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Katherine Rita McKiernan
San Diego State University, kate@betakateenin.com

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The Use of Diction to Communicate Empirical Uncertainty in Science Communication

KATHERINE RITA MCKIERNAN

Department of Rhetoric and Writing Studies
San Diego State University
5500 Campanile Drive
San Diego CA 92182-4452
Storm Hall West 141
United States
kate@betakateenin.com

ABSTRACT: Diction is a means to communicate uncertainty in science communication. Using a framework of terministic screens, the connotations of descriptions of uncertainty and risk can be evaluated. Furthermore, terministic screens can be used prescriptively to inform the writing of style guides. Journalistic style guides do not address science communications’ needs.

KEYWORDS: diction, risk, scientific uncertainty, style guides, terministic screens, uncertainty

1. INTRODUCTION

Science communication serves the important role of intermediary between the community of experts within scientific disciplines and the general public. The field’s investment in defining itself in terms of purpose, such as in Burns, O’Conner, and Stocklmayer’s “vowel analogy” model, provides an important basis for evaluation and improvement. An element of this purpose is to create a dialogue between scientists and the lay public that promotes an “[u]nderstanding of science, its content, processes, and social factors” (Burns et al., 2003, p. 191).

One aspect of the process of science is the uncertainty inherent in the nature of induction and empiricism, a fundamental aspect of science (Zehr, 1999). Uncertainty drives the related concept of risk. Recent scholarship has addressed the imperative to address and present uncertainty in science communication in an ethical fashion, including the use of multiple journalistic techniques as tools to effectively communicate with the lay public. Michael F. Dahlstrom and Shirley S. Ho have addressed the ethical uses of narrative (2012), and Molly Simis has addressed the use of framing (2013).

Another consideration important to the communication of uncertainty in science is diction. Richard Coe describes diction as “the study of naming and its rhetorical implications” (1993, p. 379). The act of entitlement, of selecting a name for something, has rhetorical consequences. Kenneth Burke describes “terministic screens” as a means of considering how diction “directs the attention” (1968, p. 45). The importance of diction has been carefully discussed in traditional journalism (e.g., Craig, 2006), one of venues for science communication. The role that both science communicators and journalists play in filtering information for an audience comes with an ethical imperative to communicate this

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1 Here and throughout this paper, “attention” is used in the general sense, not the psychological term.
information accurately and in a way the audience can understand (journalistic ethical guidelines, while not universal, are addressed in by influential organizations)(Associated Press, 2006; Society of Professional Journalists, 2008). The intersection of diction and science communication has received less direct attention, and is frequently addressed in studies that also consider other rhetorical devices. For example, Steven B. Katz includes diction in his discussion considerations of press releases: he argues that “[t]he values and emotions conveyed through organization, style, and diction” may require consideration to improve science communication (2001, p. 96).

The role diction plays in constructing public impressions of issues that are derived from probabilistic nature of scientific information, such as uncertainty and risk, remains a relatively unaddressed issue. To address this, I propose the use of Burke’s terministic screens as a tool for considering the work diction does in science communication. In this paper, I have directed my own attention in this project based on Leah Ceccarelli’s call for scholars to engage a broad and external audience with our projects, and to “project ourselves onto horizons of possibility as forces of change” (2013, p. 1). My goal is leverage a rhetorical framework into tools that can be used by external audiences as well as scholars to begin to address two questions. First, how can science communicators, scientists, and the lay public evaluate the diction describing uncertainty and risk in science communication? Second, how can science communication outlets improve diction describing uncertainty and risk?

To develop these tools, I will explore Burke’s concept of terministic screens to develop a method for evaluating diction. Then, I will conduct a case study by using that method to compare the terministic screens surrounding uncertainty and risk in two arenas: a pair of scholarly research articles recently published in BMJ (formerly British Medical Journal), and examples of the subsequent reporting about these articles. Finally, I will explore journalistic style guides as opportunities for interested parties to deliberately construct terministic screens within science communication that direct readers’ attention towards empirical uncertainty and risk in an ethical manner.

2. TERMINISTIC SCREENS

Throughout his work, Kenneth Burke shows a deep interest in and careful attention to what words do. One such instance is in Language as Symbolic Action, where he describes “terministic screens” as a way of thinking about the way language “necessarily directs the attention” (1968, p. 45). He argues that all nomenclature is inherently exclusive: “Even if any given terminology is a reflection of reality, by its very nature as terminology it must be a selection of reality; and to this extent it must function also as a deflection of reality” (45, emphasis in original). Any word is a choice that reports only some aspects of the reality its author describes; other aspects are excluded by omission. This occurs irrespective of the intent of the author: whether a word is chosen deliberately or spontaneously, selection and deflection both occur.

Therefore, the challenge is not how to avoid terministic screens in describing uncertainty and risk because that is impossible: they are inescapable so long as words are used to communicate. Rather, it is how to track the implications of words for a particular audience and to compare those implications with the purpose of the communication. In this way, we can consider whether a word (or other unit of language) both denotes and connotes in line with the author’s intention. Burke himself wrote very little on how to do use terministic screens: the 18-
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page chapter is the entirety his writing on the subject and his exploration of examples, and as is the case for the whole of the Burkean corpus, it is far from formulaic. Burke does, however, offer this key observation: “Basically, there are two kinds of terms: terms that put things together, and terms that take things apart” (1968, p. 49). Collection and division, then, are fundamental actions of words.

For the purposes of this article, I systematically describe terministic screens using the terms collection/division from Burke’s chapter, as well as the importance of inherent connotation. Additionally, I will consider the amplitude (how much) and valence (in what direction) of words and phrases. Although this is not the only way to deploy terministic screens, I contend it sufficient to get at the connotation of a word or phrase in situ while simple enough to be accessible and promote discussion both inside and outside rhetoric and science communication scholarship.

3. CASE STUDY: VITAMIN D

An important area of science communication is the coverage of health and wellness issues. Unlike many science issues, health and wellness news is directly actionable by the general public, with the potential to inform individual decisions on diet, exercise, and the choice to take dietary supplements. One topic in the area of health and wellness that receives a great deal of attention is vitamins and other dietary supplements: a LexisNexis newspaper search finds 996 hits for “vitamin” in the 2013 calendar year, and 2263 for “dietary supplements.”

The relatively high level of science communication coverage vitamins is understandable in the context of prevalent use. In 2011, the CDC reported that dietary supplement use has increased since the organization began tracking their use in the 1970s (Gahche et al., 2011). This same report indicates that that over half of Americans used supplements from 2003-2006, with multivitamins/multiminerals being the most commonly used type (with approximately 40% use). This widespread use of supplements drives big business: The Wall Street Journal reports that “[s]ales of vitamins, minerals and supplements totaled nearly $23 billion” in 2012 (Ng & Rockoff, 2013). These related driving factors create a public demand for reporting on these products, and the increasing amount of scientific and medical research, although not all directly addressing supplements, creates a ready supply.

Although vitamins are commonly used and a common topic in the media, there is no consistent scientific evidence that vitamin supplements positively impact overall health. Most scientific studies that describe them as beneficial do so in the context of specific medical conditions (e.g., pregnancy, breast feeding, diseases, or chronic medical conditions) (Guallar, Strange, Mulrow, Appel, & Miller, 2013). Furthermore, there is increasing evidence that vitamin supplements carries risk from a variety of factors, including both risk inherent in vitamin supplementation itself (such as β-carotene and vitamin E) and from consequences of the lack of regulation (such as contaminants and inconsistent levels of ingredients). A recent editorial in the Annals of Internal Medicine summarized data from multiple studies on vitamin and mineral supplements and concluded with the authors’ belief that the “case is closed—supplementing the diet of well-nourished adults with (most) mineral or vitamin supplements has no clear benefit and might even be harmful (Guallar et al., 2013).” In line with this assessment, the Children’s Hospital of Philadelphia made headlines in late 2013 when it disallowed the use of dietary supplements for its patients, except in cases where the
supplement was medically indicated and from an approved manufacturer (Children’s Hospital of Philadelphia, 2013).

One common vitamin supplement is vitamin D. Vitamin D is a group of steroid vitamins that contributes to the absorption of calcium. Vitamin D is not considered an essential vitamin because it is generated in the body in sunlight. However, the American diet has long been fortified with vitamin D, in foods such as milk, orange juice, and breakfast cereals due to its connection with the childhood disease rickets. Despite the ability to generate vitamin D and fortification in the American diet, vitamin D deficiency is prevalent. A recent analysis of National Health and Nutrition Estimation Survey 2005 to 2006 measured the rate of vitamin D deficiency in the United States at 41.6% (Forrest & Stuhldreher, 2001). Whether vitamin D supplements can improve health is an active scientific question. Here, I will examine two recent efforts to address this question.

3.1 Overview

On 1 April 2014, BMJ published two research articles about vitamin D and vitamin D supplements: “Vitamin D and Multiple Health Outcomes: Umbrella Review of Systematic Reviews and Meta-Analyses of Observational Studies and Randomised Trials,” by Theodoratou, Tzoulaki, Zgaga, and Ioannidis and “Vitamin D and Risk of Cause Specific Death: Systematic Review and Meta-Analysis of Observational Cohort and Randomised Intervention Studies,” by Chowdhury et al. Both articles are similar in that they are meta-analyses of data from previous medical studies about vitamin D. However, the authors looked at different datasets and came to different conclusions. These studies garnered modest attention in the popular press, with approximately 30 news articles published in the week following their release. The studies are covered in a wide variety of manners, with headlines varying from “Higher Levels of Vitamin D Might Save Your Life” (ABC News, 2014) to “D-bunked: Vitamin D's Benefits Are Overhyped, Study Says” (Tarlach, 2014).

This instance of scientific writing and its corresponding coverage in science communication is a good case study for examining the terministic screens surrounding uncertainty and risk for several reasons. First, both studies address technical measures of risk, such as hazard ratios and relative risk. Second, the disagreement between the articles makes this an example where the onus is on the reporter to determine whose voice is heard (Dunwoody, 1999, p. 61). Third, readers have a direct interest in the coverage of vitamin supplementation. This news potentially directly impacts readers’ actions regarding their health. Finally, I argue that the coverage of these research articles is typical of science communication surrounding health and wellness.

3.2 BMJ Coverage

The two meta-analyses of vitamin D studies each looked at large numbers of published results on vitamin D’s role in chronic disease prevention. Both of these studies highlighted the problem that most available data on vitamin D is from observational studies, and both call for more and better randomized trials before recommendations on vitamin D intake and supplementation are made. They did, however, differ in their examination of currently available evidence. Theodoratou et al. concluded that no “highly convincing evidence” exists for vitamin D in relation to any health outcome, but that it is “probable” that it is associated
with some health outcomes. Chowdhury et al., on the other hand, found that risk of death was higher for those with lower vitamin D levels in their bloodstreams, and lower for those taking one type of vitamin D supplement. In response to the mixed results from these studies, *BMJ* published an editorial contextualizing, summarizing, and analyzing the two studies. The authors, Welsh and Sattar, conclude from these studies that “before widespread supplementation can be considered, new trial data are needed with a focus on potential risks as well as benefits” (2014, p. 2).

Although these studies examined the same broad issue, they each looked at different sets of studies and evaluated their data differently. One study, conducted by Theodoratou et al., looked at different health outcomes reportedly linked to vitamin D, focused on comparing data from observational studies to randomized controlled trials. The authors then systematically sorted the 137 different health outcomes into different categories depending on the strength of the available evidence: “convincing,” “probable,” “suggestive,” “no conclusions,” (96 outcomes) “and substantial effect unlikely” (2014, p. 4). These categories, while systematically used, are specific to this study. They are not universally used terms to categorize evidence, although the underlying statistics (p-values and relative risk) are.

The study conducted by Chowdhury et al. examined vitamin D studies that examined mortality as an outcome. To evaluate the results of these studies, these authors compared their associated relative risk—a technical measure of risk used to describe situations with two outcomes, one of which is unlikely. Relative risk is a common measure of clinical studies, and is useful because it contextualizes the risk: the measure is inherently a comparison to a baseline. They found a higher mortality risk in those with low circulating vitamin D for multiple causes of death and for all causes of death. They also found a lower mortality risk for individuals taking one form of the vitamin, D₃, but not another, D₂. However, the data available for D₃ supplementation was a small subset of their data, and half of the D₃ supplement studies were described as having a high risk of bias.

### 3.3 Science Communication Coverage

To explore the terministic screens created by science communication coverage of this pair of research articles, I selected two examples to examine closely. In an effort to address the work done by different screens, I selected articles from two broad types of articles: one that privileges the Theodoratou et al. results, and one that privileges the Chowdhury et al. results. I also restricted my selection to articles from nationally known news outlets. My set includes the *Discover Magazine* article “D-bunked: Vitamin D’s Benefits Are Overhyped, Study Says,” by Gemma Tarlach, and the *New York Times* article “Low Vitamin D Levels Linked to Disease in Two Big Studies,” by Anahad O’Connor.

Gemma Tarlach’s *Discover Magazine* article headline highlights the Theodoratou et al. findings while omitting reference to the Chowdhury et al. findings. The words “D-bunked” and “Overhyped” both direct readers’ attention toward the ineffectiveness of vitamin D, and deflects away from potential benefits. Tarlach writes that “none of the studies they examined established definitive proof of a health benefit from vitamin D.” Describing the lack of “definitive proof” as a problem connotes that “definitive proof” is possible to attain in scientific research. It collects the idea of scientific research with certainty, which runs counter to both the purpose of science communication as a field (Burns et al., 2003). Paired with the following sentence, “[a]dditional research to investigate vitamin D’s potential is not only
needed, the researchers concluded, but must include better-designed trials,” the two create a problem-solution connotation. The problem the study found is a lack of “definitive proof,” and “better-designed” trials can solve this problem. At the end of the article, Tarlach addresses the Chowdhury et al. study in a single clause: “BMJ’s latest edition includes a second study questioning vitamin D’s value in disease prevention.” The phrase “second study questioning” deflects away from the differences between the two studies’ results, and gives the connotation that both studies resulted in similar conclusions. The word “questioning” acts to divide vitamin D and disease prevention. As a whole, the article creates a fairly certain perception of vitamin D supplementation as not beneficial. It creates a drama centered on knowing better than to buy into the vitamin trend.

Anahad O’Connor’s New York Times headline directs attention to Chowdhury et al. results (although it states that there are two studies, it only addresses the Chowdhury et al. results). This headlines uses less loaded language than does the Discover Magazine headline, with the key collecting word, “Linked,” connecting low vitamin D with disease. O’Conner’s lede reads “People with low vitamin D levels are more likely to die from cancer and heart disease and to suffer from other illnesses, scientists reported in two large studies published on Tuesday.” This collects low vitamin D levels and risk of mortality from diseases. This is closer to the description of the Chowdhury et al. work than the headline, which connects “disease,” not “mortality.” The article continues with “But it does not resolve the question of whether low levels are a cause of disease” (emphasis added). This language collects uncertainty (“not resolve”) with the causal nature of vitamin D (“cause”). When describing the risk of mortality due to different conditions, O’Conner writes that the article reports “persuasive evidence that vitamin D protects against major diseases.” This collects certainty (“persuasive”) with the results. Furthermore, placement between two paragraphs describing the findings on controlled supplementation studies collects these described risks with the description of randomized trials as “the gold standard in scientific research.” As a whole, the article creates a moderately certain perception of vitamin D supplementation as beneficial—less certain than the Discover Magazine article, but more certain than the articles on which it reports.

### 3.4 Summary

This case study considered two different, and somewhat opposing, science communication articles that each covered the same research reported in BMJ. Through their use of language, these articles created distinct terministic screens in their portrayal of technical descriptions of both uncertainty and risk. My evaluation of these instances is based on the Burns et al. description of science communication, though other purposes and descriptions of the field could also be used. These screens are summarized in Table 1.

Although the results of the two scientific articles differ with each other, as do interpretations in the science communication coverage, the values and world views that come through vary not by interpretation of the data but by genre. The scientific articles both use a qualifying language that reflects their perceptions of uncertainty. Each group of authors examined tens of thousands of data points, yet still cautioned that more research was needed before good medical advice on supplementing vitamin D can be made. Both groups contextualize their findings, which situates them in the ongoing conversation about vitamin D and health. The science communication authors, however, both embrace a more certain view of the data. Additionally, the same “good or not” dichotomy underlies both articles. The screens
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deflect from the different responses of different populations. Finally, neither author contextualizes the research in terms of a broader discussion about vitamins in general or vitamin D in particular.

Table 1. Terministic Screens and their Evaluations

<table>
<thead>
<tr>
<th>Article</th>
<th>Key Actions of Contents</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discover Magazine: “D-bunked: Vitamin D’s Benefits Are Overhyped, Study Says” by Gemma Tarlach</td>
<td>Headline: High amplitude, negative valance</td>
<td>Amplitude: ineffective&lt;br&gt;Valence: mixed (agrees with one study but against other)</td>
</tr>
<tr>
<td></td>
<td>Headline collects certainty with lack of vitamin D benefits</td>
<td>Ineffective</td>
</tr>
<tr>
<td></td>
<td>Connotation: “definitive proof” is scientifically possible and the purpose of future studies.</td>
<td>Ineffective</td>
</tr>
<tr>
<td></td>
<td>Divides vitamin D and disease prevention</td>
<td>Effective</td>
</tr>
<tr>
<td>New York Times: “Low Vitamin D Levels Linked to Disease in Two Big Studies” by Anahad O’Connor</td>
<td>Headline: low amplitude, positive valance</td>
<td>Amplitude: effective&lt;br&gt;Valence: mixed (agrees with one study but not the other)</td>
</tr>
<tr>
<td></td>
<td>Headline collects uncertainty with causality of disease</td>
<td>Effective</td>
</tr>
<tr>
<td></td>
<td>Lede collects to mortality due to disease</td>
<td>Somewhat effective: addresses one study while ascribing it to both</td>
</tr>
<tr>
<td></td>
<td>“Persuasive” evidence certainty and mortality risks</td>
<td>Ineffective</td>
</tr>
</tbody>
</table>

The difference in terministic screens is not the only factor that explains the vast differences between the Discover Magazine article and the New York Times article, or the difference between these articles and the articles on which they report. Other media issues are at play, such as false balance and lack of contextualization. Additionally, these articles also include examples of misrepresenting the content of the two studies, such as the Discover Magazine article describing the Chowdhury et al. article in terms of vitamin D’s role in disease prevention, when it measured risk of mortality; the same article says that ten studies “met the bar” for “rigorous testing,” when the study described ten health outcomes this way.

4. STYLE GUIDES: AN AVAILABLE MEANS OF PRESCRIPTION

Many science communicators operate within journalism, either as members of institutions or as freelance writers, which shapes their writing environment. In fact, Stocking suggests that media routines and organizational factors are the primary cause of the misrepresentation of uncertainty by these individuals (1999, p. 32). This consideration of the work environment as
an important factor, in addition to being used to identify challenges science communicators face, can also be used to discover opportunities for effecting change towards a more accurate representation of probabilistic information.

One such opportunity is the role of copy editors on published articles. Copy editors perform multiple jobs within the newsroom, many of which are important in understanding how they affect representations of uncertainty. Not only do they edit reporters’ copy, but they also write headlines. In my case study, above, I found that headlines addressing uncertainty are particularly problematic, and often have different, and less accurate, screens than the corresponding article. A few previous studies have briefly touched on the issue of headlines in sensationalizing science and misrepresenting risk (for example, Condit et al., 2001; Weingart, Engels, & Pansegrau, 2000). This same problem exists in social media posts by news outlets, even when the linked article is worded well. Consideration of the newsroom environment helps explain why this disconnect exists: the reporter who wrote the article likely did not write the headline or social media post. To effect change in science communication, there must be ripples throughout the organization.

There is a mechanism for making such ripples: the style manual. Institutions describe and define the way words are used in these documents. Unlike academic style manuals, newspaper style manuals primarily comprise word use and punctuation issues. Part of a copy editor’s job is to maintain consistency with their style manual in all areas, including headlines and social media posts. These manuals construct a terministic screen preferred by institutions by including word usage information and provide preferred terms for potentially contentious, bias-inducing labels.

Regulation of ethical diction at the level of the style guide is a particularly attractive target in part because scientific writing exists as template. Style and usage in scientific writing is highly regulated and carefully constructed. The uncertain nature of the information is embedded in the language of the argument, which helps emphasize uncertainty without relying exclusively on statistics. For example, writers avoid the word “prove,” using instead words such as “demonstrate” or “suggest” to describe empirically based conclusions, and the word “significant” is reserved for describing statistical significance and tends to be paired with a numerical measurement. The resulting terministic screen reflects the values, purpose, and worldview of the scientific community. In many cases, the underlying motivations behind this screen overlap with those of science communication. Hence, this existing “well-policing communal property,” as Gross described it (1991, p. 942), inform the deliberate construction of a terministic screen that suits the values and needs of science communication.

To explore the ways newspapers already systematically choose to represent science, risk and uncertainty, I examined four published American journalistic style guides: *New York Times*, the *Wall Street Journal*, *The Washington Post* and *The Associated Press Stylebook*. These books represent the dominant style manual in the field (*Associated Press*) as well as three of the top 10 American newspapers by circulation (Alliance for Audited Media, 2013). For each book, I examined entries for a series of science and risk-related terms: “hazard,” “health,” “probable,” “prove,” “risk,” “science,” “scientific,” “significant,” and “uncertain,” uncertainty.” I also examined the front and back matter of each and conducted an overall survey of their organization and contents.

I found two important patterns in this examination. First, none of these manuals contain science-related entries for the any investigated terms; although each included an entry under “prove,” these entries only pertain to the grammatical difference between “proven” and
“proved.” Second, none of these manuals includes a section on science-specific style and usage. The Associated Press manual includes multiple subject-specific sections, including “Internet Style” and “Business Style.” The Washington Post includes an entry for “sports words and terms” that advises writers to consult the Sports desk for words not included in the style manual or dictionary. Manuals often refer users to other entries, such as the New York Times’ “weather” entry that cites entries for terms such as “blizzard” and “cyclone.” Additionally, I found that these manuals are constantly under revision, although changes are published with varying frequencies (the Associated Press publishes a new version every year, whereas the New York Times has four published versions across its 64-year history).

These findings help explain why article-related content, such as headlines, social media posts, and graphics, produce such a different termistic screen than the articles themselves: not only are they written by someone other than the reporter at the news outlets, but these people writing this content lack guidelines for describing science and uncertainty beyond journalistic norms. The mechanism in place at these institutions to ensure diction is in line with the purpose of the communication does’t address important usage issues for covering science. Furthermore, the existence of subject-specific usage and instructions to consult an expert for specialized terms is important. The institutions that write these manuals already have systematic ways of handling discipline-specific terms and shifting connotations. The frequent change of these manuals reflects the organizational value of addressing bias in a dynamic language, such as the Associated Press’ move away from the term “illegal immigrant” in 2013.

Overall, I suggest that these findings point to journalistic style guides as an available means of prescribing diction and usage for science communicators and an opportunity for science communicators to work with the media to address this issue. As a reference used throughout entire organizations, style guides affect the representations of science by all individuals.

5. CONCLUSION

This report is highly limited in that it examined a small selection of the available science media coverage of the research. Continuation of this work will include expansion to additional examples of this coverage. Another limitation to this study is my method of article selection. I deliberately chose articles that, while from recognizable news outlets, would create different termistic screens for illustrative purposes, both from each other and from the reported research articles. As such, they represent different existing termistic screens, but not necessarily representative ones. Furthermore, I did not address the question of whether the journalistic screens should align with the scientific screens. Effectiveness was only evaluated based on whether the work done by the screen aligned with the descriptions of risk and certainty in the articles described. A key consideration for future research is when these screens should not align: when does the purpose of science communication suggest screens that counter those found within science literature?

Despite these limitations, the current findings highlight the power of diction in creating portrayals of uncertainty and risk. As such, diction represents an available means of engaging with the public about uncertainty and risk in a more nuanced fashion than a good-versus-bad dichotomy. Science communicators can choose words that help construct a shared perception of reality between scientists and the public, which can facilitate dialogue. The framework of termistic screens can be used descriptively to examine the world views that filter through
language, and in turn to evaluate how actions of the field compare to its purpose. Additionally, terministic screens can be used prescriptively to change how institutions use language to encourage (and, in some cases, enforce) diction that resonates with the purpose of science communication.

ACKNOWLEDGEMENTS: I am grateful to Professors Glen McClish, Ellen Quandhal, and Linn Bekins for their advice and support throughout this project.

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