WHERE WE FAIL: AN EXAMINATION OF SCIENTIFIC MISCOMMUNICATION

Emily M. Wilbur

UNIVERSITY OF WASHINGTON, COLLEGE OF THE ENVIRONMENT

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Abstract

In a country where scientific beliefs are closely tied to social identity and politics, it is difficult to represent objective scientific data to the public. There are hardships for both the scientific community and the populace, some of which are dealt with simply (through social outreach) and some of which seem near impassible (a culture of distrust in science). However, there are many methods such as social media, public education, and outreach that allow the scientific community to communicate so that the public is moved to act in a way that closely resembles that of a fully informed individual. This considers less the issue of communicating every detail via the simple solution of communicating the most relevant details, and allows for action without years of education. This is incredibly important with respect to politics and policy, as science shows how the world is changing, and the complexities of that research are sometimes too difficult to convey to laymen, even though the consequences of inaction—the most obvious example being climate change—can be damaging as best, and deadly at worst. The United States is resting in a purgatory of accurate science, but scientifically inaccurate politics. We explore the culture that caused this and methods to be utilized to help the nation overcome it.

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Introduction

Through observation, it may be noted that in different cultures, there exist different attitudes toward science and its conclusions. The culture in America may best be described as "agnostic" if it is treated as a belief system, or "apathetic" with regard to its attempt to inform. This is not an attitude that spans other cultures and countries, however, and many people use science to inform their everyday lives, their government policy, and their acts of defiance should their government ignore their desires. Science that is communicated well can clearly hold great sway with some, and the implications of its discoveries can be life altering. So why, in the United States, does this apathy persist? What failure has tripped up the ability to use the vital tools provided by scientific research for the good of mankind? Here we explore the idea that there are failures on both sides of the conversation, and examine how these failures can be rectified so as to restore the ability of science to achieve its goal: informing the population by answering questions.

Science is, of course, driven by scientists, i.e., human beings with thoughts and therefore not objective in every sense. This is the first side of two in the conversation about science, the reason we need scientific communication, because science does not exist in a vacuum. This has led to the popular claim that science is not credible because there are secret goals held by subjective humans. Fortunately, a scientist's main goal (it's not really a secret) is to answer a question. Questions are asked, sometimes they are answered, and then the answer or lack thereof is reported to others. Sometimes, if the discovery is significant—or sounds very cool—it is reported to the public. The way in which the discoveries are reported is significant because the readers of these public reports are not scientists; they largely do not understand the methods and terms that led to the discovery, and so the process of discovering must be boiled down to its

barest essentials so that the idea can be communicated at all. This is the main reason for the rise of the field of scientific communication: it is very difficult to rid narrow, involved fields of the "extras" because all of the information is important. Scientists tend to end up frustrated by their message being relayed incorrectly, but the general populace doesn't have the proper knowledge to understand that physicists proved that the Higgs Boson *probably* exists, not that it *does.*

Scientific concepts are long, convoluted efforts to describe the world around us, and the world is not simple or perfect, so neither are the discoveries made. Unfortunately, it takes some grace and suspension of incredulity to be on the receiving end of explanations where most of the explanation is cut out. Herein lies the second half of the conversation, the public. And while there is definitely the issue of getting the short version of science out there and accessible, there are several other issues posed on this side. One of many, there is the issue of sociopolitical polarization on whether or not to even believe scientific claim, that can result in interpersonal divides based on where one may fall with respect to the issues presented. Dan Kahan (2012) poses the idea that in America, there is a general view that the only implications of one's views on science will be where one falls on the political spectrum. He writes that for members of the public, there is no foreseeable impact to being right or wrong about climate change, only that where you stand on the issue is tied to how your peers view you, and how you view yourself as a person.

And thus, the reason that science communication is so difficult is revealed: the goal of the conversation differs wildly on either side. The goal of the scientist is to inform, the goal of the communicator is to ensure that the information is transferred effectively, but the goal of the audience is to use the questions asked by science to structure their identity. This information can and has been used to change the goal of science communication, which is now to influence the

populace to make choices that resembles as closely as possible the choices that one would make if they were fully informed on the issue (Fischhoff, 2018). This involves many methods that are utilized to motivate the audience to make the decisions through different means, including addressing the complexities of identity politics.

Methods of Science Communication

As the field of science communication has advanced, there have been many efforts to increase effectiveness, some of which have been more successful than others. While some methods have been found to work well, many efforts are unsuccessful due to lack of information or a disconnect between the informer and the audience. However, it is important to note that the so-called "deficit model" (National Academies of Sciences, Engineering, and Medicine, 2017) is false and shallow. The deficit model assumes that there is simply a lack of knowledge in the populace about science, and that it can be "fixed" by simply telling more people about more science. This model dismisses the fact that there is relatively high science literacy in the United States, and also disregards the possibility of scientific complexity. And while it is important to be clear on the theories widely accepted by the scientific community, it is also incredibly damaging to assume that every theory is absolute and without possible multiple interpretations. In light of that, we explore some methods that accomplish the goal of communicating, their results, and their perceived effectiveness.

As technology has progressed and social media has become popular, there is pressure on scientists to involve themselves with things like Instagram and Facebook, etc., to further the spread of their research and academic involvement. While this is effective if done right, it is often difficult to pinpoint exactly how it should be done. The effort to interact well on social media has evolved to the point that some institutions have even developed departments or

branches specifically to deal with the social media images of their faculty. This allows people who have experience being effective on a given platform to advise those with less experience how to go about their social media interactions without alienating their audience (too much pure science and too little fun often results in very little spread of information, while the right amount of both leads to a wide audience that pays close attention). This method results in a varied viewership, and when managed correctly is quite effective.

Fortunately for those less tech literate, there are other ways to involve the public in the issues raised by science. Many other forms can be utilized, such as accessing key members of the community (like pastors, newscasters, and other widely respected individuals) to spread the message, improved public education, and a cultural shift toward a more positive view of science as a concept. As noted in the introduction, the polarization of views on science greatly affects how willing an audience is to receive information. The method of using respected community members can help to smooth over that polarization, as they can reaffirm that the science being communicated is not at odds with the audience's identity and beliefs. The effects of doing this are noted in Communicating Science Effectively: A Research Agenda, as people are generally only willing to challenge long-held beliefs if they are presented in a way that is less of a challenge, and more of a suggestion. While this can sometimes lead to the same kind of miscommunication as journalistic interviews that incorrectly convey scientific conclusions, their ability to get the general point across is invaluable. Think of it like this: "The Really Big One" was published in the New Yorker, and immediately caused an uproar about the possibility of a large earthquake striking the Pacific Northwest. Some of the details were confused (like the actual likelihood of the earthquake to be as big as the article claimed) but there is no denying that the Pacific Northwest isn't even prepared for a magnitude 7.0 earthquake, much less a 9.0, and

the public attention has been vital in minimizing the potential impact of any earthquake. This is directly applicable to utilizing respected members of the community, since they can be anything, even journalists.

In addition, being introduced to concepts early in life can help ideas to seem more accessible to those who tie their identity into their reactions to scientific research. Early and better science education can better prepare the public for a more science based world by helping them to understand the basis of the research. While it may appear that public education doesn't need the help suggested here, states like Tennessee still require that evolution be taught as though the subject is very controversial, as though science hasn't quite figured out whether or not evolution is an observable fact (Stone, 2018). The U.S. Supreme court has ruled many similar things to be unconstitutional, but other laws still stand, and they cause serious consequences in understanding of scientific fields and concepts. While it isn't expected that this can be completely resolved any time soon, effort should still be put in to move slowly toward change.

Moving from helpful ways to communicate science, it's good to look at what one shouldn't do when trying to educate others about science. It has been noted that arguing with strangers about things like climate change doesn't usually help them to understand the science or believe in the cause, and rather sends the arguers away reaffirmed in their belief that science is a lie. These people are referred to in Lewandowsky, et al, (2016) as "contrarians" because their goal is not to actually *learn,* but to sow public distrust in science and scientists to undermine scientific claims. The range of science these contrarians dispute is wide, from AIDS to climate change, they are determined to deny and dispute. While this concept can be frustrating because it seems to remove ability to take personal action, it is actually important to note that while arguing with someone about their belief doesn't do much good, speaking with someone about one's own

experience with science and why they themselves believe in climate change can be the pebble that causes a landslide in their audience's thinking. It is important to keep these interactions conversational and to present alternatives to the misinformed beliefs held by the individual with whom one is trying to communicate.

If the reader is lucky enough to be a scientist, the best way to utilize your platform is through patient and repetitive conversation, whether it be in real life on the bus ride home or through personal or professional social media. It is good to remember how long it took to understand the material you now use on a daily basis, and expect a somewhat similar learning curve of others, especially if they doubt scientific claims as a part of their sociopolitical identity.

Utilizing Methods—Roadblocks and Remedies

It is not always easy to communicate science to some, even if the scientist is taking all of the correct steps to educate in a clear and concise manner, since individuals are not always prepared to receive the information or understand it, even in its simplest terms. Science literacy as defined as "some level of familiarity with the enterprise and practice of science" in the National Academies of Sciences, Engineering, and Medicine research agenda for 2017 remains high in the United States, but the actual ability to comprehend science and its complexities remains relatively low. Some of the options listed in the methods section attempt to deal with this issue, but as was stated in the same research agenda, science literacy is dependent on many factors, and not all of them can be addressed through a one-sided effort by scientists.

One example of the issues caused by an unprepared population is the difficulty of communicating the uncertainties and complexities involved in scientific theories. There is a very slippery slope surrounding how to convey these uncertainties without causing the false narrative that there is no certainty at all (an issue encountered with trying to convey the processes and

results of climate change to the public, resulting in a widespread belief that there is little to no agreement within the scientific community about whether or not climate change is even happening; which isn't the issue that the scientific community was trying to communicate in any sense). Just because there are some uncertainties with the exact amounts of climate change and the effects, doesn't mean that there isn't scientific consensus that climate change is happening and will have an effect. The United States is still reeling from this miscommunication, and policy in the U.S. is still dominated by that misinformed belief, which is illustrated in a poll from Leiserowitz, et al (2018), in the publication of *Climate Change in the American Mind*. The damages caused by this conviction may never be repaired. This is illustrated in the figure below, which shows that while people do belief in climate change, they also believe that the science isn't conclusive in even the most basic sense.

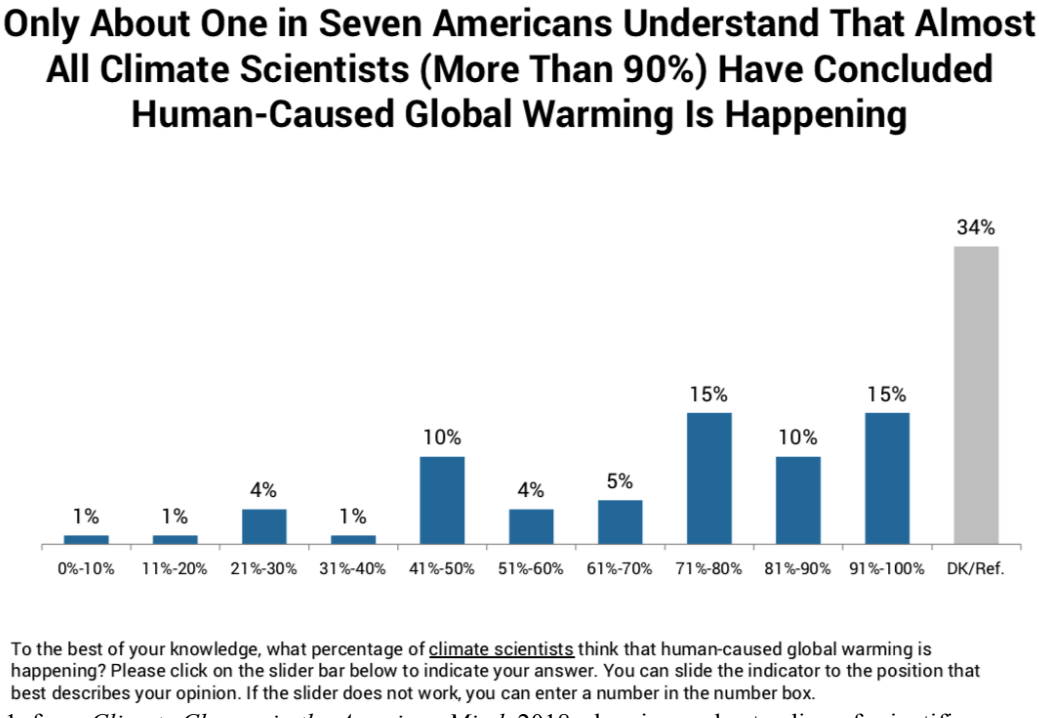

Fig. 1, from *Climate Change in the American Mind,* 2018, showing understanding of scientific agreement.

The good news is that while there persists the idea that scientific consensus is lacking, more people *do* believe that climate change is happening. This disconnect is likely caused by incorrect

media representations of an argument within the scientific community. Due to the difficulty in explaining uncertainties, it can seem like a question renders an entire concept uncertain, and scientific disagreement over minor details of a theory can be misrepresented as serious disagreement over the theory itself. Scientists aren't currently in any place to tackle media entanglement on that scale, but there are other ways to deal with this issue.

Unfortunately, this brings us back to the matter earlier presented by Fischhoff: how does one communicate their ideas effectively enough to influence the populace to make choices that as closely as possible resemble those of a fully informed individual? The methods section (page 5) is important, not necessarily because it tells you how to communicate the complexities of your field to the public, but because it tells the reader how to best influence their audience to make the decisions that they themselves would make. In other words, the methods used are important to making the audience *feel* that they are informed enough to make the right decision, because they trust the scientist and because the audience feels that the actions they take with respect to the scientist's work reaffirm their social identity.

Another roadblock to accurately communicating science, related to the one presented above is the issue of pluralistic ignorance: the issue of individuals believing that fewer people believe in something than actually do. This is partially illustrated in figure 2 on page 12, which shows that a large majority of Americans believe that climate change is happening, even though many people don't think that support of climate science is a majority held opinion. This issue is purported by N. Geiger and J. Swim below:

> We suggest that the social dynamics surrounding climate change are barriers to discussion – *a socially constructed silence* (Marshall, 2014, Norgaard, 2011, p 82). First, we propose that *pluralistic ignorance* – the tendency for a majority to misperceive others'

> opinions on a topic, falsely believing that fewer people share their opinion than actually do (Prentice & Miller, 1993) – contributes to the lack of discussion about climate change. Despite a solid majority of the public being concerned about climate change, most underestimate the degree to which others are concerned (Leviston, Walker, & Morwinski, 2013). Second, we propose that pluralistic ignorance leads people to avoid discussing climate change because people anticipate being evaluated more negatively by those who disagree with them than those who agree with them in anticipated conversations about the topic. Research on core dimensions of social evaluation suggests that anticipated negative evaluations would be in the form of anticipating being perceived to lack warmth, competence, or both (Fiske, Xu, Cuddy, & Glick, 1999). (Geiger and Swim 2016)

This information may not necessarily be new, but it is important to acknowledge the influence that beliefs like this one have on the public and government ability to act on information. The general public mostly believes in climate change, but since people don't usually talk about it, they also believe that the general public *doesn't* believe in climate change. Climate change believers are far less radical than they might think, but without sound public dialogue on the matter, the United States is engaged in an all-encompassing prisoner's dilemma. Pluralistic ignorance keeps science communication from its goal of influencing individuals to make decisions that closely resemble those of a fully informed individual through essentially making it impossible for anyone to know what that fully informed individual looks like. If science can't be acknowledged as an aspect of a social contract, it can't be acted upon.

The best way to combat the issue is to encourage people to simply talk about the problem, and other issues—like evolution—can be dealt with in a similar manner. Raising public

awareness is the shift needed to break through barriers of apathy, but the ever-present identity tied to science belief, and the perceived potential for public embarrassment should your peers not share your beliefs, call for a cultural change to allow space for dialogue on issues perceived as being more contentious than they are. The U.S. population is, ironically, not as ignorant as it collectively thinks it is.

This section would not be complete without a final barrier: corporate opposition. Corporate interests are generally entirely monetarily driven, and things like having tobacco sales driven down because the FDA says smoking is bad for health are major detractors from the company (Oreskes and Conway, 2010). Companies that don't want to address concerns raised by science work very hard to deny fact and manufacture disputes about the claims at hand to avoid financial losses. This has led to long lasting delays to actually addressing concerns, and the United States is still reeling from multiple instances of these tactics being used to delay legislation and awareness. An example of this is Shell executives knowing that the science surrounding climate change is sound, knew that it would impact them as part of the fossil fuel industry, and actively tried for twenty years to undermine climate science so as to avoid financial loss and environmental lawsuits (Waldman, 2018). Unfortunately, there are areas where the effects of these tactics can still be felt today.

The best way to combat effort like those of Shell is to pay attention, and remain skeptical of unsupported claims. Companies like Shell were able to do what they did because people weren't aware that they were being fed propaganda, and instead treated the company's claims as reasonable contributions to a nonexistent scientific debate. In turn, policymakers see the "debate" as an opportunity for inaction, which means that Shell got what it wanted: freedom to do as they please to increase sales (and further climate change without inhibition). This has happened

before with many industries, and if the people aren't aware and watchful, it can happen again (Oreskes and Conway, 2010).

Effect and Public Perspective

In many respects, the efforts of science communicators have paid off, and the population is slowly but surely becoming majority science believers. While climate change isn't the only concept addressed by scientists that is relevant to the public, it is a good gauge of public opinion toward science, so it is used in this section as a show of effective and thorough communication. From the Yale Climate Opinion data for 2018, there is a majority of positive belief in one of the most contentious claims from science, climate change. Fig. 1 shows the over beliefs held by the United States population, mostly positive.

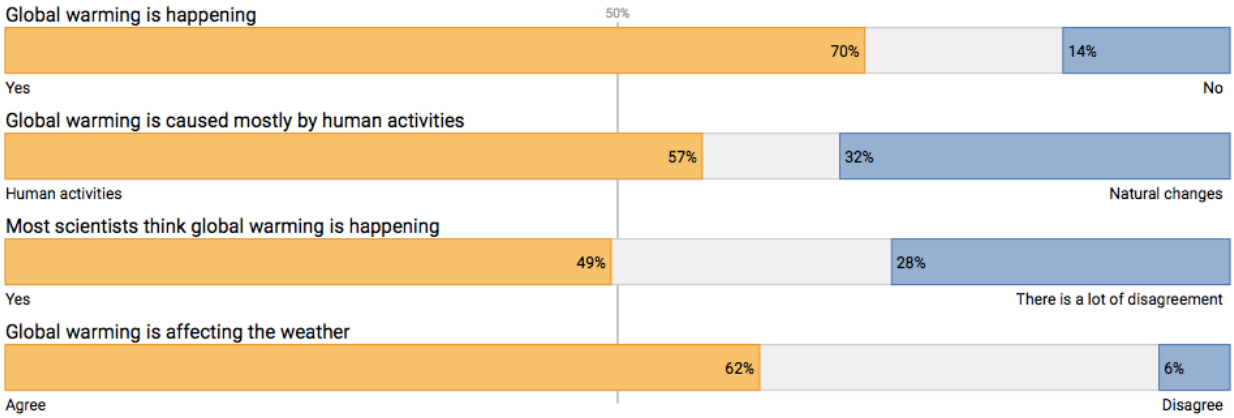

Fig. 2, from Yale Climate Opinion Maps, 2018, on public consensus with respect to global warming.

This data is helpful to show that dissent with science is a smaller voice than most people believe, which is hopeful, but also stands as a reminder that while small, it is loud and persistent. Efforts to communicate science have largely been successful at *education,* but not *motivation.* There are many causes that science has presented that need to be advocated for, and somehow the majority shown in the figure above is not loud enough to drown out the small dissent. There

is action required, but it can be difficult and inconvenient. It is now up to both scientists and laymen to move toward action rather than passive observation.

In the previous section, we explored how the component of self-silencing to the lack of public conversation surrounding things like climate change and other scientific ideas. The remedy is simple: talk. You, the reader, should talk about climate change and evolution, etc., and your family should talk about it, and your friends. The difference in fact and public opinion on how science is being perceived couldn't be more different, but that gap is easily crossed with simple conversation. This creates a positive feedback loop of conversation, and can generate a shift in public perspective toward science related discussions.

Another effect of successful science communication is movement toward a more science literate public that is better informed to act. A better informed public leads to better informed policy, and a population that feels more involved in the decision making that determines how they live their lives. In Lewandowsky, et al, (2016), the authors note situations where informed debate over local policy decisions between the engineers and the public lead to changes in a flood plan that significantly lessened the potential flood damage, while also satisfying those members of the public that had engaged in debate surrounding the previous plan. This is just one example of how a fact-based discussion can lead to greater satisfaction and empowerment on both the public side of the discussion and the scientific side.

This example also plays into the aforementioned concept of influencing individuals to behave as a fully informed people, because in some ways they *are*. In the example above, science communication achieved its goal, and the public and policy makers both used science to inform their claims and objectives. This is what the entire U.S. could look like, should the population (and the policymakers) commit to that kind of dedication to collective effort and collaboration.

In Conclusion

To summarize (even though this paper admittedly contains quite a lot), the current goals of science communication are to influence the public to act as similarly as possible to a fully informed individual— which is to say, to act like they themselves are scientists— and to use that influence to enact public behaviors and policy that are based in fact. This is difficult because one's response to scientific information is deeply tied to sociopolitical identity (as well as religious beliefs, etc.), and many people fear social embarrassment and isolation should they speak about their beliefs. This gives rise to an epidemic of pluralistic ignorance, or the self-silencing of the public on matters of great importance, such as climate change, because they believe that the rest of the population disagrees with them more than it actually does. This issue is remedied by encouraging public conversation about scientific issues, through the methods listed in this paper.

While the U.S. is attempting to move forward into the future, it is important to remind the public and policy makers that science is as objective as it can be, and that scientists are working to inform decisions for the betterment of the population, even though another common roadblock to communicating science are groups that (for any reason) would strive to sow doubt. Vaccinations, climate change, and AIDS (to name a few) are all theories and studies that can change many people's lives, and when the science is done effectively, it can change people's lives for the better. It has been shown that the best way to combat denial of such important subjects is through patience and persistence; gentle conversation about the facts as they are. While this can be testing, the potential impact makes it worthwhile.

Whether scientists or not, people hold the power to affect change, and encouraging fact based conversation through social media and in their personal lives can lead to a shift toward

openness surrounding the issues presented by scientists. Patience toward those who are uninformed and intolerance of the falsehoods meant to sow doubt are the main components that each of us can enact in our daily lives. The United States needs to move away from apathy toward science before the ability to diminish the consequences of inaction atrophies, and we are left to suffer unimaginable consequences.

Armed with all the above information, this paper requires a bit of introspection from the reader. Where do you fall on the spectrum and what can you personally do to effect the change you want to see? A recommended revisit to the methods section should stand as a good reminder that there is a way to do the work that needs to be done. Though action can be difficult and inconvenient, it is a worthy endeavor.

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