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More Complexity, Less Uncertainty: Changing How We Talk (and Think) about Science

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ABSTRACT

This article focuses on the phenomenon of complexity in scientific communication. The article argues that shifting frames in science communication and the rhetoric of science from *uncertainty* to *complexity* can benefit audience understanding of scientific issues, and can also prevent bad-faith uptake of these issues that can be used to stoke political divisions. Such detrimental uptake happened with several science communication issues related to the COVID-19 pandemic. The rhetorical strategy detailed here balances the need to support mainstream science, while also incorporating some critique of it. Such a balance can be beneficial for the *ethos* of scientists and science communicators, and can result in more robust public engagement.

Keywords: rhetoric of science, science communication, rhetorical theory, uncertainty, complexity, stasis theory, COVID-19

Introduction

In early December, 2022, the Governor of the State of Florida, Ron DeSantis, filed a petition to the state Supreme Court to start an investigation into the safety and efficacy of the mRNA vaccines for COVID-19, or, as his office's press release put it, to "investigate crimes and wrongdoing committed against Floridians related to the COVID-19 vaccine" ("Governor," 2022). Despite credible estimates that COVID-19 vaccines had saved an estimated three million lives in the US alone (Trang, 2022), the Governor argued that "truthful communication" about the vaccines from federal government officials had been "obscured" ("Governor," 2022).

As some observers of the episode pointed out, public perception of the success of the vaccines had been complicated by "misleading messaging from public health experts and from the White House," which has "created confusion that's left fertile ground" for political acts like DeSantis's (Flam, 2022). This example, though, is indicative of a broader issue: that problems with messaging, and with science communication, in general, has been a prominent feature of public discourse around the COVID-19 pandemic. Especially in the United States, debates over vaccines, over masks, over pandemic mitigation measures, lockdowns, travel bans, school closures, and a variety of other, related, issues have splintered public opinion on these subjects, have led to divergent and contradictory state-level rules and responses to the pandemic, have caused overt mass protests, and overall have fragmented the country's political, social, and, especially, rhetorical landscape.

While the pandemic may seem a unique event, it is arguably just a significantly high-profile example of a recurring problem in science communication. That is, the pandemic has sharply illustrated the difficulty in effectively communicating and discussing complex subjects, especially scientific subjects. Such a problem is hardly new in the field of science communication itself, which has long stressed this difficulty of effective communication of complex scientific subjects, and which

continues to grapple with this issue in contemporary science communication training (Bennett et al., 2020), and in science education more generally (Cook & Oliveira, 2015). Honing both scientists' and the public's ability to communicate and to understand difficult subjects in a robust way is widely seen as vital to public knowledge, and to a productive and healthy political sphere (Spoel et al., 2009).

Over the past two decades, for scholars in fields of science communication and the rhetoric of science, the particular problem of conveying nuance and complexity in scientific topics has often been framed as a question of communicating "risk," and more recently, as a question of communicating "uncertainty" (Walsh & Walker, 2016). Walsh and Walker, in their (2016) discussion of scholarship in this area, note that while there remains some "inconsistent treatment" and a lack of "principled, rhetorical frameworks" in the scholarship on uncertainty (and risk) (p. 71), the field has nevertheless gravitated toward the concept of uncertainty as a "boundary object" (p. 79), thus making it a key label for scholars studying the complex indeterminacies featured in scientific discourses.

In this article, I argue that the framing of "uncertainty" in scientific communication discourse, while still an important and useful lens for the field, can also have deleterious effects on science communication efforts and on public discourse itself. Both scientist communicators and science communication scholars, in this sense, can benefit from thinking of this thorny issue in scientific discourse as a problem of *complexity* rather than uncertainty. As I will explain in later sections, this terminological shift has significant implications, as changing the terms we use for a concept can fundamentally change our understanding of that concept, and change how we both talk and think about it. However, the main argument I make in this article is that scientific *uncertainties* have entailed *reductive* rhetorical treatments by scientists and scientific communicators, and that this aversion to complexity has harmed public discourse about these topics. Time and time again with scientific issues, communicators take a simplified approach to a scientific concept, either to facilitate public understanding, to promote agreement and spur action, or, from a rhetorical point of view, to address particular stasis points (more on this later) in order not to complicate the message. By doing this, though, communicators attenuate the message and cause the science to be understood in an oversimplified way. In turn, that science is unable to be engaged fully in public discourse, or worse, can be picked up and wrongfully appropriated to sow political dissent—such as with Governor Ron DeSantis's usage in the example that opened this article. The simplification of topics thus results in anemic science communication that can promote or exacerbate both political division and rhetorical disengagement.

In what follows, I first elaborate on the urge to be reductive, which is discussed to some extent in scientific communication scholarship, but is treated more specifically and extensively in scholarship on complexity and complex systems. Subsequently, I explore the implications of shifting terms as a rhetorical strategy, and specifically, of shifting from uncertainty to complexity. In the later sections of the article, I examine a few specific examples of science communication related to the COVID-19 pandemic, and argue that avoiding complexity in these cases harmed public understanding and created political division that might have been avoided with a different communicative strategy. As well, I discuss the implications of this argument for science communication and the rhetoric of science, and make the case that communicators cannot ignore certain stases of argument in their rhetorical approaches (cf. Ceccarelli, 2011). Ultimately, I argue that my approach strikes a middle ground between critique of scientific discourse and a full uncritical embrace of its conclusions.

Keep It Simple, Short-Sightedly

It should be noted that when discussing complex concepts, it is natural, and often even desirable, to be reductive. When there is a lot to be explained, or when there is a great deal of information about a topic—either because of its complexity or because of its breadth—it makes sense, rhetorically, to simplify it for an audience. Audiences can't always sit through book-length dissertations

on a subject; they typically need (and respond more positively to) more concise, relatable, and often simpler explanations. As prominent science/technical communication journal *Technical Communication Quarterly's* recent call for papers put it, there is an urgent need for "durable" and "portable" approaches to science communication that can "resonate" with its audience (St. Amant & Graham, 2019). Reduction can, in this sense, be a viable strategy for this kind of effective communication that resonates.

Many specific tactics of reduction are often useful in a science communication context. As Groves (2021), writing on the difficulty of communicating with skeptical audiences about controversial scientific topics, argues, "esoteric language" can be "ostracizing for non-specialists" (p. 78). There are also "surprising [. . .] gaps in technical literacy" among laypersons that make even slightly-complex explanatory elements illegible to the general public—for example, Groves mentions the poor comprehension of logarithmic graphs that were widely used to communicate disease information during the COVID-19 pandemic (p. 78). As well, as Walsh and Walker document, "scientists who speak in public experience enormous pressure to eschew uncertain expressions" (p. 78), in part because it is perceived that highlighting nuance, or any kind of doubt, may diminish scientists' credibility, weakening their rhetorical *ethos* by implying that they may not be as sure about a topic due to its complexity. Even worse, many scientists feel that any admission of uncertainty can be weaponized by opponents or those who disagree with the speakers, and can thus backfire and create more doubt and dissent among audiences (pp. 78-79). Considering these communicative exigencies, simplifying communication is often a logical rhetorical path.

On the flip side, however, there is much literature on science communication that does push against this drive to reduce. The National Academy of Sciences' (NAS) report on "Communicating Science Effectively" (2017), for example, explains that:

> scientific "facts" not only are complex but also can often be interpreted in more than one way. Effective science communication conveys both complexity and nuance, and does so in a way that is understood by and useful to the audience to which it is directed. (p. 21)

Here, the NAS emphasizes what rhetoricians of science know "in their DNA" (St. Amant & Graham, 2019, p. 101): that facts are not pre-given unassailable bits of knowledge, but rather, are the product of debate and science that is, as the NAS puts it themselves, "seldom settled" (p. 21), and that can be interpreted differently by different audiences with differing viewpoints and in divergent contexts.

These competing ideas—that foregrounding complexity and uncertainty are seen as rhetorically problematic, and that avoiding complexity and uncertainty does not do justice to the malleable and complex nuance of actual scientific facts—is where the problem lies in science communication. The conflict between these ideas, in fact, continues to pervade contemporary scientific discourse, including discourse related to the COVID-19 pandemic. In general, despite the repeated urges of science communicators and some scientists, actual science communication—especially about fraught or contested topics—still tends to reduce, to its great detriment. The story about the Governor of Florida that opened this article is an excellent example of the problems with reduction. In that case, by emphasizing the benefits of the vaccine far more than the potential harms, the science communication *did* avoid complexity. As will be discussed later in this article, a more complex discussion of this issue would have bolstered the credibility of the scientists by creating an ethos of honest communicators, and could have better supported the point those scientists were trying to make in the first place—that the potential benefits of the vaccine outweighed the potential harms. Note that this conclusion wouldn't have been proven beyond a shadow of a doubt; as with all science, there is never complete certainty. But, as this article argues, foregrounding exactly this complexity is a more fruitful rhetorical strategy than is suppressing it.

The remainder of this article will address a specific terminological shift that would focus beneficial rhetorical attention on complexity, instead of shying away from it. This shift involves moving from a rhetorical framework that revolves around "uncertainty," to one that revolves around "complexity." Such a shift recognizes existing scholarship on complexity and complex systems, which has problematized the tendency to reduce in scientific accounts of complex phenomena. This shift also recognizes a systems view of knowledge as emergent from a context rather than as a fixed quantity. This systems perspective strikes a balance between the view of science communication as a critique of scientific epistemologies that hold knowledge as stable and fixed, and an embrace of the certainty of scientific conclusions (as discussed in Ceccarelli, 2011). As I suggest below, foregrounding complexity amounts to a kind of inoculation against future attempts to misuse or discredit scientific communications.

The Importance of Terminology

"Systems theory" is a broad term that represents a variety of theoretical perspectives on complex systems. One thing that is in common to the approaches to the topic, though, is an appreciation of the incredibly high level of complexity, interconnection, and uncertainty present in systems that encompass a high degree of variables and interrelations. Everything from traffic patterns to cities to ecosystems can, from a given systems theory perspective, be considered as a complex system. The scope of this article prevents further differentiation of the overlaps and divergences of these perspectives, but suffice to say, this body of theory deals with phenomena that are, much like many scientific topics, incredibly complex.

Kauffman's (1995) notion of an "ideal of reductionism in science" is a useful point to consider in this article, as it describes much of the tendency toward reduction that occurs when discussing complex and nuanced subjects. Much like scientific concepts, conceptions and descriptions of complex systems are plagued, he argues, by a tendency to reduce to the simplest terms—in the case of much of science, descriptions of complex multi-factor systems get reduced to descriptions of basic physical elements. As Kauffman puts it, the ideal is a product of the desire in the sciences to take complex phenomena such as "economic and social phenomena" and explain them "in terms of human behavior." In turn, that behavior is to be explained in terms of biological processes, which are in turn to be explained by chemical processes, and they in turn by physical ones. (p. 16)

Kauffman does allow that this ideal is to be "respect[ed]" for its many benefits, such as creating explanations that are understandable to a wider audience, and, facilitating scientific development predicated on mechanistic, physical processes (several scientific discoveries were born out of simplified versions of complex systems). However, Kauffman also argues that this kind of reduction can be quite problematic, as it can lead to an elision of the "multitudes" of nuances in complexity (pp. 16– 23). In Kauffman's account of complex systems, such descriptive and conceptual elisions deprive us from full appreciation and understanding of the intricacies of complexity. For science communication, then, the same impulse to reduce can have a similar detrimental consequence, but also, can create unintentional negative attitudes among audiences (as will be detailed later in this article).

It is important to distinguish here that I do not argue in this article for a reduction of *uncertainty*. To do so would be to commit an error that Walsh and Walker identify: to presume that uncertainty is "an epistemological gap that can and should be reduced to zero" (p. 72). Uncertainty, per se, is not a problem in science communication. What I argue needs to be revised are the terms we use to talk about uncertainty. As I explain in the next section, uncertainty can never be reduced, ultimately. In this complex systems point of view, knowledge and uncertainty are both properties emergent from a particular system configuration, and while uncertainty can be rearranged or superficially hidden, it does not completely disappear.

Instead, then, of advocating against the reduction of uncertainty in scientific communication, I advocate in this article against the aversion to *complexity* in scientific communication. Such a terminological shift, I argue, can have significant implications on our conception of science, on our audience's conception of science, and on the efficacy of science communication.

Such a terminological shift from uncertainty to complexity may seem trivial; however, as both rhetoric scholarship and scholarship on science communication frequently emphasize, even a small change in terms can have major effects. Kenneth Burke (1966) is perhaps the most well-known rhetorician to advocate for this position. His conception of "terministic screens" summarizes it best: as Burke puts it, every choice of terminology is both a "selection of reality" and a "deflection of [other aspects of] reality" (p. 45). Terminology shapes our perception in ways that bring some aspects of the world instead of others to the forefront of our thinking. For the success of science communication, this can make all the difference. As Groves (2021) argues, making sure to "choose [one's] words carefully" is among the most important strategies for effective communication (p. 78).

As the next section explores, choosing to frame—and to emphasize rather than avoid—the notion of complexity as central to science communication, instead of uncertainty, can have beneficial consequences for an audience's understanding of not only the topic at hand but also of complexity and uncertainty itself.

From Uncertainty to Complexity

The notion of uncertainty as a thing that can be reduced recalls the scholarly discussion of the concept of "ignorance," which is itself a contested concept. For example, many treatments of ignorance regard it as a quantifiable lack of knowledge about a stable reality (Peels, 2017, p. 2; Rescher, 2009) that can be overcome with the collection of more knowledge (McGoey, 2014). Such a conception of the world, and of knowledge itself, as stable and quantifiable is contrary to many rhetoricians' view (a view that can be traced back to the sophists) of knowledge as shifting and contingent. Other treatments of the concept of ignorance, in fact, explicitly contest its ability to be quantified (e.g., Treanor, 2013), and describe it as a perpetual condition that shifts when contexts shift (e.g., Mays, 2021).

The idea that ignorance can be remedied by acquiring more knowledge is flawed in the same way as is the (repeatedly debunked, but still pervasive) idea that giving the public more knowledge and "facts" about science will increase public support for that science—a theory known as the "deficit model" (see, for example: Bauer et al., 2007; Bennett et al., 2020; Besley & Nisbet, 2013; Dozier & Ehling, 1992; Fischhoff, 1995). In this sense, thinking of ignorance as a mathematical quantity, able to be reduced by adding more knowledge, is flawed in a similar way as is the consideration of uncertainty as a quantity that can be reduced by providing more knowledge, which is similar in turn to the idea that antipathy toward science is a deficit that can be reduced with more facts.

If conditions such as ignorance, uncertainty, or antipathy cannot be remedied by countering them with their opposite, it may seem counterintuitive that I am here calling for more complexity in scientific communications. After all, my point might seem to resemble the deficit model, which, as mentioned, calls for more information as a strategy to gain support among audiences. However, the argument here is not that more=better, it is that complexity is not quantifiable in the first place, but rather is a quality that should be emphasized and elaborated in scientific communication.

In fact, I argue that none of the qualities discussed here are mathematical at all. For example, as Hogg and Blaylock (2012) point out, feelings of uncertainty often result in the amplification of certainty elsewhere (p. xxiii), and not necessarily in a linear or mathematical way. Uncertainty, in this sense, is emergent from contexts; it is greater than the sum of its parts, and therefore it can evolve in ways that defy linear accounting. To be sure, there are things that we know we don't know (known-unknowns) that can in a sense be itemized. But, in the end, a mathematical view of uncertainty suggests

that there is a stable quantity of knowledge in the world that can in theory all be acquired. And, according to this view, this knowledge is universally accessible and is the same in all contexts. This is not, I argue, how knowledge works. The view of knowledge as finite and sortable into discrete quantities of information directly opposes a view of knowledge as a shifting flux that changes as contexts change. This latter view is a rhetorical view, and it is what I advocate here. Uncertainty manifests in a communicative situation unpredictably, and it is not a stable or quantifiable thing that can be countered or eliminated.

Instead of treating uncertainty as something isolatable that can be reduced linearly, the proposal here is to use a different term altogether to talk about the concept. The use of "uncertainty" as a frame is a problem precisely because it suggests that it *can* be reduced or countered with certainty. This is borne out by the science communication literature on uncertainty, which, as Walsh and Walker point out (and as was discussed previously), is pervaded by the belief that it can be brought to zero. Using the term complexity, however, avoids this tendency. To be sure, one can still discuss complexity as being reduced, and this can slip into mathematical thinking—but I argue that complexity is less prone to be characterized as a quantifiable quantity since complexity is ever-present. Thinking of complexity as a quality to be embraced, rather than a thing that can be quantified, of course, is a key part of this terminological shift. But the argument here is that an issue that is complex cannot be magically made less complex, it can only be discussed in ways that work to reduce the impression of its complexity.

Overall, though, splitting hairs about the possibility of quantifying uncertainty versus complexity is not the point. While I argue that neither is mathematical, the important part of my argument here is aimed at science communicators themselves. That is: audiences don't need to grasp whether uncertainty is a quantity or not; I argue that the term complexity better captures the situation, and it is *less likely* to be seen as something that can be balanced with its opposite. Thinking of complexity and simplicity suggests a rhetorical emphasis rather than a mathematical one.

In addition to the argument that complexity as a frame is better suited than is uncertainty in discussions of scientific communication, this article has a second, potentially more important argument: that avoiding complexity in scientific communication is detrimental. The next section of this article explores this second premise.

Simple Messages Gone Wrong

The development of the COVID-19 vaccines was, by many accounts, an unprecedented scientific achievement. Overall, the trials for the Pfizer and Moderna mRNA vaccines showed remarkable promise: upwards of 90% efficacy of protection against symptomatic disease, with a relatively low rate of side effects (Flam, 2022). Given that success, it was scientifically reasonable that the vaccines should be made available to the general public as soon as possible, and that the public would be well served by taking the vaccine. Sure enough, in December 2020, within a year of the pandemic becoming widespread, scientists had developed, trialed, and produced a vaccine with significant efficacy against severe disease, and to some extent, against symptomatic illness as well (Trang, 2022).

Here, though, is where the communication problems came in. The speed of the vaccines' rollout, while a huge benefit in many ways, was also a potential drawback. The clinical trials for the vaccines were conducted over a period of several months (the Pfizer trial, for instance, followed 50,000 people from July to November in 2020), and largely didn't measure asymptomatic infections (Flam, 2022). So, that it was scientifically reasonable (i.e., that it was supported by credible scientific evidence) to support the vaccines is clear. That individuals would be well-served from taking the vaccine—given the current knowledge about the success rate of the vaccines, the potential lethality of the virus, its capacity to make people quite sick even if the sickness wasn't fatal (not to mention the at-the-time

new reports of long-lasting COVID-19 symptoms)—is also clear. However, this does not mean that there were no complications, or, complexities, in that calculus. Because the vaccines were trialed over a period of months, researchers weren't able to determine the duration of protection, nor the nature of that lasting protection. Certainly, there were reliable predictions about duration based on settled immunological and epidemiological principles—specifically, that vaccines can provide lasting protection against severe disease because of our immune system's ability to remember the shape of prior infections, which the vaccines are able to mimic. But, this conclusion was not something that was proven by the trials themselves, and therefore, the nature of that lasting immune protection for this novel virus wasn't completely assured. Neither was there a way to predict all of the side effects—nor the specific extent of them—that would show up from vaccines, given that their administration would effectively be scaled up from a sample size of tens of thousands (in the trials) to the hundreds of millions (in the general population).

As it turns out, there were some complications and imperfections in the vaccine rollout. Side effects did occur (though relatively rarely), protection did wane (though mostly against symptomatic, but not severe, disease), variants did evolve that were more able to avoid the vaccine, and vaccine protection and disease severity was uneven across age groups as well as across other individual risk factors. Even that assessment over-simplifies the state of the science, which was continually evolving and subject to some debate—there was some disagreement even among scientists as to whether, for example, vaccine boosters were needed for all age groups (just to name one prominent disagreement) (Flam, 2022).

The main issue here is that the science of the vaccines, while suggesting one major important takeaway—that people should take the vaccine—was complicated; it was *complex*. The public messaging about the vaccine, however, largely eschewed this complexity in favor of that one takeaway. The Johns Hopkins Medicine information page (most recently updated in January of 2022) bears the title "Is the COVID-19 Vaccine Safe?," and has a communication style and strategy representative of mainstream science communication about the vaccines. In the first paragraph, the site answers that question:

> Yes. The two mRNA vaccines, Pfizer and Moderna, authorized by the U.S. Food and Drug Administration (FDA) and recommended by the Centers for Disease Control and Prevention (CDC), are very safe and very good at preventing serious or fatal cases of COVID-19. The risk of serious side effects associated with these vaccines is very small. (para. 1)

Further down the page, the site goes on to give more information about vaccine safety (it says that the vaccines are safe), reported side effects (it says that these are rare and only occur in certain populations), risk of allergic reactions (it says that if you are allergic to injectables, you should talk to you doctor, and all other individuals are safe), why the vaccine was developed so quickly (the mRNA technology made this possible), whether one has to wear a mask (this is somewhat ambiguous, but the gist is that they recommend it), and their ultimate recommendation (yes, one should get the vaccine). Nothing on the page is wrong, nothing is false, and nothing is overtly misleading about this information. It is clear science communication that shows no uncertainty, and projects the utmost confidence in the message.

I argue, though, that this kind of communication is precisely what led to the divergent interpretations of different audiences, and to the aggressive resistance to the dominant official messaging about the vaccines. It is also what allowed political figures like Florida Governor Ron DeSantis to exploit this divergence for political gain, as he did in filing his petition to investigate the safety of the mRNA vaccines.

This kind of messaging—one that reduces uncertainty and projects confidence—was the norm for several related issues during the pandemic. On masks, the questions of whether and to what extent

they work, and under what conditions, were largely answered in simple, straightforward, and reductive terms, with inconsistencies minimized. On social distancing, the questions of how much space is enough, and whether and to what extent the environmental contexts matter, were largely eschewed in favor of simple admonishments to keep one's distance (disapproving pictures of crowded beaches, for example—often taken using telephoto lenses that exaggerated the closeness of the crowd—became a staple on social media sites).

This kind of communicative strategy, of course, is decried by many science communication scholars and rhetoricians of science, who argue that reducing uncertainty is not a viable way to gain adherence to one's arguments. Instead of thinking in terms of uncertainty, though, these communicative situations could have been better addressed by *explicitly embracing their complexity*. Not necessarily by expressing uncertainty—as in, "we don't know whether [for instance], vaccines will work as we expect." But rather, to actually broadcast the *specifics* of why the vaccines were being promoted, and why there might be complications of the vaccines, especially down the line. Giving the public a view "under the hood" of the science, showing them how and why the controversies among scientists are happening (if they are happening in a substantial way), and overall, not taking shortcuts in discussions of the complexity of the situation—and even emphasizing that complexity, *as* complexity, not as uncertainty—could serve several practical benefits for the public's understanding of, and reaction to, that science.

Shifting Stases or Skipping Steps? Implications and Benefits of Embracing Complexity

Rhetoric scholar Leah Ceccarelli (2011) has famously advocated that scientists and science communicators not shy away from acknowledging scientific controversies. Instead of dwelling in those controversies and ceding ground to their detractors, though, Ceccarelli argues that these communicators should emphasize that these debates are "fairly settled" (p. 217). In this way, she argues, science communicators can shift the debate from those already (fairly) settled stasis points to ones that are more important to their objectives. To briefly explain this idea: points of stasis are rhetorical concepts that refer to the *kinds* of arguments one can have about a subject. The stasis of "fact" (i.e., arguing about what are the established facts of a situation) is considered a lower, and more primary stasis, whereas the stasis of "policy" (i.e., arguing about what should be done about those facts) is considered higher, and more secondary. As Walsh (2009) explains, public debates about science tend to have an "upward pull" on the stasis points (p. 42), wherein matters of fact (e.g., do vaccines help prevent disease) are inexorably drawn toward—and conflated with—matters of policy (e.g., should we mandate the vaccines for all United States citizens).

Ceccarelli argues that science communicators should explicitly shift to those higher stasis points, effectively bracketing off the questions of fact as already settled, so as to avoid getting into thorny debates about facts that obscure these communicators' purpose—which is typically to suggest a course of action, and to determine policy (pp. 212-13). As she writes (Ceccarelli's point was about global warming debates, but the same applies to pandemic debates):

> For example, arguers who disagree about whether global warming is happening might find a point of contact in support of a policy to promote the development of alternative energies, regardless of where they stand on the technical issues surrounding climate science. (p. 213)

This strategy, though, directly contributes to the divisive nature of these debates, precisely because it suppresses complexity. These matters of fact are, for the opponents, *not* "settled," and so they aren't able to get past those stasis points to argue about policy. If I don't agree with you that global warming is happening, I'm unlikely to agree with you about any policy related to that issue—in other words, contrary to Ciccarelli's assertion, interlocutors are often not able to get past what is often a complex

"facts" debate and stasis point. Similarly, in the case of the pandemic debates, if I don't agree with you that vaccines are safe, I'm not going to agree with you about the scope of vaccine mandates. In fact, I argue that skipping steps (and stasis points) here exacerbates these disagreements over latter stasis points, because the skipping over of the matters of fact debates is perceived as patronizing and duplicitous. If communicators want to establish trust, they need to acknowledge the complexity of the lower stasis debates. Even if, for them, those questions are "fairly settled," being transparent as to how they became settled (i.e., walking the audience through the issue), and even acknowledging that there is some dissent (and being clear as to why that dissent is overruled by the consensus view) would go a long way toward establishing that trust in the conclusions of these communicators. Treating audiences as capable of handling complexity avoids them feeling as if they are being talked down to.

It is no coincidence that global warming debates took quite a long time to get to substantive policy actions (and there is still, to be clear, a long way to go). The dynamics of the debate around the facts had to play out first, before policy could even begin to be agreed upon (again, to be clear, total agrement hasn't happened yet, but there is more movement on policy related to global climate change than there was when Ceccarelli was writing). For the pandemic, there wasn't nearly the same timescale to get past matters of fact to get to matters of policy: public pandemic policies needed to be decided very quickly, almost on the spot. In communicating the rationales for these policies, an emphasis on the complexity of the science, then, could have at least gotten audiences to understand that there wasn't a perfect solution, but that the vaccines, for instance, were, on balance, beneficial. This kind of discussion of complexity could have foregrounded the point that yes, there *was* the potential for harm from the vaccine, but that the CDC and the federal government were recommending its use because the potential for harm from *not* taking the vaccine was greater than the potential for harm from taking the vaccine.

Of course, one could argue that this strategy brings us back to a focus on relative risk, which is often paired with uncertainty in science communication scholarship (e.g., Beck, 1999; Grabill & Simmons, 1998; Sauer, 2003). But here, the choice of terminology is important. The rhetorical strategy should be to emphasize the complexity of the debate, not to emphasize the risks, nor the uncertainty of the scientists. In part, this strategy is about ethos-creation for scientists and science communicators. By emphasizing complexity, and by being transparent about the immense complexity of the situation, there is less of a chance that they will be perceived as dishonest, or as acting in bad faith.

Such a negative reaction is precisely what the DeSantis petition depends on: the public feeling like they are being patronized, at best, or lied to, at worst. The Johns Hopkins site about vaccines conveys a message that getting the vaccine is simply a good thing to do. There is no mention, though, that the trials were on a time scale that meant that long-term side effects could go undetected (even if the science suggests this is unlikely). Nor is there specific and candid acknowledgment that infections still happen, nor that there is debate over the efficacy of additional vaccine booster doses for some cohorts. This information is certainly available to readers of the Johns Hopkins site, but not from the site specifically. A significant potential rhetorical effect of the rhetorical strategy employed by this page is to make audiences feel as if they can't handle complexity, and that they need to be spoon-fed curated information that leaves out any negativity.

Supporting Science, But Not Uncritically

Embracing complexity, then, avoids the kind of subtle evasion that arouses suspicion, distrust, and animosity. Moreover, using complexity as the primary frame for this rhetorical strategy applies in situations where the issue is not quite uncertainty, per se, nor is it "risk." Complexity is broadly applicable, and for the most part, has much less negative connotation than does uncertainty (or risk). Complexity is—as it should be—a good thing, and both scientists and science communicators should operate from that premise.

Ceccarelli's discussion of science controversies and global warming also argues for a "supportive orientation toward mainstream science" (p. 200), which can counter the danger that overly critical rhetoricians of science have opened up an avenue for bad actors to exploit that skepticism and to discredit important—and potentially life-saving—scientific progress. Embracing complexity, though, is not the same as being critical of mainstream science. Rather, this embrace foregrounds the nuance of complicated subjects, and entails that we not wholeheartedly accept mainstream science, but neither should we mindlessly discount it either.

The embrace of complexity detailed here also has the potential benefit of exposing publics to the very same dissenting arguments and critique that might be used by the abovementioned bad actors, but also, exposing these publics to the precise counter-arguments that were used by scientists to debunk those dissenting views. In this sense, embracing complexity, and walking audiences through the scientific debates that got scientists to their current consensus view, constitutes a kind of inoculation against any bad faith attempts to use these dissenting views as a rhetorical wedge in public opinion. If the public already knows why the dissents were overcome, there is no potential to frame those dissents as having been suppressed by a nefarious group of mainstream scientists—which is precisely what DeSantis's complaint alleges.

This approach, of course, wouldn't have guaranteed that the vaccines would have been universally accepted. However, providing transparency by embracing complexity in the communication of the scientific issues surrounding the pandemic could have elevated the complexity of public discourse about vaccines, and avoided at least some of the stark disagreements and extreme politicization of practically every issue related to the pandemic. While such an embrace is not a cure-all, it could be a beneficial strategy for science communicators, especially when they are dealing with concepts or issues that are, in fact, quite complex. It is commonly believed that in the face of uncertainty, people try to find certainty. In the face of complexity, though, they may be more willing to accept it.

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