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INTRODUCTION

Science—The Next Generation

I DISCOVERED I WAS A *STAR TREK* NERD relatively late in life, in my midthirties. I amused my family members with regular references to Vulcans and Klingons, androids and warp drives. Before watching *Star Trek: The Next Generation*, I had assumed that a Trekkie (or Trekker, the more distinguished term) was someone more obsessed with space than with life on Earth, but as I became increasingly immersed in the world of the USS *Starship Enterprise*, the appeal that the show held for me was not in its discovery of new worlds and alien life-forms, but in the promise of what human society could someday become—equitable, advanced, and plentiful. Humans in *The Next Generation* were no longer plagued by twenty-first century problems such as poverty, discrimination, and war, in large part because the promises of science and technology ensured that the basic needs of all humanity had been met. In this bold, new world, all individuals were thus free to pursue their passions and curiosity.

As I got over my initial embarrassment of being a Trekker, I came to learn that most of my scientist friends were also *Next Gen* fans. How could

one not be? The series—more than any other—validates what science is about.[1] The dream of the rational, peaceful, and supremely intelligent human and alien creature (if they happen to be Vulcan, anyhow) is both reassuring and compelling. Multidisciplinary research teams explore the universe in search of new ideas, friendships, and, ultimately, meaning. Contact and the ensuing collaboration with other cultures are highly esteemed; meals are eaten in a mess hall with colleagues and friends; and every member of the crew is valued not just for their individual genius, but for how they contribute to the greater good of the mission. Perhaps most importantly, science's role as a beneficiary goes unquestioned, not only for humanity, but across the reaches of the galaxy.

Contrast this utopian vision with the relationship that science holds with society today—one in which the scientific consensus on key issues, including climate change, vaccines, and, in some corners, even of the roundness of Earth—is frequently called into question.[2] Sometimes it seems as if the more evidence that mounts, the more pushback it faces. And such perceptions are not shadows in the dark. They result in major consequences for society, such as the battles over the teaching of evolution in some parts of North America or the documented decrease in routine childhood immunization across the world.[3]

Those of us who work in science increasingly believe that it is our responsibility to do what we can to explain its value. We write blog posts, we give radio interviews, we get into heated debates on social media, and we spend countless hours preparing lectures for undergraduates who, we hope, will lead us one step closer to a *Next Gen* future. Yet it often seems that no matter what we do, it isn't really helping. Even as we produce more and more reliable data, we are beginning to understand that facts aren't quite enough, and we're at a loss about what to do next.

I understand this feeling because, as someone who has worked in the environmental field as a researcher and practitioner for more than twenty years, it has long played in my own mind. Scientific research has

been crucial to our movement—from measuring air and water pollution to studying the benefits of clean environments for physical and mental well-being. I got into research to better understand how people perceive, connect to, and ultimately care for natural spaces, whether those be richly biodiverse landscapes of the Amazon or polluted waterbodies in densely populated cities. But I never wanted my research to stay within the confines of academia. I wanted it to *matter* for society—to have impact in terms of the way people thought or even acted. And I know I'm not alone.

Many of us in the scientific community are here because we care about producing interesting research and we wish to "make an impact" with our work. We want to influence the way society thinks about a certain issue and, in turn, the decisions of policy makers. But often we don't feel like we know how to achieve those goals. Scientists endure criticism for not doing more to educate or engage with the public. Almost within the same breath there is acknowledgment that scientists lack the training and skills to communicate effectively. Even James Hansen, the NASA scientist and climate activist known for his groundbreaking testimony to the US Congress about climate change in late 1980s, said, "Most scientists are not good communicators. We're not trained to do that. Science itself is hard enough without trying to communicate with the public."[4]

He has a point. As a newly tenured professor, I have a deep understanding of the pressures in academia that make it almost impossible to take the time needed to think about how my research could have a greater impact on society, let alone to engage in actions to do so. I know the stress that comes with trying to juggle an ever-increasing load of teaching, research, and administrative tasks and the frequent fantasy of giving it all up to start a sheep farm in Vermont. I can remember once, during a particularly frenzied hour as a new assistant professor, eating my lunch at my desk so fast that a piece of bread flew out of my sandwich and got stuck in my eye.

In part because of the sheer amount of work that needs to be done, academic research is increasingly lonely and stressful. As a result, we are entering and leaving academia in droves—pulled in by its promise, pushed out by its pressures. Even among those who have "made it," some are looking back at their careers and wondering if the impact of their science is what they intended at the start. A good friend of mine, a tenured full professor of ecology at a research institution, told me that he's taken to emphasizing to students the importance of fields like business and engineering in addressing environmental issues like climate change, as opposed to specializing in science-focused disciplines such as ecology. "We don't need any more papers about the predator-prey relationships of dragonflies and tadpoles," he told me, provocatively, having published quite a few himself.

But I have pushed back against my friend, not because I think he is wrong about adding to the stack of papers on dragonflies and tadpoles but because I think there is a future for those who wish to make a difference with their research. However, something different is needed than the model we currently have, which is largely based on the premise that the fact-based recommendations made by scientists will somehow trickle down to the masses and influence the way our societies function.

This is where I'll return to *Next Gen*. At first glance, this utopia seems to be a natural product of three centuries of technological progress and scientific discovery that has made life easy and plentiful. The famous *Star Trek* "replicators" can instantly produce anything—food, water, clothing, the latest Barbie doll—anyone could desire for free, thus obliterating the need to earn money. Faster-than-light-speed travel (warp drives) enable humanity to connect with other civilizations and thus broker world (and, ultimately, intergalactic) peace. And medicine is constantly advancing in leaps and bounds, with "hyposprays" instantly administering vaccines to newly discovered diseases, basically eliminating illness.

Upon deeper analysis (cue to rewatch those favorite episodes),

however, what makes the *Next Gen* utopia so compelling is not really the advanced gadgets and gizmos. Yes, warp drive, food replicators, and medical tricorders are cool, but they don't automatically make for a better world. Rather, what makes all the difference are the *choices* made around science and technology.[5] Intergalactic travel could have meant colonization of other planets and an expansion of war and exploitation, as in many other sci-fi franchises, but the *Enterprise* is not a military vessel but a scientific one, dedicated to encountering (not conquering or extracting) other forms of life and knowledges. Food replicators are not patented, profit-driven ventures, but are open-source technology, shared freely among more than one hundred planets.

In the *Star Trek* universe, choices are also made about whose knowledge counts, which reflect certain values. Yes, logic is prized (after all, who doesn't love our pointy-eared friends?). But valid knowledge and valuable perspectives come in many shapes and sizes and from many lifeforms and cultures, including those not human. Diversity of all kinds is seen as extremely valuable, and different abilities are not just accommodated, but celebrated.[6] The autonomy of alien worlds is protected by a commitment of noninterference (the "Prime Directive"), so societies are left to develop in the ways they see fit. The most interesting discoveries (and episodes) arise when a given character has been challenged to see things differently and thus must update their worldviews and actions accordingly. Ethics and philosophy are constant companions of science and technology, seen as friends rather than foes.[7]

So, too, is this book about choices. Specifically, it is about the choices that scientists and their supporters can make to effectively engage with communities, influence policy, and get more people genuinely excited about science. Years ago, I began a journey to tackle, head on, the question of what makes research impactful for society. Throughout this process, I interviewed many people from different walks of life—environmental managers, policy makers, Indigenous land stewards, farmers,

educators, health workers, science communicators, agricultural extension agents, and lobbyists, among others—about their perceptions of research and the role of evidence in individual and collective processes of change.

At the heart of my inquiries is the word—or perhaps concept of—*impact*. Dictionary definitions of the word often include phrasing such as "an impinging or striking especially of one body against another" and "the force of impression of one thing on another." Synonyms include bump, collision, concussion, crash, impingement, jar, jolt, jounce, kick, shock, slam, smash, strike, wallop, affect, impress, influence, move, reach, and sway. If you search images of "impact" online, one common image you will find is of a drop of water splashing into a larger body of water, ripples spreading outward. Another is a finger about to topple a line of dominos, where they will fall in sequence, one after the other.

These definitions and images convey a few popular notions about what we think impact means. First, that for impact to occur, two or more separate entities are required, one that impacts the other in a predetermined direction—an impactor and an impactee. Further, there is the impression that an impact is something controllable. We throw the stone, we make the ripple—the larger the stone and force, the greater the ripple and the longer and farther the waves will continue to go. Similarly, impact is often seen as predictable. If we push one domino and the others are lined up and ready to go, they too will fall in a predetermined row.

Now more than ten years into my journey, one thing is clear: scientific research can—and frequently does—have great impact for society, but not in the way many of us have traditionally believed. As you will learn in the coming chapters, impact is not straightforward, nor does it travel in one, predictable direction. Rather, it looks more like a complex network, with arrows and lines spreading across space and time and

where scientific "facts" are just one piece of a very large system that, above all, is social in nature.[8]

In this book, I will share what I have learned about the impact of science beyond academia to influence how policy makers make decisions and how society operates. I will share some of my own choices, both good and bad, to demonstrate the types of impact (not always positive) that can arise at different stages in the scientific process. I will also talk about how my choices were never just my choices, but rather emerged from a complex mix of individual preferences, societal pressures, and institutional resources (or the lack thereof). As such, this book is written not only for the individual researcher, but for a wider professional audience committed to the societal use of research, including those involved in grant funding, science communication, and research policy. The choices scientists make about how to "have impact" are thus not theirs alone but belong to the entire scientific community.

I made a few choices while writing this book. First, I opted to publish with Island Press, a small, nonprofit publisher that specializes in environmental and science books, rather than a standard academic press. I did so because I wanted to reach a wider, professional audience, not just an academic one. I also wanted some freedom to have fun with the writing without going down too many scholarly rabbit holes.[9] For those who wish to dive further into the scholarship, I have provided an extensive endnotes section with resources.

Additionally, I have tried to make this book as much of a guide as possible. To this end, part one partially follows my own journey in learning more about the different ways science can have impact. Chapter 1 describes the way I used to think science communication had to work, which I like to call the "Will You Please Just Listen to Me" approach. Chapter 2 provides an alternative model of how to spread science-based ideas and behaviors based on the story of one of the most powerful

public health achievements in history. And chapter 3 describes how my understanding of impact changed from focusing on the products of science to focusing on a process that is based in opportunities for encounter and connection.

I have also structured some of the chapters the way my friend and colleague Monica Palta recommended. She was trained in ecology and biology and suggested that the book should be structured the way scientists think—like the different stages of the scientific process. That made a lot of sense to me, and part two is organized in this fashion. For example, chapter 4 focuses on the research stage when we ask questions; chapter 5 is about choices we make when setting up a research project, such as determining location and methods; chapter 6 is centered on the data collection stage; and chapter 7 addresses peer review and the dissemination of research results. In this sense, the book takes a closer look at the multitude of choices that are made throughout the process of scientific inquiry, even before any samples are collected or analyzed.

When it comes to impact, what many people often think about is disseminating the results of science to policy makers and various other "publics." That's the focus of part three. Chapter 8 explores conversations and stories about science, chapter 9 dives into the question of how to communicate uncertainty, and chapter 10 is about engaging in policy and advocacy. The chapters in parts two and three have accompanying flowcharts on islandpress.org/impactful to guide readers to the specific choices they might need to consider in various stages of their journey.[10]

Although this book provides guidance on including and impacting a wider array of participants in science, there are important aspects of diversity and inclusion in science that it does not directly address, such as how to increase participation of people who have been historically excluded from the science and technology workforce, particularly women, minorities, and persons with disabilities. For more guidance on how educators, mentors, researchers, and academic administrators

can create equitable opportunities for these groups, two excellent books are *Making Black Scientists* by Marybeth Gasman and Thai-Huy Nguyen and *Women in Science Now* by Lisa M. P. Muñoz.[11] Similarly, this book does not directly explore the various types of impacts that science can have in terms of industrial, technological, and military uses and related ethical debates. A superb book that does directly tackle the broader issue of values in science for industry and other considerations is *A Tapestry of Values* by Kevin Elliott.[12]

Some choices I made around the guidance provided in this book were not quite my own but, rather, stem from my positionality and location in the world. I write from the village of Sleepy Hollow, about an hour's drive north of New York City, where the institution that employs me, Pace University, is located. Although I have spent approximately half my adult life outside the United States (in Mexico, Nicaragua, Costa Rica, England, and Bolivia), my perspective is very much influenced by the political, ethical, and social debates happening in my neck of the woods.[13] Thus, while I have attempted to provide examples from other parts of the world in this book, its message comes to you from a specific lens—one that is North American, white, female, and politically liberal. As any responsible researcher, I've shared drafts of this book with many different people, all of whom have their own set of lenses through which they view the world, and it is my hope that this practice, more than any other, will make the material relatable, interesting, and applicable to different contexts.[14]

Above all, I chose to write a book that would reconcile the idealistic Trekker within and the logical pragmatist who dives into the peer-reviewed literature when she has a question about how the world works. Fundamentally, this book is written to challenge the scientific community to consider whether our work is having the desired impacts for society and, if it is not, how we can change to make it so. Although calls for change can seem daunting in the face of current barriers,

structures, and incentives in the academic system, in the pages ahead I hope to show that such changes are not only possible, they're already happening. Or to put it in the defiant words of Jean-Luc Picard, captain of the USS *Enterprise*, "Things are impossible until they're not!"[15]

PART ONE

Searching for Impact

"Once you do away with the idea of people as fixed, static entities, then you see people can change, and there is hope."
—bell hooks

"If you think you're too small to have an impact, try going to bed with a mosquito."
—Anita Roddick

CHAPTER 1

Will You Please Just Listen to Me?

If *Star Trek: The Next Generation* provides an idyllic vision of what humanity could become if science takes its rightful place in society, an increasing number of apocalyptic films seek to portray what will happen if it does not. One film in this category, 2021's *Don't Look Up*, features two astronomers—PhD candidate Kate Dibiasky and Dr. Randall Mindy (played by Jennifer Lawrence and Leonardo DiCaprio, respectively)—who discover that a comet will collide with Earth within the year, causing the extermination of the human population.[1] However, when they present their findings to White House officials, they are met with derision and apathy. The film quickly devolves into an Earth-Is-Doomed adventure complete with internet memes, sex scandals, and an Elon Muskesque scheme to harvest rare elements from the comet instead of destroying it. It's quite a ride, and the message is clear: look what happens if we don't listen to scientists.

Although *Don't Look Up* is clearly a satire, designed to exaggerate the apathy of government officials and ignorance of the public to very real

threats, it was explicitly written as an allegory for how governments, media, and the wider public have reacted (or not reacted) to decades of warnings from scientists about climate change. One article published in *Wired* magazine, aptly titled "*Don't Look Up* Nails the Frustration of Being a Scientist," quoted climate scientists who said they could relate to the experiences of the main characters, who were simultaneously desperate to get the word out and baffled at why their message was not getting across.[2] In another article, the film's scientific advisor, NASA scientist Dr. Amy Mainzer, was quoted as saying, "I told (the actors), you really have to speak for the science community, when we feel like we're being ignored. . . . There are some lines in the movie that are just, 'we're trying to tell you, you're not listening and we really want you to listen, because we know we can make things better if everybody does.'"[3]

The idea that scientists need to be listened to is at the heart of what many of us think of when we talk about science communication and scientific impact. Rigorous scientific research is carried out, again and again, until the scientific community begins to develop a consensus around a topic. The science is so strong that it is practically indisputable (in the case of *Don't Look Up*'s comet, a 99.78 percent chance that it will destroy Earth). Furthermore, the science has clear policy implications—something must be done to address the issue. Scientists and their allies thus must do what they can to get the right information to the right people to make this change.

I like to call this model the "Will You Please Just Listen to Me" approach to science communication. It assumes that the problem is one of lack of knowledge, understanding, and motivation to act and thus what is needed is to get the facts out to the masses to convince people to do what the science says needs to be done.[4] Indeed, in the film, the scientists tried their darndest to do just that. They repeatedly talk to the press, they post livestream videos on social media, they travel to Washington, DC, to speak with policy makers, and they even organize a benefit

concert with rapper Kid Cudi and singer-songwriter Ariana Grande, who emerges onstage dressed like a comet to perform the original song "Just Look Up" for tens of thousands of lighter-holding fans.

Alas, their efforts are not exactly met with resounding success. The scientists, particularly the young female PhD student, are ignored and mocked, first by White House staff, then by the media, and even within their own social circles. In one humorous scene, the scientists wait for hours outside the Oval Office for a reception with the president of the United States and are charged for snacks by an Air Force general. Later in the film, Dibiasky, the student who discovered the comet, goes home to find that her parents have locked her out of the house. "No politics!" her dad says as they look at each other through the screen door. "We're for the jobs the comet will provide," says her mother.[5]

Thus, even as the scientists spend their time and money trying to save the world, nothing is enough. Spoiler alert: Humanity will not save itself from the comet, though at least the scientists and their allies get to have one good final meal before they die. So, although *Don't Look Up* does a great job at demonstrating that the "Please Just Listen to Me" approach isn't sufficient to convince society to take action, it doesn't quite explain why that is the case and what scientists might do differently.

So why aren't the facts enough to incite change or influence policy? How can it be that large groups of individuals see some scientific findings to be in conflict with their worldviews, thus forestalling societal change and political action? To begin to answer these questions, let's travel to Tangier Island in Virginia, a tiny island that is quickly going under water due to sea level rise and whose residents are skeptical that climate change is the culprit.

Notes from a Disappearing Island

Tangier Island is a small island in the Chesapeake Bay off the eastern coast of the United States, part of the state of Virginia. For centuries,

the island was used by the Pocomoke peoples for oystering, fishing, and possibly as a seasonal settlement.[6] In the eighteenth century, the island was homesteaded by White farmers, who established a community that eventually grew to approximately thirteen hundred inhabitants by 1930.[7]

Along with many islands in the Chesapeake Bay, Tangier Island is slowly being swallowed by the sea. Since 1850, two-thirds of the island's landmass has disappeared, a trend that has been increasing due to erosion driven by sea level rise and increasing storms.[8] As the land has disappeared, so have many of the inhabitants; by 2021, the population of Tangier had dwindled to approximately four hundred residents.[9] Scientists say that climate change is the main culprit and predict that the island will be uninhabitable within the next few decades.[10] If that happens, the residents of Tangier will be among the first climate refugees in the United States, a label more commonly associated with island communities in the South Pacific, who have been at the front lines of the fight for climate action at an international level.

However, unlike communities from the Pacific islands of Tuvalu, Nauru, and Kiribati, the residents of Tangier have not been spokespeople for climate action. To the contrary. Many of the residents of Tangier contest the idea of human-caused climate change and sea level rise and think that it is, if not quite a hoax, a distraction from the real issue of God-made erosion. Indeed, if you travel to Tangier, you can stop by a gift shop and purchase a T-shirt that reads, "I refuse to be a climate change refugee."[11]

Scientists often understand that scientific knowledge on a particular issue is difficult to get across to nonexperts. It's not always easy to explain the mechanisms of how things work, especially when those mechanisms are abstract, invisible to the human eye, or beyond one's personal experience.

But the impacts of climate change on Tangier Island are none of these things. Residents have regular floods in their yards and in their homes. The level of the Chesapeake Bay has risen by approximately three feet in the last five hundred years, the number of intense storms has increased, and whole sections of the island have been lost along with the homes of many residents.[12] Although many communities across the world are facing impacts from climate change, Tangier is a place where it can be experienced in a visceral way.

But that is not how many Tangier residents see it. In 2017, the island became the center of a media storm when its mayor, James "Ooker" Eskridge, was filmed making a plea to then US president Donald Trump for help in shoring up their island. "They talk about a wall; we'll take a wall," said Eskridge, adding that he was a fan of Trump.[13] In an atmosphere in which much of the country was still reeling from Trump's election to office and his quick withdrawal of the United States from the Paris Climate Agreement, the subsequent public shaming was quick, witty, and mean. In the opening monologue of *The Late Show with Stephen Colbert* in June 2017, Colbert made fun of the mayor's faith in Trump to cut through red tape to protect the island, saying, "Trump is going to get them that wall and make the ocean pay for it!"[14] And in another news satire program, *Full Frontal with Samantha Bee*, a reporter visited Tangier Island to interview its residents, poking fun at the social, cultural, and religious differences between the islanders and her (presumably) more urban and liberal audience.[15]

What was lost on the media, who often reported this story as a battle of conservative, religious viewpoints over liberal, science-based perspectives, was that the islanders of Tangier simply, and quite literally, saw things differently. When residents said it was erosion, not climate change, taking their island, they were not just being obstinate. They really meant it.

What Our Brains Do in the Shadows

Think about these questions:

Do you believe we are already experiencing the impacts of climate change?
Do you believe human activity is the primary cause of modern-day climate change?
How did you determine your beliefs?

If you have a few minutes, go online and research these climate change topics. Perhaps you will find data and information to support your beliefs, and perhaps you will also find data and information that challenges them. Which did you click on? Which did you spend the most time reading?

Now think about these related questions:

Why exactly does the presence of carbon dioxide in the atmosphere create a greenhouse effect?
If pressed, could you explain why to someone else?

If you are not an atmospheric scientist and find these questions somewhat challenging, take a moment for some online research. Possibly you will find some websites that refer to the molecular structure of various molecules and how the structure of carbon dioxide differs from that of nitrogen gases. Okay, that might make sense. Read on, and you may learn about how the bonds between atoms in certain molecules can vibrate in different ways, which influences whether the energy of a photon corresponds to the frequency of a molecule and then whether that energy (or heat) is absorbed. If the infrared photon is absorbed, the energy will cause the molecule to vibrate—until it in turn reemits the photon to another molecule, increasing the speed of that other molecule's motion.

Have you had enough yet?

If you are like most people, with limited time and your own work and life concerns, after a while you will probably conclude that you don't have time to understand the scientific details that underpin the greenhouse effect and settle on one or two articles from sources you trust. That's completely natural and normal. The world is extremely complex, so the way we make sense of it is to rely on what our intuition, the world around us, and other people tell us to be true.

In research, we do that all the time. We don't know every aspect of what we study, yet that does not stop us from collaborating on projects and papers with experts from other disciplines whose expertise fills in our own gaps. It's not just because science is overly specialized; it's because there is an extraordinary amount of information out there and our brains can only contain so much information. This is true for all of humanity and can be explained through our evolutionary past.

Humans are social creatures. We evolved from hunter-gatherer units in Africa, and in many ways we were not physically well adapted to our environment. We could not run as fast as animals that preyed on us or those we preyed on. Our skin was not covered in protective spines or scales, and we suffered greatly from cold temperatures. We needed to drink and eat every day, and many foods available to other animals were poisonous to us. Our young were born so developmentally immature that we had to watch them carefully for years lest they be snatched up by a lion or bitten by a snake.

Given that early humans were comparatively weak, vulnerable, and slow, how did we not only survive, but thrive, in the face of such handicaps? The answer is deceptively simple: we learned to cooperate.[16] We formed social groups that shared the labors of hunting, building shelter, preparing food, and rearing children. It was a lot of work, so we became specialized in certain tasks and relied on others in our group to become experts in others. Some group members hunted while others gathered medicinal plants and prepared meals, which allowed those who were

hunting to dedicate time and effort toward improving their skills in that area and, similarly, for those preparing the food to make it taste better.

As we have evolved as a species and our society and technology have become more and more complex, our knowledge has become increasingly specialized.[17] We may know how to go to the supermarket and buy the correct ingredients to make chili for our friends, but very few of us know how to raise and butcher a cow for ground beef. We live in homes full of piping and wires that we do not fully understand, so when the sink backs up, we typically call a plumber, and when a fuse blows, we call an electrician. In our daily lives, we rely on the expertise of others so regularly that we almost forget how reliant on others we are. As cognitive scientists Steven Sloman and Philip Fernbach argue in *The Knowledge Illusion: Why We Never Think Alone,* we live in the illusion that we are independent thinkers and self-sufficient, an illusion that holds as long as the internet doesn't inexplicably cut in the middle of watching our favorite football team.

Because we cannot know everything, when we encounter new knowledge, we do our best to make sense of it. But "making sense" of that knowledge does not mean some Spock-like approach to logical information processing. Rather than carefully deliberating over every new piece of information, what typically happens is something more akin to a gut reaction. Our brains automatically make assumptions about the validity and importance of the information, relying more on our prior experiences than logic to inform us.[18] Most of this process is unconscious and requires very little effort or energy, which is by design. Our brains evolved to prioritize survival. If we heard noises in the underbrush that sounded like a predator approaching, we didn't wait around to confirm our assumptions—we ran for it.

Behavioral scientists often refer to our brains as "cognitive misers," cheapskates when it comes to having to spend time or conscious thought on new ideas.[19] Being cognitive misers means that we often rely on

almost anything besides brain effort to make sense of the world, and thus we typically use mental shortcuts (often referred to as heuristics) to make rapid assessments about ideas about which we know very little.[20] Being a cognitive miser is mostly a good thing as it means that we can go about our lives efficiently, not spending hours deliberating the utility of everyday actions. Life without such heuristics would be exhausting—we would regularly spend hours pondering matters as trivial as what to have for breakfast or the best route to get to work.

The use of such mental shortcuts can have costs, however. Specifically, they bias our decision-making processes, causing us to get stuff wrong. Our cognitive stinginess means that we tend to rely heavily on previous experiences and stories that quickly come to mind for decision-making rather than taking the time needed for thoughtful deliberation. We're also prone to see patterns that aren't there and to accept or refute new information without evidence. And "we" isn't just other people—it is all of us, scientists included. For example, historians have argued that some of the most prominent examples of science losing its way have come about when the leading researchers at the time were biased toward one theory or approach, discounting others.[21]

In addition to our cognitive limitations, another major influence in terms of how we interpret new information is related to our social networks and identities. As mentioned earlier, humans are social animals, and if we don't know what to think about something, we often turn to those we trust to tell us what's what.[22] We are attuned to what is considered normal or acceptable in our social environments, and we instinctively know that acting in violation of such norms will have negative consequences. Most such social obedience feels so natural that we don't even realize we're doing it most of the time. Typically, it's only when we encounter someone who doesn't share a given social norm that we realize our behavior is learned rather than natural. For example, an Indian friend shared that she was taught to touch elders' feet as a sign of respect,

which was surprising to me, as doing so among my own family would be disconcerting to all parties.

Prior experiences and social factors are hugely influential in how we see the world, sometimes quite literally so. One striking example is "the dress" phenomena, in which a picture of a blue-and-black dress was posted on social media. Bizarrely, not everyone's brains processed the colors of the dress in the same way. Some people, including myself, saw the colors of the dress as being white and gold. Neuroscientists who later studied the phenomena discovered that what was happening was that the picture was so overexposed it essentially forced our brains to make assumptions about the lighting conditions in which the photo was taken.[23] Because our perceptions of color are informed by our perceptions of lighting, those of us whose brains assumed the picture was taken under natural lighting (possibly outside) saw it as white and gold, and those whose brains assumed it was taken under artificial lighting (indoors) saw it as blue and black.

Researchers surveyed thirteen thousand people to try to understand why some brains assumed one lighting condition and not another and found that the main difference between the blue-black people and the white-gold people was how much time in their life they had spent working inside as compared to outside. Those who were more accustomed to outdoor lighting conditions were more likely to see the dress as having been illuminated by natural light, which led their brains to subtract blue light, leading the image to look more yellow. In other words, our brains quite literally saw the dress as being a different color based on our prior life experiences. This process is out of our control. For example, even though I now know that the actual color of the dress is blue and black, I still see it as white and gold. I've tried to tell my brain that it is wrong, but I suppose my years of working (and even living) outdoors will simply not allow me to see it differently.

This example is rare in some ways, but in another sense, it is extremely common. In his book *How Minds Change*, David McRaney used the example of "the dress" to explain that just as our brains can trick us into seeing different colors or shapes based on a process of filling in missing information, so do we do this in other areas of our life.[24] When faced with a novel situation, our brains will automatically and unconsciously make assumptions based on what we have most frequently encountered in the past and what "feels right" based on our social environments. For example, researchers at Yale's Cultural Cognition Project conducted a study in which they showed two separate groups of participants a video of people protesting and asked them whether they believed the protesters were acting lawfully or not. One group of participants was told that the protesters were protesting abortion outside of an abortion clinic, and another group was told that the protesters were protesting against the military's then-existing position against openly LGBTQ+ soldiers outside a military recruitment center. The researchers found that participants' political and cultural identities largely dictated how they interpreted the actions of the protesters.[25] Participants who the researchers categorized as having more "egalitarian and individualistic" worldviews (associated with more liberal or progressive perspectives) saw the abortion protesters, but not the military protesters, to be unlawful, whereas "hierarchical communitarians" (associated with more conservative or traditional viewpoints) perceived the opposite. But they were all looking at the same video. This tendency to interpret the same information differently, McRaney argued, is why we disagree so much and why such disagreements often seem to happen across different social identities (such as political ideologies), writing: "Unaware of the processing that leads to such disagreement, it will feel like a battle over reality itself, over the truth of our own eyes. Disagreements like these often turn into disagreements between groups because people with broadly similar experiences and

motivations tend to disambiguate in broadly similar ways, and whether they find one another online or in person, the fact that trusted peers see things their way can feel like all the proof they need: they are right and the other side is wrong factually, morally, or otherwise."[26]

Because of this reaction, information that challenges our preexisting worldviews or our social identities can feel threatening and even offensive. The more complex and stressful the information, the more likely it is to be processed in parts of the brain such as the insula, ventral striatum, or amygdala (associated with emotions such as fear or pleasure) rather than in the prefrontal cortex (associated with rational thinking and deliberation).[27] Research has found that although winning an argument triggers "feel good" hormones such as dopamine and adrenaline, when our beliefs are threatened, we release cortisol, a hormone associated with stress and the fight-or-flight response.[28]

In a similar way, climate change was not a neutral concept to Tangier residents. For decades, they had been trying to raise awareness about the increasing rate of land loss to the sea. In fact, the islanders had been doing measurements of their own for more than a half century, calculating the loss of land from the ocean long before scientists arrived to talk about climate change.[29] That their island was disappearing, and disappearing fast, was something anyone who lived on Tangier Island knew. Erosion was part of the natural cycle of life, which fit into their Biblical worldviews that God controls the doings of Earth. Furthermore, erosion was the so-called enemy they knew, something that their parents and grandparents had dealt with and something that could be addressed in the future.

In contrast, climate change was a concept from the outside, promoted by the "come-heres" ("outsider" in the local dialect of the island) with whom the residents had little in common. It was human caused and often used by liberal politicians (the "other" political party) to promote solutions such as carbon taxes and electric cars, but who offered little in

terms of protecting coastlines. Whereas erosion could be addressed by shoring up the perimeter of their island—perhaps by a seawall—climate change meant the end of their island.

Furthermore, scientists had a poor track record as far as Tangier residents were concerned. The residents had a long and frustrating history trying to work with scientists and government officials to bring actionable solutions to address the loss of land. The first government study commissioned to look into the problem was conducted in the 1970s, and solutions to protect the island have typically been half measures that proceed at a glacial pace. In 2017, when the press visited the island in droves to poke fun at the irony of a climate-denying island of soon-to-be climate refugees, islanders were waiting for construction of a promised rock jetty to begin. The jetty had first been proposed in the mid-1990s but had been mired for years in studies and red tape. In his book *Chesapeake Requiem: A Year with the Waterman of Vanishing Tangier Island*, author Earl Swift captured the frustration of the townspeople, epitomized in a conversation he had with Mayor Eskridge, who said, "They do studies, then they study the studies. I know that's their procedure, but it gets frustrating. We're at the point now that it's like me coming across a family in a boat that's sinking, and I say, 'I'm going to rescue you, but I have to study it first."[30]

How a Hockey Stick Became a Boomerang

In 2017, with all the press attention on Tangier Island, Eskridge was invited to take part in a televised town hall on climate change, which featured former vice president Al Gore.[31] Gore is most well known for raising awareness about climate change through the release of his award-winning documentary film, *An Inconvenient Truth*.

I clearly remember when *An Inconvenient Truth* came out. It was 2006, and I was in a graduate program focused on environmental issues. Climate change was a regular point of discussion in my classes,

among my peers, and with my professors. Prior to watching the film, I had already accepted the links between an increase in greenhouse gases, global temperatures, and more intense and more frequent hurricanes in wetter parts of the world and unprecedented wildfires in drier parts. My left-leaning worldview was also consistent with the policy recommendations that would inevitably stem from climate science—reductions in CO2 and other greenhouse gas emissions from polluting corporations and a focus on community and social responsibility for addressing the issue.

So as a budding environmental researcher, Gore's film really resonated with me. At the time, I remember thinking, "Wow, now everyone will know about this problem." To my twenty-something mind, Gore was straightforwardly presenting the facts, even using graphs to prove his points. Who could dispute that?

Many people did. Conservative-leaning Americans saw Gore, a Democrat who lost the 2000 US presidential election and thus failed to advance his policies through government, make a film depicting a global environmental problem that could only be solved with sweeping policy change. More taxes. More environmental regulation. More public transportation. Hmm. Such proposals were like those that had been promoted for decades by liberals, long before discussions of climate change took the national stage. Right-wing media called the phenomenon a "watermelon"—green on the outside, red on the inside. They mocked climate change action as an "Al Gore deal" and flouted the hypocrisy of his flying around the world to promote the issue, charging a hundred thousand dollars a pop for the pleasure of his telling people to reduce their carbon footprint. Climate change skeptics, with major funding by fossil fuels–supported right-wing think tanks, made it seem like the science was debatable.[32] They talked about theories of sunspots and solar radiation, false data, and parts of the Antarctic that were getting colder. At a 2010 conference organized by the Heartland Institute, a free market

think tank skeptical of climate change, attendees were even handed miniature hockey sticks as a symbol of their alternate interpretations of the hockey stick graphs popularized in Gore's film.[33]

So even as *An Inconvenient Truth* helped raise awareness and concern among liberals like me, it had the opposite effect among many conservatives, particularly in the United States. In 1997, 52 percent of Democrats and 48 percent of Republicans agreed that the effects of global warming had already begun, but by 2008, while the percentage of Democrats who agreed that global warming was occurring increased by 24 points, to 76 percent, for Republicans that percentage decreased by 6 points, to 42 percent.[34] Some scholars referred to this change as the "boomerang effect," which is said to occur when a message designed to persuade has the opposite impact of that intended by the communicator.[35] In other words, rather than convincing conservative-leaning Americans that climate change was real and happening, the film and similar efforts to get the word out contributed to an increasing perception that the news about global warming was exaggerated.[36]

Given this political climate, perhaps Gore would not be thought to be the best messenger to speak with a Tangier resident about climate change, yet that was precisely the setup when Eskridge was invited to ask a question of Gore at the televised town hall in the summer of 2017. As the mayor of Tangier, Eskridge could have used the opportunity to ask why the government wasn't investing in communities such as his or to ask for a commitment from climate change activists such as Gore to raise awareness about Tangier Island's plight. But tellingly, Eskridge had a different question. After explaining his background as a crabber with fifty years of experience on the water, he said, "I'm not a scientist, but I'm a keen observer. And if sea level rise is occurring, why am I not seeing signs of it? I mean our island is disappearing, but it's because of erosion and not sea level rise and unless we get a sea wall we will lose our island. But back to the question, why am I not seeing signs of the sea level rise?"

Gore, perhaps assuming that Eskridge was just trying to give him a hard time, took the bait. He asked the mayor, pointedly, to what Eskridge attributed the disappearance of the island. When Eskridge replied that it was due to erosion caused by wave action and storms, Gore then asked, rather skeptically, "So you're losing the island even though the waves haven't increased?"

Yes, said Eskridge. He explained that erosion had been a constant part of life on Tangier ever since its formation. "If I see sea level rise occurring, I'll shout it from the house top," he said. "But I'm just not seeing it."[37]

Watching the exchange as an outsider, it is striking how the two men seemed almost to be talking about completely different things. I brought that up in an interview with author Swift, who lamented the lost opportunity for Gore to explain the difficulty of using anecdotal observation to perceive something as slow moving as sea level rise. As Swift told me, "The biggest problem in terms of the Tangier view assimilating with that of science is that a Tangier waterman has a different way of collecting data. Instead of the model favored by science, a Tangierman goes out on his boat every day and looks at the water. And that anecdotal style of data collection leads him to a completely different set of conclusions. Namely, he's trying to gauge incremental change over the course of decades from the pitching deck of a tiny boat offshore."[38]

But just as Eskridge's limited perspective made it impossible for him to *see* the sea rising up to swallow his island, neither could Gore *see* that the man in front of him was asking him a valid question. Thus, instead of attempting to answer it, he told a parable about a man who, stranded in a flood, asked for the Lord to save him. As the flood waters rise, the man continuously rejects help from others, saying that "the Lord will provide." The man ends up drowning, and Gore concludes: "And I think that we have heaven sent, so to speak, enough solar energy in one hour

to provide what the entire world uses for a full year. And from wind, we get 40 times as much energy as the entire world needs. We have the tools available now to solve this crisis. And whether you attribute what's happening to Tangier to what the scientists say it's due to or not, I'm assuming that if you could get cheaper electricity from the sun and the wind, that would be a pretty good deal for you, right?"[39]

Yes, agreed Eskridge, and the town hall moved on to other matters. But the exchange was unsatisfactory at best. When Eskridge asked why he couldn't "see" climate change, what kind of answer was he looking for? And although it was clear from the parable that Gore wanted Eskridge to think differently, what, specifically, did he want him to do differently? The average Tangier resident uses less energy, lives in a smaller home, and drives far less than the average American.[40] Perhaps the approximately 220 voting-age adults living on Tangier are not on Team Climate, but they also represent less than 0.00003 percent of Virginia's population, thus making any attitudes of the islanders unlikely to determine the fate of any future energy policy in the state, let alone nationally. Furthermore, pointing out that green energy will lead to cheaper electric bills might not be very relevant to a community whose home is threatened with disappearance.

From "Please Just Listen to Me" to Something Else?

In 2007, Gore, along with the Intergovernmental Panel on Climate Change, was awarded the Nobel Peace Prize for his efforts to spread the science of climate change, the first time the prestigious award had ever been focused on science communication. In the words of the committee, Gore was "the great communicator," "the single individual who has done most to rouse the public and the governments that action had to be taken to meet the climate challenge."[41] For many, he continues to be viewed as a central messenger for the environmental movement, even

making guest appearances on popular television shows such as *30 Rock*, where he played humorously exaggerated versions of himself as a heroic environmentalist running off to save animals in trouble.

But for others, the fact-based appeals to address climate change have fallen short. In 2020, climate change and environmental issues were the two most polarized issues in the United States, surpassing traditional fighting fodder such as immigration, health care, and guns.[42] Although more than 75 percent of Democrats considered climate change to be a top priority, less than one-fourth of Republicans agreed.[43] And as climate change has become more associated with liberal politics, bipartisan efforts to address it in policy arenas have dried up. Some conservative lawmakers who became concerned about climate change pushed back and suffered mightily as a result. For example, Representative Bob Inglis, a Republican from South Carolina, set out to convince his party and constituents that the science of climate change was real, only to lose his seat in 2010 in a landslide defeat. Two years later, another Republican policy maker, Senator Richard G. Lugar of Indiana, followed suit by losing his seventh term to a challenger who called climate change "junk science." These defeats were widely discussed in the media and sent a clear message to other Republican policy makers that climate change was not an issue that resonated with their voters, and if they wanted to get elected (or reelected), one had best steer clear.

This polarization has led to political impasses for getting much done in terms of climate action, not just in the United States, but internationally. As a result, the amount of carbon in the atmosphere continues to increase, and the global temperature continues to rise. In 2006, the concentration of carbon dioxide in the atmosphere was at about 380 parts per million, whereas in 2024, we were exceeding 422 parts per million.[44] And although the latest round of negotiations at the UN Climate Change Conference provided avenues for the countries of the world to

(continued...)

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