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A 2014 Pew Research poll revealed large gaps between public opinion and scientific opinion over environmental and biomedical issues (Funk and Rainie). Similarly, a number of recent popular books have described a growing public mistrust in scientific expertise (Mooney; Storr; Specter). Why is it, then, that so much of the public opinion is at odds with expert, scientific opinion? In this thesis I examine this research question in two ways: first from the perspective of the disciplines of Science Communication and Public Understanding of Science in Chapter 1, then in Chapter 2, from the perspective of rhetorical studies, using critical theory and affect scholarship, and lastly, in the case study of Chapter 3, I examine a specific instance of failure in Science Communication—the failed 2013 measure to implement a community fluoridation program in Portland, Oregon—analyze this failure as a result of rationalist and scientistic assumptions about public deliberation, and finally suggest that fluoride could have been communicated more effectively using a more local, nonrational, and values-based approach.

Public Proof: Science Communication, Weak Theory, and the Nonrational

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Wesley M. Snyder, Author

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Before some audiences not even the possession of the exactest knowledge will make it easy for what we say to produce conviction. For argument based on knowledge implies instruction, and there are people whom one cannot instruct.

-Aristotle. *The Rhetoric.*

Introduction

In 2013, when I was living in Portland, Oregon, voters of that city rejected a measure to fluoridate the public water supply for the fourth time in its history, leaving Portland the largest metropolitan area in the country without fluoridated water. Many of the anti-fluoridation arguments hinged on calling into question the safety of fluoridated drinking water, despite overwhelming scientific consensus. In 2015, Benton County, Oregon, where I live now, voted on a ballot initiative Measure 2-89, which, if passed, would have "prohibit[ed] cultivation of genetically engineered organisms" ("Benton County"). Many researchers at Oregon State University worried that, if passed, the measure would require all genetically engineered (GE) organisms to be destroyed within ninety days. For some, this county measure appeared to threaten decades of research. Although support for the measure was, in large part, fuelled by antipathy toward corporate agro-industry and fear of contamination, undergirding these concerns was the fundamental rift between scientific and public understanding of the safety of GE food. (The measure was defeated by a large margin.) Similarly, a 2014 campaign for statewide initiative to label all GE food, Measure 92, was predicated on this rift between public and scientific understanding. The measure was defeated by a margin of less than 0.2% ("Oregon Mandatory Labeling").

GE foods and fluoride are not the only issues about which scientists and the public disagree. Anthropogenic global warming, to begin with perhaps the largest debate, enjoys a strong consensus among scientists. Certainty within the scientific process is hard to measure, and absolute certainty nearly impossible (as we'll discuss later). The figures vary. In a 2014 Pew Research poll 87% of scientists belonging to the American Association for the Advancement of Science (AAAS) agreed that "climate change is mostly due to human activity" (Funk and Rainie). A 2013 quantitative analysis of peer-reviewed scientific papers revealed a 97% consensus for anthropogenic climate change among works published between 1991 and 2001 (Cook et al.). Another analysis of abstracts by Naomi Oreskes published between 1993 and 2003 found that of the 928 papers examined, 75% accepted the consensus view and 25% took no position. "Remarkably," Oreskes writes, "none of the papers disagreed with the consensus position" (1686). These numbers, though, contrast drastically with the opinions held by the American public. In the same Pew Research poll, only 50% of Americans think "climate change is mostly due to human activity." This gulf between the opinion of the scientific community and the American public is not limited to the phenomenon of climate change. In fact, this disparity of opinion—by 37 points—is not even the largest gap that the Pew poll revealed. In general, scientists and the public are more likely to agree on issues concerning "climate, energy, and space sciences" (Funk and Rainie). For example, there is a 23 point opinion gap between scientists and the public when asked if the "growing world population will be a problem", an 8 point gap between scientists and the public over the proliferation of fracking practices, and a marginal 4 point difference of opinion concerning whether or not "the space station has been a good investment for the U.S." (Funk and Rainie).

Issues concerning biomedical sciences, on the other hand, show some of the largest differences in opinion between scientists and the public. Eighty-eight percent of scientists polled in 2014 agree that genetically modified (GM) foods are generally safe to eat, yet only 37% of adults in the U.S. say that such foods are safe. This 51 point discrepancy represents the largest gulf in opinion between scientists and the public. In other words, the public and the scientific community currently disagree more about the safety of GM foods than about any other scientific issue. The two groups also largely disagree about the ethics of using animals in research (a 42 point difference) and the safety of consuming foods grown with pesticides (a 40 point difference). The theory of evolution, in fact, is more agreed upon than the previously listed issues (a 33 point difference).

Statistics like these, as well as the perennial debates raging throughout the public sphere, intimate what has become a tired theme: the notion that the public's trust in the authority of science is eroding. It's not difficult to find this sentiment elsewhere. In his 2009 book *Denialism*, Michael Specter calls this public tide of opinion "a fundamental shift in the way we approach the world in the twenty-first century" (9). Specter writes, "More than at any time since Francis Bacon invented what we have come to regard as the scientific method (and Galileo began to put it to use), Americans fear science at least as fully as we embrace it" (9-10). In his 2015 book *The Unpersuadables: Adventures with the Enemies of Science,* Will Storr points to a similar trend at the beginning of the century. Storr writes that this past decade

> saw what has the appearance of an increasing suspicion of science. The white-coated priests of the laboratory, to whom we have granted custody of the truth for so long, are seemingly being treated with growing levels of doubt. We don't trust the MMR jab, we don't trust climate data, we don't trust genetically modified wheat or 'conventional' medicine or supermarket-bought beef. (9)

Media coverage seems to bolster these claims that our trust in science is eroding. The seemingly interminable public debate over climate change has been grinding on for decades, with little hope for agreement in the near future. The public controversy over the safety and public health of childhood vaccinations makes news frequently—although this debate serves as a good example of how media can over-represent one side of an argument for the appearance of a democratic and fair-sided discussion, a phenomenon caused by what Leah Ceccarelli calls the "balancing norms" of American journalistic institutions (198). Despite its presence in media discussions, there is a relatively small disagreement (18 points) between scientists and the public over the requirement of childhood vaccines (Funk and Rainie).

Why is it, then, that so much of the public opinion is at odds with expert opinion? In this thesis I examine this question in two ways, first from the perspective of the disciplines of Science Communication and Public Understanding of Science in Chapter 1, then in Chapter 2, from the perspective of rhetorical studies, using critical theory and affect scholarship, and lastly, in the case study of Chapter 3, I examine a specific instance of failure in Science Communication—the failed 2013 measure to implement a community fluoridation program in Portland, Oregon—analyze this failure in light of the previous two chapters, and finally suggest ways that it might have been communicated differently.

This thesis, as a whole, functions to apply concepts from rhetorical studies in support of Science Communication and Public Understanding of Science. Rhetoric's relationship with science has been largely influenced by the "rhetoric of science" work done in the 1980's and 1990's by Bruno Latour, Alan Gross, Lawrence Prelli, Charles Bazerman, and many others. Rhetoric of science has been, for the most part, critical of the "world-defining hegemony of scientific discourse" (Ceccarelli 199). But in the atmosphere described previously, when mistrust and denial of scientific consensus polarize and obstruct any shift toward the collective understanding integral to, say, mitigating climate change and world-wide food shortages (or to simply obviating tooth decay and the contraction of preventable illnesses), the deconstruction of scientific authority seems a less advisable aim than it previously did. In fact, in this century, Latour has expressed regret that his work to show the social construction of scientific knowledge has been seized by "the wrong sort of allies" (231). Expressing frustration over climate change deniers, Latour askes, "[w]hy does it burn my tongue to say that global warming is a fact whether you like it or not? Why can't I simply say that the argument is closed for good?" (227). Given this climate, Leah Ceccarelli has argued for "a new orientation toward the rhetoric of science" (198). Although support of scientific consensus is uncommon in the field, Ceccarelli argues that there are times "when the rhetorical critics should be prepared to develop scholarly insights that can be turned to the defense of a scientific orthodoxy" (199). This thesis, aligned with Ceccarelli's "new orientation," will synthesize the history of Science Communication and Public Understanding of Science theories with rhetorical, psychological, and affect studies to offer approaches that might be employed to aid mainstream science, rather than criticize it.

In Chapter 1, I explore how Science Communication has approached communicating science to the public in the past, the flaws and shortcomings of those models, and how newer models of science communication are addressing (or failing to address) this issue of skepticism or denialism in the face of scientific consensus. In the United States, the idea that the public should have a basic understanding of science—a concept known as scientific literacy—dates back at least until 1930 when educator John Dewey asserted that young people would benefit from a "scientific attitude" with which to rationally solve everyday problems (Gregory and Miller 3). Historically, models of popular science communication have been founded on this ideology—that the better the public understands science, the better informed its decisions will be. In a democracy, the reasoning follows, better-informed decisions will result in more rational, better-informed laws and policies (The Royal Society). A less sunny way to look at this notion, of course, is that the more closely a public is aligned with science, the more likely it is that laws and policies will reflect the interests, goals, and values of the scientific endeavor.

Many of the initiatives aimed at improving the public's scientific literacy—at least through the 1990's—have been characterized by Science Communication researchers as "deficit models," because these projects were aimed at filling a public deficit of knowledge. According to Brossard and Lewenstein, the deficit model is characterized by "linear transmission of information from experts to the public" (17). Implicit behind this top-down, dissemination model are the beliefs that effective transmission of scientific information can reduce the public's deficit in knowledge, and the belief that such a reduced deficit leads to more support for science, as well as "better decisions" (17).

The deficit model has since been largely criticized as ineffective at accomplishing—and sometimes directly antagonistic to—its two aforementioned goals. Many other communication models have emerged among scholars and researchers, but the authoritarian and linear aspects of the deficit model no doubt remain in use in many instances of science communication, as well as its goal to fill a "deficit" of knowledge in the public.

The deficit model ignores its audience, leading rhetoric scholar Alan Gross to indict it as "rhetorically ineffective." Rather, Gross has proposed a contextual model of communication, informed by rhetoric studies, that employs a "rhetoric of accommodation" in which specific audiences are targeted for specific scientific issues that relate to them (6). Gross's contextual model predates the Lay Expertise model and the Public Engagement with Science (PUS) model, which move beyond merely informing the public toward a model that engages the public in dialogue. Sarah Tinker Perrault's book *Communicating Popular Science: From Deficit to Democracy* has recently championed Peter Bok's Critical Understanding of Science in Public (CUSP) model, representing a critical shift within PUS in which the public does not only engage with science, but critiques it. In Perrault's conception, the task of the science communicator is threefold: to inform and engage a non-expert audience, as well as to criticize the scientific community where criticism is due.

Chapter 2 looks outside the fields of Science Communication and PUS, in order to address the multiple, social, linguistic, and nonrational ways that non-scientists must understand science. As insightful and refined as some of these models of Science Communication are, to my mind, they do not utilize the entire spectrum of persuasive possibilities. One of the fundamental concepts undergirding even these intelligent theories of communication is that better scientific understanding will result in better decisions. The 1985 report "The Public Understanding of Science" published by The Royal Society of London defines the nature of this assumed public decision-making:

> Better overall understanding of science would, in our view, significantly improve the quality of public decision making, not because the right decisions would then be made, but because decisions made in the light of an adequate understanding of the issues are likely to be better than decisions made in the absence of such understanding." (9)

What advocates of Science Communication often presume, then, is that its entire audience *rationally makes decisions* about scientific issues. This is what cognitive linguist George Lakoff calls the "trap of enlightenment reasoning." Lakoff writes "The old view [of how we think] claimed that reason is conscious, unemotional, logical, abstract, universal…" (72). To Lakoff, this view has been proved false by the last thirty years of cognitive science. Instead, Lakoff argues that "Real reason is: mostly unconscious…; requires emotion; uses the 'logic' of frames, metaphors and narratives" (72). One thing that rhetorical and affect studies can offer to Science Communication, then, is the ability to view communication as persuasion, less as a process of logical decision-making, and more as a nonrational process of understanding.

Much of this thesis will work to refute the assumption that better understanding of science leads to better attitudes toward science, and, as a result, publicly-decided policy that reflects scientific conclusions. Political scientists Brendan Nyhan and Jason Reifler have done extensive studies on what they call "the backfire effect." Journalists Cari Romm describes the backfire effect as "the idea that when presented with information that contradicts their closely-held beliefs, people will become *more* convinced, not less, that they're in the right." In psychology, this phenomenon is known as "reactance" (Romm). A 2012 study by Dan Kahan and colleagues concluded that, as Philip Eubanks puts it, "worldview was a far greater predictor of attitudes toward climate change than scientific and technical literacy" (58). In Kahan's study those who subscribed to an "Egalitarian Communitarian" worldview were far more concerned about global warming than those who subscribed to a "Hierarchical Individualist" worldview, despite levels of scientific literacy. In fact, those Hierarchical Individualists with higher levels of science education were the least concerned of all (Kahan et al.). On the topic of the study, Philip Eubanks writes, "[i]f you are inclined to discount climate change [based on your worldview], a better understanding of scientific and technical matters makes you even surer that you are right" (58). Eubanks, like Lakoff, recognizes that Enlightenment reasoning is in fact very rarely at work, and that rather, most of us, most of the time, are engaged in what he calls "adversarial reasoning" in which we unconsciously form conclusions (based on value judgements) first, and then arrange evidence and experience to support those conclusions. As Jonathan Haidt puts it, "one becomes a lawyer trying to build a case, rather than a judge searching for the truth. When we reason about our intuitions, we do not act as detached scientists but rather as lawyers arguing our side of a case" (814).

Many in Science Communication have recognized the failures of the deficit model, both to inform and to persuade. Rick Borchelt, communications director of science for the U.S. Department of Energy, recognizes that there is large minority of Americans—about twenty percent—who are what he calls "science attentive." Borchelt recognizes that that group—and that group alone—are science communicators' audience. He writes, "Nothing we are doing as science communicators is recruiting new people into the ranks of the science attentive. Or improving science literacy." If the goals of science communication are to persuade its small, science attentive audience that is well and good, but if its goal is to reach a larger audience, it may need to borrow from rhetorical studies to shift the focus of those Science Communication models that conflate the purposes of informing and persuading.

As troubling as the phrases "faith in science" or "(dis)belief in global warming" might be to a scientist, the words "faith" and "belief" represent the manner in which the public reaches conclusions about scientific issues. If the scientist has empiricism, isolated variables, and replicable results to allow him to "know" a scientific truth definitively (assuming a positivist view of science which we will address later), the lay person has none of this things, or perhaps only a belief (or disbelief) in the expert methods that allow the scientist such certainty (scientific "certainty" will also be addressed in the following chapters). The scientific mastery that produces knowledge is inherently expert, specialized, and exclusive. By definition, then, the process which allows experts to reach conclusions is, at least partly, unavailable to the public. The nature of expertise is inherently exclusive, elite, and esoteric. It is an arduous, indeed a lifelong pursuit, for one to be become an expert in one subject, compoundingly difficult to be an expert in two, and impossible to be expert in all things. Without the expert acumen to critically analyze scientific data (and even with such acumen, I suspect), belief is formed with some degree of the authority of the scientist, as well as the process of science, in mind.

Shy of the expertise that produces scientific knowledge, a non-expert likely relies largely on a kind of trust in the dispassionate and neutral methods of science. David J. Tietge notes that while maintaining that total objectivity in the scientific process is illusory, the discourse of science may be more even-handed than that of other disciplines. He writes:

> The positivistic strain of empiricism and analytical rationality that informs the scientific methodology is a large part of its mystical allure, because while the rest of us struggle with the irrational, emotional, and discriminatory (in the most anti-intellectual sense), science remains aloof, transcendent of the more primal impulses that taint other forms of discourse. This description of science is not entirely mythic; it has managed to achieve more objectivity than most other epistemological methods (like logic or philosophy)… (189)

This allure of objectivity is, no doubt, one of the main sources of the credibility of science. The allure of objectivity that science commands is so well-established, in fact, that, as Philip Eubanks has pointed out, skeptics and denialists rarely challenge the scientific process itself (27). Paradoxically, arguments that dispute scientific consensus often do so in “Enlightenment-friendly terms” (Eubanks 25). This phenomenon of capitulation to the scientific process, despite resistance to the conclusions of that process, is instantiated in the climate change denier who employs empiricism’s own stubborn skepticism against itself, or, even better, in the term “creation science.”

Without the expertise to influence science itself, and faced with a conception of the process of science as—for better or for worse— "objective," the most open-minded, rational non-scientist (the best case scenario) informs his opinion largely based on trust. For example, science reporter Chris Mooney thinks that far too many non-expert journalists assume the authority to make *scientific* pronouncements that are not theirs to make. Instead, Mooney writes, "I believe that journalists, when approaching scientific controversies, should use their judgment to evaluate the *credibility* of different sides and to discern where scientists think the weight of evidence lies, without presuming to critically evaluate the science on their own" (vii). Without the expertise to "critically evaluate" the science on which they are reporting, for Mooney, the only ethical route for journalists is to evaluate the *credibility* of scientists or the science itself.

David J. Tietge has written extensively on the role of *ethos* in both scientific communication (peer to peer) and science communication (expert to non-expert). Tietge argues that within the scientific community, *ethos* plays an important role in the production of knowledge. Indeed, as much of the work on the rhetoric of science has shown, scientific discourse, like all other discourses, is not entirely objective, nor purely logical in its methods of productions. Tietge draws from the work of Thomas Kuhn, Bruno Latour and Charles Bazerman to point out the essential "connectedness" that constitutes a scientist's reputation and, as a result, his discursive influence. Latour writes:

> The adjective 'scientific' is not attributed to *isolated* texts that are able to oppose the opinion of the multitude by virtue of some mysterious faculty. A document becomes scientific when its claims stop being isolated and when the number of people engaged in publishing it are many and explicitly indicated in the text.

> When reading it, it is on the contrary the reader who becomes *isolated.* The careful marking of the allies' presence is the first sign that the controversy is not heated enough to generate technical documents. (qtd. in Tietge 177)

That is, scientific *ethos*, like most academic *ethos*, is socially created, marked by an allegiance from others in the discipline. Latour calls these supporters "allies" or "friends." Bazerman calls this referencing "intertextuality." In any regard, scientific *ethos* can be easily defined by the maxim: strength in numbers.

Going further, though, Tietge argues that within scientific discourse, *ethos* and *logos* become closely intertwined. Tietge, revisiting a nuanced Aristotelian description of *ethos*, argues that scientific *ethos*, much more than simply innate moral character, "is attributed to the knowledge base he or she is able to draw upon and is able to successfully articulate to the audience" (175). That is to say, within the scientific community, *ethos* is related to one's ability to provide "new data, information, numbers, and arguments... from different times and places," as well as character (176).

It is perhaps no surprise that in such an objectivity-oriented discipline such as science, *ethos* is closely related to—and stems from—one's ability to argue rationally and garner support from others who have done the same. My original research question, though, is not how knowledge is produced among scientists, but how such knowledge comes to be (dis)regarded among the large segments of the population. Tietge's view on scientific *ethos* sheds some insight. It is the mistake of the scientist, Tietge argues, to assume that the same attributes that earn him credibility in the disciplinary world of science will also earn him credibility in the public. Tietge proposes that one reason the public's opinions are so often at odds with those of scientific experts is that science has projected its own values of rationality and logic onto a general audience. "When science fails to engender trust in a popular audience," Tietge writes, "it is because, according to Carolyn Miller, it has overemphasized *logos* at the expense of *ethos*" (193-194). The technical, rational arguments that garner scientists *ethos* inside their discipline may fail to inspire the same sense of *ethos* in an audience that does not value or has not been trained in the strictures of scientific and mathematical reasoning or formal logic. As Carolyn Miller writes in "Expertise and Agency," "we might therefore have predicted that an *ethos* that allies itself too closely with *logos*, like the *ethos* of expert system, will fail to persuade" (qtd. in Tietge 194). This problem of rationally-derived *ethos* before a popular audience may do more than fail to sway an audience toward acceptance of a scientific consensus; in some cases, it may actively sway an audience to further distrust scientific experts, similar to "the backfire effect" in Nyhand and Reifler. Tietge argues that "Strict logical analysis will almost always fail to persuade a general audience, largely because the expression of logical strictures is often mistaken for arrogance or, ironically, an attempt to deliberately obscure an argument in voluminous prose or loquacious speech" (194). Worse than simply falling short of credible, experts who argue technically before certain general audiences may appear elite, technocratic, and deliberately opaque.

In response to the rationalist ways that scientists understand science—and the resultant tendency of early Science Communication and Public Understanding of Science to understand it the same way—the remainder of Chapter 2 recognizes that, in the past two decades or so, Science Communication and Public Understanding of Science scholarship has begun to incorporate the nonrational ways that publics understand science. To explain this trend—which largely depends on tailoring the message of science communicators to specific audiences— I use Eve Sedgwick's notion of "weak theory" to describe Science Communication's history as a move from the "strong" theory of the deficit model—in which one model applies to and explains all communicative instances—to a "weak" theory of communication in which multiple models may be chosen, depending on the context of the instance.

Furthermore, if this thesis works to undo the notion that publics make rationally-informed decisions about scientific understanding, it would be incomplete if it did not address the specific nonrational ways that publics understand and deliberate about science. Chapter 2 builds on Brian Wynne's claim that the credibility and trust integral to public understanding "are contingent upon the social relationships and identities which people feel to be affected by scientific knowledge" ("Misunderstood" 281). Then, in order to include the emotional within Wynne's claim, and give a contemporary vocabulary by which to explore these "social relationships and identities", Chapter 2 ends by borrowing from critical affect studies and affect theory. Specifically helpful is the notion that emotions, feelings, and affect (to be defined later) are not solely personal but rather circulate within communities—in what Sarah Ahmed calls "affective economies"—and constitute the very relationships and identities by which publics understand science.

Finally, in Chapter 3, I highlight the largely rationalist, deficit-like arguments made by the proponents of a community fluoridation program in Portland, Oregon. Alternately, the case study also highlights the community-specific, emotional, and *ethical* proofs that were made (more successfully) by fluoride opponents. The case study reveals that community fluoridation program proponents *do* attempt, to some degree, to employ emotional and *ethical* proofs, but that some of these proofs are misdirected or misunderstand the values of its audience, and that others, although they properly assessed the values by which Portlanders identify themselves, were crowded out by the ceaseless and ubiquitous appeals to scientific authority.

A Note on Key Terms, Scope, and Audience

It is important to clarify and define the use of the term "nonrational" in this thesis. I use it in much the same way that Debra Hawhee and Diane Davis defined it for their 2011 workshop on nonrational rhetorics. Hawhee and Davis describe nonrational rhetorics as "theories (or histories) that emphasize the dimensions of rhetoric that operate apart from—or in some cases, in opposition to—reason or rationality." The authors see nonrational theories as a response to an "overemphasis on reason"; rather than simply meaning irrational, they use the term more prodigiously to mean bodily, affective, and animal rhetorics that emphasize reason *less* than traditional rhetorics. Just as Hawhee and Davis suggest in their definition, the notion of emphasis suggests that there may be *aspects* of reason in the nonrational. Similarly, I use the term to mean social, emotional, affective, and metaphorical ways of knowing that *emphasize* reason *less* than traditional rhetorics, but by no means necessarily exclude all rationality. In fact, much of Wayne Booth's book *The Rhetoric of Assent*—from which I draw heavily—argues against the assumption that we cannot reason about our emotions, sociality, and prejudices.

Although, the "non" in nonrational (unfortunately) suggests an binary of rational and irrational, as I use the term, it does not necessarily exclude all things rational, but instead refers to all kinds of alternatives to "purely" rational, logo-centric epistemologies.

The term Public Understanding of Science in its more general use—encompassing the entire body of scholarship concerned with science and the public—has a dual meaning. Martin Bauer and Bankole Falade write that, first, PUS "covers a wide field of activities that aim to bring science closer to the people and to promote public understanding in the tradition of a public rhetoric of science" and secondly that it "refers to empirical social research that investigates the public understanding of science and how this might vary across time and context" (140). In other words, PUS, in this larger sense, has a praxis component concerned with activities, outreach, and the actual communication of specific areas of science to the public, as well as a research/theory component more concerned with the measurement, efficacy, history, and underlying assumptions of science communication. In *Science Communication: A Practical Guide for Scientists* Laura Bowater and Kay Yeoman reify this divide along the line of theorists and practicing science communicators. The practical performance of producing and communicating science to the public is the task of scientists. On the other hand, "the reflection on its worth and effectiveness" is a task undertaken by social scientists (Bowater and Yeoman 8). Although these classifications are probably too reductive, research done by Steve Miller roughly bears out the divide (Miller "So Where's the Theory?"). Furthermore, there is significant discord between PUS activities that actually reach out to the public and PUS research and theory that is mostly intended for other academics in the field (Miller "So Where's the Theory?"; Davis "Science Communication"). Miller, for example, discovered that that 55% of a group of Science Communication practitioners—largely from a scientific background—had *never* read *Public Understanding of Science* nor *Science Communication,* two of the major peer reviewed journals in the field (279). Dominique Brossard and Bruce Lewenstein have noted that recent work has been done in an attempt to bridge this rift. "Such efforts," they write, "have aimed at building conceptual models of public communication of science that could give a comprehensive view of the frameworks that are at play for research in the field, one implicit goal of which is to implement these models systematically in the practical realm of outreach" (12). However problematic this deep divide within an already dissociative and interdisciplinary field, the first two chapters of this thesis largely limit their concern to the theoretical component of PUS and communication models entailed within—both described and prescribed—with the goal expressed by Brossard and Lewenstein in mind, that these theoretical models will inform praxis. Chapter 3, however, offers more practical conclusions helpful for those who are neither theorists, nor professional science communicators. As a result, the primary audience for this thesis may be those who are interested Science Communication/PUS theory. However, the conclusions of this thesis (particularly the latter chapters) are extremely relevant to all those who act as communicators of science—scientists, governmental agents, journalists, health agencies, and citizen groups.

Furthermore, as I use nonrational rhetorics as a reaction specifically against western epistemologies, and as Public Understanding of Science and Science Communication scholarship are rooted in western countries—especially the U.S. and the U.K.—this thesis will limit itself to public rhetorics within those contexts.

Chapter 1: Science Communication and the Public Understanding of Science

In order to understand gaps between scientific knowledge and public knowledge, a background and context for science communication models is requisite. In this chapter I will revisit the history of Science Communication theories from after World War Two to the near present, to get at both the strengths and weaknesses of those theories so that we may recognize—in current instances of science communication—whether science communicators are building off the successes of certain theories, or repeating the mistakes of the past. This chapter will take a synoptic view of the past sixty years of expert to non-expert communication. For this synopsis, I borrow heavily from Martin Bauer's three paradigms of Public Understanding of Science and for each I will examine three aspects: communication models, underlying assumptions, and critiques.

Theoretical Background

Martin W. Bauer and Bankole A. Falade, in their article "Public Understanding of Science: Survey Research Around the World," categorize Public Understanding of Science (PUS) into three paradigms: *scientific literacy*, *public understanding of science* (see Dndnote 1 for further disarticulation of this phrase), and *science in society* (145). The authors typify each paradigm by considering three factors: "the questions they raised, the interventions they supported, and the criticisms they attracted" (140). Although grouping more than fifty years of (inter)disciplinary thought into just three categories requires broad strokes—indeed there may be certain outlying communication models that will not fit neatly into one paradigm, or underlying philosophies that straddle two assumptions—dividing science communication theory into three worldviews helps make sense of what can be, at times, a disassociative field. Bauer and Falade write that PUS over the last forty years has “spawned a field of enquiry that engages, to a greater or lesser degree, sociology, social psychology, history, communication studies and policy analysis” (144). I would add philosophy of science, cognitive linguistics, rhetoric, and environmental studies to that list.

In some ways, these three paradigms construct a history of Science Communication in the United States and the United Kingdom, but it is a tempting fallacy to assume that one paradigm replaces the next. The researcher who claims, for example, that linear, top-down communication models characteristic of the two earlier paradigms has no place in modern science communication will soon be eating crow. He or she would only need to open the most recent copy of *Nature*. Bauer and Falade have assigned each paradigm a general time period in which it flourished, but they explicitly warn that rather than a line of succession, “more realistically we must assume that these frames of mind co-exist in the present and in different contexts. This is not a model of progress, but one of multiplication of discourses” (144-145).

Scientific Literacy

Bauer and Falade place the heyday of scientific literacy from the 1960’s to around 1985, but in the United States, the idea that the public should have a basic understanding of science—the foundation of scientific literacy—dates back at least until the 1930’s when educator John Dewey asserted that young people would benefit from a “scientific attitude” with which to rationally solve everyday problems. The “scientific attitude” of the 1930’s that Dewey and others professed largely amounted to an understanding of the scientific *process*. In “The Supreme Intellectual Obligation” published in 1934, Dewey argues it is paramount that the public “adopt into the very make-up of their minds those attitudes of openmindedness, intellectual integrity, observation, and interest in testing their opinions and beliefs” (qtd. in Miller “Scientific Literacy” 30). Dewey’s “scientific attitude” then, was one that valued the logic, empiricism, and an experiment-focus foundational to the scientific process. Others—such as Ira C. Davis, Victor H. Noll, A.G. Hoff—defined the “scientific attitude” similarly. Jon D. Miller, reviewing the history of scientific literacy in 1983, writes that “virtually all of the empirical work done before the Second World War had at its focus the development of the scientific attitude” (“Scientific Literacy” 31). The scientific attitude—workable knowledge of the scientific process—was the yardstick by which to measure scientific literacy at least until the late 1940’s. Following the launch of Sputnik in 1957, the need for a public understanding of science gained traction among educators and legislators, and decades of federally funded science education ensued (Gregory and Miller 4). Jon D. Miller notes that after World War Two, the expansion of publicly-funded education consequently led to the expansion of standardized testing to measure the efficacy of such education. Researchers began to focus on the public’s comprehension not just of the scientific process, but their comprehension of scientific facts and constructs (“Scientific Literacy” 31).

Jon D. Miller has provided the most influential definition of scientific literacy. Working largely with a survey done by Stephen Withey at the University of Michigan in 1957 and surveys administered by the National Science Foundation (NSF) from the 1970’s onward, he has come up with evolving literacy indicators. The literacy indicators for Miller’s designation of “literate” include the two aforementioned elements—public comprehension of both scientific process and scientific facts—as well as two more elements added in a 1992 article. According to Miller, then, the public's scientific literacy can be measured by four elements: (1) the understanding of the methods, philosophy, values and the process of science, (2) the comprehension of textbook facts, terms and constructs —what Miller calls "cognitive scientific knowledge"—(3) the recognition of the positive results of science for society, and (4) the dismissal of "superstition" ("Scientific Literacy"; "Toward a Scientific Understanding"; Bauer and Falade). It is interesting to note that there is much more than a cognitive understanding requisite of Miller's literate citizen; he or she must also recognize the usefulness of science for society—what Sarah Tinker Perrault calls "science boosterism" (50)—as well as renounce other ways of thinking. A "literate" citizen in the scientific literacy paradigm would not only share the same understanding and comprehension of scientific matters as a scientist, but also a scientist's value of the endeavor itself. In short, the closer a citizen's values resemble those of a scientist, the better.

This paradigm is the longest running conception of Public Understanding of Science among scholars—arguably beginning with John Dewey and continuing through Jon D. Miller's most recent, 2011, opinion article in *Nature Medicine*. And although this paradigm has largely fallen out of favor with communication and PUS scholars, it still widely persists in scientific experts themselves. For these reasons, a large segment of this chapter will discuss, analyze, and critique the scientific literacy paradigm.

Before examining critiques of Miller's definition of science literacy, and critiques of the underlying assumptions of the paradigm as a whole, it will be helpful to examine the communication model that the values and assumptions of this paradigm inform.

The aforementioned 1979 NSF survey and subsequent surveys, both in the U.S. and the U.K., revealed a startling “deficit” in the public’s scientific literacy. The 1979 NSF survey, for example, found that a large percentage of respondents claimed to have a “clear understanding” of the scientific process, but only fourteen percent of these Americans could provide a satisfactory answer when prompted to describe it, revealing a significant discrepancy between confidence and measured “understanding.” (A satisfactory answer included the mention of testing and modifying hypotheses against an experiment.) This fourteen percent was only slightly higher than the twelve percent of satisfactory answers provided in response to a similar question on the 1957 survey distributed by The University of Michigan (“Scientific Literacy” 36-38). Thus, the NSF study revealed that more than two decades of publicly-funded science education yielded little improvement of the public’s understanding of the scientific process, a primary literacy indicator. Respondents reported similar confidence in other science literacy indicators—like an understanding of basic scientific constructs—but no follow up questions were asked to verify these self-assessments. Miller assumes that any follow-up questions regarding scientific facts would have yielded numbers dismally similar to the assessment of the scientific process. “Although the accuracy of these self-assessments was not verified as it was for the understanding of the meaning of scientific study,” he writes, “there is little reason to believe that such checks would not have shown the same discrepancy” (“Scientific Literacy” 39). The numbers can be cut (and were) in many different ways, but, ultimately, the 1979 NSF survey took three literacy indicators into consideration to construct a single measure of science literacy; it concluded that only seven percent of the respondents—mostly male college graduates over the age of thirty-five—could be called scientifically literate ("Scientific Literacy" 41).

The 1979 NSF study was the beginning of a string of surveys—largely uninterrupted to the present day—that uncovered an alarming "deficit" in the public's scientific literacy. Such surveys often produce singular statistics that have often been taken out of context and often resound throughout scientific, media, and public circles with the intention to shock. Bauer and Falade write:

> Some items are notorious, have travelled far and hit the news headlines, not least because of their scandal value when answered incorrectly and considered in isolation. Public speakers and mass media repeatedly pick out single items as *proof* of public ignorance and as a cause for moral panic. (146)

In continuing to pursue measurement of the public's scientific literacy throughout the 1980's, John Durant and his colleagues designed a quiz-like survey to assess the public's understanding of facts and constructs (Miller's second literacy indicator.) The results, published in *Nature*, revealed that only 34% of Britons "were able to state correctly both that the Earth goes round the sun and that it takes a year to do so" while "the comparable number in the United States was 45%" (Durant, et al. 12). Indicators like Durant's have been revealing similarly arresting and isolated statistics through the new millennium. A compilation of NSF surveys conducted throughout the 1990's and early 2000's reveals a well of these standalone (il)literacy stats: during this time period, the public's scientific literacy dips as low as five percent by some measures; only ten percent of Americans can define a molecule; and about half think that dinosaurs and humans lived during the same time period (Brossard and Lewenstein 12).

In response to the public's "deficit", new programs were founded to fill this apparent yawn in lay scientific knowledge (Brossard and Lewenstein 13). In 1985, a report published by the Royal Society in London proposed proper science education in public school as a remedy (Bowater and Yeoman 13). The Royal Society Report, titled "Public Understanding of Science" led directly to the creation of the Committee on the Public Understanding of Science (COPUS) in the UK, an organization that provided funding for scientists and journalists to communicate science to the public. In the United States, large projects to address science (il)literacy among the public emerged as well, like the National Science Education Standards in 1993 (Brossard and Lewenstein 13). Because these projects were aimed at filling a public deficit of knowledge, science communication researchers characterize these approaches as deficit models.

Communication Models

The values of the *scientific literacy* paradigm are reflected in the methods of the deficit communication model. Because it originates in response to alarm from within the scientific community, the model aims to fill the public with scientific knowledge. In this sense, the deficit model is an "empty vessel" model, in which the receiver is a container to be filled. For science communicators within this paradigm, the problem to be addressed is a cognitive deficit, and the way to address it is education (Bauer and Falade 148). The fact that in this model the remedy to the public "deficit" is education shows the marks of its origin in universities and science-institutions. Brossard and Lewenstein characterize the deficit model as the "linear transmission of information from experts to the public" (17). The pattern in this model is similar to a lecture one might encounter in a university lecture hall, with the same foundational assumptions: that students (non-experts) have nothing or little of value to communicate to professors (experts). As a result the deficit model is authoritative, transmission-based, and one-directional.

The deficit model is similar to the Shannon-Weaver model of communication that largely influenced the *transmission* theory of communication. Slack, Miller and Doak write that, within the transmission theory:

> meaning is something that is "packaged up" by the sender, shipped out, and "unwrapped" by the receiver who can then act or think accordingly. Of course, there are numerous points in the process where difficulties can render the transmission less than perfect. The sender may encode the message poorly such that the message fails to contain the intended meaning. The decoder may decode poorly, not reading the intended meaning properly. There may also be "noise" in the channel that distorts the message so that, consequently, the meaning it contains is not received the form in which it was sent. (Noise may take many forms, from static on the telephone line to the wandering mind of the listener during the transmission.) (16)

This model inherently places authority with the sender. What Shannon and Weaver call *information*, what science communicators might call *knowledge*, Slack, Miller and Doak call *meaning.* The difference in these terms, of course, is that knowledge and information can be transmitted (either correctly or incorrectly depending upon the encoder, the decoder or the channel) wholesale to the receiver without the receiver having any bearing upon it. Meaning, however, is something that can be negotiated between sender and receiver. In the transmission model—as well as within the deficit model—the receiver is not granted the power to co-create meaning. Knowledge only is transmitted correctly and successfully if, after it is decoded, the meaning identically matches what the encoder intended.

All communication involves power, and in the transmission model "power is simply that which is exercised when the communication is successful. The sender has power when the receiver behaves in the intended manner. Power, like meaning, is something that can be processed and measured; its measure is to be found in the response of the receiver" (Slack, Miller, and Doak 16). The power of the speaker is to be measured within the receiver, yet the only agency of the receiver, in this model, is to correctly or incorrectly decode the meaning. If the meaning is decoded "correctly," the receiver still exhibits no power, no shaping of the knowledge to his own understanding. If the meaning decoded by the receiver does not match the meaning "packaged up" by the sender, communication has failed, and because knowledge is only that which the sender intended, whatever meaning the receiver is left with is wrong, incorrect, or invalid.

Underlying Assumptions

Implicit behind this top-down, dissemination model are the beliefs that effective transmission of scientific information can reduce the public's deficit in knowledge, and the belief that such a reduced deficit leads to more support for science, as well as "better" public decisions (Brossard and Lewenstein 17). It is important to note, here, what the authors mean by "better decisions." The 1985 Royal Society report provides some insight. The report states that:

> Better overall understanding of science would, in our view, significantly improve the quality of public decision making, not because the right decisions would then be made, but because decisions made in the light of an adequate understanding of the issues are likely to be better than decisions made in the absence of such understanding." (Royal Society 9)

In other words, a good public decision is not defined necessarily as the right decision, but one based upon a sound *understanding* of science. This is delicate reasoning that suggests two important elements of human decision-making. First, it suggests that scientific understanding is beneficial for its own sake. Even if scientific understanding cannot help society make the "right" decision—which, as we will see, Jon D. Miller and other advocates clearly think it can—it should still bear upon public decision-making. This is a portent of scientism (which will be discussed in the following chapter), the notion that the scientific ways of knowing are applicable to—and authoritative in—all situations of human inquiry. Secondly, this piece of language suggests that humans, scientist and non-scientist alike, make decisions based on logic, rationality, and reason.

This segment from the Royal Society report gets at another foundational argument for the scientific literacy paradigm, that public scientific literacy is especially important to democracy. Jon D. Miller has captured this argument in straightforward terms. "In a democratic society," he writes, "the level of scientific literacy in the population has important implications for science policy decisions" ("Scientific Literacy" 29), although, as the language from The Royal Society report suggests, it has important implications for *all* policy decisions. The goal of science literacy among the public, he continues, is to "foster an informed and intelligent participation in science policy issues" (29). It is the understanding of the process—and knowledge of terms like atom, molecule, cell, and gravity—that allow public to follow discussions of science policy, and, in the sense of The Royal Society report, make informed decisions.

Miller realizes that many public policy decisions are not direct-democracy affairs in which a majority of the voting population decides policy. He writes:

> No individual today, no matter how good his or her intentions can hope to acquire and maintain a mastery of more than a few political issues at a time. Thus the modern citizen who chooses to follow political affairs opts for political specialization—that is, selects out of the myriad issues those few in which he or she is willing to invest the time and other resources necessary to become and remain informed ("Scientific Literacy" 42).

Political specialization has limited the number of issues about which even the most diligent citizens can remain adequately informed. A result of this specialization, Miller argues, is that a rarified number of "Decision-Makers" become the foremost arbiters of policy, very similar to the formulation of legislation in representative democracy. This group, largely composed of governmental actors, sits atop a pyramid of "science and technology policy formulation." Below the "Decision-Makers" is a larger number of nongovernmental "Policy Leaders"—the scientific or technological expert and elite. Below them sit a select—Miller estimates about eighteen percent of the population—number of the population deemed scientifically "Attentive Public." Lastly, the base of the pyramid is made up of the rest of the population, what Miller calls the "Nonattentive Public." In many cases, when the top two tiers of the pyramid—the governmental decision-makers and the nongovernmental policy leaders—are in concurrence, "policy is made, and there is no wider public participation in the policy process" (43). If disagreement arises within the leadership group, or discord between a unified leadership group and the decision makers, policy leaders may appeal to the attentive public—directly below them in the pyramid—to contact and persuade governmental decision-makers (write a letter to your congressman). So, in many cases, policy is decided without input from the majority of the public, who are nonattentive (see figure 1).

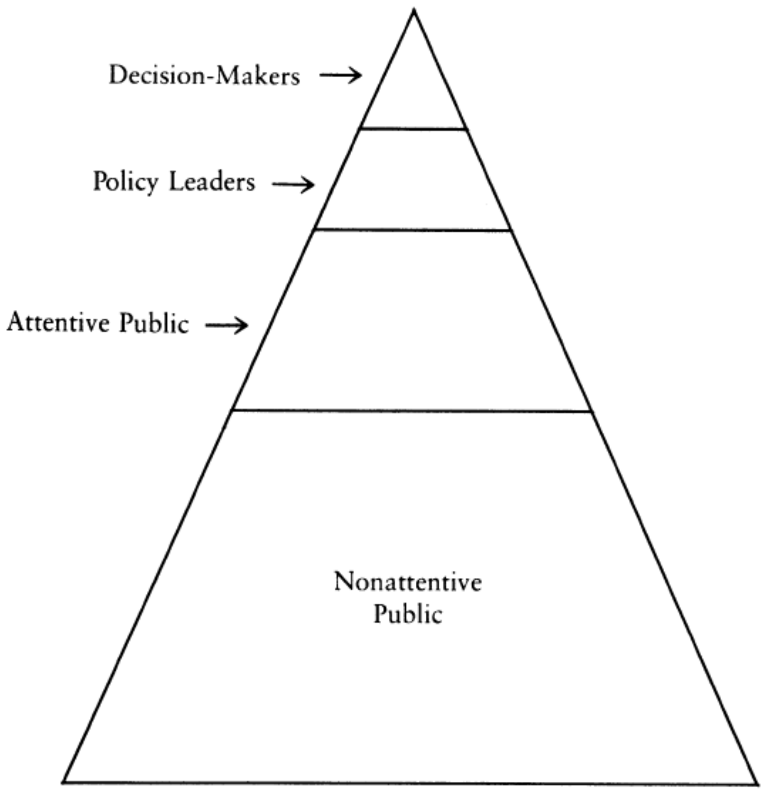

Fig. 1. Jon D. Miller's "Stratified Model of Science and Technology Policy Formulation" from "Scientific Literacy: A Conceptual and Empirical Review"; *Daedalus* 1983: 29–48. Print.

However, Miller writes, when "the general population become[s] sufficiently unhappy about the policies that the decision-makers, leaders, and the attentive public have fostered in any area, it can exercise a political veto" (45). Miller claims that it was this general public who ended the wars in Vietnam and Korea, and it was ultimately this nonattentive public who successfully opposed Portland City Council's decision to fluoridate the public water source in the 2013 community fluoridation program referendum in Portland, OR. A referendum vote by the electorate on the single issue was the sole determiner of Portland's city-wide health policy. Similarly, the proposed GM ban in Benton County (see introduction) put the course of GM research at Oregon State University, as well as the course of agriculture throughout the county, directly before the public. The Royal Society's reasoning, we can assume, still applies here. In the *scientific literacy* paradigm, an informed and scientifically literate public will make rational, well-informed—and as a result, "better"—decisions that reflect the objective, empirical, and authoritative values of the scientific endeavor.

For Miller, these are the situations that hold public policy accountable to the public. He argues that, "It is this very ability of the general population to intervene and veto that sustains the democratic nature of the policy formulation process" ("Scientific Understanding" 45). However, these situations are also the most problematic for science literacy advocates because—according to the model—expertise, technical achievements, and hard-earned scientific know-how are often shunted aside by groups of nonattentive voters of whom, Miller estimates, about 97% or 98% are scientifically *il*literate (45). The lofty goal of the *science literacy* paradigm, then, is to educate this nonattentive and illiterate public, so that their rational decisions about policy issues will more or less align with policy leaders, and (hopefully) governmental decision-makers. In theory, it is a win-win situation in which policy formulation is both scientific and democratic; in practice, scientific policy decisions are often at odds with democratic decisions.

Critiques

Criticism of the scientific literacy paradigm is not difficult to come by. Critiques largely fall under one of three (related) headings: 1) the paradigm has failed to achieve any significant increase in its own definition of public scientific literacy, 2) scientific literacy itself is an unreasonable expectation, and 3) the paradigm is alienating for those who are not "science attentive."

The first—and perhaps most damning—critique of the scientific literacy paradigm is that it has been unable to achieve any significant increase in scientific literacy, as the paradigm has defined it. Jon. D. Miller—who has both defined the indicators for scientific literacy, and has been measuring the public against those indicators for decades—concluded in a 2004 report that science literacy in Americans the past two decades had "nearly doubled" from ten percent to seventeen percent ("Toward a Public Understanding"). If we look at these rates over a longer timeline, however, and compare Miller's 2004 figure to his own calculation of a 1957 figure—in which only seven percent of adults qualified as "literate"—the advancement (from 1957 to 2004) from seven to seventeen percent, hardly seems robust.

Rick Borchelt, communications director for science at the U.S. Department of Energy puts it this way:

> In fact, there is little evidence that anything we have done as science communicators since the end of World War II has moved the needle one mark on the science literacy scale — we've poured lots of money in it and literacy hasn't changed, we've gone through lean times with almost no funding and literacy hasn't changed, science journalism has been in the catbird seat for a while and then in a tailspin for a decade and science literacy hasn't changed, Bill Nye the Science Guy came and went on television and science literacy didn't change, we've launched initiative after adult, informal science education initiative after initiative from NSF, NASA, NOAA and the rest of the known science funding universe and science literacy remains stubbornly low. And we continue to agonize over this. (Borchelt)

Secondly, many critics of this paradigm suggest that the unreasonable definition of scientific literacy necessarily causes the public deficit. These critiques range from criticism of literacy indicators, to criticism of the notion of science literacy itself. At what point, critics ask, does a person move from "literate" to "illiterate"? Bauer and Falade ask "Is literacy a continuum or a threshold measure?" The authors argue that "Miller originally envisaged a threshold measure… However, the definition of this minimal level of literacy changed from audit to audit, and it is unclear whether the reported changes, or for that matter lack of changes… reflect shifts in definition or in substance" (147). Further, critics have pointed out that certain indicators—like the one that requires literate citizens to denounce superstitions—measure values, religious beliefs, or other cultural factors just as much or more than they measure science literacy (Allum and Stoneman; Bauer and Durant). These definitional qualms aside, some critics add that the paradigm does not make a convincing case for its own prioritization. Why, for example, is scientific literacy more important than other types of literacy, like historical literacy, or say, financial literacy? Alan Gross has argued that the goal of scientific literacy is the cause of the deficit itself; it is unreasonable, as well as rhetorically ineffective, to expect the public to cultivate a literacy that, in general, has no significance for them. For Gross, it is not necessarily a deficiency for the public to be ignorant of matters that are publically insignificant. As Gross puts it, “most of us are ignorant of most matters. What is deficient, rather, is to be ignorant where it matters to you, in particular situations” (8).

Lastly, the *scientific literacy* paradigm is often criticized for creating an isolated, outside-of-society, and infallible construction of science. By defining the literacy indicators of the public so closely to those of practicing scientists, and by communicating scientific issues in one-directional, authoritative, and largely scientific discourse, adherents of the science literacy paradigm are guilty of alienating the large majority of citizens who are not “science attentive,” or do not have a personally-motivated interest in science. Bauer and Falade write that, “any attempt to share knowledge *without simultaneous empowerment* will alienate rather than bring the public closer” (148) (emphasis added). In short, this paradigm is accused of having lectured the public for decades, in its own jargon, to little effect, while refusing to open its ears to public feedback.

Public Understanding of Science

As we move beyond the *scientific literacy* paradigm, it is helpful to remember the warning in the introduction to this chapter: many elements of these paradigms overlap, and co-exist, sometimes contradictorily. Moving beyond a paradigm does not mean leaving it behind. As many of the subsequent theories are defined as reactions to and improvements upon the *scientific literacy* paradigm and the deficit model, aspects of the paradigm will be revisited throughout the rest of this chapter for the sake of context.

Bauer and Falade place the beginning of the *public understanding of science* (*PUS*) paradigm around 1985, and point to the Royal Society report—published that same year—as a watershed document. Although some scholars consider The Royal Society report the dawn of a new phase of Science Communication, the report has at least one foot rooted firmly in hardened scientific literacy theories and values. For one, the report makes very clear that its authors are in line with the fundamental scientific literacy tenet that all people should have a basic understanding of science. Furthermore, the report recognizes a public deficit, as well as placing an emphasis on science education, preferably at a young age.

The largest difference between the two paradigms, then, is that that the *PUS* paradigm acknowledges, at times, that the public's understanding of science might not be entirely *rational*. The Royal Society report—and the paradigm as a whole—recognize that the public's *attitude* toward scientific institutions, practitioners, and culture bear upon their understanding. As Bauer and Falade write, "PUS inherits the notion of a public deficit; however, now it is the attitudinal deficit that is foregrounded" (148). The authors of the report call for research into existing surveys of public attitudes toward science, as well as more measurements of attitudes toward science. (Not to be confused with Dewey's "scientific attitude.")

The Royal Society report displays the sometimes-contradictory nature of shifting paradigms, especially about how decisions are made by the non-expert citizen. For example, this is the report that produced the language that we analyzed in the previous section, that "better overall understanding of science would, in our view, significantly improve the quality of public decision-making, not because the 'right' decisions would then be made, but because decisions made in the light of an adequate understanding of the issues are likely to be better than decisions made in the absence of such understanding" (9). As concluded previously, this passage suggests two hallmarks of the literacy paradigm: that science literacy is good for its own sake, and that the public's decision-making process is a rational, cognitive one ostensibly governed by what George Lakoff calls they myth of "enlightenment reason" (Lakoff 72). Yet, the report also acknowledges that, to some degree, the public's *attitudes* toward scientific institutions and culture—not necessarily its *reason*—are "clearly relevant to [the committee's] main concern" (Royal Society 12). The *PUS* paradigm, then, brings the public's *attitudes* nearer to their *understanding.* I hesitate to say that the *PUS* paradigm expands the notion of understanding to *include* attitude, because its approaches are often rationalist and cognitive, but at the very least, this paradigm acknowledges a relationship between non-rational, perhaps even emotional, attitudes and public understanding. The relationship between *attitude* and *understanding,* however, becomes more muddled when we examine the complicated role that knowledge and literacy play in this paradigm.

The *PUS* agenda to improve understanding by means of increased science education is slightly nuanced from that agenda in a *science literacy* paradigm. To *science literacy* researchers, a scientific education will help raise the public's literacy rates, and therefore aid a larger number of them in making reasonable and logically-informed decisions. This fundamental assumption can easily be found within the *PUS* paradigm (see the aforementioned definition of the quality of public decision-making from the Royal Society report) but, having noted a relationship between attitude and understanding, *PUS* acknowledges that education affects the public's knowledge, which in turn, affects their attitude. Bauer and Falade characterize the relationship between knowledge and attitude within *PUS* as "the commonplace notion" that "the more they know, the more they love it" (148). That is, the paradigm advocates for increased science education, not solely because it will improve the quality of decision-making, but also because it will ostensibly improve public attitudes toward science.

The *PUS* paradigm does more, perhaps to address *appreciation* and *support* of scientific endeavors rather than just an understanding of them than science literacy did. Nevertheless public support and appreciation of science are goals of both *science literacy* and *public understanding of science* paradigms (Lewenstein). Remember that, ultimately, the ability to recognize the positive effects of science upon society is an indicator of literacy for Miller and the NSF.

Communication Models

The deficit model and its goals of scientific literacy, public support of the sciences, and "better" public decisions were at the heart of many public-scientific endeavors up to and throughout the 1990s. The deficit model, though, has since been largely criticized by researchers and theorists as ineffective at accomplishing—and sometimes directly antagonistic to—its aforementioned goals. Robert Logan notes that the authoritative and linear transmission modes of the deficit model led to, in some cases, the growth of "anti-science" attitudes in public opinion (151). Theorists argue that the authoritarianism of the deficit model creates a false image of science as "fixed and certain" (Einsiedel and Thorne 49), when, as Allen Gross argues, the scientific record of failed theories and failed hypotheses suggests just the opposite. Gross writes, "the history of science undermines the deficit model by undercutting its presupposition that its methods routinely generate truths about the material world" (8). In this regard, the authoritarianism of the deficit model "falsifies" science both for journalists and the public. When science is represented as certain to the public, and then is revealed to be uncertain, the goals of the deficit model are not met, and in fact the public's attitude toward science is negatively affected. Leah Ceccarelli has dealt with the dilemma of whether science communicators should present science as "objectivist" (that is, as a methodology of uncovering absolute knowledge) or "constructivist" (that is, as an ultimately social process of dissent and debate). Ceccarelli notes that, although it might seem intuitive that painting science as objective, absolute, and created through complete consensus would strengthen its sway with the public, she concludes that this is a common rhetorical pitfall of scientist and science supporters that is often ultimately harmful. When science is presented as objective to the public, a single dissenting scientist—whether motivated by scientific means or otherwise—can destroy the public's idea of complete consensus, and, in turn, present "manufactured scientific controversy" for the public. Ceccarelli argues that this tactic, suggested by Frank Luntz, was successfully used by certain American Republican politicians to obfuscate the scientific consensus on global warming, to turn what was a wholly settled scientific consensus into a public debate (204-205).

An oft-cited example of objectivism gone wrong is the Bovine Spongiform Encephalopathy (BSE) or mad cow disease crisis in the UK in the 1990's. The British government, believing that the risk of transmission of BSE to humans was remote, downplayed the seriousness of the disease in order to temper alarmism in the public. When the government had to announce that, in fact, BSE probably had transferred to humans, the public felt betrayed. In the wake of this betrayal, an effort to raise public awareness and improve the public opinion of Genetically Modified (GM) crops had the opposite result on a skeptical public (Irwin 306-307). In this regard, the authoritative and linear transmission of information via the deficit model did not foster public support for science, nor encourage "better decisions" on public policy. Rather, an anti-science sentiment had set in on the public, and policy decisions were made by a public who intentionally refused to be informed of scientific findings. In both of these instances an "objectivist" definition of science ultimately harmed the goals of Science Communication.

In response to the rhetorical inefficacy of the deficit model—which takes no notice of the different groups that are its audience, why certain scientific knowledge may or may not be important to them, or how to tailor its message according to these variables—Alan Gross has proposed a contextual model of communication that employs a "rhetoric of accommodation" (6) in which specific audiences are targeted for specific scientific issues that relate to them. In this way, the contextual model aligns with the fledgling trend—within the *PUS* paradigm—of acknowledging the public not as one group, but as a multiplicity of groups whose understanding of science is affected by context.

The contextual model of communication takes into account the varying factors and situations that might affect how a certain group interprets scientific information. Brossard and Lewenstein write "the Contextual Model acknowledges that individuals do not simply respond as empty containers to information, but rather process information according to social and psychological schemas that have been shaped by their previous experiences, cultural context, and personal circumstances" (13-14). In a sense, it does away with a "single public" to focus on how science might most effectively be communicated to a wide range of publics.

Underlying Assumptions

By acknowledging differences in audiences and their perception of information, the contextual model has drawn comparisons to modern marketing and advertising techniques (Brossard and Lewenstein; Michael; Toumey et al.). Bauer and Falade recognize a concurrent split within the *PUS* paradigm as a whole. The authors argue that *PUS* researchers can be divided into two camps. Both camps agree that there is public deficit in knowledge and attitude. They disagree, however, on what to do about it. The *rationalist* approach is one based on a rationale that this chapter has already explored: insufficient public attitudes are a result of insufficient public information or nonrational biases. As a result, if the public just had sufficient information (Miller's literacy indicator #2) or could operate without the biases of subjectivity, anecdotal evidence, cultural lenses, etc. (literacy indicator #1) they would hold more positive attitudes toward scientific expertise. As a result, for the *rationalist*, "the battle for the public is thus a battle for rational minds with the weapons of information and training in probability and statistics" (Bauer and Falade 149). For *realists*, however, such subjectivities and biases are not elements to be eradicated, but to be utilized. *Realists*, within this paradigm, recognize the limitations of their audiences' objective reason and tailor their message thusly. Bauer and Falade write "realists work the emotions and appeal to people's desires, moral stances and gut reactions, and thus follow the logic of modern sophistry in advertising and propaganda" (149). Most scientists and science communicators would prefer not to be aligned with "sophistry," "advertising," and "propaganda," but realists contend that decades of rational expectations of the public has failed to instill significantly greater attitudes or understanding within the public, and acknowledge that publics can be persuaded, for better or for worse, by means other than rational appeals.

As we can see, the *PUS* paradigm makes many of the same assumptions of scientific literacy: the public is deficient (whether in knowledge or attitude), scientific knowledge and public attitudes toward science are intertwined, better scientific knowledge leads to better policy decisions. Yet the very recognition of public attitudes amounts to a recognition of the complex, contextual factors—linguistic, cultural, values-based, etc.—in which certain publics understand science, factors that played no part in the deficit model.

Critique

The contextual model, though, however rhetorically aware of its audience, has been criticized as merely an advanced version of the deficit model. Like the deficit model, it recognizes a deficit (both in attitude and knowledge) within the public. Though the contextual model recognizes its audience not as a "vessel" to be filled, but rather many diverse groups who interpret meaning in many—often nonrational—ways, such considerations are only a means to more effectively *transmit* authoritarian information (Brossard and Lewenstein). This model, like the deficit model and the transmission model, invests little to no power in the receiver, and is ultimately linear.

Furthermore, many researchers and theorists argued that the fundamental assumption behind *PUS*—that more scientific knowledge leads to necessarily greater appreciation of science—is in fact untrue. Bauer and Falade point out that, through a social psychology lens, cognition is not a *factor* of attitude, but rather a *quality.* They write, "knowledge fortifies the attitude to resist influence and makes it more predictive of behaviour, whatever its direction" (150). In other words, attitude comes first, then cognition, in support of that attitude, comes second. As Philip Eubanks puts it, "[i]n short, people's views do not become more flexible as their ability to understand the science increases. What matters is the worldview of the person making the judgment" (58). This notion has been corroborated by social-science and psychological studies (Pomerantz et al; Kahan; Nyhan et al.; Stoknes). The common sense notion that more knowledge breeds more support has repeatedly been shown to be just that, common sense. An illustrative case is a 2012 study by Dan M. Kahan and his colleagues that investigated the effects of science literacy on public perceptions of climate change. The study determined that, contrary to what the *PUS* paradigm would predict, "members of the public with the highest degree of science literacy and technical reasoning capacity were not the most concerned about climate change" (Kahan et al.). Furthermore, the study concluded that what we have called contextual factors—values, beliefs, personal interests, and social cohesion—were much better predictors of attitudes on climate change. Specifically, the study found that participants who both had a "Hierarchical Individualist" cultural worldview *and* were science savvy were the least concerned of all about the risks of climate change (Kahan et al.). Eubanks uses the data to argue that "[i]f you are inclined to discount climate change, a better understanding of scientific and technical matters makes you even surer that you are right" (58). Knowledge of science is not, in fact, corollary with positive attitudes toward the outcomes of science. Rather, it is one's values that correlate with attitudes toward scientific outcomes, and scientific understanding, subordinate to values-based judgment, determines the *quality* of that attitude—one's ability to reason, in Enlightenment terms, on behalf of belief.

Science in Society

Criticism of both the theoretical underpinnings of *science literacy* and *public understanding of science* paradigms, as well as the communication models that reflect their goals, led to a radical re-attribution of the "problem" within science communication theory in the mid-1990's. Unlike the previous paradigms, *science in society* does not attribute the communicative problem to the public, but rather to the scientist or science communicator. Bauer and Falade write, in this paradigm, "the public deficit of trust is mirrored by a deficit on the part of science and technology and its representatives. The focus shifts to the deficit of the scientific expert: their prejudices of the public" (150). Brian Wynne has noted the unending feedback loop that decades of public deficiency thinking have created for both communicator and audience. The public, Wynne argues, are continually shown—by surveys like Miller's and Durant's—to have little interest in or understanding of science, and as a result, cannot be trusted by scientific experts. Wynne calls this condition *institutional neuroticism*. Such distrust of the public by scientific actors, then, is detected in deficit-based communicative efforts and reciprocated by the public. These negative attitudes, construed as a deficiency, reify the prejudice of scientific experts, who in turn re-project those deficiencies on the public, and the cycle continues *ad infinitum* ("Public Uptake" 1993).

In the *science in society* paradigm, the prejudices and deficiencies of scientists and science communicators come under the same scrutiny as those of the public. In this paradigm, science operates within society, not above or outside of it, and as a result it is not invulnerable to accountability and criticism. Neither does it necessarily earn authority solely by virtue of its (now refuted) position as infallibly and invulnerable placed outside of social processes.

Communication Models

The value of public participation in this paradigm is reflected in two of its corresponding communication models: the public engagement model and the lay expertise model. The lay expertise model has largely grown out of the work of Science and Technology Studies (STS) scholar Brian Wynne. In a case study of Cumbrian sheep farmers dealing with fallout from the Chernobyl disaster, Wynne noted that not only did the authoritarianism of scientific "outsiders" damage trust, but that scientists' certainty came across as arrogance, and hugely damaged credibility, especially when the local knowledge disregarded by scientists actually proved valuable. In "Misunderstood

Misunderstanding," Wynne explains that experts in the U.K. advised the sheep farmers to graze their lambs in valley fields for longer, so that the high caesium levels in the hilltop fields would decrease before sheep were allowed to graze. However, experts ignored the "lay knowledge" held by the sheep farmers that valley grazing must be limited to short periods of time due to a short supply of valley grass. One interviewee noted that the grass would be "reduced to a desert in days" if not carefully protected with disastrous results for future herds ("Misunderstood" 295).

The lay expertise model, then, acknowledges and accepts expertise outside of scientific expertise. In doing so, it also recognizes specific audiences and their contexts, like the contextual model, but radically breaks away from the one-way transmission function of both the deficit and contextual model to legitimize and allow for a more dialogic, interactive and participatory conception of the scientific process.

The public engagement model has grown in prominence in the last two decades. Jack Stilgoe et al. note that since its inception in 1992 the journal *Public Understanding of Science* "has steadily described and mapped the gradual and incomplete shift from 'understanding' to 'engagement'" (Stilgoe et al. 4). Public engagement, like the lay expertise model, is dialogic. Perhaps even more than the lay expertise model, though, public engagement strives for widespread, democratic participation—not necessarily in the scientific endeavor itself, but especially in the formulation of public policy dependent upon scientific and technical expertise. Public engagement strives to create venues and mechanisms by which the public can engage; most often these activities include "consensus conferences, citizen juries, deliberative technology assessments, science shops, deliberative polling, and other techniques" (Brossard and Lewenstein 16).

Underlying Assumptions

As Wynne's case study shows, the *science in society* paradigm operates on foundational assumption that a linear, authoritative approach can greatly damage the trust and credibility of science in the eyes of non-expert communities. Wynne argues that the "public uptake of science depends primarily upon the trust and credibility public groups are prepared to invest in scientific institutions and representatives" credibility and trust, which he observes "are contingent upon the social relationships and identities which people feel to be affected by scientific knowledge, which never comes free of social interests or implications" ("Misunderstood" 1992). As in the Kahan study, Wynne acknowledges that social, personal, and emotional factors are paramount in the way that publics understand science. Furthermore, he argues that absolute authoritarianism destroys critical trust and credibility, and such authoritarianism stems from a conception of science as outside or above society.

The exclusion of public concerns—characteristic of both *science literacy* and *PUS* paradigms—is exactly what the *science in society* paradigm combats. Many of the efforts of *science in society* are driven by the rebalancing of the "contract" between science and society. Perrault describes the "traditional contract," circa World War Two, as one in which 1) all science is inherently beneficial to society, 2) separation from science is not only possible, but necessary and 3) "society should provide science with resources and otherwise allow it autonomy, and in return, science will provide society with knowledge and with consumer goods" (Perrault 7). Alternately, Perrault describes an emerging contract in which "the internal validity of science" is just as important as in the old model, but in which a sort of synthesis occurs between expertise and public concerns to achieve a “socially robust knowledge, the production of which is ‘both transparent and participative’” (7). She argues that “public oversight of technoscientific developments is heralded as one of democracy’s strengths” but she sees how *scientific literacy* and *PUS*, configured as they are outside of society, dismiss public concern “because [publics] are not part of the technoscientific paradigm they question” (xii).

Perrault has the same hope for Science Communication that Miller does: a configuration in which public policy is made both scientifically and democratically. Yet, it becomes clear that the two can be problematically exclusive of one another. If the public, by definition, and despite decades of science literacy advocates, is largely illiterate, decisions made purely scientifically will exclude the will of the majority. Conversely, the nature of expertise is necessarily elite, stratified, and hierarchical, and policy decisions based wholly on democratic majorities are bound to exclude this rarified expertise. If Jon D. Miller has been accused of favoring the scientific in this delicate balance, Perrault and the *science in society* paradigm more generally have been accused of favoring the demotic.

Critiques

The goal of the public engagement model, Brossard and Lewenstein write, is “real public authority over policy and resources” (17), but its ability to achieve this goal remains in question. Stilgoe et al. note that the discussion over public engagement has largely moved from the value of its goals to its means and processes. They write, “The *how* trumps the *why* and there is insufficient systematic reflection on what all this activity has achieved" (5). Some researchers argue that despite its commitment to dialogue, engagement with the public continues to reify deficit-like attitudes among scientists (Grove-White; "Public Engagement as a Means"). Furthermore, the public engagement model has been criticized for focusing too much on policy formulation and too little on science education, for "addressing politics, not public understanding" (Brossard and Lewenstein 16). Like the lay expertise model, the public engagement model acknowledges and considers methodologies, knowledge, and worldviews outside of scientific expertise, and, as a result, risks the aspersion "anti-scientific" (Brossard and Lewenstein 15). The paradigm as a whole can be criticized for privileging lay knowledge over the long-established authority of scientific expertise; despite *science in society's* attempts to achieve a synthesis between science and the public, and indeed to try to erase divisions between the two, many critics continue to see the scientific and the democratic in policy deliberation as an opposed binary, and are quick to lament what they as sense a power shift within in a *science in society* paradigm.

Conclusion

This chapter has surveyed the various ways that Science Communication and Public Understanding of Science scholars have approached communicating the scientific to non-scientific groups. One way to make meaning from the previous chapter is to view the science communication models and the paradigms that engendered them as an evolution. It is possible to both heed Bauer and Falade's warning that "this is not a model of progress, but one of a multiplication of discourses" (144-145) and to note some marked trends across the emergence of these models. Just as in evolution, the new iterations do not necessarily replace the old, and the process is not one of linear progress. The branching, say, of the *deficit model* into a *contextual model* by no means denotes the end of the deficit model. Indeed, the goals of *scientific literacy* and the means of attaining them no doubt, have continued along their own branch to this day (look to the NSF scientific literacy indicators that are still recorded every two years, or to Jon D. Miller's most recent opinion piece titled "To Improve Science Literacy, Researchers Should Run for School Board"), and, as a result coexist with newer public engagement models. Noting the differences at each branch, however, can illuminate the general course that Science Communication scholarship has taken over the decades. First, in terms of the power in the communicative instance, the changing paradigms represent an increased legitimacy of non-scientific knowledge, and an increased power of public audiences to negotiate, co-create, and synthesize that knowledge with scientific knowledge. Second, the communication models, as they have become more nuanced, have exhibited an increased rhetorical sensitivity to publics and the many situations in which they understand science. This chapter has looked at how the fields of Science Communication and Public Understanding of Science have mediated a tension between the ascendancy of scientific authority with the demands of democratic deliberation. In the following chapter, I look to the fields of rhetorical studies, critical theory, and affect to see how other groups of scholars have approached this tension, and I will incorporate theories from these fields to further identify, contextualize and magnify where Science Communication has been and where it can go.

Note

1. The phrase public understanding of science (PUS), used largely, has a few nuanced meanings. To avoid confusion, I will address each. Bauer and Falade's use of the phrase entails the study of science-and-public generally, beginning in the 1960's and continuing to today. In many instances, I use it generally, and interchangeably with "Science Communication." However, they also use it to describe a specific theoretical and research paradigm most popular from 1985-1995, the era from which the phrase itself arose. To differentiate, between the two I have put the phrase in italics when it is used to describe this specific paradigm.

Chapter 2. Softer and Weaker: Weak Theory, Affect, and Science Communication

The research question remains the same in this chapter; I continue to examine how non-expert populations understand expert scientific knowledge. However, as the previous chapter detailed how scholars of Science Communication and Pubic Understanding of Science have addressed the question, this chapter will visit the ways that rhetoric, critical theory, and affect scholars have reconciled the post-World War Two dominance of scientific rationality with non-scientific knowledge in the academy, and more importantly, with the ways of knowing and deliberating available to non-scientific experts. First, I introduce Eve Sedgwick's notion of "strong" and "weak" theories to describe the "weakening" trend in Science Communication models, and its benefit. Secondly, I will look at how rhetorical scholars like Wayne Booth and Peter Elbow, writing during the same time period of the scientific literacy paradigm, resisted the rationalist assumptions of that paradigm, both within and without the university. Then, I will employ rhetorical notion of *pisteis*, or proofs, to illustrate how the proof that traditional Science Communication has largely relied on (*logos)* is not the only way that many publics understand science, and that decades of Science Communication theory and practice is based on an incomplete picture of the public deliberation. Finally, I borrow from affect scholars to provide an alternate way of understanding the deliberative process of certain publics.

The changes that Science Communication has undergone in past decades can be seen as a "weakening" of what was originally a "strong" theory. I use "strong theory" here as Eve Sedgwick uses it. For Sedgwick, a strong theory is characterized by "the size and topology of the domain that it organizes" (134) and, necessarily, the reductive nature by which it explains such a large range of phenomena. That is to say that the "stronger" a theory is, the more seemingly unrelated phenomena it appears to explain. Silvan Tomkins, whose work Sedgwick draws from, writes "any theory of wide generality is capable of accounting for a wide spectrum of phenomena which appear to be very remote, one from the other, and from a common source" (qtd. in Sedgwick 134). Lacan's theory of language, for example, is a strong theory. Within Lacan, "all language [and] all signification" is an "expression of patriarchal law" making it strong both because it holds to explain a wide range of phenomena (all of language and signification) and because to do so it must necessarily reduce the complex and various scenarios of all of human communication to one entity, and frame that entity solely in relation to another (similarly reductive) entity of patriarchy ("Engendering Theory"). Marxism, too, is a strong social theory, both because it explains a wide, diverse range of phenomena, and to do so must simplify complex social and political factors, across different nations and culture. In the sciences, of course, the value of a theory is often relative to its strong nature. Tomkins writes, "this [ability to explain a wide range of phenomena] is a commonly accepted criterion by which the explanatory power of any scientific theory can be evaluated" (qtd. in Sedgwick 134). Furthermore, rationalism—the notion that rational thinking can be used to understand all phenomena human or otherwise— and positivism—the notion that the only justifiable assertions are those that can be scientifically verified—are strong epistemological theories.

Similarly, the *scientific literacy* paradigm is strong in that its communication models are rooted in the empiricism, rationality and authority of science derived from these epistemologies. If strong models of Science Communication hold that there is one model by which all communication phenomenon between experts and non-experts can be explained, positivist and scientistic theories of knowledge reserve similarly expansive "explanatory power" for empirical and logical ways of knowing. In other words, the notion that empiricism and reason can explain *all phenomena*—including human signification and semiotics—to the exclusion of any other ways of knowing is a strong theory. The deficit model, then, is scientistic and positivist in that it privileges scientific expertise above all other ways of knowing. It is strong—and *arhetorical*, for that matter—in that it applies these values in all communication contexts, regardless of, say, audience, purpose, text or subject.

The deficit model, and its very goals of *universal* scientific literacy are strong in that it places heavy explanatory power on the slippery notion of literacy. The scientific literacy paradigm is strong in exactly the same way that the notion of alphabetic and/or textual literacy has been called strong by New Literacy scholars. Brian Street and Ruth Finnegan, for example, have pointed out that the notion of literacy as always powerful, all the time, for all groups of people is strong in its explanatory power, but operates on a largely unexamined, uncomplicated, and singular notion of what literacy is and can do (Harker 110).

However, Science Communication's gradual acknowledgment and recent incorporation of certain nonrational concepts into its communication theories—framing, metaphor, *ethos*, *pathos*, affect, symbology, polysemy—represent a slight departure from this strong, positivist approach (Yang and Kahlor; Lu, Kendall-Taylor et al.; Williams et al.). In this sense of the term, Science Communication's very "multiplication of discourses" (Bauer and Falade) can be viewed as a "weakening" of once strong theory because, for one, multiple theories may implicitly limit the explanatory power of other competing theories. More directly, though, the discourses themselves, which have gradually incorporated contextual and situational awareness—Gross's contextual model, Irwin's lay expertise model, and the public engagement with science model—are an acknowledgement of, and a response to, the inefficacy of the stronger theory of the deficit model. This is a movement in the right direction, as I will argue that this positivist notion of science among science communicators has been damaging to its goals of public understanding of science.

Responses to Rationalism and Positivism

Although our goal is to see how alternate ways of knowing can continue to benefit Science Communication, it is illuminating to view this impasse as it has arisen between academics. The positivism embedded within the *scientific literacy* paradigm is rooted within a perceived rationality/emotion split in the sciences themselves, and indeed within most modern academic pursuits. Wayne Booth has called this division between logic and emotional values "modern dogma" because of its ubiquity, especially in the 19th and 20th Century. He writes, "the belief that you cannot and indeed should not allow your values to intrude upon your cognitive life—that thought and knowledge and fact are on one side and affirmations of value on the other—has been until recently a dogma for all right-thinking moderns" (13). That this dualism that has dominated not only science, but most of intellectualism, would have colored the earliest models of communication seems unavoidable. More recently, scholars have begun to explore the problematic nature of this dichotomy (*Writing Without Teachers*; Rivers; Carolyn Miller, "The Rhetoric of Decision Science" or any of the rhetoric of science scholars, for example).

One complaint against separating and illegitimating bodily, emotional, and values-based ways of knowing is that the critical stance it engenders—Eve Sedgwick calls it the "hermeneutics of suspicion" or the "paranoid" stance—if always turned on, severely narrows what can be known and how, resulting, among other things, in an impasse in discourse between scholars. For Booth, this narrow attenuation of acceptable ways of knowing—or more specifically the strict separation of reason from values, and subsequent illegitimacy of value —has resulted in the "loss of good reasons", a 20th century result of the acceptance of the fact/value split as a truism. For Booth, before the 20th Century, "values could still be reasoned about," meaning that it was indeed *reasonable* to base values on matters of fact, and that the split was not absolute (14-15).

The damage upon academic discourse that the split has wrought, for Booth, is ultimately upon mental agency. "There are no good reasons for changing your mind, except (sometimes) in choosing means or techniques" (24). The total sequestration of reason and value prevents belief and worldviews from influencing facts and knowledge, *and* conversely, prevents facts and knowledge from impressing worldviews and facts. In this total split, facts and knowledge are not good reasons to change one's mind because "choices of ends and worldviews and of political and religious norms are value choices, and since value judgments are not about matters of fact, there can be no final superiority… of one line of reasoning over the other" (24). In part, it would seem, Booth is reacting to the groundswell of postmodernism that is shaking the university in the 1970's. He laments, for example, that "The very word *truth* has for many been ruled out of court" (33). But even in the 1970's Booth is *feeling* the impasse in discourse that pure rationality as separate from pure values brings.

Tautology

Booth notes that one of the biggest hits to academic discourse is the tautological nature of such thinking. He writes:

> Anyone who believes that all reasons are disguises for irrational motives of various kinds is sure to find confirming examples wherever he looks, partly because cases of rationalization in this sense are indeed plentiful and partly because belief in the hypothesis leads one to look at other people in a certain way and to find what one looks for (32).

Sedgwick echoes this effect of such thinking on discourse decades later in *Touching Feeling.* She writes that a strong epistemology is "a mode of *selective* scanning and amplification... that can't help or can't stop or can't do anything other than prove the very same assumptions with which it began" (135). Sedgwick notes, like Booth, that such skeptical ways of thinking, constantly vigilant for any hidden values or ideologies, inherently casts doubt on the motives of all others. This paranoia (for Sedgwick) or motivism (for Booth) is in itself a strong theory and, as Sedgwick writes, "a strong theory risks being strongly tautological" (135). Both scholars worry about the effect of such skeptical rationality on the progress of intellectual discourse. For Booth "motivism makes hard intellectual and practical problems seem easy" (33). The complete sequestration of value-judgments necessarily excludes rationality, making their wholesale dismissal easy. (It seems to me that such judgments play a key role in the Wynne's notion of institutional neuroticism and its vicious cycle upon public trust; it is easy for science to dismiss public knowledge or attitudes precisely because they are irrational.) For Sedgwick, the strong, tautological nature of paranoia—as well as its affective contagiousness in both its easiness to teach and in its ability to make others paranoid—can make it difficult to see the circular pattern of only finding what one set out to look for, and, in fact, can make such methodologies appealing, satisfying and self-perpetuating. The resultant harm to discourse, then, is that "both writers and readers can damagingly misrecognize whether and where real conceptual work is getting done, and precisely what that work may be" (136).

Booth points out, importantly, that not all nonrational reasons are "good," that there are, of course, spurious rationalizations perpetrated in the name of values. He acknowledges that cases in which "reasons are disguises for irrational motives…are indeed plentiful." In other words, to acknowledge and critique the ubiquity of the rationally skeptical, paranoid stance is not to say that it is not without merit, that it does in fact have some explanatory power. Sedgwick similarly argues that a "reparative" stance does not necessarily imply a naïve credulity, but that, in fact, the "reparative" stance can only be occupied in conjunction with the rationalist-skeptical stance. The caveat for both authors, of course, is that just because a paranoid theory explains some phenomenon of discourse, it very strongly "wants" to attempt to explain all phenomena, but this "want" should be resisted. Both authors recognize that it is the strong nature of these theories—their tendency to account for every situational phenomenon—that is most problematic to discourse. Booth argues that this sequestered distinction of value and knowledge is, "only a half-truth, useful in some inquiries, entirely misleading in others"

(14). In other words, such ways of knowing may not be the best-suited for all situations. Similarly for Sedgwick, paranoid strategies "represent *a* way, among other ways, of seeking, finding and organizing knowledge. Paranoia knows some things well and others poorly" (130).

It is this strong and exclusive nature of rationalist epistemology that is most often criticized in critiques of the paranoid stances. Peter Elbow, whose "believing game" predates Booth's "rhetoric of assent" by about a year, has argued that the benefits of a "believing stance" can complement the critical mode of thinking (what Elbow calls the "doubting game") rather than contradict it. For Elbow, assuming a reparative stance—trying to see an argument as those who champion it—can point to the merit within an argument that might initially sound "wrong," just as assuming the paranoid mode encourages us to poke at and uncover flaws in an argument that might sound "right". For Elbow, this sort of antipodal "binary thinking", which he traces in a long line—from Hegelian dialectical thinking and further back to the Socratic method—is a more whole and incisive method of inquiry than just its critical half ("The Uses of Binary Thinking" 51-53). For both Elbow and Booth unbridled skepticism is as unsavory as unbridled dogmatism (and as Booth's title *Modern Dogma* suggests, their very absoluteness makes them quite similar). Elbow writes in a 2005 symposium with Booth, "We're both trying to avoid the same two dangers: dogmatism and skepticism…Booth and I agree in our analysis of these two root dangers to the intellectual enterprise ("Symposium" 389). It is not necessarily the skeptical mode itself that these scholars rail against, rather it is the *prominence* of this mode to the exclusion of others, that is to say its strong nature, that is most threatening for intellectual discourse.

What does this mean for Science Communication?

For our purposes, though, the heart of the matter is the communicative impasses that positivist epistemologies create, not necessarily between intellectuals, but especially between expert and non-expert populations. I want to explore the particularly valuable implications of legitimating nonrational proofs, a move that Science Communication has begun to make as it has weakened.

One of the primary goals of scientific literacy—as the name suggests—is to create a public that accepts the rational proofs that science itself exclusively accepts. Operating as it does on an absolute split between rational proofs and nonrational proofs, however, this framework is largely ineffective in convincing the public because it offers them only one avenue to knowing. Offering exclusively rational proofs to the public can be *unhelpful* to understanding because an acceptance of such an absolute proof is unfamiliar to the untrained non-expert. Similarly the empiricism related to rigorous scientific proofs is *unavailable* to the public, defined, as they are as, non-practicing.

Rational Proofs May Be Unhelpful for Non-Scientific Audiences

Perhaps one of the most persistent, familiar and yet illuminating concepts from the tradition of rhetoric is the idea of the *pisteis*. The very division of these three proofs can be problematic in that it encourages us to consider them as isolated, both in their definitions (there is no emotion in a logical appeal, or no credibility involved in a logical appeal) and in their use within arguments (his argument was purely logical). All discourses, to some degree, rely on all three *pisteis*, and of course the three are largely inoperable without the other. An appeal to the speaker's credibility, for example, will often rely on trust, clearly intertwining *ethos* and *pathos*. So, too, might an appeal to an audience's sense of logic be intertwined with an appeal to both their pride (*pathos)* in themselves as logical thinkers, and with the rhetor's own credibility (*ethos*) as a rationalist. Nevertheless, noting the interrelatedness of the three, and their presence in each discursive situation does not necessarily bar us from pointing out where certain proofs might be more heavily relied upon than others within models of Science Communication.

Science Communication, in its early stages, largely relied on rational proofs. *Logos* is clearly the proof most valued within scientific discourse. The very disinterested, logical, and empirical stance that science has assumed is responsible for both its many breakthroughs, especially in the physical world, and its status as arguably the most authoritative method of inquiry. It seems natural, then, that these values—foundational, as they are to Scientific Communication (peer to peer)—would imbue the early stages of Science Communication (scientist to non-scientist).

However, these rigorous scientific values, these largely logical ways of knowing, were successful for scientists because an audience of similarly-trained scientists could identify and accept formal logic and rationality as valid. However, these proofs inherent to the scientific endeavor were not established as broadly among non-scientific publics. One goal of early communication models then is not simply to argue logically, but to instill the values and knowledge of the scientific endeavor in the non-scientific public so that they might recognize, and more importantly *receive* the heavily *logos*-laden argument. We can see this goal articulated at least as early as 1934 in Dewey' "scientific attitude." This expectation of the public has continued, more or less unadulterated into the *scientific literacy* paradigm. As recently as 2011, Jon D. Miller has argued that it is imperative for all people to be "biologically literate," that is to "to understand the basic conceptual constructs of the life sciences, such as the nature of a cell, the function of DNA and the development of life over billions of years through natural selection" ("To Improve" 21). Miller defines the acceptable level of literacy, as he has for decades, as a "level at which the individual can grasp the full meaning of a biomedical news story in the *New York Times* Science Times in the US, *Science & Vie* in France, or similar publications elsewhere" ("To Improve" 21). In other words, the *literacy* paradigm holds that the public should value and be fluent in the process of science to the extent that they can rationally comprehend scientific processes and conclusions with as little deviation from their articulation within the scientific community as possible. The focus of early Science Communication models is to create an audience that will be persuaded by the *logos* of science. Yet, David Tietge has pointed to this inability to deemphasize *logos* in arguments aimed at a lay public as one of the biggest reasons that science fails to persuade publics (193-194). The *literacy* paradigm's commitment to pure *logos* as the sole acceptable way of knowing is largely unhelpful to non-expert publics who have remained untrained in its strictures and unable to employ it in decision-making, that is to say, who have remained "scientifically illiterate," for at least five decades ("Scientific Literacy").

Rational Proofs May Be Unavailable for Non-Scientific Audiences

Even more than being unhelpful, the *literacy* paradigm's commitment to empiricism, strictly defined, is wholly *unavailable* to a non-practicing public. In many ways, the skepticism and demand for empirical proof within the scientific process has been established in non-expert publics. As a result of the centuries-long primacy of science, most lay audiences have inherited the trappings of positivism. Philip Eubanks, analyzing the discourse surrounding anthropogenic global warming, one of the most incendiary scientific controversies of our lifetime, writes that "[a]lthough skeptics' attacks on climate science in general…have taken many forms, what I want to point out here is this: The attacks have never included a challenge to the scientific method itself. Rather, skeptics have explicitly appealed to it" (27). In many cases, the values and methods of science have shaped the arguments of those who oppose its long-held verities. For example, an oft-cited criticism of the theory of evolution is that there is insufficient evidence in fossil records. Evolution skeptics then, do not discount the theory for being empirical, *but for not being empirical enough*. A lay non-expert can appeal to the skepticism of empiricism as a valid way of knowing, can embrace his own version of reason. Yet, without say uncovering a "missing link" fossil himself, the empirical evidence is and will always be unavailable to him. (This is clearly a distortion and misunderstanding of the theory of evolution, as well as a distorted understanding of scientific consensus. Ceccarelli has noted this tactic as a "manufactured scientific controversy." This anecdote supports the notion that ration is often employed to defend notions or beliefs that are pre-formed by other processes, rather than as a means to arrive at such a belief).

Booth reminds us that positivist ways of knowing—which necessarily exclude trust—can be "totally misleading when applied indiscriminately to the whole of life" (40). Booth, of course, was concerned with debilitating skepticism among academics, but there is similarly debilitating skepticism among non-expert publics. What, after all, is the difference between critical skepticism and science denialism? Is denialism not the very skepticism that science has championed for centuries turned against it? In many ways, the science denier is the very paragon of rational skepticism. The empirical, first-hand, and positivist ways of knowing that are (arguably) available for the scientific expert, are not available for the denier. He cannot "know," say, that global warming is a reality, in any purely rational way. He is completely reliant upon other ways of knowing, most obviously upon trust—in the motives, objectivity and explanatory power of science. And entangled within that trust are values.

At the heart of this expert to non-expert communicative impasse is the same matter that Sedgwick, Booth, and Elbow have identified within intellectualism: the strong and rationalist theory of knowledge applied to all ways of knowing. If one can only "know" through pure cognition, reason and empiricism while other proofs—trust, faith, value, emotion, affect—are to be dismissed, one can know very little. I'm reminded of Alan Gross's critique of the deficit model: "most of us are ignorant of most matters" (8). For Gross, it is unreasonable to ask the public to know all of what science knows if "knowing" is a strictly rational and empirical process that excludes emotion, framing, and especially trust. Indeed, it could be argued that it is impossible even for the most accomplished scientist to "know" anything more than a few areas of expertise if we exclude the nonrational proof of trust—in the scientific process, in the faithfulness to experimental conditions, and in the objectivity of the publishing process of scientific papers.

The insistence on the rational proof has been a damaging framework for Science Communication. Science Communication has been unable to instill any significant number of the population with the rigor to be as heavily rational as science itself, and even if it could, purely empirical ways of knowing would be wholly unavailable to non-practicing scientists. To yearn for the public to be purely rational is a poorly chosen goal as it excludes the avenues that *are* available for lay publics. For science communicators, much of their audience, as Brian Wynne has argued, "understand" science in various emotional, *ethical* and linguistically-framed ways. Furthermore, as one of the explicit goals in *public understanding of science* is "better" democratic decisions, its insistence on rational proofs—and on educating a public that can accept them—is clearly intertwined with the assumption that deliberation, decision-making, and belief-formation is primarily rational, an assumption that we have seen is inaccurate (Kahan et al.; "Why It Matters"; Nyhan et al.; Stoknes). In the following section, I argue that Science Communication's continued allowance for nonrational proofs can make it wholly more persuasive.

Science Communication Has Moved Toward Accepting Other Proofs

In one sense, the history of Science Communication can be grossly characterized as a move away from *logos* toward *ethos* and *pathos.* Here, however it is important to remember the dangers of taking each *pistis* in isolation. As Tietge has pointed out, in scientific communication (peer to peer) one's authority and credibility (*ethos*) is inseparable from his or her ability to persuade within the rational confines of scientific argumentation (*logos*). As a result (and as Tietge would argue, a mistake) the deficit model assumes a similarly-configured relationship between *ethos* and *logos* in non-expert contexts. The rhetor within the deficit model—whose goal is to create an audience receptive to *logos*—necessarily leans on his own *logos*-derived *ethos.* Therein lies a major flaw in the deficit model: it leans upon on an *ethos* that is only validated by association with other experts, or worse, it appeals to the very sense of *logos* of which it recognizes that its audience is deficient.

In order to make stronger *ethical* appeals, science communicators needs to continue to find ways to attach their credibility not just to objectivity and expertise, which are necessarily unavailable to non-expert publics, but also to the values and lay expertise of their target publics. More rhetorically sensitive understandings of Science Communication have noted the complicated role of the *ethical* proof for certain publics. As Tietge has shown, a scientist's *ethical* appeal may fail before a lay audience because it derives its value from logical, expert proofs unavailable or unimportant to a public audience. (Certainly, for some particularly entrenched publics, the more authority a scientist has earned within an "elite" scientific context, the less authority he carries before that group.) Brian Wynne writes that embedding the understanding of science within the *ethical* proof, and then embedding the *ethical* proof within the social realm is "not one, but two steps beyond the cognitivist approach" ("Misunderstood" 282). Wynne puts it nicely; he writes, "the best explanatory concepts for understanding public responses to scientific knowledge and advice are not trust and credibility *per se,* but the social relationships, networks and identities from which these are derived" (282). Trust, of course, is entangled within a social web of identity and value. Just as Tietge has argued that *ethos* is dependent upon *logos* within the academy, Wynne argues that *ethos* is dependent upon *pathos* in certain publics, that it is absurd to theorize about trust and credibility in the context of lay audience without acknowledging the social, and ultimately affective, elements from which credibility is successfully (or unsuccessfully) achieved.

Within the academy, Booth, Sedgwick, and Elbow ask scholars and students to suspend their deeply-ingrained skepticism in certain situations and toward certain ends. They ask their readers to weaken their dominant critical lens. Booth asks his readers what would happen if they reversed the motivist formula, and cultivated a "benign acceptance" as their modus operandi (40). Booth's hope is that, in relinquishing the empirical and rationalist mode, even for just twenty-four hours, his readers might see the value, in some situations, of other proofs, of "good reasons" to change one's mind. Similarly, I see Brian Wynne's "Misunderstood Misunderstanding" as posing a similar question, directed not necessarily at scholars and students regarding their ways of knowing, but at science communicators regarding the acceptable methods of creating meaning for, and in tandem with, public audiences. What if, Wynne asks science communicators, we also suspended the singular, rational-authoritative way of knowing, in this very specific situation (his case study of Cumbrian sheep farmers in the wake of Chernobyl) and also accepted the local lay knowledge as a valid way of knowing? (Wynne's case study, if nothing else, shows the spectacular failure that can occur when strong positivist ways of knowing are forced upon a public.) For science communicators, this emphasis on, and acceptance of lay knowledge—whether it be local, emotional or *ethical* ways of knowing—is the antidote to the impasse that can occur when science communicators refuse to budge from rationalist, positivist ways of knowing, and non-expert publics refuse—or are necessarily barred from—those same ways of knowing.

This weakening in its acceptance of proofs other than the rational does not mean that science communicators must necessarily privilege nonrational proofs above their "native" logical proofs. Making room for public nonrational proofs *does* mean that that it is necessary to engage in both epistemologies at once, to recognize the types of knowledge that rigidly logical thinking yields, and simultaneously explore the kinds of knowledge that social, *ethical* and values-based thinking can yield, as both are suited to certain situations. Furthermore, this move toward a weaker theory requires Science Communication to know its distinct public audiences well, making a strong case for the rhetorical case study. This weakening of Science Communication theory has rendered it both more malleable and multiple, more contingent and contextual, than the stronger deficit model. Weak theory, by definition, is only able to explain a smaller range of phenomena—weak theory sometimes borders on little more than a description of the situations which it theorizes (Sedgwick)—and it requires the complicated and messy tasks of holding multiple paradigms of knowing and meaning. The true value of the weaker Science Communication model, though, is its ability repair a broken discourse between experts and non-expert publics by acknowledging and engaging the nonrational ways of knowing that are available for non-expert audiences as in Gross's contextual model, Wynne's lay expertise model, and the current iteration of such audience awareness, the public engagement model. The current public engagement with science paradigm does the most to acknowledge the multiple, nonrational ways that publics may understand science. This is not to say that it has achieved all of its goals, nor that it cannot be improved upon.

Public Deliberation and Affect

If we are to accept that non-expert publics may understand science in nonrational ways, and as a result, form beliefs, make decisions, and vote in similarly nonrational ways, it certainly seems worth the while of Science Communication to continue attending to the comprehensive communicative elements of *pathos*, affect, *ethos*, framing, and metaphor. The emerging fields of affect theory and critical affect studies provide productive ways to think about the social relationships and identities—as mediated by affect or emotion—among lay audiences that Wynne has identified as crucial for their understanding of science. He writes "'understanding' or knowledge … is a function of social solidarity, mediated by the relational elements of trust, dependency, and social identity; constructing that 'intellectual' understanding should be seen as a process of social-identity construction" ("Misunderstood" 283). Wynne conceives "understanding" as a result of many ways of knowing. Successful Science Communication must acknowledge and engage these complicated ways—far beyond sole rationality—that lay publics know and understand science in order to become more wholly communicative, more wholly convincing, and more wholly *persuasive.*

To some degree, the public engagement model has accommodated the multiple ways that lay publics know and understand science. Alan Irwin reflects that the point of many of his arguments in the 1990's was "to move to 'taking values seriously'" ("Deficit to Democracy" 73), and certainly the public engagement model has recognized the related and similarly complicated ways that public trust does not always positively correspond with scientific authority. But after two decades of public engagement, proponents of the model have expressed some doubt and disappointment toward its outcomes. “Those of us who have been involved in advocating, evaluating, and conducting public engagement practice could be accused of overpromising” (Stilgoe, et al. 4). Brian Wynne, twenty years after “Misunderstood Misunderstanding,” is still disappointed in the movement’s inability to see science the way lay audiences might. He writes, “It remains puzzling to me, how we can aim seriously to make sense of publics in responding to ‘science,’ if we neglect to examine what it is that those publics experience…” (“Further Disorientation” 60). Wynne argues that the paradigm, while it does focus on publics, has failed to sufficiently envision “what is meant by ‘science’ in its variable public forms, including discourses” (“Further Disorientation” 60). Wynne’s repeated call for attention to the public discourse that “creates” science is particularly insightful. Public engagement has succeeded in including science communicators in the public conversations by which audiences form their understandings of science. However, as Stilgoe et al. note, this “dialogue continues to reflect deficit-like assumptions,” (5) the most glaring of which, for me, is the assumption that public conversation is a rational and deliberative process.

Jenny Edbauer Rice argues that critical affect studies can helpfully show how previous conceptions of the public sphere as solely dialectic and deliberative space might be overstated. Affect theory holds that affect and emotion, far from private, internalized phenomena, are inherently relational, that they exist and interact between bodies, words, and images. Rice argues that public discourse does far more than its “official” role of exchanging and responding to ideas in a slow march toward understanding. For Rice, "public participants get something from deliberation *beyond* deliberation" (211). In other words, the act of deliberating is an identity-shaping end in itself, separate from deliberation. This view in itself is not particularly groundbreaking; it does however offer a response to Wynne's critique. Affect theory can offer Science Communication the lens and language it currently lacks to analyze certain public rhetorics in order to discover how they function to create the identity of social groups, how "the talk itself holds together a public even when that talk does not have direct bearing on the common affairs being deliberated" (Rice 211). In this conception of public understanding, the false divide between logic and values, rationality and emotion are broken down and thoughts, opinions, stances, and beliefs are formed in no clear deliberative interaction with science communicators, but rather, are formed somewhere within the messier process of an individual identifying with, or rejecting, a social group—a process that is necessarily affective and emotional. Furthermore, the proliferation of digital outlets has made certain public rhetorics more robust, with entire social groups or sub-groups able to mediate understanding of a phenomena—including the scientific—without any exchange with science communicators.

Rice reviews a case study that affect scholar Sarah Ahmed conducted on the hate-speech rhetoric on the website of the white power, anti-immigration group the Aryan Nation. Reviewing Ahmed's study, Rice writes that:

> the public rhetoric surrounding immigration issues was not necessarily born from a single exigence, or even from subsequent conversations about illegal immigration. Instead of framing the public through its deliberative conversations, anti-immigration rhetoric seems to be an outgrowth of many prior articulations. In

Ahmed's terms, anti-immigration public rhetoric is perhaps less *conversational* and *deliberative* than it is *additive* and *associational*" (210) (emphasis added).

To understand what Rice and Ahmed mean by associational rather than deliberative rhetorics, a brief overview of affect theory and critical affect studies, as well as a working definition of affect, will be helpful.

What is Affect?

Affect is tricky word. Even within the scholarship of affect and emotion studies, some scholars define it more poetically than others, some more pragmatically. For the sake of simplicity we can identify two lineages in affect theory. One traces Baruch Spinoza's works through the works of Felix Guattari, and into the works of Brian Massumi today (Seigworth and Gregg 5-6). Spinoza has defined this strain's definition thusly, "by affect, I understand affections of the body by which the body's power of acting is increased or diminished, aided or restrained, and at the same time, the ideas of these affections" (qtd. in Marshall 58). (Note that Spinoza's conception of bodies acting and being acted upon directly opposes the Cartesian mind/body split.) This conception of affect as a force between bodies can be traced through the works of Guattari and Massumi down to the definition that appears in the recently published *Affect Theory Reader.* In their introduction, Gregory Seigworth and Melissa Gregg write:

> Affect arises in the midst of in-between-ness: in the capacities to act and be acted upon. Affect is an impingement or extrusion of a momentary or sometimes more sustained state of relations as well as the passages (and the duration of passage) of forces or intensities. That is, affect is found in those intensities that pass body to

body (human, non-human, part-body and otherwise), in those resonances that circulate about, between and sometimes stick to bodies and worlds, and in the very passages or variations between these intensities and resonances themselves. (1)

As the title of their introduction suggest, Seigworth and Gregg consider affect to be the minute, quick, often-unnoticed "shimmers" of nonrational force between people, and bodies, ideas and objects. They describe affect as "forces of encounter", but point out the subtlety possible within these flashes; they write that "the term 'force', however, can be a bit of a misnomer, since affect need not be especially forceful… In fact, it is quite likely that affect more often transpires within and across the subtlest of shuttling intensities: all the miniscule events of the unnoticed. The ordinary and its extra—" (2). Conceived this way, affect is often described as an invisible, almost mystical force that gathers on and passes between people and things, impactful and compelling, yet often unnoticed.

Another lineage of affect studies defines it more scientifically. This lineage can be traced back to Darwin's *The Expression of the Emotions in Man and Animals* and down through the experiments of Duchenne De Boulogne, Sigmund Freud, Silvan Tomkins, and Paul Ekman (Jensen). This strain places affect as a neurological phenomena, although one that may extend beyond whatever physicality the synapse of the brain may be said to have. Looking at affect as a neurological phenomenon, scholars in this lineage often look to the human face, skin, and body as the main site of affect (cf. Paul Ekman's work on "Facial Action Coding System"). Silvan Tomkins, then, in this vector of affect studies puts forth a taxonomy that will be helpful for our purposes, especially in distinguishing between the notions of affect, feeling, and emotion. Tomkins defines affect as "the innate, biological response to the increasing, decreasing, or persistent intensity of neural firing [which] results in a particular feeling, facial and body display, and skin changes" ("Tomkins Institute"). As a psychologist, Tomkins is interested in the neurobiology of affect, as well as its role in human evolution. Going further, Tomkins defines "feeling" as the *awareness* of affect—which of course implies that affect can and does, at times, go unregistered by the conscious mind. Lastly for our purposes, Tomkins defines "emotion" as an awareness of affect (feeling) combined with a memory of previous similar feelings ("Tomkins Institute").

These definitions are not universal across all affect scholarship, nor do they go uncontested, but I think they are helpful, especially in their designation of *affect* as the sometimes subtle, sometimes unregistered forces, and alternately, their designation of *feelings* and *emotions* as awareness of the accumulated affect. In less poetic terms than many scholars have put it, we can think of affect as the building blocks of feeling or emotion, blocks, however, that need not be built-up or accumulated to be impactful.

These two lineages of affect scholarship share marked similarities. The neural firings of Tomkins certainly share some similarities with Seigworth and Gregg's "shimmers." Furthermore, the importance of bodies as sites of affect are pronounced in both vectors. The most important similarities for our purposes, though, is the necessarily social nature of affect as the interplay of shimmers (in one camp) or stimuli (in another) between people and objects, images and words, a sociality that is very much intertwined with the nonrational proofs—of *ethos* (as relational trust), *pathos*, framing, and metaphor—by which non-expert publics understand science. Perhaps, even more than being intertwined with these proofs, affect—defined as a subtle, yet impactful and sometimes unnoticed force—can be seen as directly influencing an audience's acceptance or refusal of these proofs. Clearly the affect of a piece of writing—the connotations of a few words, perhaps the author's likeness to someone you like (or dislike), or even the typeface of the piece—could impact the *ethos* or *pathos* of the writing in a manner that could not be called logical, cognizant, or self-aware, yet a manner that is impactful nonetheless.

Affect in Public

Pointing to this relational nature of affect, Ahmed describes "affective economies" by which affect glimmers between people and objects, words and arguments. In her conception, affect (and emotion) are less experienced personally and internally, and more exchanged between groups. For Ahmed, affect "sticks" to words and images, and this "stickiness" can work to draw words and ideas together—thereby creating meaning—in a "metonymic slide," or in simpler words, by association. For example, analyzing the Aryan Nation's website, Ahmed points out that it is solely the emotion hate that binds together the (imagined) immigrant and the (imagined) rapist, conflating the two and making an implicit argument, however nonrational, that all immigrants are rapists (119). This is what Rice means when she describes public rhetorics as "less conversational and deliberative than [they are] additive and associational" (210). Furthermore, Ahmed's notion of affective "stickiness" lends itself well to George Lakoff and Mark Johnson's arguments that humans understand even the most familiar concepts—like love, or time, or good or bad— through the necessarily relational modes of framework and metaphor (Lakoff and Johnson). Just as a metaphor "sticks" two things together by highlighting their similarities, or as a framework "sticks" more than a few ideas together, affect can "stick" objects, ideas, bodies and people together in similarly compelling ways.

For Ahmed, rather than being experienced personally and psychologically, emotions circulate economically, and in doing so "work in concrete and particular ways" (119). "In such affective economies, emotions *do things*, and they align individuals with communities…through the very intensity of their attachments" (119). Far from being something that one experiences privately, or something that one categorically acknowledges and pushes aside when deciding "what to think," affect, feelings, and emotions can create meaning and mediate understanding. As Ahmed writes, they *do things*.

For Rice, this reconfiguration of how belief and ideology circulate within certain public rhetorics has possible important applications for how rhetors might counter discourse emerging from these publics. "Theories of affect suggest a process of disarticulation, or an unsticking of those figures that seem to be glued together, followed by a rearticulation, or a new way of linking together images and representations" (Rice 210). Rice recalls how, in order to combat popular rhetorics about AIDS and its associations with death and immorality, magazines like *Pos* and *HIV Plus* began to articulate AIDS and HIV with life by featuring colorful smiling, images of happy men and women of all sexual orientations, ages, and races. Similarly, she cites a 2006 campaign to rearticulate AIDS with a kind of normalcy. The campaign featured "posters with attractive young people surrounded by the words: 'Does HIV look like me?' The answer, of course, involves a disarticulation of prior associations of HIV with death, abnormality, and otherness" (Rice 210). Could similar tactics by science communicators work to disarticulate the prior associations that certain publics may hold toward climate science, GE foods, or community fluoridation programs? In the next section, I study the case of Portland, Oregon's vote to remain the largest unfluoridated metropolis in the country. In this analysis I identify the praxis of the Science Communication theories discussed in the previous chapter, their successes and their failures, and the "associational" elements within the nonrational rhetorics circulating within the public. Lastly, I hope to suggest a way that science communicators might have done better to identify the public's prior articulations toward fluoridation, conceive of those articulations as affective, and worked more effectively—which is to say nonrationally—toward disarticulating them.

Chapter 3. Keep Fluoride Weird: A Case Study

On September 12, 2012, Portland, Oregon's City Council unanimously voted to pass Ordinance 185612 directing the Portland Water Bureau to "devise and implement a program to fluoridate the City of Portland's public drinking water supply…" ("2013 Special Election"). The very same day, dissenting petitioners filed for a prospective public referendum of the ordinance. By October, the petitioners delivered 33,015 valid signatures to the City Auditor, by December the City Council passed a resolution to place the decision to fluoridate—now known as Measure 26-151—on a special election ballot, and by May of the next year, the measure was defeated by a public vote of 61-39 (2013 Referendum).

In all instances, the failure of Measure 26-151 in Portland was a failure of Science Communication, and a particularly large one; Portland remains the largest city in the nation with an unfluoridated water supply. The consensus among medical organizations is that community fluoridation programs are safe and effective at fighting tooth decay. The Center for Disease Control (CDC) has listed fluoridation of community drinking water as one of the "Ten Great Public Health Achievements in the 20th Century" and designates it as a "major factor responsible for the decline in dental caries (tooth decay) during the second half of the 20th century" ("Achievements"). Healthy Kids, Healthy Portland—the organization backing Measure 26-151—enjoyed support from the CDC, the American Dental Association (ADA), the Oregon Dental Association, the American Academy of Pediatrics, and most regional hospital systems, universities, and dental associations. Community water fluoridation programs, in general, are also endorsed by organizations as authoritative as the World Health Organization (WHO) and the

American Medical Association (AMA). The earliest version of the Healthy Kids, Healthy Portland website boasts "There is 100% agreement among major health organizations that fluoridation is the right thing to do." Although this claim suggests a simplified process of scientific consensus—and is perhaps problematically positivist—it is pretty close to accurate. Yet, despite the endorsements of some of America's leading medical and dental associations, and despite raising $850,000 in contributions as opposed to the opposition's $270,000, Measure 26-151 was roundly rejected by Portland voters (2013 Referendum).

In this chapter I use the defeat of Portland's fluoridation measure as a case study to examine how those acting as science communicators—Healthy Kids Healthy Portland, city officials, outspoken citizens, local dentists and doctors, an others—failed, and how their strong, and largely rationalist approaches overlooked Portland's "weird" affective domain, its anti-establishment values, and its environmental commitment to the preservation of its waterways. Furthermore, this chapter looks at the anti-fluoride arguments—those provided by the anti-fluoride group Clean Water Portland, among others—through Ahmed's lens of "affective economies" to see how a large portion of Portlanders came to understand the issue by way of these aforementioned values, and how the grass-roots nature of these arguments, created by Portlanders for Portlanders, represent a necessarily weak theory of communication. Lastly, I propose ways that community fluoridation program proponents might have utilized a weaker model themselves, one that acknowledges the multiple ways that publics understand science—as formulated in the previous chapter—to have achieved a different result. Furthermore, I think this case is particularly useful in dispelling the inaccurate notion that public dismissal of scientific consensus is a partisan phenomenon. Although the anti-science issues that have often received the most attention—global warming and evolution—have become partisan issues in which science denial or misunderstanding falls to right-leaning voters, this case illustrates that left-leaning voters are equally guilty—if not more so—of (mis)understanding scientific consensus based on their values. It is worth revisiting a fact that I pointed out in my introduction: it is not in the issues of evolution and global warming, in fact, in which we see the widest divide between the public and scientists, but rather the largest disagreement is over the safety of genetically-modified food, a traditionally left-wing cause.

Healthy Kids Healthy Portland

The arguments provided by Healthy Kids, Healthy Portland (HKHP) lean heavily on the *logos*-derived *ethos* of medical organizations. The first line of one of these arguments, supplied by KJ Lewis of HKHP, on the first page of in-favor arguments in Multnomah County's voter's pamphlet reads "Water fluoridation has overwhelming support from health organizations we trust" ("Pamphlet" M-50), followed by statements from the CDC, ADA, WHO, American Association for the Advancement of Science, and others. The "we" in this sentence, though, is much more inclusive of proponents of the measure, and largely exclusive to the most crucial audience. Those who are suspicious of fluoridation, of course, are suspicious of the very groups cited. Lewis's "we" might trust these groups, but much of his or her audience does not, which renders this argument at best ineffective and alienating, and at worst, reifying of anti-science attitudes. This alienation is similar to Reifler and Nyhan's work on the "backfire effect," the phenomena that "when presented with information that contradicts their closely-held beliefs, people will become *more* convinced, not less, that they're in the right" (Romm). After the defeat of 26-151, Bill Lunch, a political science professor at Oregon State University told The Oregonian, "There's a libertarian component to Oregon politics … a kind of opposition to what the establishment might want. Those who have more money…" and I would add scientific credibility, "despite the kind of popular presumptions in this regard, don't always win elections" (qtd. in Kost "For the Fourth Time"). It is clear how HKHP's *ethical* appeal to scientific credibility via national and global health establishments might fail before an audience with such a noted anti-establishment streak. One of the fundamental misunderstandings of the campaign, it seems, was a misunderstanding of audience. The appeal of HKHP to centralized scientific consensus and to large federal organizations is an example of a strong theory of communication assumption (that that which has persuaded other publics will persuade this public) and a rationalist assumption (that in light of scientific reason, publics deliberate, reason and vote accordingly) breaking down when applied to a self-proclaimed "weird" city.

Oregon supplies its voters with a voters' pamphlet that includes paid arguments in favor of and in opposition to candidates and measures on upcoming ballots. Due the contentious nature of 26-151, the pamphlet that came out in 2013 was the thickest in the history of Multnomah County (Foden-Vencil); the section concerning Measure 26-151 included sixty-three arguments in more than thirty pages, making it a rich resource for analysis, both the failure of the "in favor" arguments and the success of the opposition. The voters' pamphlet is interesting because anyone with a few hundred dollars can contribute arguments. Some of its arguments fall under the umbrage of Science

Communication, defined, as it as, as expert or authority to non-expert. Other arguments, contributed by non-experts for non-experts, give valuable insight into Wynne's "social relationships, networks and identities from which [trust and credibility] are derived" ("Misunderstood" 282).

Pro-fluoride arguments in the pamphlet that lean heavily on *logos*-derived *ethos* are abundant. Many are supplied by members of HKHP. Many more are supplied by dentists, orthodontists, local dental associations, and hospitals. It is not difficult to see how an audience already suspicious of fluoride might be suspicious of these establishment institutions as well. For an anti-establishment audience, the more traditionally authoritative a source, the more suspicious. Then-governor John Kitzhaber argues in the pamphlet that he is voting yes both as a physician *and* governor ("Pamphlet" M-52). For an anti-establishment voter who is already suspicious of establishment medicine and local government (there were many accusations that City Council tried to rush the fluoridation ordinance through behind closed doors), this is a doubly ill-fated argument. Yet these *logos*-derived *ethical* proofs are one of the primary arguments for those in favor of 26-151. These relentless appeals to scientific authority are symptomatic of Science Communication's fetishization of rational proofs discussed in the previous chapters. It is a near-textbook showcase of the assumptions of the *scientific literacy* paradigm, the assumption that a linear, logical explanation of community water fluoridation will change the public's deficit of knowledge, and that such a knowledge, when attainted, will dictate a rational decision about policy. The in-favor arguments are peppered with *ethical* proofs aimed at fostering trust in these medical, governmental, and scientific institutions, but, just as in Wynne's case study, proponents failed to account for the degree to which trust is couched within social identity and value, or perhaps more accurately, misunderstood the values and identify of their audience. The result is a slew of *ethos* appeals bolstered by *logos*, but poorly connected to the shared *pathos* of its audience.

To say that HKHP's message was poorly connected to the shared *pathos* of its audience is not to say that there were no *pathetic* appeals at all. After all, the very title of Healthy Kids, Healthy Portland is a pathetic proof, as are the visual choices made by the organization (see figure 2). Similarly, in the voters' guide, frequent appeals are made to improve the health of children. Five of the arguments point to the "dental health crisis" among Portland's children. Kitzhaber—aside from voting yes as Governor, and as a doctor—also writes that he is voting yes "as a parent" (M-52). This instance proves that the science communicators in this case were not necessarily averse to using values-based proofs, but it does, however, show a misunderstanding of the place of those values among voters, especially considering that an unusual number of Portland households are childless.

Figure 2. HKHP's graphic used on their website; HealthyKidsHealthyPortland.org; captured by the Wayback Machine 30 March, 2013; Web; 22 June 2016.

Keep Portland Weird

In 2010, at the time of the last census, only 30% of Oregon households were home to children 17 or younger, "the lowest rate among all but seven states." Yet, while an aging population contributes to the state's high rate of childless-households, Portland itself is "bulging with residents of prime child-rearing age" (Hannah-Jones). Despite having a higher percent of residents between the ages of 25-44 than any other community in the state, the rate of households with children 17 and younger in Portland is even lower than the state's already low average. Only one in four Portland households includes a child below the age of 18 (Hannah-Jones). Charles Rynerson, a demographer at Portland State University says, "Young people come here not to raise families but because the urban core is a place with close proximity to jobs, nightlife, good restaurants and having fun. Many people who come here either haven't started a family here yet or they will somewhere else" (qtd. Hannah-Jones). The *pathos* appeal to the health of children would have been a safe bet for a more demographically average voting bloc, but Portland's "weird" demographics (and values) requires a weaker communicative approach, better tailored to its audience, an approach, in fact, that worked exceedingly well for opponents of 26-151.

Portland's "keep it weird" ethos cannot be overlooked. Referendum petitioners opposed to 26-151, for example, were able to gather the requisite 20,000 signatures so quickly thanks, in part, to a "Public Water/Public Vote" music festival headlined by popular Portland band The Dandy Warhols (Millman)[1]. Clean Water Portland, the group organized to oppose 26-151, was much more successful in its appeals to the unique alternative values of the voters of Portland. This was perhaps out of necessity. Opponents were either unable or unwilling to lean on the pedigree of medical institutions that supporters did. In any regard, the opposition's weaker, more individualized appeal to the values of its audience obviously faired well.

Just as with Healthy Kids, Healthy Portland, the opposition organization's name, Clean Water Portland, represents a distillation of the *pathetic* appeals within its arguments. The opposition arguments in the voters' pamphlet—which run about twice as long as the in-favor arguments—are less likely to be furnished my medical professionals or governmental officials (although there *are* a few Ph.D.'s, a former city commissioner, some dentists, even a doctor of veterinarian medicine). Instead, the authorities that the opposition produced were largely alternative medicine practitioners (Oregon Association of Acupuncture and Social Medicine), consumer advocates (Food and Water Watch, Organic Consumers Association, Ralph Nader) and environmental organizations (a local Sierra Club chapter, Willamette Riverkeepers).

A large number of contributors, however, were unaffiliated citizens, allowing us insight into how affect circulates within this public, creating associational meaning. In Sarah Ahmed's notion of affective economies, "emotions *do things*, and they align individuals with communities…through the very intensity of their attachments" (119). Ahmed's conception of emotion as necessarily social gives insight into its role in, not just a motivator itself, but as a factor in the "social relationships, networks and identities" from which Wynne argues trust and credibility must arise (282). Furthermore, Ahmed's model allows us to "consider how emotions work, in concrete and particular ways, to mediate the relationship between psychic and the social, and between the individual and the collective" (119), and how this emotional process of social alignment with social groups affects scientific understanding, or in this case misunderstanding.

The most prominent instance of this is the opposition's use of the phrase "fluoridation chemicals." By my count, the phrase appears thirty-nine times in the opposition section of the voters' pamphlet, or about twice on every page. It is also featured prominently on the widely distributed yard signs manufactured by Clean Water Portland. (See Figure 3).

Figure 3. Yard signs common around Portland, OR in the months previous to the special election. From Jon Coney and Bren Wojahn of *The Oregonian*; 3 May 2013; Web; 22 June 2016

Proponents of 26-151 prefer to characterize fluoride as a “mineral.” The ADA calls it a “compound.” The denotations of the three words, of course, are quite similar, yet the connotations vary wildly. “Chemical” is a dirty word in a few ways. It denotes artificial production, therefore connoting industrial or pharmaceutical products (or byproducts) perhaps unfit for ingestion. Many opposition arguments, however, do more than to rely on connotation. A fluoride opponent representing the Organic Consumer Association pointed out that citizens would be ingesting “hydrofluorosilicic acid (HFSA),” that was described as “a toxic industrial byproduct from phosphate fertilizer manufacturing” that “contains lead, arsenic, copper and other toxic byproducts of fertilizer production that would be added along with fluoride compounds” (“Pamphlet” M-66). For the registered Portland voter, who is more likely to value organic, local, and small-scale products than the national voter, fluoridation, as described by the opposition, entails the antitheses of all of these qualities. Even the phrase “industrial byproduct from phosphate fertilizer manufacturing” evokes negative affective associations. Of course, fertilizer can be organic, industry can be local, and manufacturing can be small scale, but through affective metonymy, the words achieve a meaning directly opposed to the values of many Portland consumers.

It is perhaps difficult to see the “emotional” in these linguistic choices, especially as Tomkins has defined it as an awareness of affect combined with a memory of previous similar feelings. But, in defining affect as social, the slight twinges of affect in the connotations of “industrial” “chemical” and “byproduct” become pronounced (even if they may, as our definition allows, go unnoticed by those who experience them), and furthermore allow us to see the affect attached to these words is also attached to the social class of capitalists and industrialists.

In addition to the serious value of what Portland's voting demographic puts into its bodies is the even more strongly-held value of what it puts into its water. Portland is particularly proud of its public water supply and its seemingly unmediated journey from the Bull Run watershed near Mt. Hood. The Bull Run watershed, which has been managed since 1892, delivers unfiltered water from the source twenty-six miles east of downtown Portland entirely by gravity, "requiring no fossil fuel consumption to move water from its intake to the main storage reservoir" ("Bull Run"). The Portland Water Bureau boasts the slogan "from forest to faucet!" advertising that it "provides the highest quality water, customer service and stewardship of the critical infrastructure, fiscal and natural resources entrusted to our care" ("About Us"). It is clear that the value of Portland's public water is not just derived from the quality of the water itself, but also the environmental system that provides it. Ninety-six percent of the Bull Run Watershed Management Unit (BRWMU) is federally owned, evoking comparisons to certain other preservationists or conservationists parcels. Intertwined with the purity of the water is the perceived purity of the place itself. The PWB does not just provide "high quality water," but also stewardship of "natural resources entrusted to [their] care" ("About Us").

This closeness between water quality and environmental quality is reflected in opposition arguments to 26-151. Opponents argue that "fluoridation chemicals"—toxic, industrial byproducts that they are—should not be added to the ostensibly pure Bull Run Watershed. The group Food and Water Watch advises voters to vote no in order to "protect the incredible Bull Run" ("Pamphlet" M-71). Greg and Jason Kafoury are a father and son who “grew up fishing in Oregon’s rivers and streams” as well as “drinking Portland’s water”; the pair notes how water everywhere else tastes bad. “When we return home, the first water from the tap reminds up [sic] of how special it is to have the pure water from the Bull Run Preserve as part of our heritage” (“Pamphlet” M-79). In this sentence, we have, by Tomkin’s definition, full-blown emotion—registered and recognized—which works to make meaning “through sticky associations between signs, figures and objects” (Ahmed 120). As this argument makes clear, for some opposition voters, the perceived “risk” of water fluoridation for human consumption is not the primary motivator. For these voters, the ecosystem of the Bull Run Watershed inspires in them their own affective ecosystem. It “sticks” unfluoridated water to physical and emotional goods: the bodily pleasure of taste, the sense of home and heritage, and treasured father-son memories.

The reference to fishing is no passing coincidence. It is a key piece in the identity of the Pacific Northwest—for industry, native, and recreational fisherman alike—and no fish symbolizes the regional ecosystem more than the salmon. An opponent representing the Sierra Club writes that “adding a million pounds of fluoridation chemicals per year to our water creates another toxicity threat to salmon,” adding that “Human health cannot be separated from environmental health” (“Pamphlet” M-66). Framed thusly, a community water fluoridation program in Portland is tantamount to water pollution. The organization Columbia Riverkeeper argued that “what we add to our drinking water, we add to our rivers and salmon.” They add, pleadingly, “At a time when many families continue to rely on the Columbia’s fisheries as an important source of nutrition and employment, we are concerned about a new source of toxic pollution into the Columbia River”

("Pamphlet" M-70). Again, the safety of fluoridated water for humans does not enter the argument. Instead, through an environmental symbol, unflouridated water is disarticulated from the health of humans, and rearticulated to the health of rivers and salmon which, in turn, are tied to sustenance, livelihoods, and families. Celilo Falls tribal elder Linda Meanus likens 26-151 to the completion of The Dalles Dam—which destroyed Celilo Falls and obstructed the salmon run—in 1956. Meanus writes, "I am writing to ask that voters do not add fluoridation chemicals to my water *or the rivers where salmon live*" ("Pamphlet" M-63) (italics added). For Meanus, like many others, the issue is as environmental as it is medical.

This re-framing allowed the opposition to expand its authority on the Measure by changing the issue of the argument from that of medical science—on which very little testimony could be mustered—to that of local environmentalism, an issue that, by definition, privileges local authority and values. This is reminiscent of the "lay expertise" expounded in Wynne's case study, expertise to be ignored at the peril of science communicators. In other ways, the grass-roots nature of the opposition—in which the public is informing Clean Water Portland *as much as* the organization is informing the public—provides an interesting twist on the *science in society* paradigm, and especially on the public engagement with science model. As arguments from the voters' pamphlet made clear, publics will engage with science whether science communicators are present or not. Oddly, the dialogic relationship between Clean Water Portland and voters is an illustrative triumph of the public engagement model in *anti*-science communication.

The opposition arguments showcase the power of a weak theory of communication—even, as no one group or person was consciously enacting such a theory—that knows and acknowledges the various nonrational ways that a specific publics understand medical science. The arguments represent a weak theory in their specificity to the rhetorical situation, as well as their willingness to relinquish scientism. These arguments, I think, would fail miserably outside of the Pacific Northwest, which, strangely, is a testimony to their success within the region. The tailored-to-values characteristic of the opposition argument stand in stark contrast to the tired rationalism within many of the in-favor arguments. It seems that one of the greatest benefits of a weak-theory approach is that if one can appropriately detect the values of a public, one can build an argument that will be proven by the values of its audience, an argument that will convince by the very *pathetic* proof (*pistis*) supplied by its audience. Such arguments are enthymematic, in that a premise of the argument is provided by the audience itself. The "fluoridation chemicals" argument is enthymematic in that allows for a premise to be proved from within (locally), rather than from without (from national organizations).

Keep Fluoride Weird

In this last section, I address how my proposed weak theory of Science Communication—which, intentionality aside, we undeniably see elements of in the success of the opposition's arguments—might have been applied with better result to arguments in favor of 26-151.

We have already addressed the failure of the misdirected values-proofs within the rhetoric of many arguments in favor of 26-151. Another values-proof, however, can be seen in a few of the arguments, and an amplification of that proof might have been more successful. Alongside endorsements from national health organizations, Healthy Kids, Healthy Portland was also endorsed by a number of advocates for under-represented groups and economically-disadvantaged youth. HKHP was endorsed by the African American Health Coalition, Asian Pacific American Network of Oregon, the Latino Network, Philippine American Chamber of Commerce, Urban League of Portland, and the Native American Youth and Family Center (NAYA), among others. As proponents of these groups make clear, one of the biggest advantages of a community water fluoridation program is that it benefits the dental health of everyone, even those who cannot afford dental care. (This is, of course, also one of the reasons that the CDC considers it such a successful public health measure.)

Healthy Kids, Healthy Portland should have done more to emphasize the *community* within a community fluoridation program, the *public* within the public health measure. One in-favor argument authored by Matt Morton of NAYA does particularly well to emphasize the demotic, communitarian aspect of Measure 26-151. "Should every child have healthy teeth?" He asks, "Or just the kids whose families can afford it?" ("Pamphlet" 55). The author then goes on to address the racial and social lines along which tooth decay increases. He urges readers to:

> consider that children from low-income households and communities of color, and especially immigrants and refugees have 2-3 times more dental decay. For a city that values equity and justice, we can no longer turn our backs on the disparities and lifelong health, education and economic consequences. Approving fluoridation will help advance racial and social justice in Portland. (M-55)

The values of racial and social justice, just as Morton rightly intimates, would have been a more successful value to emphasize to Portland voters than the value of "healthy kids" more generally. Despite political scientist Bill Lunch's statement that there is a "libertarian component" to Oregon politics, the values of Portland, Oregon voters are much more complicated. Compared to the demographics of other communities that have recently voted down fluoride measures (Wichita, Kansas and Pinellas County, Florida) Portland has a markedly less fiscally-conservative voting bloc. Anti-fluoride campaigns in Kansas and Florida were funded by conservative groups staunchly committed to economic freedom, groups averse to all public programs, which I think also reflects the personal politics of the voters in those communities (Lefler and Calovich; Millman; Jaquiss; Mesh; "Florida County"). Yet, despite some voters' distrust of large, centralized governmental organizations, many Portlanders value equity and social justice, even pride themselves on it, and are even willing to vote for public programs that support those values. Just months before Measure 26-151 went on the ballot, Portland voters overwhelmingly approved the Portland Arts Tax, a measure that taxes every adult citizen above the poverty line $35 a year, separate from income tax, in order to fund arts and music programs in Portland Public Schools. The Arts Tax passed 62%-38% ("Portland City Arts Tax"). This result shows that Portlanders are not wholesale averse to funding community programs, especially when those programs uphold dear values. Furthermore, the city has shown its values of social, racial and economic equality before. In 2014, the Oregon Alternative Driver Licenses Referendum, which "would have made four-year driver licenses available to those who cannot prove legal presence in the United States" ("Oregon Alternative") received enough signatures to appear on the ballot, although it was defeated. Similarly, the city is acutely aware and critical of the racial and economic injustices of its own gentrification. Currently, Mayor Charlie Hales has ordered police forces to cease removing the dwellings of the city's homeless (to admittedly mixed approval) in an effort to address Portland's housing crisis.

All this is to show that Portland voters value, and even pride themselves on being a city that embodies equity and social justice. A weak theory approach to this rhetorical situation, combined with a *science in society* communicative model, like the public engagement model, would have called science communicators' attention to these values, and emphasized them more, above the value-proof of healthy children, perhaps even above the ostensible credibility of national heath organizations. In this scenario, I imagine many more arguments like Morton's that emphasize that fluoridation is "matter of fairness" ("Pamphlet" M-55), arguments that might circulate and reify phrases like "fluoride is fair," "public vote for public health," or "community fluoride is right for our community,"—arguments that both re-frame the issue, disarticulate fluoride from its previous associations, and effectively re-articulate community water fluoridation programs with social justice, egalitarianism, and community equity. Just as we saw the negative affective connotations at work in opposition arguments, these arguments would allow that a "no" vote could be associated with elitism, classism, and racism. In the affirmative, these positive affective connotations would align community fluoridation programs with the social group in which most Portlanders see themselves. Such an orientation would work to harness the affective value of that particular public to stick community fluoridation programs to what Portlanders love most: Portland.

In the end, I hope to have shown that a weak theory of Science Communication would have listened to the arguments and the values-proofs for fluoridation that already exists among its citizen advocates, and amplified them. The supreme advantage of designing an argument this way is that it is inherently enthymematic, that the proof of at least one premise in the argument (social, racial and economic injustice are issues worth fighting) will be provided by your audience, rendering the argument that much more effective. A weak theory of Science Communication, then, would have recognized that the *ethical* proofs from organizations like the ADA, and CDC are worth something only to those who did not need persuading in the first place, and are anathema to those who do, that perhaps endorsements from local organizations like NAYA and the Coalition of Communities of Color should have topped their website, rather than follow the national and global organizations like an afterthought. Above all, I hope what this case shows is the futility and failure of a blind, stubborn insistence on purely rational thought before an audience to whom that faculty is both unavailable and, on its own, unconvincing.

Note

1. Not all rockers were anti-fluoride. Colin Meloy of the popular band the Decemberists tweeted “How can you hate on the GOP for being creationist science deniers and then go on about how vaccines and fluoridation are poison?” (Millman).

Conclusion

Why is it that so much of public opinion in America is at odds with expert opinion? This thesis has provided a few answers to that question. One answer, put simply, is that expertise alone—whether scientific or otherwise—is not inherently persuasive for much of the public. This has been the hardest-learned lesson for the fields of Science Communication and Public Understanding of Science. But it *has* been learned, and attentiveness to audience—and to the emotional, affectual, social and linguistic ways that they understand science—has become more common in recent Science Communication research, a trend that I imagine will continue.

This thesis has worked to show that the linear, rationalist communication of science is not persuasive for a majority of the lay public, and it has begun to address the various nonrational ways publics *do* deliberate—if that word is appropriate for nonrational decision-making—about scientific policy issues. The notion of weak theory applied to Science Communication will help to ensure that each communicative instance gets the due consideration—of audience, of linguistic and visual connotations, *ethos*, and *pathos*—it needs to be successful. (One testament to the efficacy of weak communicative theory is its proliferation in advertising research.) (See Ehrenberg; Fill).

Yet, in its recognition of these nonrational ways of knowing, I cannot help but feel that Science Communication has been left to reinvent the wheel. Many of the ideas that Science Communication is discovering—that communication is emotionally complex, inexact, trust-based, social and audience-specific—have been discussed by rhetoricians for millennia. Especially in the 20th Century, the works of rhetorical scholars like Kenneth Burke and James Berlin (among many others) have firmly established in rhetorical studies the notion that knowledge is necessarily shaped by language, and language is necessarily social. Yet, rhetoric of science and science studies scholars largely used this as a charge against scientific authority, rather than an aid to bolster its credibility among non-scientists. Bruno Latour, writing in 2004 among the hysteria of the early global climate change debate, clearly questions the work of the previous century. For Latour, the discursive climate has changed in pace with the global one. He writes of a new danger, "no longer [ ] coming from an excessive confidence in ideological arguments posturing as fact—as we have learned to combat so efficiently in the past—but from an excessive *distrust* of good matters of fact disguised as bad ideological ideas" (227). He asks:

> While we spent years trying to detect the real prejudices hidden behind the appearance of objective statements, do we now have to reveal the real objective and incontrovertible facts hidden behind the *illusion* of prejudices? And yet entire Ph.D. programs are still running to make sure that good American kids are learning the hard way that facts are made up, that there is no such thing as natural, unmediated, unbiased access to truth, that we are always prisoners of language, that we always speak from a particular standpoint, and so on, while dangerous extremists are using the very same argument of social construction to destroy hard-won evidence that could save our lives. (227)

As we see in Latour's lament, a social and rhetorical constructivist view of science, when seized by the "wrong sort of allies," can be incredibly harmful, and makes one long for the very same supreme objectivity and authority of science that science studies and rhetoric of science worked to deconstruct.

In this new climate, in which the stakes are so high, in which Science Communication is charged with communicating "evidence that could save our lives," rhetorical studies has much to offer the field. Leah Ceccarelli has called for "a new orientation toward the rhetoric of science" in which "the rhetorical critic should be prepared to develop scholarly insights that can be turned to the defense of a scientific orthodoxy" (198-199). Ceccarelli's work, I think, has done the most to answer her own call. She provides practical rhetorical devices with which science communicators can counter damaging charges of social constructivism without falling into the trap of objectivism. David Tietge's *Rational Rhetoric* and Philip Eubanks's *The Troubled Rhetoric and Communication of Climate Change* also represent steps by rhetorical scholars to aid mainstream scientific consensus. In the end, I echo Ceccarelli's call, but with a caveat: as Science Communication enters the domain of affect, emotion, *pathos,* I call for increased cooperation and aid from the burgeoning fields of affect studies and nonrational rhetorics.

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