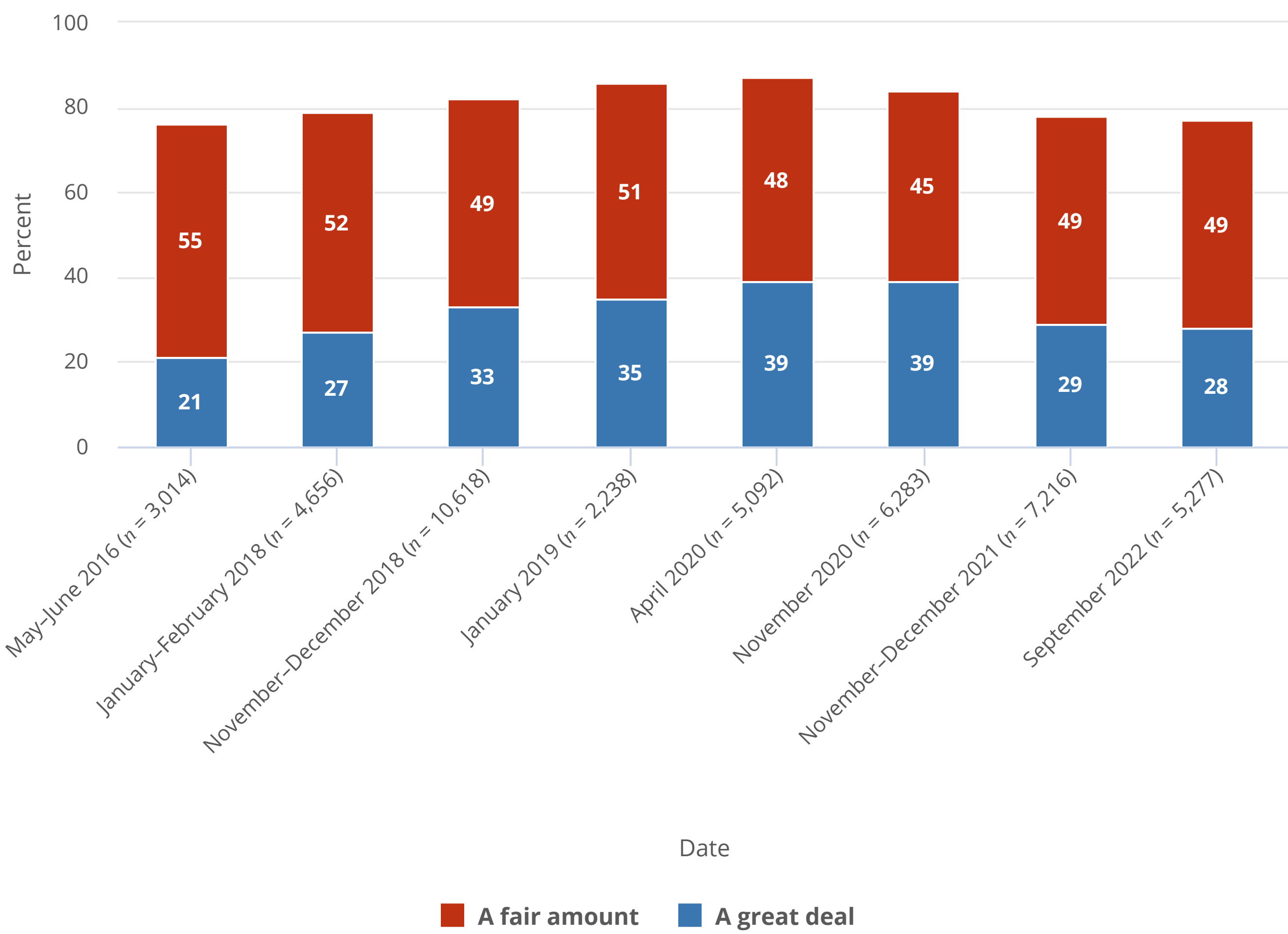
Perceptions of Scientists

Since the 1980s, Americans' confidence in scientists has been high relative to their confidence in other professionals (Krause et al. 2019). From 1985 to 2022, most Americans were confident that scientists act in the best interests of society (**Figure PPS-3**; **Table PPS-1**; also see *Indicators 2022* report **"Science and Technology: Public Perceptions, Awareness, and Information Sources"**: **Figure PPS-4**). Over that period, for example, several surveys, including the GSS, asked respondents the extent to which they agreed that scientists are dedicated people who work for the good of humanity, help to solve challenging problems, and work to make life better for the average person. A consistently high percentage of

Americans agreed with those statements in every GSS during that period, although there has been some fluctuation. For example, the percentage of Americans who believe scientists work to make life better for the average person ranged from 80% in 1985 to 89% in 2018. The tendency of Americans to express confidence in scientists and scientific institutions is notable, given that some recent headlines have implied a decline in Americans' levels of trust or even implied widespread mistrust—without accompanying evidence—in scientists (Fearnow 2021; Piccone 2020).

Figure PPS-3

Confidence in scientists to act in the best interests of the public, by survey date: 2016–22



Note(s):
See Table SPPS-6 for standard errors. Responses are to the following: *How much confidence, if any, do you have in [scientists] to act in the best interests of the public?*

Source(s):
Pew Research Center, American Trends Panel Wave 17 (2016), conducted 10 May–6 June 2016; American Trends Panel Wave 31 (2018), conducted 29 January–13 February 2018; American Trends Panel Wave 40 (2018), conducted 27 November–10 December 2018; American Trends Panel Wave 42 (2019), conducted 7–21 January 2019; American Trends Panel Wave 66 (2020), conducted 20–26 April 2020; American Trends Panel Wave 79 (2020), conducted 18–29 November 2020; American Trends Panel Wave 100 (2021), conducted 30 November–12 December 2021; and American Trends Panel Wave 114 (2022), conducted 13–18 September 2022.

Science and Engineering Indicators

Table PPS-1

Confidence in scientists to act in the best interests of the public, by demographic characteristics: 2022

(Percent)

Characteristic	Level of confidence in scientists			
	A great deal	A fair amount	Not too much	None at all
All adults (*n* = 5,277)	28	49	18	5
Sex				
Male (*n* = 2,314)	30	47	18	5
Female (*n* = 2,905)	26	52	18	4
Race or ethnicity				
White (*n* = 3,589)	29	48	19	4
Black (*n* = 598)	26	50	18	5
Hispanic (*n* = 687)	23	54	17	5
Family income[a]				
Upper income (*n* = 1,299)	37	45	14	2
Middle income (*n* = 2,564)	27	50	18	5
Lower income (*n* = 1,138)	25	49	19	6
Education				
Postgraduate (*n* = 1,145)	42	44	11	2
College graduate (*n* = 1,429)	32	48	16	3
Some college (*n* = 1,728)	27	51	18	4
High school or less (*n* = 960)	21	50	21	6

[a] Income tiers are based on 2021 family incomes that have been adjusted for household size and cost of living in respondents' geographic region. Middle income includes respondents whose family incomes are between two-thirds of and double the median-adjusted family income among the panel of respondents. For a three-person household, upper income is approximately $131,500 and above, middle income is from $43,800 to $131,500, and lower income is less than $43,800.

Note(s):
Percentages may not add to 100% because the nonresponse category for level of confidence is not shown. See Table SPPS-7 for standard errors. Responses are to the following: *How much confidence, if any, do you have in [scientists] to act in the best interests of the public?*

Source(s):
Pew Research Center, American Trends Panel Wave 114 (2022), conducted 13–28 September 2022.

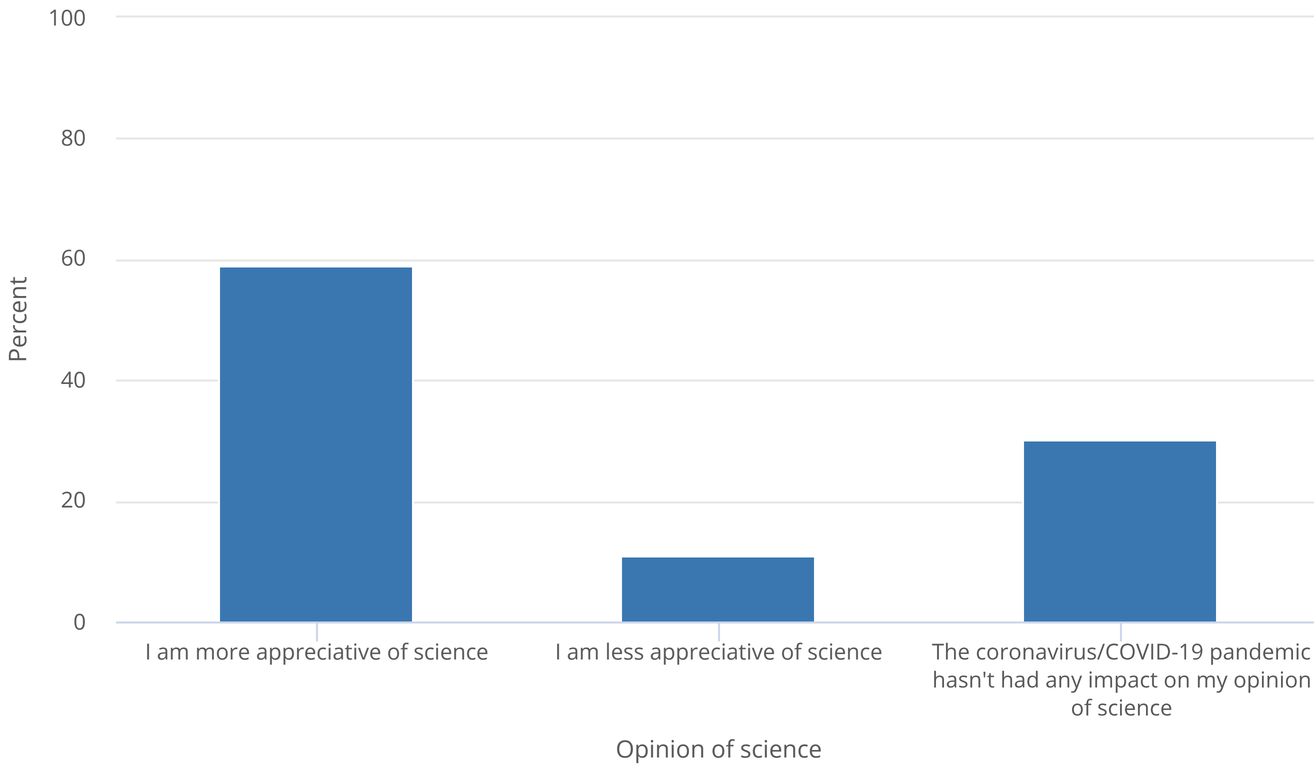
Science and Engineering Indicators

Recent historical events such as the COVID-19 pandemic have not dramatically dampened the general tendency of Americans to trust scientists. The onset of the COVID-19 pandemic did not immediately coincide with a decline in U.S. adults’ confidence in either scientists in general or medical scientists in April and May 2020 (Funk, Kennedy, and Johnson 2020). The broader empirical picture of Americans’ confidence in scientists in general since 2016 includes a continuous pattern of high confidence levels, with the majority of U.S. adults expressing confidence in scientists at multiple points, as well as a brief uptick in 2019 and 2020 and a regression to 2016 confidence levels by late 2021 (**Figure PPS-3**).[2] As recently as September 2022, a clear majority of U.S. adults expressed at least a fair amount of confidence in scientists to act in the best interests of the public (**Figure PPS-3**), as has been the case for decades. The percentage of U.S. adults expressing a great deal of confidence in scientists in general rose to 39% in April 2020 and remained at 39% in November 2020 before declining to 28% by September 2022.

Data collected for the 2021 3M State of Science Index survey highlight the tendency of U.S. adults to believe their appreciation for science increased following the 2020 onset of the COVID-19 pandemic (3M 2020). A majority of Americans (59%) reported growing more appreciative of science in light of the COVID-19 pandemic according to data collected from September through December 2021 (**Figure PPS-4**). Such appreciation likely reflected at least in part the public salience of scientific research during the first year of the pandemic.

Figure PPS-4

Impact of the coronavirus or COVID-19 pandemic on U.S. adults' opinion of science: 2021



Note(s):
See Table SPPS-5 for standard errors. Responses are to the following: *How has the coronavirus/COVID-19 pandemic impacted your opinion of science?* A total of 2,523 adults responded to this question.

Source(s):
3M. 2022. 2022 State of Science Index, conducted 27 September–17 December 2021.

Science and Engineering Indicators

Although confidence in scientists has remained high at a population level for decades, Americans are not uniform in their expressed confidence. According to September 2022 data from the Pew Research Center's American Trends Panel (ATP), confidence in scientists in general differed by education and income (**Table PPS-1**). For example, 42% of U.S. adults with a postgraduate degree expressed a great deal of confidence in scientists, whereas 21% of U.S. adults with a high school diploma or less did. Income also predicted confidence in scientists to act in the best interests of society: 37% of U.S. adults in the highest of three family income tiers in the survey expressed a great deal of confidence, whereas 25% of U.S. adults in the lowest family income tier expressed that same level of confidence. What accounts for the differences in confidence in scientists between adults with different education and income levels is an important empirical question. Factors such as race, ethnicity, and sex do not appear to account entirely for the confidence differences between socioeconomic groups, because the 2022 ATP data demonstrate no differences in confidence in scientists as a function of respondent race based on measured categories and because any observed differences reflecting respondent sex and ethnicity were smaller than 10 percentage points (**Table PPS-1**). Later, this report assesses one factor that predicts confidence—namely, the extent to which people understand how scientific inquiry ideally occurs. (See section **Public Familiarity with Science and Technology Research Processes**.)

Perceptions of Engineers and Engineering

Social science researchers have limited evidence as to whether Americans draw distinction between scientists and engineers. Some experimental evidence comparing survey respondents' answers with questions about scientists and engineers suggests that Americans tend not to differentiate between scientists and engineers in terms of their value to society, including 2012 GSS data (see *Indicators 2020* report "**Science and Technology: Public Attitudes, Knowledge, and Interest**"). According to a 2013 Pew Research Center study, U.S. adults respect the work of engineers in a similar manner as they respect the work of medical doctors and scientists. The majority of U.S. adults in that study reported holding medical doctors, scientists, and engineers in roughly equal regard (Pew Research Center 2013). (Whether U.S. adults draw distinctions within topical domains, such as distinguishing between medical practitioners who see patients and medical researchers, is unclear.) Among American adults, 63% believed engineers contribute a lot to societal well-being, 65% believed scientists contribute a lot to societal well-being, and 66% believed medical doctors do so. Those positive perceptions of engineering generally align with earlier survey research commissioned for the National Academy of Engineering (NAE 2008).

Perceptions of Specific S&T Topics

Although Americans have tended to broadly support S&T, they sometimes express concerns about specific topics that arise with the publication of new research and the introduction of new technologies. As described in this section, recent peer-reviewed literature highlights evidence on public perceptions of research on a variety of topics, including conceptualizations of AI, robotics, and automation technology; neurotechnology; perceptions of climate change and climate change research; perceptions of water contamination; and beliefs about STEM education. Past public perception research has involved a range of topics about which popular conceptualization has changed over time, such as biotechnology (Bauer 2005). This report includes example topics that have been prominent recently in public discussions and for which available data may be relevant to evaluating Americans' trust in scientific institutions, understanding of scientific processes, or exposure to scientific activities.

Artificial Intelligence, Robotics, and Automation Technology

Public understanding of what constitutes AI and how to evaluate such technology has evolved. Even prior to recent news coverage of technologies such as content generation applications, AI became a relatively prominent topic in public discussions about science in recent decades compared with previous discourse. Fast and Horvitz (2017) studied 30 years of *New York Times* references to AI—between 1986 and 2016—and found that mentions of AI, including references both to optimism and concerns about ethics and loss of control, began increasing in 2009. The emergence of new AI developments since 2022 (e.g., refinement of large language model applications) has inspired new survey research (Vogels 2023), although the pace of prominent news coverage has yet to be matched by extensive social science survey research specifically focused on AI technology released since 2022. At the same time, a body of existing survey evidence suggests uncertainty and variation among Americans in their perceptions of AI, robotics, and automation technology, which helps to forecast U.S. adults' perceptions in the near future.

Data from 3M's 2020 State of Science Index survey suggested some uncertainty among Americans over the definition of AI.[3] When Americans were asked how much they know about AI in 2020, 22% reported knowing "nothing" about AI, 17% reported that they know "a lot," and 62% reported knowing "some" (3M 2020). Americans also recently have varied in their familiarity with different applications of AI. In December 2022, the Pew Research Center asked U.S. respondents about the extent to which they have heard or read about tasks that AI technologies could perform, including prediction of extreme weather events, skin cancer detection, and writing news stories. According to results, 46% of U.S. adults had encountered information about AI being used to aid weather prediction, 22% were aware of information about the use of AI for skin cancer detection, and 33% had heard or read information about AI being employed to write news articles (Funk, Tyson, and Kennedy 2023).

Public understanding of AI, robotics, and automation technology also may change in coming years if patterns of public perceptions predict future tendencies. Evidence suggests, for example, that popular conceptions of automation technology and robotics change as more people have opportunities for direct experience with various automated applications. Tenhundfeld and colleagues (2019, 2020) found that participants' willingness to rely on an automatic parking feature in an electric car varied as a function of how much experience they had with the technology. Over time, as they gained more experience with the feature, participants' tendency to allow automation to control the car increased (measured as the lack of behavioral intervention to stop the automated system from operating) (Tenhundfeld et al. 2020).

In a different example, Sanders and colleagues (2017, 2019) investigated human perceptions of robots in terms of perceived trust and willingness to allow a robot to perform various tasks. One of these studies (Sanders et al. 2017) found that prior interaction with robots was positively associated with trust in them. Another study (Sanders et al. 2019) found that participants were more likely to choose a robot for a task that was relatively dangerous and was likely to result in death. Respondents were also more likely to choose humans to do mundane warehouse tasks, noting job and income considerations for human workers and the implications of robots replacing human workers.

In recent years, news outlets have highlighted AI technologies capable of generating content such as news stories and visual images in response to text prompts; for example, Knight (2022) reported on the topic. As noted earlier, the Pew Research Center surveyed Americans in 2022 regarding perceptions of those and other AI technologies. Results revealed a diverse range of perspectives regarding the perceived importance of various AI developments (Funk, Tyson, and Kennedy 2023). Among those who had encountered information about AI to write news articles, 16% viewed such technology as a major advance. Among those who had heard or read about AI to predict extreme weather, 50% saw such technology as a major advance. The perceived importance of AI technology developments may change over time as Americans become more familiar with various AI technologies. At the same time, the 2022 Pew Research Center data also are consistent with the hypothesis that Americans' judgments about the importance and risks of technologies reflect perceptions of the implications of specific technologies for personal safety and well-being.

Popular imagination regarding AI beyond automated mechanical tasks and robotics is potentially fertile ground for future investigation; currently, however, much about human perceptions of AI remains undocumented. In March 2023, for example, the Pew Research Center surveyed U.S. adults about their awareness and use of ChatGPT, an open-access AI tool that relies on the use of a large language model to respond to user questions and requests for content. Among U.S. adults, 58% reported to have heard at least a little about the technology, but only 14% had used it to learn something new—and, among those who reported having used it, 66% reported it was only somewhat useful, not too useful, or not at all useful (Vogels 2023). That sense of utility may change as users spend more time with the technology or if more users try the technology.

Earlier survey research also has shown some ambivalence in public opinion about AI R&D. Analysis by Zhang and Dafoe (2019) of a public opinion poll of 2,000 adults (ages 18 and older) found that a substantial number (nearly half) of Americans support further development of AI, defined in the survey as "computer systems that perform tasks or make decisions that usually require human intelligence" (Zhang and Dafoe 2019:5). This study is consistent with results from a Pew Research Center report (Johnson and Tyson 2020) in which roughly half of U.S. respondents said that the development of AI "has mostly been a good thing for society." A related review of public opinion surveys between 2010 and 2022 suggested that U.S. adults tend to anticipate AI will facilitate future advances in medicine (Beets et al. 2023).

Existing evidence also suggests widespread ambivalence and lack of awareness of specific details regarding AI applications. More than a third of participants in the Zhang and Dafoe (2019) analysis, for example, neither supported nor opposed AI development (28%) or were unsure about what they thought of AI development (10%). What support for AI research existed among participants also appears to be conditional. The vast majority (82%) of those surveyed by Zhang and Dafoe believed robots or AI should be carefully managed. A review of over a decade of public opinion data on the use of AI in health care settings also suggested approximately half of U.S. adults are not aware of specific instances in which AI is applied in health care (Beets et al. 2023); in the 2020 Science Media and the Public study conducted by YouGov, for example, 48% of U.S. adults had little or no awareness of the use of AI to improve disease diagnosis efficiency. Taken together, current public perception research on AI suggests that many Americans lack awareness about AI or feel uncertain about it, yet they feel some conditional optimism about it as well. The vast majority of U.S. adults appear to have some concern about future technology management.

Neurotechnology

Neurotechnology refers to manufactured devices that can monitor human brain processes and provide feedback to people based on that monitoring. As Farahany (2023) has noted, consumer neurotechnology devices now include a wide range of tools that connect human brains to computers as well as algorithms that make it possible for computers to analyze and respond to data resulting from brain monitoring. Neurotechnological devices have been developed to treat conditions such as chronic pain, epilepsy, Parkinson's disease, and depression as well as to assist individuals with disabilities (Sattler and Pietralla 2022). For example, brain-computer interfaces show promise in helping to rehabilitate patients with severe motor impairments, paralysis, and disabilities using wearable or implanted electrodes that harness brain activity to control external devices like wheelchairs and body prostheses (Chaudhary, Birbaumer, and Ramos-Murguialday 2016). Neurotechnology applications to generate feedback from consumers and enable consumer input and control of various interfaces also now exist (Farahany 2023). Neurotechnology development has attracted industry investment and has posed ethical challenges related to identity, privacy protection, data tracking, and rights to cognitive liberty and mental privacy (Farahany 2023; MacDuffie, Ransom, and Klein 2022).

Empirical evidence regarding public perceptions of neurotechnology is limited. Extant data also reflect changes over time in the physical nature of neurotechnology devices; this is important to note, given that developers appear likely to continue changing and improving such devices in coming years. In 2016, the Pew Research Center surveyed U.S. adults regarding biomedical technologies to enhance human abilities and found that 69% of adults reported they would be "very" or "somewhat" worried about brain chips. Moreover, 66% of adults said they would not want enhancements of their brains (Pew Research Center 2016). Similarly, the Pew Research Center reported in 2022 on another study of U.S. adults in which 78% of adults would not want a computer chip implanted in their brain for enhanced cognitive function and improved processing of information if it were available to them (Rainie et al. 2022). **Table PPS-2** describes conditions in which respondents reported they would be comfortable with an implanted device. The majority (77%) of U.S. adults reported that they favored the proposed use of computer chip implants in the brain to allow increased movement for people who are paralyzed, for example, whereas a lower percentage (25%) favored the use of implanted chips to make it possible for thoughts in the brain to search content on the Internet without typing. Evidence specifically regarding implanted devices may not necessarily generalize to technologies that are not as physically invasive as implanted devices, however; Sattler and Pietralla (2022) surveyed German adults, for example, and found respondents tended to prefer noninvasive technologies over relatively invasive technologies.

Table PPS-2

Responses to proposed uses of computer chip implants in the brain: 2021

(Percent)

	Response options		
U.S. adults (*n* = 5,107)	Favor	Oppose	Not sure
To treat age-related decline in mental abilities	64	13	21
To allow increased movement for people who are paralyzed	77	8	14
To make it possible for thoughts in the brain to search content on the Internet without typing	25	42	31
To translate thoughts in the brain, without speaking, into text on a screen	32	34	32

Note(s):
Percentages may not add to 100%. See Table SPPS-8 for standard errors. Responses are to the following: *Computer chip implants in the brain could be used for a number of purposes. Would you favor or oppose the use of computer chips implants in the brain for each of the following purposes?*

Source(s):
Pew Research Center, American Trends Panel Wave 99 (2021), conducted 1–7 November 2021.

Science and Engineering Indicators

At least some evidence also suggests that public acceptance of neurotechnology devices may be conditional on the perceived context and the purposes of use. In two waves of surveys in 2018 and 2019, MacDuffie, Ransom, and Klein (2022) asked a sample of U.S. general public respondents (*n* = 1,088) and a sample of industry representatives (*n* = 66) about perceptions of "neural devices" that read information from the brain or spinal cord. Most general public respondents (82%) agreed that the topic of user data privacy was important to them, yet only 47% of general public respondents agreed that they were confident neural devices will be designed with privacy in mind. (Among the small sample of industry representatives surveyed, 64% agreed that they were confident devices will be designed with privacy in mind.) In Germany, Sattler and Pietralla (2022) found that moral acceptability and willingness of devices depended on the perceived purposes of those devices. For example, respondents preferred the use of devices for treatment of medical conditions rather than individual human enhancement. Moreover, respondents were not uniform in their acceptance of neurotechnology devices; in the Sattler and Pietralla (2022) study, factors such as perceived stress, religiosity, and gender identity predicted potential user openness to such devices.

In the United States, public opinion research on the frontiers of noninvasive neurotechnology has been limited to date, with available survey data focused on perceptions of either specific technologies such as implanted chips or perceptions of general categories such as neural devices. Some evidence suggests widespread concern among American adults when asked about the use of neurotechnology, but it is currently unclear how well they understand the specific capabilities and planned future uses of such devices. The recent pace of neurotechnology development in various industries and the likely future iteration of device formats and purposes suggest a need for additional public opinion research to address whether such technology changes could be useful.

Climate Change

The percentage of Americans who have expressed concern about the rise in the Earth's average temperature over time has increased in recent decades (see *Indicators 2020* report "**Science and Technology: Public Attitudes, Knowledge, and Interest**"). U.S. adults' beliefs about climate change S&T include both relatively broad support for including climate scientists in government policy deliberation as well as a common perception that climate scientists do not yet extensively understand climate change mitigation. An April 2021 Pew Research Center survey found that 54% of Americans agree that climate scientists should play a larger role in climate policy debates, although a smaller percentage (18%) agreed that climate scientists currently understand "very well" the best ways to mitigate climate change (Funk 2021). The belief that climate scientists do not extensively understand climate change mitigation possibilities, however, has not dampened support for mitigation strategy research, as illustrated by Pew Research Center data collected in May and June 2023. According to data from the 2023 survey, 67% of U.S. adults believe the United States should prioritize efforts to develop renewable energy sources, such as wind and solar, instead of expanding oil, coal, and natural gas production (Tyson, Funk, and Kennedy 2023). U.S. adults generally acknowledge the relevance of climate science research to societal decision-making even as more remains to be learned about climate change mitigation, and they express support for relevant renewable energy S&T development.

Recent research also offers insight on factors that can shape and influence perceptions of climate change concepts. The vocabulary that researchers use to describe concepts and the use (or absence) of specific examples may affect public understanding of climate change terminology. In a study of understanding of terms from the United Nations' Intergovernmental Panel on Climate Change reports, for example, respondents expressed difficulty in understanding phrases such as *carbon neutral* (which refers to processes that result in no net addition of carbon dioxide to the atmosphere) or *unprecedented transition*—which, in turn, complicated their interpretation of report content (Bruine de

Bruin et al. 2021). In addition, exposure to news stories can directly affect public opinion about climate change, both in terms of increasing the perceived general importance of the topic as well as issue-framing effects (Newman, Nisbet, and Nisbet 2018). News references to the credibility of science and scientific institutions can indirectly affect beliefs about the credibility of climate change research (Hmielowski et al. 2014).

Personal experience also may affect interpretation of climate change messages. The extent to which a person has thought about climate change previously also appears to limit possibilities for media content to affect beliefs about climate change (Wonneberger, Meijers, and Schuck 2020). Local weather experiences and natural disasters appear to shape individuals' beliefs regarding whether climate change is occurring (Sloggy et al. 2021) as well as risk perceptions of climate change and preferences for government climate policy (Kim, Seo, and Sinclair 2021). Research indicates that perceptions of climate change and climate change research are functions of both existing beliefs and patterns in the information environment—suggesting the *potential* for change but also relative stability if consistent news coverage and online information about climate change slowly accumulate over time.

Water Contamination

Water is vital for human life (Jéquier and Constant 2010), and contaminant-free drinking water is important for human health. Although water quality in the United States generally has improved according to conventional metrics in recent decades, research has documented important threats to human health related to water contamination. Specifically, substances such as lead (GAO 2020) and human-made chemicals such as per- and polyfluoroalkyl substances (PFAS) (GAO 2021)—sometimes found in public drinking water systems, private wells, and various consumer products—can threaten water quality, as can harmful bacteria. News coverage in the past decade has spotlighted the discovery of toxins in drinking water in communities such as Flint, Michigan, and Jackson, Mississippi (Breslow 2022). Despite national news coverage and scientific inquiry regarding the prevalence and effects of contamination, available peer-reviewed literature lacks robust empirical evidence of the extent of public understanding of water contamination research, although recent research suggests the potential value of water research education for encouraging public cooperation with testing efforts (Gibson et al. 2022).

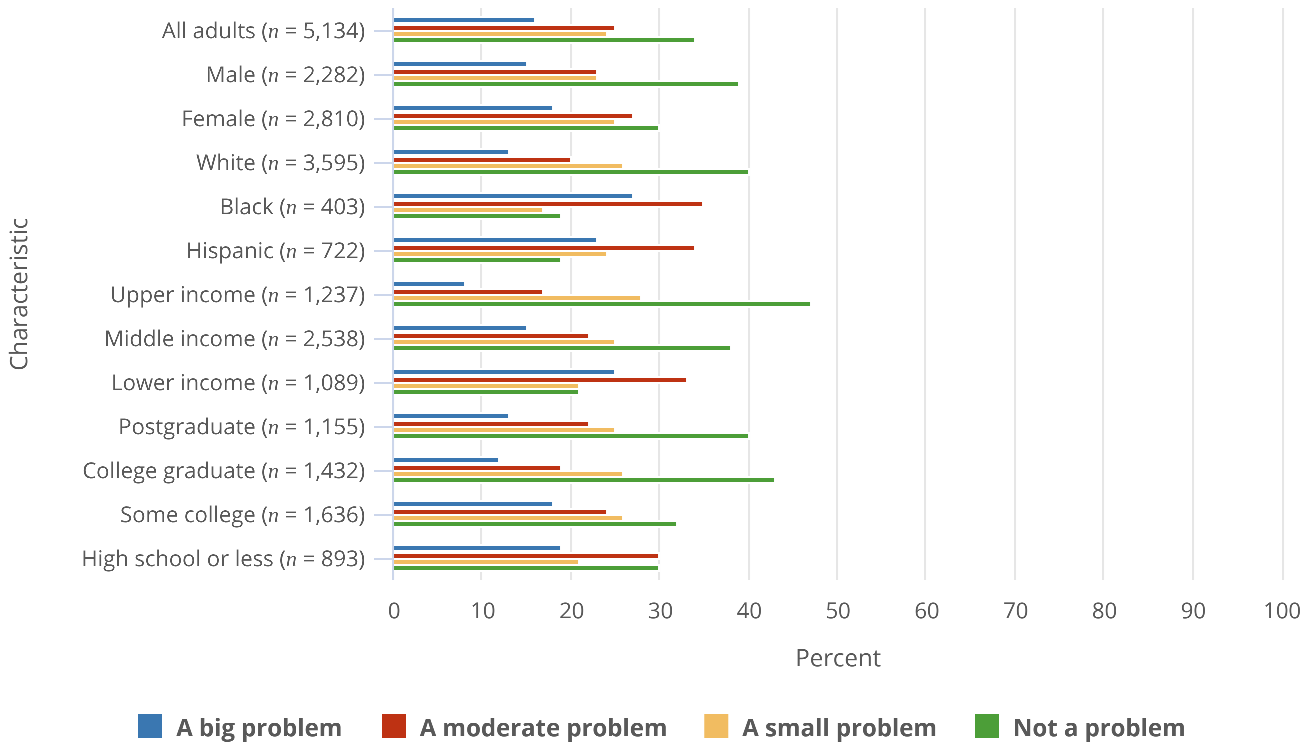
Water safety and quality have been topics featured in public discourse in the United States in recent years. Evidence suggests that water safety and quality topics have increased in prominence on social media platforms. For example, social media posts mentioning PFAS-related content increased on two platforms, Reddit and Twitter (known as X subsequent to this study), by more than sixfold (by 670%) from 2017 to 2019 (Tian et al. 2022), a pattern that study authors attribute in part to news coverage about PFAS exposure in the United States. Survey evidence also suggests that a substantial minority of Americans have harbored concerns about drinking water safety since at least 2018. A 2018 survey of more than 4,000 U.S. adults found that 15% did not believe their home tap water was safe to drink (Park et al. 2023).

Americans' perceptions of home tap water safety vary by socioeconomic factors. In the Park et al. (2023) study, those with relatively less than a high school diploma were more likely to report concern about home tap water safety compared with those with a college degree, and people living in a household with $35,000 or less in annual income were more likely to report home tap water safety concerns than those with $100,000 or more in annual income. Among those with less than a high school diploma, 21% did not believe their home tap water was safe to drink.

May 2022 ATP data from the Pew Research Center underscore important differences between socioeconomic groups in the perceived quality of local community water (**Figure PPS-5**). Among Americans with a high school diploma or less, 19% viewed the safety of drinking water as "a big problem" in their local community; among college graduates, however, 12% of adults saw drinking water safety as "a big problem." Similarly, among those in the lowest income tier of respondents (less than $43,800 annual household income), 25% saw drinking water quality as a big problem, while among those in the highest income bracket (with incomes above $131,500 annually), 8% viewed drinking water as a big problem in their local community. Such perception differences coincide with research on variation between neighborhoods in demonstrable exposure to some types of contaminants such as lead (Xue et al. 2022).

Figure PPS-5

Opinions on safety of drinking water, by demographic characteristics: 2022



Note(s):
Percentages may not add to 100% because the nonresponse category for level of confidence is not shown. See Table SPPS-9 for standard errors. Income tiers are based on 2021 family incomes that have been adjusted for household size and cost of living in respondents' geographic region. Middle income includes respondents whose family incomes are between two-thirds of and double the median-adjusted family income among the panel of respondents. For a three-person household, upper income is approximately $131,500 and above, middle income is from $43,800 to $131,500, and lower income is less than $43,800. Responses are to the following: *How much of a problem, if at all, do you think [safety of drinking water] is in your local community?*

Source(s):
Pew Research Center, American Trends Panel Wave 108 (2022), conducted 2–8 May 2022.

Science and Engineering Indicators

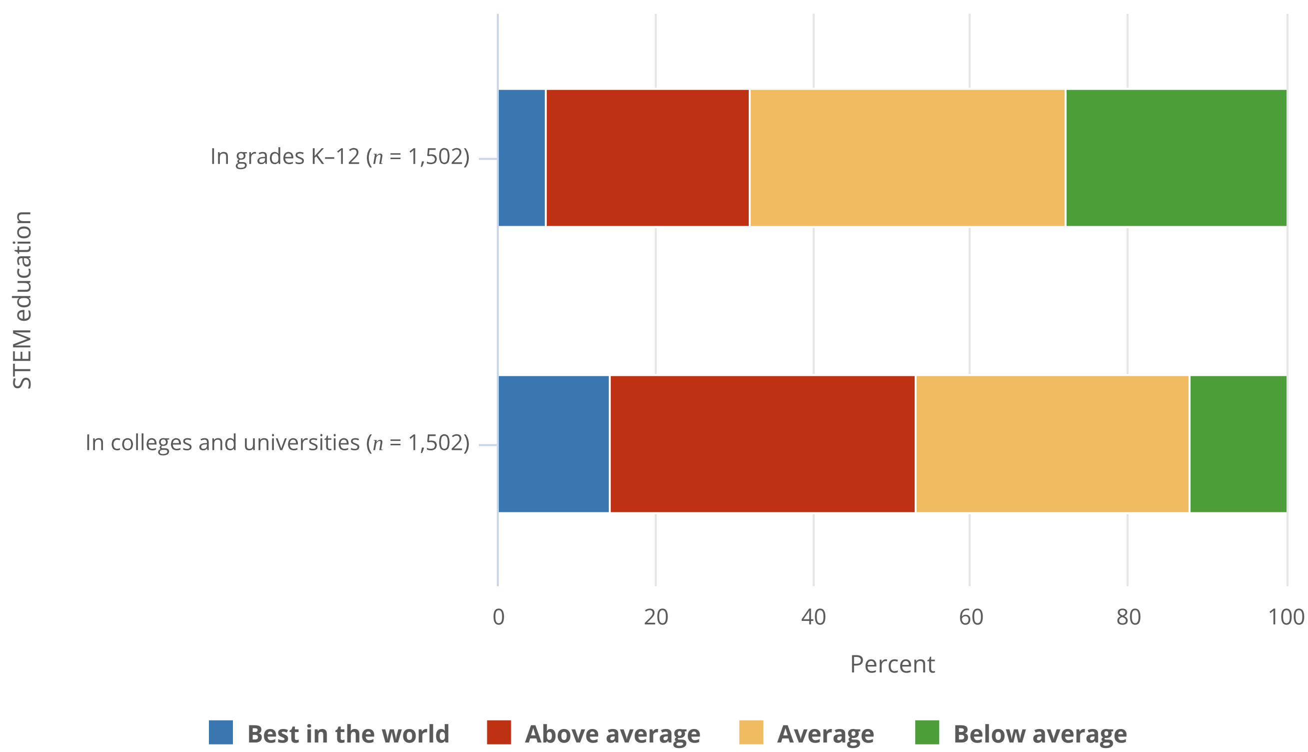
Aside from evidence of general concerns about water quality, however, the extent to which American adults understand water contamination processes, water quality research, and potential remedies is not yet clear in available peer-reviewed literature. Some evidence suggests that educational information about certain aspects of water quality testing and research can motivate relevant water testing behavior. Experimental evidence from a study with North Carolina residents, for example, demonstrated that residents with a private well who were offered a free well test, along with information as to why such testing is important (e.g., because using one's senses such as vision or taste alone can be insufficient to detect water problems), tended to opt for testing more than their counterparts (Gibson et al. 2022). Those offered a free test and information were more likely to opt for well testing than those in a control group, those who were offered a free well test without explanatory information, and those who were offered explanatory information without a free well test. Such responses to information about water quality testing may reflect the importance of addressing existing gaps in residents' mental models of how water researchers conduct their work and what data water testing can produce (Gibson et al. 2022). Future research could investigate whether Americans understand that water safety research comprises different attributes of water quality: those that are apparent to human sensory perception and those that are invisible or not detectable by typical human senses alone.

STEM Education

Public perception of STEM education in K–12 U.S. public schools comprises a mix of fond recollection of science classes; concern about present investment in K–12 schools; and widespread judgment that the STEM education offered to elementary, middle, and high school students in the United States is worse than that offered in at least some other countries. A Pew Research Center survey (Funk and Parker 2018) found that 75% of U.S. adult respondents reported that they liked science courses during their time as K–12 students; 58% of adults reported liking their K–12 mathematics courses. When asked to choose whether they liked those courses because of the subject matter itself or because of the way the subject matter was taught, 68% of those who liked their science courses said the subject matter was the main reason they enjoyed those classes. Despite Americans' fondness for their own STEM experiences, only 31% of U.S. respondents in October 2019 considered K–12 STEM education in the United States to be at least above average when compared with what is available in other nations (**Figure PPS-6**). Regarding undergraduate and graduate STEM education in the United States, about half of respondents (52%) thought STEM education in U.S. colleges and universities is above average or the best in the world compared with what is available in other countries. Future inquiry could explore the basis for such perceptions.

Figure PPS-6

Perceptions of U.S. STEM education compared with other nations at K–12 and university levels: 2019



STEM = science, technology, engineering, and mathematics.

Note(s):
Percentages may not add to 100% because the nonresponse category is not shown. See Table SPPS-10 for standard errors. Responses are to the following: *I'd like you to compare the United States to other nations in a few different ways. Do you think the U.S. is the best in the world, above average, average or below average? Its science, technology, engineering and math education in grades K to 12. Its science, technology, engineering and math education in colleges and universities.*

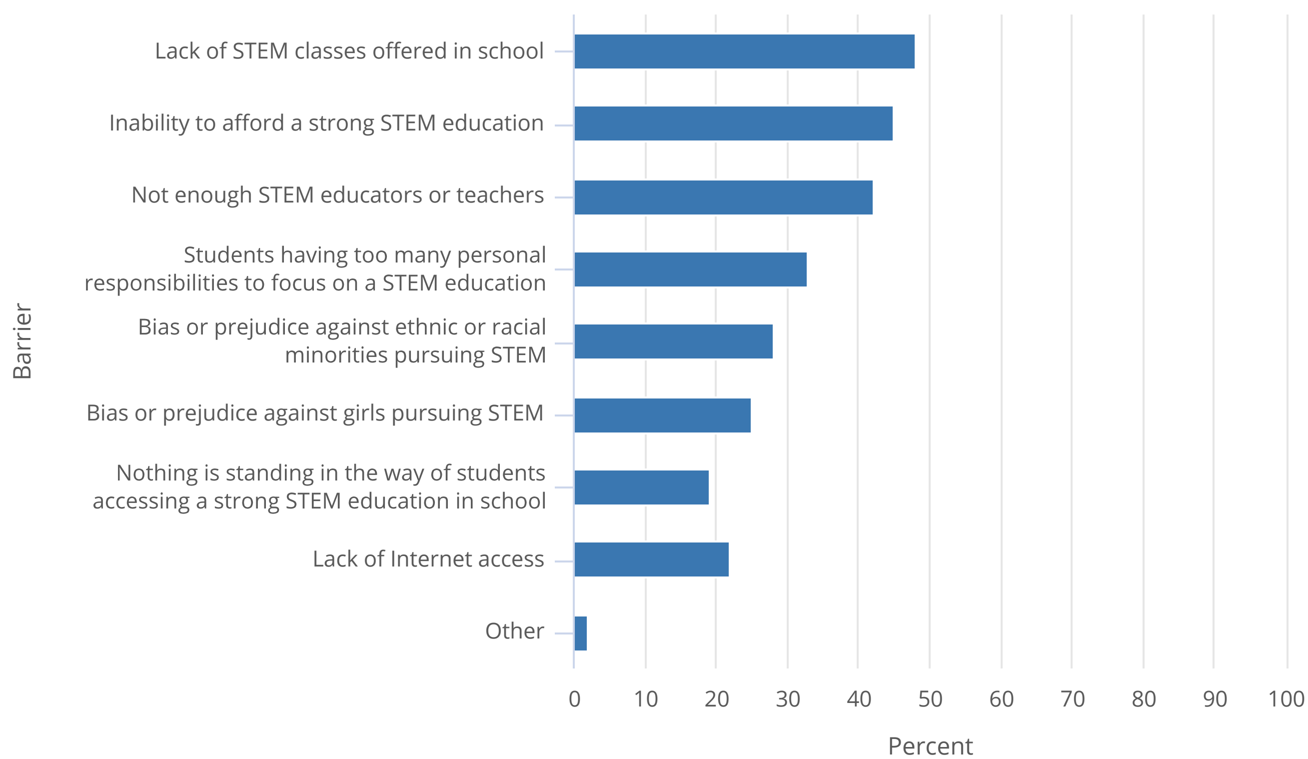
Source(s):
Pew Research Center, International Science Survey (2019–20), conducted in the United States 1–28 October 2019.

Science and Engineering Indicators

Perceptions of STEM education quality among Americans appear to reflect concerns about resource availability more than reasons such as dismissive cultural beliefs. The 2022 3M State of Science Index survey asked U.S. respondents what barriers were most important in "standing in the way of students accessing a strong STEM education," and the most common responses were a lack of STEM classes in school, the inability of students to pay for STEM education, and a lack of STEM teachers (**Figure PPS-7**). Although most Americans see value in STEM education, they typically do not see elementary, middle, and high school STEM education as the best in the world, and they are most likely to cite resource constraints as major barriers to access. Other *Science and Engineering Indicators* reports focus on institutional measures of STEM education quality in the United States (see *Indicators 2024* reports "**Elementary and Secondary STEM Education**" and "**Higher Education in Science and Engineering**").

Figure PPS-7

U.S. adults' belief on top three barriers to students accessing strong STEM education in the United States: 2021



STEM = science, technology, engineering, and mathematics.

Note(s):
See Table SPPS-11 for standard errors. Responses are to the following: *What do you believe are the top barriers, if any, standing in the way of students currently accessing a strong STEM education within your country? Select top three.*

Source(s):
3M. 2022. 2022 State of Science Index, conducted 27 September–17 December 2021.

Science and Engineering Indicators

Public Familiarity with Science and Technology Research Processes

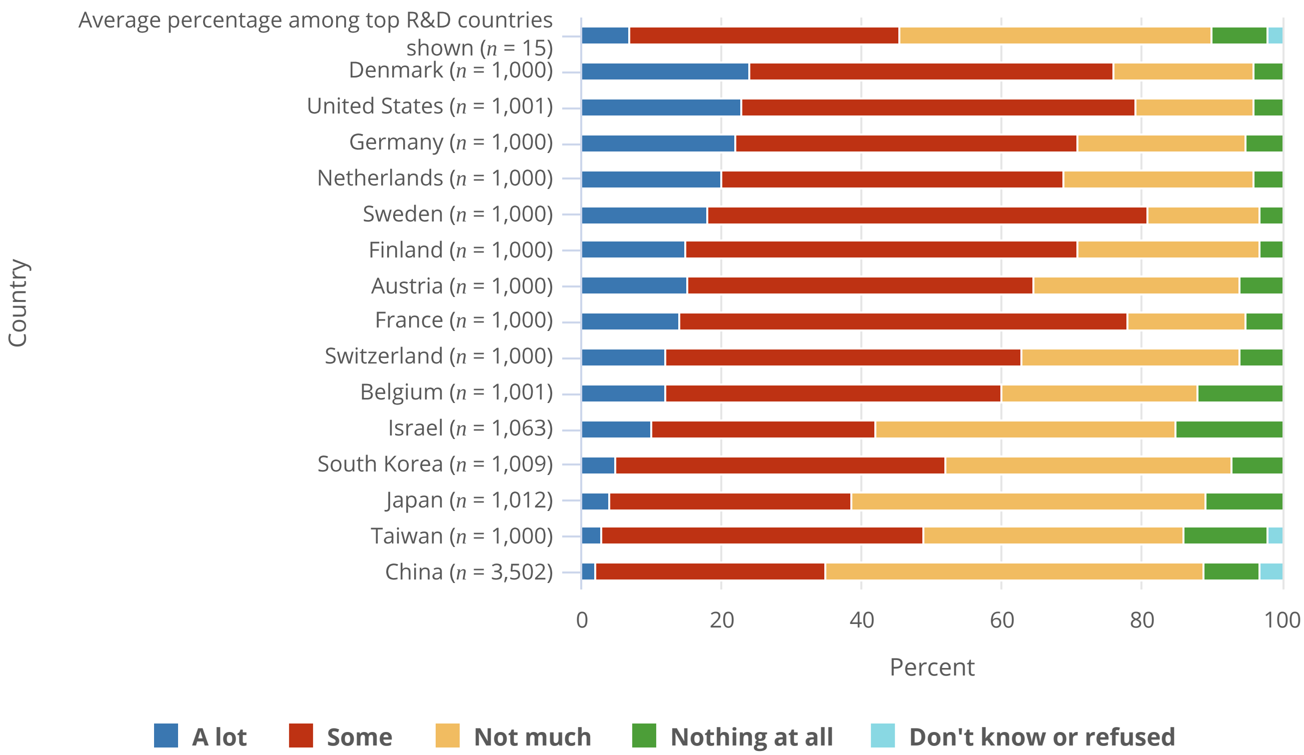
As noted earlier, research on public perceptions of science has shifted over time. Although earlier work often focused on public knowledge of facts, more recent work emphasizes how people understand the practice of science. Building on the notion that scientific literacy should include comprehension of how to conduct scientific inquiry (Miller 1983), recent research on public understanding of science has begun to assess what people know about *how* scientists perform scientific research (Hendriks, Kienhues, and Bromme 2020). Scientists can vary in their methods of inquiry and in the quality of their inquiries. At least some recent research has assessed the extent to which people tend to understand basic principles of scientific inquiry that are often taught in the context of higher education science training.

What Americans understand about how S&T research is conducted is also related to how the general U.S. population views S&T institutions and professionals, including the extent to which American adults trust S&T institutions and professionals. Knowing how well Americans understand the processes that S&T professionals use to make observations about the world can offer insights about the context of, and even potential explanations for, their general perceptions about S&T. For example, proactively acknowledging that uncertainty is an element of the scientific process because scientists continue to test ideas over time can encourage confidence in science in general (Druckman 2015; Jamieson and Hardy 2014).

Many Americans report not having much scientific knowledge when asked for their subjective report of how much they know. Data from the 2020 Wellcome Global Monitor survey found that 23% of Americans surveyed believed they knew “a lot” about science (**Figure PPS-8**). This was, nonetheless, a higher percentage than was reported by citizens of the 15 other countries with the largest gross domestic expenditures on R&D as a percentage of their GDPs included in the report except Denmark, Germany, and the Netherlands, which were not statistically different in the percentage reported. On average, 7% of citizens across all 15 surveyed countries said they knew “a lot” about science.

Figure PPS-8

Perceived knowledge about science, by country: 2020



Note(s):
Percentages may not add to 100% because of rounding. See Table SPPS-12 for standard errors. Countries are those with top 16 gross domestic expenditures on R&D as a percentage of gross domestic product in 2019, listed in order of percentages that perceive knowing "a lot" about science from highest to lowest. (See *Indicators 2022* report "Research and Development: U.S. Trends and International Comparisons": Table 4-5.) Gallup adjusted each individual country total for nonresponse and population size. The average percentage shown in the figure is the mean across individual country percentages reported by Gallup. In 2019, Iceland was ranked in the top 16 but was not included in the Wellcome Global Monitor 2020 survey; therefore, only 15 of the top 16 countries are shown. Responses are to the following: *How much do you, personally, know about science? Do you know a lot, some, not much, or nothing at all?*

Source(s):
Gallup. 2021. Wellcome Global Monitor 2020.

Science and Engineering Indicators

According to ATP data collected in November 2020 by the Pew Research Center,[4] when asked which of a series of statements best describes the practice of science, a majority (66%) believed that the scientific method produces findings that are meant to be continually tested and updated over time, but a substantial minority of respondents (34%) believed that the process produces “unchanging core principles and truths” or was unsure (see *Indicators 2022* report “**Science and Technology: Public Perceptions, Awareness, and Information Sources**”). These results suggest that most American adults understand the possibility of changes over time in the empirical evidence generated by scientific research, but a third of this population does not. At least some scientific knowledge reflects a relatively established body of evidence and does not change often, which some respondents might understand; nonetheless, the majority of respondents in the Pew Research Center study also reported that science can include new studies to test established ideas.

Additional evidence from the ATP reveals that a majority of U.S. adults have some substantive understanding of experimental logic; 60% of U.S. adults could correctly note that a control group can be useful in making sense of study results (see *Indicators 2022* report "**Science and Technology: Public Perceptions, Awareness, and Information Sources**"). When asked, however, only half of U.S. adults (50%) could correctly identify a scientific hypothesis. Those results suggest that a sizable proportion of the U.S. adult population may not currently understand the scientific process of hypothesis testing in the same way that professional scientists working in scientific communities do.

U.S. adults' understanding of scientific logic and of the effectiveness of the scientific method is positively related to their confidence in scientists to act in accordance with public interests, which is an indicator of trust. Trust comprises not only perceptions of competence but also perceptions of shared interest between parties (Southwell et al. 2019). The latest national evidence available to illustrate an association between individuals' understanding of science as a process and their confidence in scientists is Pew Research Center data collected in November 2020. In those data, accurate understanding of the scientific process is positively associated with respondents' expression of "a great deal" of confidence in scientists to act in the public's best interests (**Table PPS-3**). For example, among those who accurately responded that assigning a control group to not receive medication would be a useful way to test whether a medication works, 44% also expressed a great deal of confidence in scientists to act in the best interests of the public. By comparison, a lower percentage (32%) of those who incorrectly did not report that a control group would be useful (meaning those who did not demonstrate understanding of experimental logic) expressed such confidence. In addition, approximately half (47%) of respondents who knew what a hypothesis is expressed a great deal of confidence in scientists, whereas 31% of those who did not demonstrate knowledge of what a hypothesis is expressed a great deal of confidence in scientists "to act in the best interests of the public" (**Table PPS-3**).

Table PPS-3

Confidence in scientists to act in the best interests of the public, by indicator of scientific method understanding: 2020

(Percent)

Perception of the scientific method	A great deal	A fair amount	Not too much	None at all
Understanding of the use of control groups in a hypothetical scientific study about the effectiveness of a medication				
Create a control group that does not receive the medication (*n* = 4,432)	44	43	11	2
Other responses[a] (*n* = 1,851)	32	48	16	4
Understanding what a hypothesis is				
Selected "hypothesis" as answer (*n* = 3,725)	47	41	10	2
Selected answer other than "hypothesis" (*n* = 2,558)	31	49	16	3

[a] Includes "not sure," incorrect responses, and refusals.

Note(s):
Percentages may not add to 100% because the nonresponse category for level of confidence is not shown. See Table SPPS-13 for standard errors. Responses are to the following: *How much confidence, if any, do you have in [scientists] to act in the best interests of the public?*

A scientist is conducting a study to determine how well a new medication treats ear infections. The scientist tells the participants to put 10 drops in their infected ear each day. After 2 weeks, all participants' ear infections had healed. Which of the following changes to the design of this study would most improve the ability to test if the new medication effectively treats ear infections? Create a second group of participants with ear infections who do not use any ear drops. Create a second group of participants with ear infections who use 15 drops a day. Have participants use ear drops for only 1 week. Have participants put ear drops in both their infected ear and healthy ear. Not sure.

The time a computer takes to start has increased dramatically. One possible explanation for this is that the computer is running out of memory. This explanation is a scientific… Hypothesis. Conclusion. Experiment. Observation. Not sure.

Source(s):
Pew Research Center, American Trends Panel Wave 79 (2020), conducted 18–29 November 2020.

Science and Engineering Indicators

Americans' confidence in medical scientists was similar to confidence in scientists generally according to the November 2020 Pew Research Center data; those respondents who had a greater understanding of science as a process tended to have higher levels of confidence in scientists generally and in medical scientists (**Table PPS-3**, **Table PPS-4**). Among those who understood the value of a control group in a study, 43% also expressed a great deal of confidence in medical scientists; among those who did not acknowledge the value of a control group, only 35% expressed a great deal of confidence in medical scientists.

Table PPS-4

Confidence in medical scientists to act in the best interests of the public, by indicator of scientific method understanding: 2020

(Percent)

Perception of the scientific method	A great deal	A fair amount	Not too much	None at all
Understanding of the use of control groups in a hypothetical scientific study about the effectiveness of a medication				
Create a control group that does not receive the medication (*n* = 4,407)	43	45	10	1
Other responses[a] (*n* = 1,958)	35	45	15	4
Understanding what a hypothesis is				
Selected "hypothesis" as answer (*n* = 3,746)	46	43	9	1
Selected answer other than "hypothesis" (*n* = 2,619)	34	47	15	3

[a] Includes "not sure," incorrect responses, and refusals.

Note(s):
Percentages may not add to 100% because the nonresponse category for level of confidence is not shown. See Table SPPS-14 for standard errors. Responses are to the following: *How much confidence, if any, do you have in [medical scientists] to act in the best interests of the public?*

A scientist is conducting a study to determine how well a new medication treats ear infections. The scientist tells the participants to put 10 drops in their infected ear each day. After 2 weeks, all participants' ear infections had healed. Which of the following changes to the design of this study would most improve the ability to test if the new medication effectively treats ear infections? Create a second group of participants with ear infections who do not use any ear drops. Create a second group of participants with ear infections who use 15 drops a day. Have participants use ear drops for only 1 week. Have participants put ear drops in both their infected ear and healthy ear. Not sure.

The time a computer takes to start has increased dramatically. One possible explanation for this is that the computer is running out of memory. This explanation is a scientific… Hypothesis. Conclusion. Experiment. Observation. Not sure.

Source(s):
Pew Research Center, American Trends Panel Wave 79 (2020), conducted 18–29 November 2020.

Science and Engineering Indicators

Information Sources and Involvement

Where and to what extent have Americans encountered information about science? To what extent do they seek information about science? Are U.S. adults involved in any informal activities (i.e., activities outside of a formal school setting) that could affect their understanding or perceptions of science? Recent data offer insights on these questions. (Related *Indicators* reports explore Americans' formal STEM training through educational institutions; see *Indicators 2024* reports "**Elementary and Secondary STEM Education**" and "**Higher Education in Science and Engineering**.")

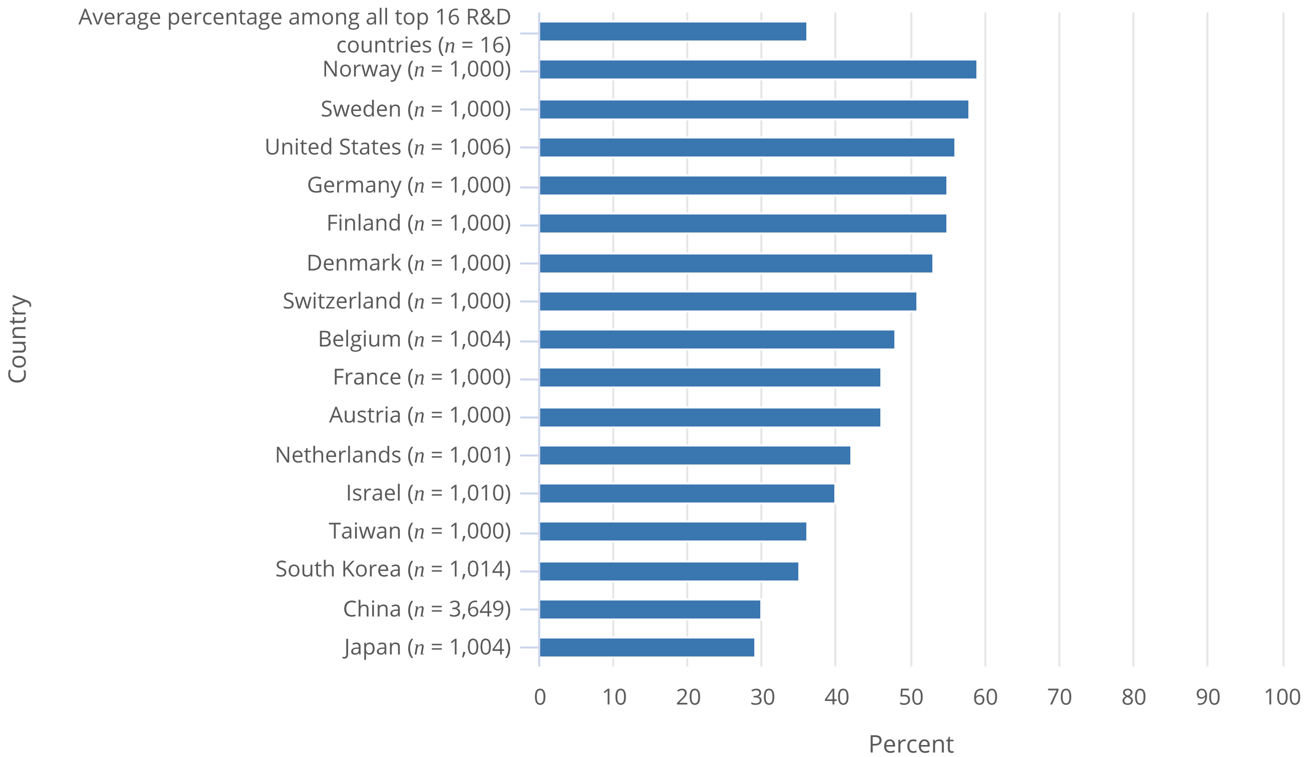
Sources of Information about Science

American adults tend to learn about science from general news sources rather than from specialized information sources dedicated to science (see *Indicators 2022* report "**Science and Technology: Public Perceptions, Awareness, and Information Sources**"). Especially in the past decade, U.S. adults also have cited social media platforms as a source of information regarding topics such as COVID-19 (Mitchell et al. 2020). That pattern of attention to general news outlets or social media content, which are often unmoderated by a professional science editor, is notable because that content typically differs substantively from content offered by specialized science information venues. Scientists and professional scientific organizations do participate on social media platforms and share study results and insights on some topics. Nonetheless, specific details about study limitations that appear in an original, peer-reviewed article may not be reported in all related news coverage or highlighted in all social media posts about the topic. Few local news outlets have staff who specialize in covering science, and even large news outlets often rely on press releases about new developments as sources for science news rather than offering continuing thematic discussion of how scientific research occurs over time or covering research topics without highly publicized research results (Schafer 2017). Moreover, in the contemporary American information environment, items reported in general news outlets compete for audience attention with numerous other stories not directly related to science (Lupia 2013).

Prior to the COVID-19 pandemic, data indicated that most Americans do look for S&T-related information—at least occasionally—on their own. The Wellcome Global Monitor 2018 survey highlighted the extent to which people around the world had attempted to get information about science in the 30 days before the survey (Gallup 2019). The majority of Americans surveyed (56%) reported having sought such information (**Figure PPS-9**)—a significantly higher percentage than most of their counterparts in 15 other countries that, like the United States, make substantial investments in S&T R&D. Americans also had sought information about medicine and disease at higher rates than citizens of most other nations in the survey, with 72% having looked for information on medicine, disease, or health in the previous month; the average for citizens seeking similar content in all nations was 50% (**Figure PPS-10**).

Figure PPS-9

Tried to get information about science in the past 30 days, by country: 2018



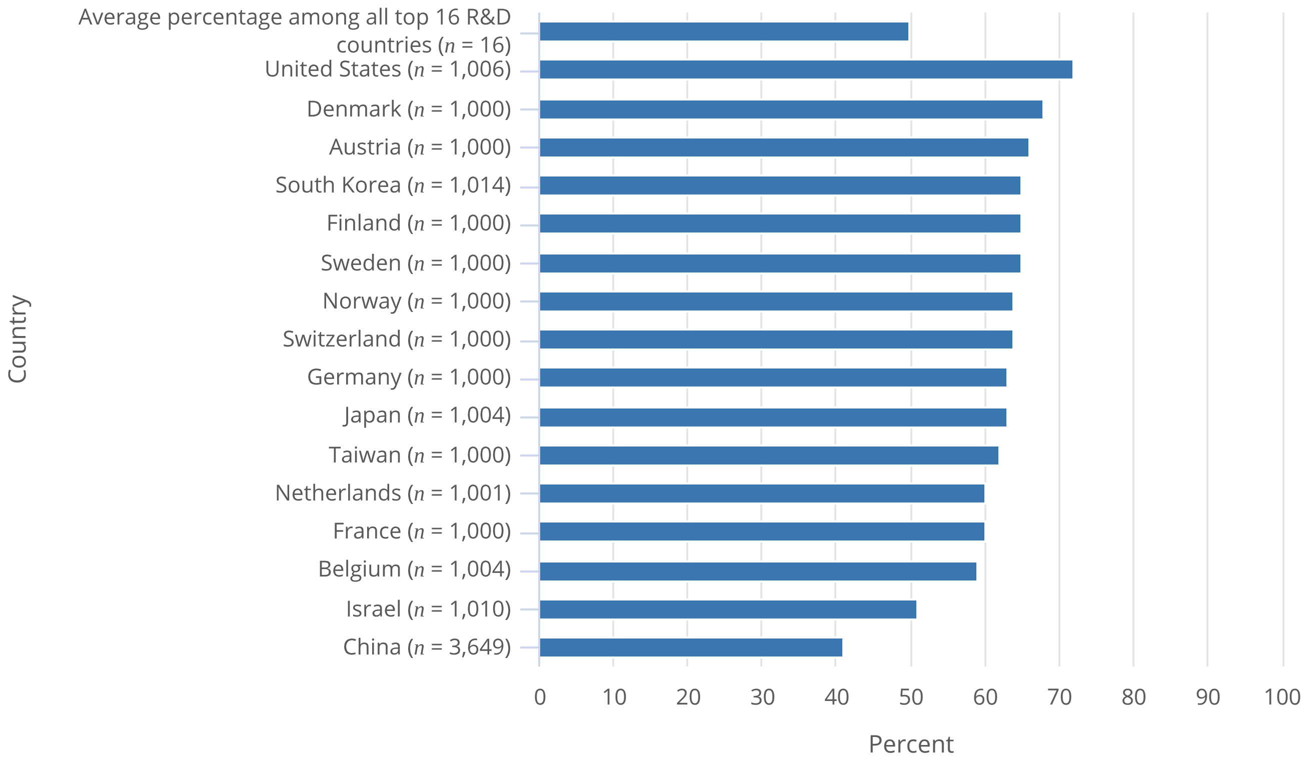
Note(s):
See Table SPPS-15 for additional details and standard errors. Countries are those with top 16 gross domestic expenditures on R&D as a percentage of gross domestic product in 2017, listed in order of percentages that tried to get information about science from highest to lowest. (See *Indicators 2020* report "Research and Development: U.S. Trends and International Comparisons": Table 4-5.) Gallup adjusted each individual country total for nonresponse and population size. The average percentage shown in the figure is the mean across individual country percentages reported by Gallup. The average percentage shown in the figure is the mean across individual country percentages reported by Gallup. Responses are to the following: *Have you, personally, tried to get any information about science in the past 30 days?*

Source(s):
Gallup. 2019. Wellcome Global Monitor 2018.

Science and Engineering Indicators

Figure PPS-10

Tried to get information about medicine, disease, or health in the past 30 days, by country: 2018



Note(s):
See Table SPPS-15 for additional details and standard errors. Countries are those with top 16 gross domestic expenditures on R&D as a percentage of gross domestic product in 2017, listed in order of percentages that tried to get information about medicine from highest to lowest. (See *Indicators 2020* report "Research and Development: U.S. Trends and International Comparisons": Table 4-5.) Gallup adjusted each individual country total for nonresponse and population size. The average percentage shown in the figure is the mean across individual country percentages reported by Gallup. Responses are to the following: *Have you, personally, tried to get any information about medicine, disease, or health in the past 30 days?*

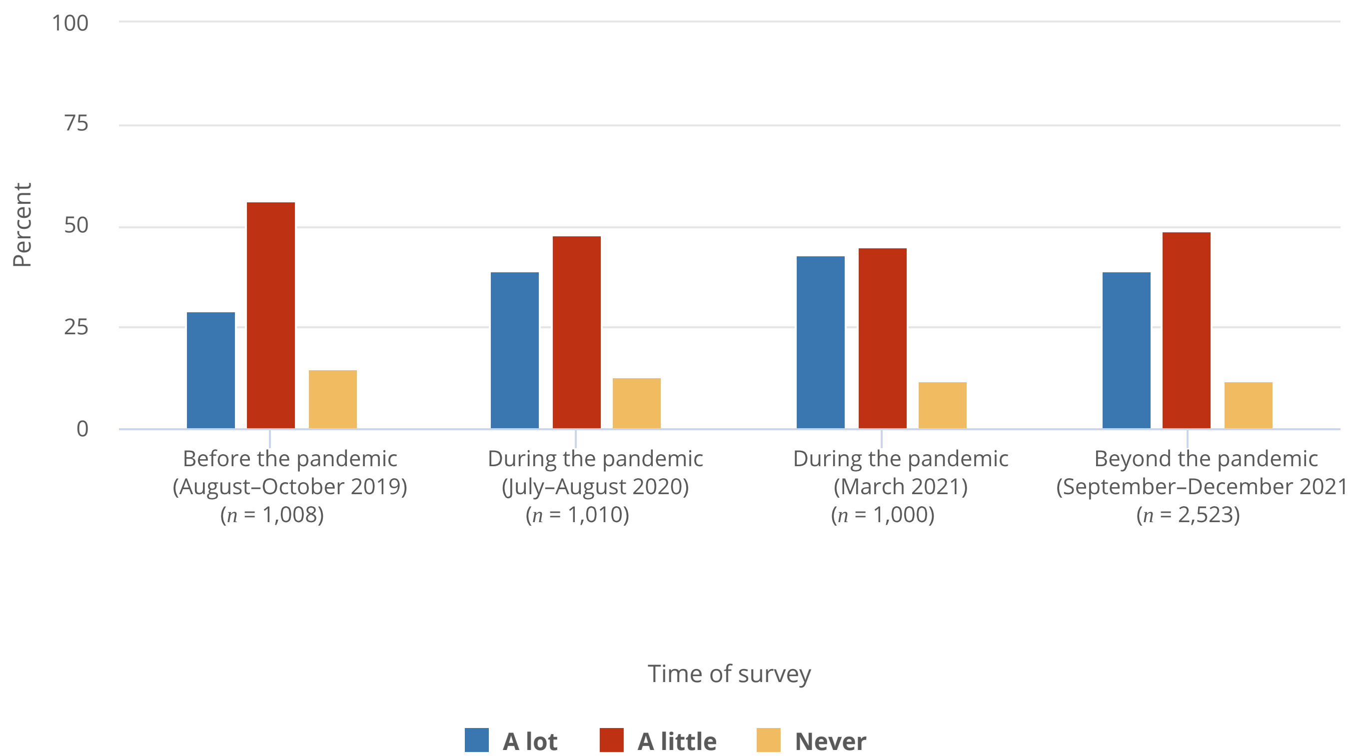
Source(s):
Gallup. 2019. Wellcome Global Monitor 2018.

Science and Engineering Indicators

Information seeking regarding science topics can rapidly rise and fall at times. Factors such as news coverage of disease-related scientific research predict online search behavior, for example, as occurred in the United States, Guatemala, and Brazil during the 2016 Zika virus outbreak (Southwell et al. 2016). Media coverage of COVID-19 research and personal experiences during the COVID-19 pandemic also may have increased the salience of science information in the everyday life experiences of Americans—at least temporarily. For its 2020 State of Science Index survey, 3M collected data from around the world,[5] both just before the large-scale spread of COVID-19 (August–October 2019) and during the pandemic (July and August 2020) (3M 2020). In late 2019, 29% of U.S. adults asked about how much they “think about the impact of science in your everyday life” responded that they thought about that topic “a lot”; in 2020, however, that figure jumped to 39% (**Figure PPS-11**). Although the majority of U.S. adults seek general scientific information on occasion and interest in specific topics sometimes sharply increases, most U.S. adults profess to not having “a lot” of specific scientific knowledge, as discussed earlier (**Figure PPS-8**).

Figure PPS-11

How often U.S. adults thought about the impact of science on their everyday lives: 2019–21



Note(s):
See Table SPPS-16 for standard errors. Responses are to the following: *How much do you think about the impact of science in your everyday life? Select one.*

Source(s):
3M, 2020 Pre-Pandemic Survey, conducted August–October 2019; 2020 Pandemic Pulse Survey, conducted July–August 2020; 2021 State of Science Index, conducted February–March 2021; and 2022 State of Science Index, conducted 27 September–17 December 2021.

Science and Engineering Indicators

Engagement with Science Activities

The extent to which American adults participate in science activities is one aspect of their direct opportunity to learn about scientific logic and processes. Available survey data depict low science activity participation rates among American adults, yet recent academic literature nonetheless describes noteworthy efforts to offer science activities for communities in the United States.

The U.S. governmental website CitizenScience.gov has described opportunities for public participation in the scientific process such as participation in forming research questions, conducting experiments, collecting or analyzing data, or interpreting results (FedCCS 2019). An example of this approach is the Audubon Society's annual bird count, in which volunteers report counts of various birds (Soykan et al. 2016). At least some American adults have had opportunities to generate science and engineering knowledge through participatory initiatives (Brossard, Lewenstein, and Bonney 2005; Pandya and Dibner 2018).

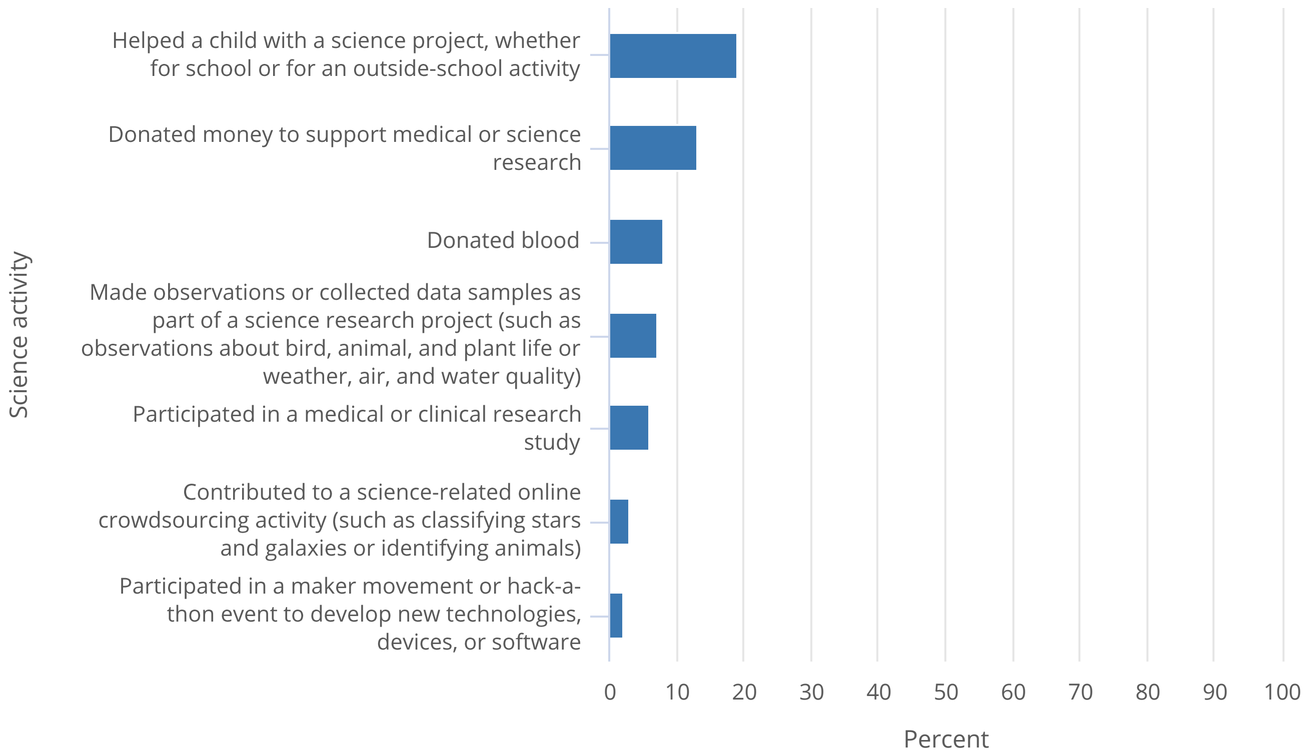
To date, population-level evidence of the reach of citizen science or participatory science activities has been limited. Researchers also have begun to ask questions about who gets involved in such activities and the extent to which activities are inclusive of various groups of people. Bonney (2021) notes that some projects have begun to use the phrase “community science” instead of “citizen science” to label such activities in recent years to encourage inclusivity in participation. Cooper et al. (2021) also have noted that just switching to “community science” as a label for activities does not necessarily guarantee that scientific activities welcome and include a wide range of people in practice, instead emphasizing the importance of offering accessible and participatory activities to increase the inclusion of people in scientific inquiry.

For more information about the state of citizen science or participatory science and the role of federal agencies as sponsors of such activities, see the sidebar **Citizen Science in Federal Agencies and Departments** in *Indicators 2022* report “**Invention, Knowledge Transfer, and Innovation**.”

American adults tend to not report direct experience with science activities. The Pew Research Center’s November 2020 ATP survey included questions about whether respondents had participated in a medical or clinical research study, made observations or collected data for a science research project, contributed to online crowdsourcing for a science project, or helped a child with a science project, among other activities. Only a small percentage of U.S. adults had participated in each of those science activities in the past 12 months (**Figure PPS-12**; **Table PPS-5**). Approximately 19% had helped a child with a science project either for school or outside of school, suggesting that exposure to science activities through children in the household offers involvement in science for some U.S. adults. Participation in STEM activities also varies as a function of income and education (**Figure PPS-13**; **Table PPS-5**). Adults in households with relatively low incomes or with less formal education report less exposure to science activities via school projects with household children. Such differences might reflect inequity in time available to participate or scientific literacy differences (Kalil and Ryan 2020). Evidence directly comparing Americans’ time spent with STEM activities and time spent with a range of education, athletic, and employment activities is lacking.

Figure PPS-12

Participation in science activities in the past 12 months: 2020



Note(s):
See Table SPPS-17 for standard errors. Responses are to the following: *Thinking about things you have done outside of work over the past 12 months, have you ever done the following?* A total of 10,957 adults responded to this question.

Source(s):
Pew Research Center, American Trends Panel Wave 67 (2020), conducted 29 April–5 May 2020.

Science and Engineering Indicators

Table PPS-5

Participation in science activities in the past 12 months, by family income and education: 2020

(Percent)

Characteristic	Participated in a medical or clinical research study	Made observations or collected data samples as part of a science research project (such as observations about bird, animal, and plant life or weather, air, and water quality)	Contributed to a science-related online crowdsourcing activity (such as classifying stars and galaxies or identifying animals)	Helped a child with a science project, whether for school or for an outside-school activity	Participated in a maker movement or hack-a-thon event to develop new technologies, devices, or software	Donated blood	Donated money to support medical or science research
All adults (*n* = 10,957)	6	7	3	19	2	8	13
Family income category[a]							
Upper income (*n* = 4,781)	7	9	3	23	2	10	19
Middle income (*n* = 3,624)	5	6	2	19	1	8	13
Lower income (*n* = 2,085)	6	7	4	17	2	6	8
Education category							
Postgraduate (*n* = 2,770)	9	12	4	27	2	9	23
College graduate (*n* = 3,176)	6	8	3	22	2	11	17
Some college (*n* = 3,294)	7	6	3	18	1	8	13
High school or less (*n* = 1,692)	4	5	3	17	1	6	8

[a] Income tiers are based on 2018 family incomes that have been adjusted for household size and cost of living in respondents' geographic region. Middle income includes respondents whose family incomes are between two-thirds of and double the median-adjusted family income among the panel of respondents. For a three-person household, upper income is approximately $112,601 and above, middle income is from $37,500 to $112,600, and lower income is less than $37,500.

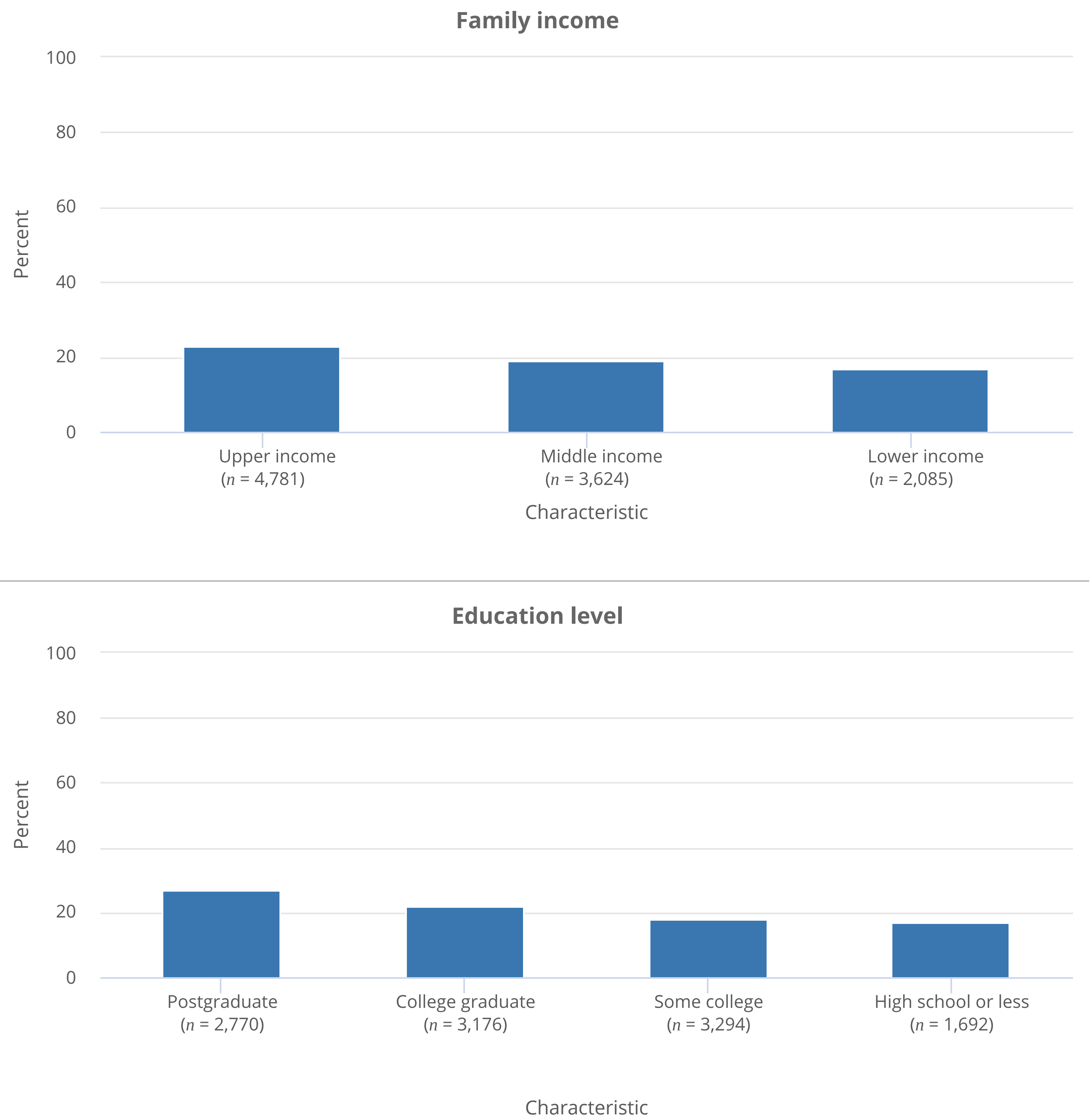
Note(s):
See Table SPPS-17 for standard errors. Responses are to the following: *Thinking about things you have done outside of work over the past 12 months, have you ever done the following?*

Source(s):
Pew Research Center, American Trends Panel Wave 67 (2020), conducted 29 April–5 May 2020.

Science and Engineering Indicators

Figure PPS-13

Helped a child with a science project in the past 12 months, by family income and education level: 2020



Note(s):
See Table SPPS-17 for standard errors. Income tiers are based on 2018 family incomes that have been adjusted for household size and cost of living in respondents' geographic region. Middle income includes respondents whose family incomes are between two-thirds of and double the median-adjusted family income among the panel of respondents. For a three-person household, upper income is approximately $112,601 and above, middle income is from $37,500 to $112,600, and lower income is less than $37,500. Responses are to the following: *Thinking about things you have done outside of work over the past 12 months, have you ever done the following?*

Source(s):
Pew Research Center, American Trends Panel Wave 67 (2020), conducted 29 April–5 May 2020.

Science and Engineering Indicators

According to May and June 2017 Pew Research Center data (Funk, Gottfried, and Mitchell 2017), a majority of U.S. adults (62%) reported having visited at least one type of science-related venue or event in the past year (including venues such as public parks, zoos, aquariums, natural history museums, or S&T centers, or an event such as a science talk). The percentage of U.S. adults who reported having visited reporting specific venues was smaller, however, with only national, state, or county parks garnering reported visits from almost half (47%) of U.S. adults. For example, 30% of U.S. adults reported having visited a zoo or an aquarium in the past year, and 18% reported having visited an S&T center. Although most U.S. adults reported occasional visits to science-related venues or events prior to the COVID-19 pandemic, U.S. adults also have tended to encounter sources of science information such as news media outlets more often than physical venues focused on science topics. Respondents in the 2017 Pew Research Center study were more likely to report getting science-related news from general news outlets that cover a range of topics (54%) or science video programs (45%) than from visits to S&T centers or museums (12%). (A previous version of this report also discusses topics such as visits to museums and zoos; for information, see the *Indicators 2020* report "**Science and Technology: Public Attitudes, Knowledge, and Interest**.")

Outside the classroom, there are many opportunities for informal science education in the United States. For example, an exhaustive National Research Council report (NRC 2009) found thousands of organizations producing science content in the United States. Whether the availability of that informal content has had a robust effect on Americans' perceptions of science over time, however, is an important empirical question, especially given the extent to which U.S. adults have not yet engaged with such content. Whether Americans experience equity in access to informal science education, which offers evidence-based content, also is a question that current literature has yet to address extensively.

Conclusion

Americans' perceptions of science have remained generally positive and stable over time in recent decades. Confidence in science and scientists to act in the best interests of the public, as measured by public opinion surveys, has remained generally high among Americans for decades despite changes in social discourse, technology, and health. At the same time, Americans' perceptions of science are not universally held, and at least some perceptions—such as trust in science and scientists—are associated with factors that vary between Americans such as comprehension of how professional scientific inquiry occurs.

Perceptions of S&T also can change over time as people gain more experience with new technologies or concepts. Recent literature highlights the potential for changes in public perceptions of new science topics, such as AI and neurotechnology. The onset of the COVID-19 pandemic also appears to have made, at least temporarily, the contributions of science and scientists more evident to Americans.

The nature and extent of Americans' engagement with S&T information is multifaceted. Americans report seeking information on science more than the populations in most other countries with high levels of R&D spending, especially information about medicine and health. News coverage of scientific research that benefits society also appears to sometimes bolster positive perceptions of science. At the same time, a minority of Americans report recent, direct experience with science activities such as making observations for a research project or participating in a crowdsourcing activity to identify animals, and Americans do not universally report comprehension of important aspects of scientific processes. Moreover, participation in science activities varies by factors such as income and education.

Although Americans report having interest in at least certain types of S&T information, the majority of Americans report not knowing a lot about science and generally do not report regular and direct experience with scientific activities. That pattern suggests that direct exposure to how S&T professionals conduct their work to generate peer-reviewed research publications has been limited among Americans, and future changes in such exposure could hold implications for Americans' relationships with S&T institutions.

Glossary

Definitions

Artificial intelligence (AI): The ability of machines to learn and draw on prior experiences to accomplish new tasks, sometimes similar to what human beings can do (Manning 2020).

Citizen science: Public participation in the scientific process in ways that can include forming research questions, conducting experiments, collecting or analyzing data, interpreting results, making new discoveries, developing technologies and applications, or solving complex problems (FedCCS 2019).

Climate change: Any distinct change in measures of climate lasting for a long period. Climate change means major changes in temperature, rainfall, snowfall, 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 (Royal Society and NAS 2020).

COVID-19: Disease associated with severe acute respiratory syndrome coronavirus 2, labeled by the World Health Organization in February 2020 (WHO 2020).

Global warming: An average increase in the Earth's temperature. 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 on. (See *Indicators 2020* report "**Science and Technology: Public Attitudes, Knowledge, and Interest**.")

Key to Acronyms and Abbreviations

AI: artificial intelligence

ATP: American Trends Panel

COVID-19: coronavirus disease

GDP: gross domestic product

GSS: General Social Survey

NRC: National Research Council

PFAS: per- and polyfluoroalkyl substances

R&D: research and development

S&T: science and technology

STEM: science, technology, engineering, and mathematics

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Notes

1 Results include countries with the top 16 gross domestic expenditures on R&D as a percentage of GDP in 2019 (see *Indicators 2022* report "**Research and Development: U.S. Trends and International Comparisons**"). Iceland was ranked in the top 16 but was not included in the 2020 Wellcome Global Monitor survey, so results presented include 15 of the top 16 countries with the largest gross domestic expenditures on R&D as a percentage of GDP in 2019.

2 The Pew Research Center provided restricted-use data from September 2022 for this analysis that are presented here and in other sections of this report with the center's permission. The Pew Research Center's ATP is a nationally representative survey panel composed of more than 10,000 randomly selected adults in the United States. For more information about the ATP, see **https://www.pewresearch.org/our-methods/u-s-surveys/the-american-trends-panel/**.

3 3M shared data for this analysis that are presented here and used with 3M's permission. The 3M State of Science Index survey is an independent, nationally representative research study commissioned by 3M to track global attitudes toward science. It has been conducted annually since 2018; due to the coronavirus pandemic, however, two waves of data were released in 2020 after an additional survey was fielded during summer 2020. The 2020 Pre-Pandemic Survey was conducted in 14 countries, while the 2020 Pandemic Pulse Survey was conducted in 11 countries; the United States was included in both surveys. For more information about the survey methodology, see **https://www.3m.com/3M/en_US/3m-forward-us/2020-summary/**.

4 As noted earlier, the Pew Research Center provided restricted-use data from November 2020 for this analysis that are presented here and used with the center's permission.

5 As noted earlier, 3M shared data for this analysis that are presented here and used with their permission.

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