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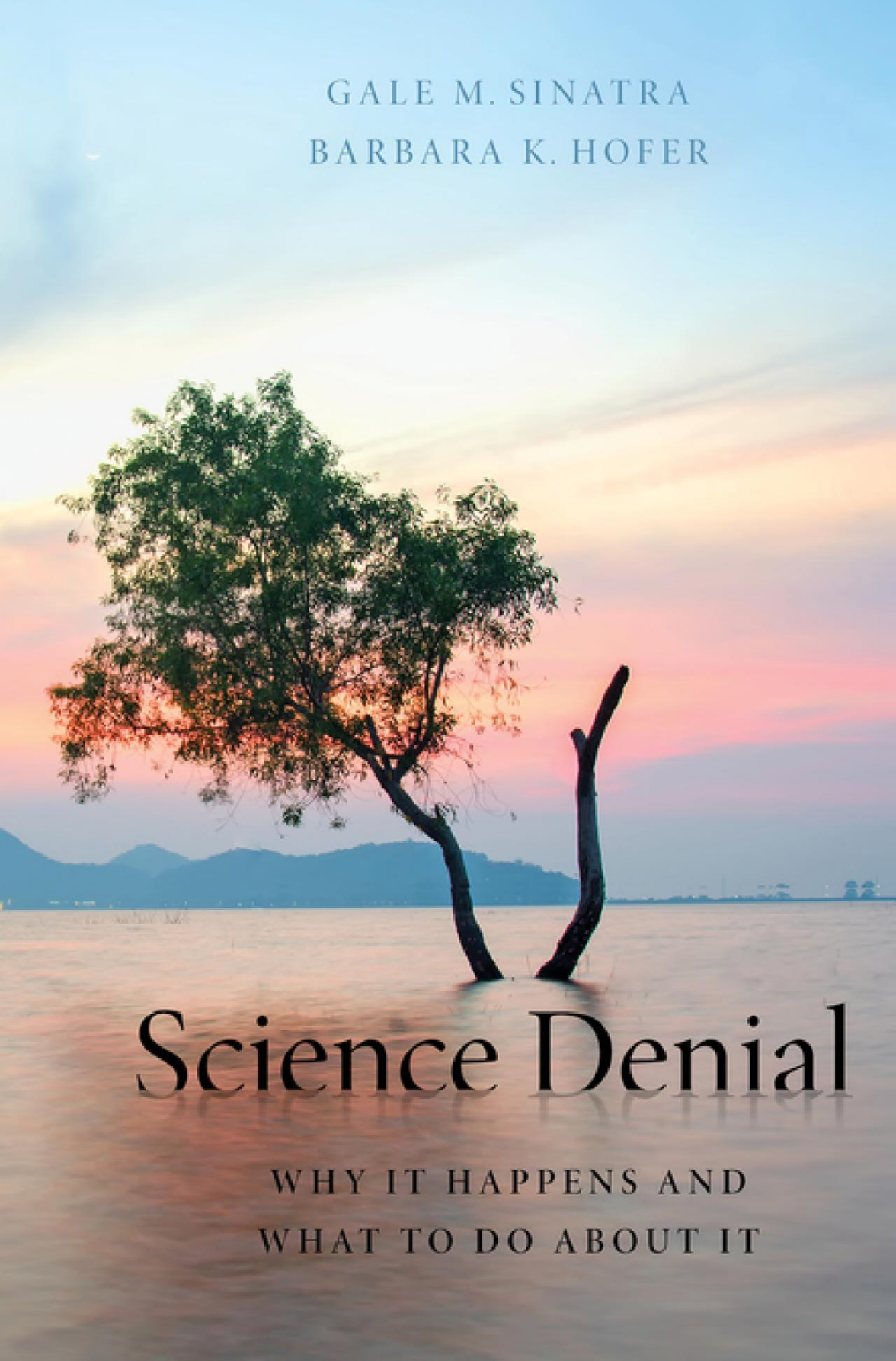

Science Denial

WHY IT HAPPENS AND WHAT TO DO ABOUT IT

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Preface

Science denial, doubt, and resistance have been persistent and growing problems in the United States, as well as in other countries. At no time, however, have the consequences been as deadly as in 2020, with a global pandemic ravaging the world's population, spreading rapidly when unchecked, fueled by denial of its lethality and the steps needed to contain it. At the same time, the effects of climate change continue unabated, threatening life on this planet. We have never felt more passionate about the need for this book and our desire to help others make sense of the psychological explanations for science denial, as well as learning how to address it.

The day we submitted a draft of this book, February 25, 2020, the US Centers for Disease Control and Prevention (CDC) alerted the nation to the potential community spread of the novel coronavirus. At that time only 14 cases had been documented in the United States, with the first US case confirmed more than a month earlier on January 20.[1] When we drafted this preface in mid-June 2020, the world had exceeded 8 million cases, with a full quarter of the cases—and deaths—in the United States, which has only 4% of the world's population. A reported 22 states were seeing their highest number of positive tests of COVID-19, most likely as a result of reopening restaurants, gyms, and other businesses, in spite of what scientific interpretation of the data suggested. Now, just 9 months later, in March 2021, the world has had 120 million cases, and the United States continues to lead the world in the spread of the virus, even as increasing numbers of people are vaccinated. More than 500,000 in the United States have died. Yet some elected officials have failed to model the most basic protective behaviors of social distancing and mask wearing recommended by the CDC. Throughout these months of the pandemic, science denial has indeed become deadly.

The scientific and medical community warned that the virus was dangerous and that unprecedent steps were immediately necessary to limit the potential catastrophic impact. The United States was slow to act, however, in terms of testing, contact tracing, travel limitations, and orders to stay at home. Scientists quickly worked to make sense of the novel coronavirus and

the disease it causes, COVID-19, with an understandable degree of uncertainty in the epidemiological modeling and in the early advice about prevention, with no clear-cut predictions about when vaccines and treatments would exist. Yet their growing knowledge did not translate to policy at the national level. Within weeks of the onset of the virus, a barrage of confusing, misleading, and inaccurate information spread faster than the virus itself. Misinformation was coming from all corners: politicians, newscasts, social media, dark web conspiracy theorists, and even the presidential briefing room. Never has it been so imperative that individuals have the skills to understand scientific inquiry and know how to evaluate what they read and hear. Nor has it ever been more critical that policy makers listen to scientists and make use of scientific data to guide decisions to protect their communities, states, and countries. The first vaccine received emergency approval in mid-December 2020, others have followed, and the rate of vaccinations grows. Yet worries persist about whether enough citizens will choose to be vaccinated, a deeply concerning problem when such decisions affect others' lives, not just one's own.

As the virus has raged, the differential and more damaging effects on those who are Black, Hispanic/Latino and Indigenous have become increasingly evident. Disparities in access to quality healthcare and overrepresentation in jobs deemed "essential" exposed the impact of systemic racism yet again. Racial gaps were evident in all age groups and most pronounced in middle age, with death rates at least 6 times higher for Black and Hispanic/Latino individuals than for Whites.[2] (Such differences also exist for Alaska Native and American Indian groups compared to Whites, but incomplete data prevented analyses at the same level.) For too long, science has ignored issues of structural racism within the discipline and the practice of science. The need for a more socially just science that would examine such inequalities is paramount.

As the virus wreaks havoc on the world and individuals both deny its existence and avoid preventative measures, we are increasingly aware of the need to explore and interpret the conditions for science denial, doubt, and resistance. In this book we shed light on key psychological reasons that have been the subject of our research independently and collaboratively over the years: cognitive biases, evaluating science claims, science knowledge, motivated reasoning, social identity, beliefs about knowledge and science, and the effect of attitudes and emotions. We also offer action steps for individuals,

educators, science communicators, and policy makers to support public understanding of science.

The idea for this book came from our individual and collaborative work over two decades. Many long conversations at conferences and meetings about public understanding and misunderstanding of science, coupled with our complementary research agendas in the psychology of thinking and learning about science, led us to collaborate on an article for *Policy Insights from the Behavioral and Brain Sciences*, entitled "Public Understanding of Science: Policy and Educational Implications."[3] That article, others, and many conversations since led us to the desire to speak to a broader audience than those who read psychology research journals.

We extend our gratitude to those who have supported us in writing this book, collaborated with us on related research, and assisted in many other ways. Thank you to our colleagues and collaborators whose work directly informed our thinking in these chapters, especially several of Gale's former graduate students, Jackie Cordova, Robert Danielson, Ben Heddy, Marcus Johnson, Suzanne Broughton Jones, Doug Lombardi, and Louis Nadelson, and at Middlebury, Barbara's undergraduate research assistants, especially Alex DeLisi, Lauren Goldstein, Katie Greis, Amber Harris, Chelsea Jerome, Chak Fu Lam, Jonas Schoenfeld, and Haley Tretault. We appreciate the extensive conversations with colleagues whose work also addresses the public understanding of science: Ivar Bråten, Rainer Bromme, Clark Chinn, Susan Fiske, Heidi Grasswick, Jeff Greene, Susan Goldman, Michelle McCauley, Krista Muis, Michael Ranney, Viviane Seyranian, and Andrew Shtulman. We thank those who read and commented on earlier chapters: Tim Case, Donna Decker, Mike Gorrell, Jennifer Gribben, Joan Sinatra Hathaway, Imogen Herrick, Neil Jacobson, Alana Kennedy, Ann Kim, Ananya Matewos, Beverly McCay, Catherine Nicastro, and Ian Thacker. Our special thanks go to Doug Lombardi, who provided feedback on the entire book and gave it a trial run in his course at the University of Maryland. We are especially appreciative of reviews we received both at the proposal stage and with the final manuscript and are grateful for the time, attention, and critical reading provided by these anonymous reviewers. Family and friends have been gracious in their support and discussions, including Zach, Erin, and Selene Hofer-Shall; and Helen Young, Kirsten Hoving, and Carole Cavanaugh.

We have been inspired in our own research and theory-building on the importance of scientific understanding by the writing and research of

others, including Eric Conway, Sara Gorman, Jack Gorman, Naomi Klein, Stephan Lewandowsky, Michael Mann, Lee McIntyre, Bill McKibben, Chris Mooney, Naomi Oreskes, Shawn Otto, Priti Shah, Per Espen Stokenes, and Neil deGrasse Tyson. Other writers who have influenced our thinking about the broader range of topics addressed in this book include Dan Ariely, Philip Fernbach, Michael Patrick Lynch, Tom Nichols, Michael Nussbaum, Eli Pariser, Jennifer Reich, Steven Sloman, Keith Stanovich, and Sam Wineburg. Mistakes and misrepresentations are indeed our own, and we welcome corrections and elaborations.

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Notes

1. Michelle L. Holshue et al., "First Case of 2019 Novel Coronavirus in the United States," *New England Journal of Medicine* (January 31, 2020), https://www.nejm.org/doi/10.1056/NEJMoa2001191.
2. Tiffany Ford, Sarah Reber, and Richard V. Reeves, "Race Gaps in COVID-19 Deaths Are Even Bigger Than They Appear" (Brookings Institute, June 16, 2020), https://www.brookings.edu/blog/up-front/2020/06/16/race-gaps-in-covid-19-deaths-are-even-bigger-than-they-appear/.
3. Gale M. Sinatra and Barbara K. Hofer, "Public Understanding of Science: Policy and Educational Implications," *Policy Insights from the Behavioral and Brain Sciences* 3, no. 2 (2016).

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SECTION I

SCIENCE DENIAL, DOUBT, AND RESISTANCE

1

What Is the Problem and Why Does It Matter?

The idea that science should be our dominant source of authority about empirical matters—about matters of fact—is one that has prevailed in Western countries since the Enlightenment, but it can no longer be sustained without an argument.

Naomi Oreskes, *Why Trust Science*[1]

How do individuals decide whether to vaccinate their children against childhood diseases, wear a mask during a pandemic, or eat foods that have been genetically modified? How can they fairly evaluate the environmental and public health risks of fracking or climate change? In a democracy, educated citizens must make informed decisions about scientific issues. However, as people read online news and information or scan social media accounts to connect with friends and family, they are confronted with complex and often conflicting information about science. Evaluating this information is necessary to make consequential decisions that impact one's health and well-being, as well as communities, nations, and the planet. Yet many individuals question or deny the scientific consensus on critical issues or lack the skills to assess media reports of scientific findings. Many do not know or misunderstand the scientific process that produces these findings, challenging their ability to understand and evaluate research results presented in the media. They may not understand or appreciate the role of scientists in contributing to theory, creating advancements in science that are elegant and explanatory.

A gap exists between scientific knowledge and the public understanding and acceptance of science. Over 98% of climate scientists concur that humans are causing climate change, but only 57% of the US public think climate change is mostly caused by human activities.[2] Most parents vaccinate their children; but many do not, or they delay the process or make selective choices,

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putting their children and others at risk. Some question the value of getting vaccinations themselves, for flu or COVID-19. Communities vote to ban public water fluoridation without sound scientific reasons. Consumers buy organic, gluten-free, or non-GMO (genetically modified organism) foods, often without a clear understanding of what these labels mean. No one demographic or political group has a corner on science doubt or denial. Science misunderstanding is evident across racial, gender, age, and political lines.

Perhaps better science education can help address some of the issues of science misunderstanding, doubt, and denial. This does not mean, however, that we simply need to address a knowledge deficit among the public to fix the problem or that such a deficit is the root of the problem.[3,4] Through our own research and that of many others in psychology and education, we have come to understand how making decisions about complex scientific topics requires more than just better knowledge of the facts. It takes the ability to critically evaluate evidence and explanations, take into account the source of that information, and appreciate how the methods of science lead to specific conclusions. People need to know where to turn for reliable information, whom to trust on issues of science, why to value science, and how to resolve conflicting points of view.

Individual actions alone will not address the pressing issues of our era, but understanding and addressing individual resistance and misunderstanding of science can further the potential for the collective action that is needed. Citizens who acknowledge the human causes of climate change, listen to the advice of medical experts during a pandemic, or are able to interpret data regarding gun violence are likely to be far more prepared to support initiatives that will improve health and well-being of the planet and its communities and inhabitants.

Why Value Science?

Since humans began to ponder their own existence, they have wondered about the natural world and their place in it. Why does the sun appear to move across the sky? Why do the seasons change? What causes illness? Prior to the scientific revolution, humans were at the mercy of the elements of nature. Maladies of all types were a mystery with no means of redress other than hope and superstition.

Science has led to remarkable discoveries, such as the eradication of diseases that once claimed lives by the millions, the sequencing of the human genome, and effective treatments for many forms of cancer and HIV/AIDS.

Science provides insights into the origins of our universe, the chemistry of the brain and many mental health disorders, how an asteroid striking the Earth contributed to the extinction of dinosaurs, and how the dramatic rise in CO_2 corresponds with the current change in climate.

Each of these discoveries and thousands more have contributed to the health and well-being of generations of humans. According to cognitive psychologist Steven Pinker, when the track record of science is objectively evaluated, "we find a substantial record of success—in explanation, in prediction, in providing the basis for successful action and innovation."[5] In *Enlightenment Now*, Pinker explains that through the "awe-inspiring achievements" of science, "we can explain much about the history of the universe, the forces that make us tick, the stuff we're made of, the origins of living things, the machinery of life, including our mental life."[6]

How does science earn this reputation for having such impressive explanatory power? Science is a natural outgrowth of human curiosity. Our ancestors likely had many questions about the natural world, such as whether a plant was safe to eat, why the water was making people sick, or what materials would offer protection from the elements. Science is a systematic and reliable way to collectively pose questions and seek answers about the natural world. Its power comes from scientists' willingness to trust the combined results of many tests, both when these tests support hypotheses and when they do not, an accumulation of scientific consensus. Much of science is not obvious or observable to the individual naked eye. Germs were not understood as the causes of illness until there were microscopes to see them. Although scientists have made significant mistakes, the systematicity and social nature of science allow for self-correction over time. Missteps, wrong assumptions, faulty experiments, and even fraud are eventually uncovered and replaced with ideas that better describe the natural world.

Philosopher of science Lee McIntyre explains how the true value of science comes from adopting a *scientific attitude*, which he describes as an openness to seek new evidence and a willingness to change one's mind in light of evidence.[7] Naomi Oreskes, historian of science, explains in *Why Trust Science?* that while empirical evidence is a cornerstone of science, "it is insufficient for establishing trust in science."[8] The reason the public should place trust in science comes not from individual scientists' contributions, from its mythic "scientific method," or even from specific evidence (as that can change) but rather from the fact that science is a collective enterprise, a social activity. Scientists are fallible and imperfect humans, and there is no single method that leads to some objective truth. Rather, trust comes from "the social

character of science and the role it plays in vetting claims."[9] It is through the collective efforts of the social enterprise that scientific consensus is reached.

Examples of the social system that affords science its true value include peer review of scientific articles and grants and governmental organizations such as the National Academy of Sciences. As new evidence comes to light, more accurate views replace those that are flawed. An example of a collective enterprise is the Intergovernmental Panel on Climate Change (IPCC), which derives its conclusions through the work of teams of scientists from diverse backgrounds, multiple countries, and different disciplines, weighing evidence collectively.[10] Through this collaborative effort, the IPCC manages to vet and make public the current, best available evidence on climate change.

If science is such a remarkable achievement and the evidence it has amassed is so compelling, then the roots of resistance beg explanation. Climate scientist Michael Mann cautions that "there is a weakness in the scientific system that can be exploited. The weakness is in public understanding of science, which turns out to be crucial for translating science into public policy."[11] Public misunderstanding of science, coupled with the allure of skepticism, conspiracy theories, or just contrarian points of view, creates a toxic psychological brew. Environmental psychologist Per Espen Stoknes has argued, "We need to look closely at the demand side for doubt—the inner reasons why disbelief is attractive. How does denialism—with very few facts, lots of grand rhetoric, and very little scientific brainpower—continue its dark victory?"[12] Stoknes called for "psychological-level answers" to explain the rising levels of doubt, denial, and resistance prominent today. We intend to do just that in the chapters ahead.

Why Science Is Not Infallible

In this book we call for better-quality and more inclusive science education, science funding, and consideration of scientific consensus in personal and policy decision-making. However, we do not believe science is a panacea for all problems. Nor do we think science is perfect or infallible; it would be foolish to suggest so. Scientists are human beings who can and do make mistakes. Their human characteristics often include brilliance, creativity, imagination, and concern for the health and welfare of fellow human beings and planet Earth. However, individual scientists can also be subject to jealousy, dishonesty, greed, selfishness, and biases that can adversely affect their work.

This is why individual scientists and individual scientific studies should not be given the same level of trust as the collective work of a scientific community amassed over time through rigorous evaluation. It is this consensus that should be widely understood and seriously considered in problem-solving and decision-making, both personally and in education and policy spheres. This is one reason why diversifying science is so important. African American women are woefully underrepresented in the medical field, and they are 3 to 4 times more likely to experience problems with childbirth[13] than their White counterparts. Solutions depend on better representation in both medical and scientific fields.

Even as we call for greater appreciation of science, we acknowledge the history of science as an enterprise replete with mistakes, missteps, sexism, and racism. Science has both helped and hurt individuals and groups who understandably may be wary of accepting scientific claims. There are legitimate concerns with the current scientific enterprise. These include the challenge of replicating findings in psychology and the research dissemination system of journal publication that keeps publicly funded research behind an expensive firewall of inaccessibility. Decreases in public funds for research may motivate researchers to work for entities with vested interests, calling the objectivity of their findings into question. Many critics of science have detailed these and other challenges with science, and we appreciate these efforts to hold science and scientists accountable.[14] The historical and current challenges of science make the call for increased understanding of how science works (and in some cases how it goes awry) all the more important.

But the well-documented racist ideas advanced by science are the most egregious wrongs that must be acknowledged.[15] From the past through to the present, science has propagated false taxonomies of people and cultures to justify European Whites' claims of superiority and used flawed theories of mental measurement of intelligence to justify racial inequity in the United States.[16] If science is to eschew racist ideas and be a force for public good, it must represent the public it serves. This can only be addressed by diversifying science through supporting opportunities for women and people of color, especially African Americans, to be represented in all science fields in numbers that reflect the population. Efforts to diversify science have been made but have yet to reach representative levels.[17] These failures contribute to mistrust of science and hold science back from realizing its full potential to creatively and effectively solve problems that help all citizens.

Why Does It Matter if the Public Understands Science?

The scientific revolution brought civilization the benefits of widespread health and well-being, through fighting disease, providing insights into the natural world, and solving technological challenges.[18] Will science continue contributing solutions to pressing problems? In the midst of a global pandemic, the world's citizens are hopeful yet understandably baffled by what they hear and read. The spread of misinformation and disinformation about science, magnified by a divisive political system and media bubbles, is creating skepticism and mistrust. The common phrase "You can't believe everything you read on the internet" has been expanded by some to "You can't believe anything you read anywhere."

Turning away from science will not solve the complex challenges of climate change, the global spread of the novel coronavirus, clean water, food insecurity, alternative energy production, and a cure for diseases such as Parkinson's and Alzheimer's. Scientific research is needed to understand mass extinctions and perplexing issues such as the rise in rates of food allergies and infertility. Science can play a role in helping to address contemporary problems great and small, and this can be enhanced if the public understands and trusts science to support that role. It also can only play such a role if policy makers learn to listen to scientists and utilize data and evidence to make decisions that affect the lives of others.

Furthermore, adopting a *scientific attitude* is helpful in everyday life, not just in the research lab or field. Individuals with a scientific attitude, as McIntyre describes, care about evidence and are willing to change their minds in light of new evidence. Adopting a scientific attitude might be even more important than taking a deep dive into each nuanced debate on today's scientific topics. Although core consensus remains rather stable over time on many topics, scientific knowledge at the edges is always being updated and revised based on new evidence. A scientific attitude supports understanding the science of tomorrow, not just the science of today.

Maintaining a scientific attitude helps individuals solve problems, sharpen analytical skills, and improve their health and well-being. Science is a process that involves systematically questioning what one knows, revising thinking based on new information, discarding outdated modes of thought, overcoming biases, and using evidence to argue against suspicion and prejudice.[19]


image
not
available

unacceptable to those who believe that "everything in nature was controlled by necessity."[28]

Scientists, too, have sometimes been slow to ratify consensus on issues that now seem clearly substantiated.[29] Many were notably resistant to Darwin's theories for several decades. The idea of continental drift, proposed in 1912 by geophysicist Alfred Wegener, only gained acceptance 50 years later, when plate tectonics was proposed.[30] The theory that germs caused infection and disease was long resisted, a disregard for the simple finding that when doctors washed their hands, contagion plummeted. Yet many discoveries, such as the structure of DNA, proposed in 1954 by James Watson and Francis Crick, as well as their colleague Rosalind Franklin, garnered quick scientific support. Notably, such a finding does not require a change in attitudes or behavior, nor is it threatening to identity and beliefs.

Science Doubt and Denial in the Modern Era

A cogent example of fostering science denial in the modern era involves the link between smoking and cancer, a connection that had become evident to tobacco companies based on their own research. Beginning in the 1950s, these companies suppressed the research, denied the findings, and then engaged experts to testify on the lack of certainty. Sowing doubt and ambiguity where none existed, they masterminded a campaign of disinformation that went on for decades.[31] As described by Oreskes and Conway in *Merchants of Doubt*,[32] other corporations took note. Admiring the success of the tobacco companies and their ability to delay acceptance of responsibility (and therefore payments to victims) for decades—while continuing to reap massive profits—several major corporations and their consultants took this strategy as their blueprint. Monsanto, producer of multiple pesticides, sought to discredit and defame Rachel Carson, author of *Silent Spring*, a book that not only exposed the effects of DDT but also has been credited with launching the environmental movement in the United States.

Industry's refutation of its role in acid rain (blaming it on natural causes such as volcanos)[33] and DuPont's dismissal of the role that chlorofluorocarbons played in ozone depletion both set the stage for the denial of climate change. In all such cases, the scientific conclusions were resoundingly supported, but actions to mitigate negative effects of commercial products such as tobacco, aerosol sprays, and industrial pollution were

continued in multiple areas as environmental regulations have been rolled back. The need to understand science denial, doubt, and resistance is paramount. How do we each keep ourselves from falling for such schemes?

Science Denial and Doubt Today

As the climate crisis illustrates, we are now living at a time when well-substantiated factual claims based on evidentiary science that have been documented, published, and supported through expert consensus can be doubted by large swaths of the public. Moreover, as the novel coronavirus traveled rapidly across the globe and epidemiologists projected its spread and the likely deaths that would result, the United States responded slowly, and political leadership at various levels failed to heed the science and fostered doubt. Even evolution still has resistance, and numerous attempts have been made to teach creationism or "intelligent design" alongside evolution, falsely equating religion and science as two sides of a story. Vaccination hesitancy flourishes, a serious concern at a time that herd immunity is needed to slow and eventually halt a pandemic. Many people find themselves following spurious health claims. Why does it seem worse and more widespread now?

One obvious factor is, of course, the internet and the preponderance of information available to anyone with a smart phone or access to a computer. Our skills for verifying and validating the vast amount of information we each encounter have not kept pace, while the sophistication of those who wish to portray fiction as fact has increased. Social media can amplify our existing beliefs, and people tend to create echo chambers in their media use, hearing more of what they already believe. The corporate "merchants of doubt" have multiplied, with well-funded attempts to willfully ignore, reject, and undermine scientific findings that aren't in their financial interest. Denial has become politicized, and what has been called a "post-truth" era[40] reflects a devaluing of truth. The idea of an "inconvenient truth" (as Al Gore alluded to climate change) is now widespread, seeming to apply to anything a politician would prefer that citizens not believe. In addition, science educators may neglect teaching the underpinnings of science that could help students and future citizens keep alert to attempts to undermine accepted scientific consensus.

What this requires is awareness and vigilance on the part of the public, a willingness to challenge sloppy thinking, spurious claims, the rejection of