Whose stance is it, anyway? A corpus-based study of stance expressions in science news articles

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Abstract

Communicating scientific research to the public is as important as ever. Several studies have investigated the ways that science news writers communicate personal feelings and assessments, otherwise known as stance, in their writing, reporting somewhat mixed results. In this study, I examine the grammatical stance marking of science news articles. I compare the ways that writers and the researchers that they quote uniquely contribute to the overall expression of stance in these articles. Results reveal that the researchers' talk substantially contributes to the overall stance of science news articles compared to their writers, indicated by a greater use of modal verbs, stance verbs and adjectives controlling *that* complement clauses, and stance adverbials, including a greater use of 'boosters'. This study suggests that researchers' talk in science news articles co-participates in the newsworthiness of science and offers an alternative perspective on academic research that complements research writing.

Keywords: Science communication, stance, corpus linguistics, science journalism, popular science.

Resumen

¿Quién se está posicionando? Un estudio basado en corpus de expresiones de posicionamiento en artículos de noticias científicas

Comunicar la investigación científica al público es más importante que nunca. Si bien diferentes estudios han investigado las formas en que los autores de noticias científicas comunican sentimientos personales y evaluaciones a través de mecanismos analizados bajo la noción de posicionamiento (stance), estos han

obtenido resultados dispares. En este estudio se examinan las marcas gramaticales de posicionamiento empleadas en artículos de noticias científicas. En concreto, se comparan las formas en que los autores y los investigadores a los que citan contribuyen a la expresión general del posicionamiento en estos artículos. Los resultados obtenidos revelan que el discurso de los investigadores citados contribuye de manera sustancial al posicionamiento general de los artículos de noticias científicas en comparación con el de los propios autores. Esto se evidencia en un mayor uso de verbos modales, verbos y adjetivos que marcan el posicionamiento que gobiernan oraciones subordinadas introducidas por que, así como de adverbios de posicionamiento, entre los que destaca un mayor empleo de intensificadores. El presente artículo sugiere que la referencia a los investigadores en los artículos de noticias científicas contribuye a la construcción del valor noticioso de la ciencia y ofrece una perspectiva alternativa sobre la investigación académica que complementa la escritura científica.

Palabras clave: Comunicación científica, posicionamiento, lingüística de corpus, periodismo científico, ciencia popular.

1. Introduction

From the tools people use at work to topical issues like the pandemic, science and technology are integrated into nearly everyone's daily life. The significant presence of science and technology in daily life is also matched by growing numbers of academic publishers, journals, research articles, and scholars (Hyland & Jiang, 2019). As a result, there is now more scientific information to communicate and a great need to communicate it with diverse, lay audiences (National Academies of Sciences, Engineering, and Medicine, 2017).

Scholars from diverse fields have examined the contexts of science communication, producing a significant body of research. For example, several scholars have become interested in the emergent genres of science communication on the Internet (Luzón & Pérez-Llantada, 2019). Studies have investigated science blogs (e.g., Sidler, 2016), science-focused crowdfunding proposals (e.g., Mehlenbacher, 2017), science podcasts (e.g., Ye, 2021), research videos (e.g., Luzón, 2019), and graphical abstracts (e.g., Buehl, 2022), among others, to learn more about the ways writers and speakers meet the demands of communicating with diverse audiences.

Science journalism, too, has found a foothold in the digital world (Dunwoody, 2014), published in highly visible outlets like *The New York Times*

as well as smaller venues like *The Academic Times*. This study contributes to the growing literature on science communication by examining the language of science journalism, specifically the 'stance' taken up by different voices within science news articles. Stance refers to the linguistic means by which writers (in the case of written texts) express their personal feelings and assessments (Conrad & Biber, 2000), sometimes in very subtle ways. Several studies have investigated the stance expressed by science communicators, especially the level of epistemic certainty ascribed to the reported research (e.g., Fu & Hyland, 2014; Hyland, 2010; Larsson, 2019; Myers, 1989). But results have not always been conclusive.

In this study, I adopt a corpus-based approach to examining four kinds of grammatical stance marking, namely certain verb and adjective complement clauses, modal verbs, and stance adverbials. Specifically, I compare the stance expressed by science writers and the researchers that they quote in their articles, illustrating how these two actors contribute different kinds of stance with different frequency. Below, I review relevant background literature in section 2, followed by a description of the study's methods (section 3), the findings and discussion (section 4), and finally a conclusion in section 5.

2. Background

2.1. Communicating science to diverse audiences

Concerted efforts to communicate science with the general public have existed for decades. For example, in the United Kingdom, the 1985 'Bodmer Report' represented a milestone in efforts to understand the general public's attitudes about and knowledge of science (Miller, 2001). In the United States, the National Science Foundation (NSF) has similarly published reports on the general public's attitudes to and knowledge of science since 1979 (Bauer & Falade, 2014). Efforts like these evolved out of a growing fear that academics had begun to recede into closed off worlds, resulting in little interaction with the general population.

This would be a concerning trend given the increasingly crucial role that science and technology play in daily life. Recent issues such as the COVID-19 pandemic, the growing threat of climate change, and advances in artificial intelligence continue to bring science into the public consciousness. Additionally, there is more published research today than ever before

(Hyland & Jiang, 2019), resulting in more knowledge to be shared with interested audiences.

However, the Internet and resultant technologies have also served as a catalyst to develop new methods to communicate scientific information (Luzón & Pérez-Llantada, 2019). For example, several scholars have investigated science blogs for their unique affordances (e.g., Luzón, 2013, 2017; Sidler, 2016), chief among them their ability to provide free-flowing interactive spaces where readers can share, critique, and discuss research (Blanchard, 2011). Other digital genres examined by scholars include science-focused crowdfunding projects (e.g., Mehlenbacher, 2017), social media platforms (e.g., Orpin, 2019), science podcasts (e.g., Ye, 2021), research videos (e.g., Luzón, 2019), graphical abstracts (e.g., Buehl, 2022), and TED Talks (e.g., Valeiras-Jurado & Bernad-Mechó, 2022), among others.

This body of research has largely focused on the rhetorical features of texts, such as the organization of their rhetorical moves and steps (e.g., Jiang & Qiu, 2022; Mehlenbacher, 2017; Ye, 2021). Their findings suggest that communicating scientific information, even to diverse audiences, involves paying attention to conventional aspects like background literature, methods, and findings. At the same time, science popularizers also make a greater effort to tailor information to non-experts, embedding hyperlinks to additional explanations, ordering information to facilitate reader understanding, and personalizing the text with attitude markers (Hyland & Zou, 2020; Luzón, 2013; Qiu & Jiang, 2021).

Traditional venues such as science journalism also remain important in the digital age. Dunwoody (2014) argues that journalism represents an important source of "independent, evidence-based information" in a time when people are bombarded with one issue after another (p. 27). Indeed, scientists around the globe regularly communicate with journalists to share their research (Peters et al., 2008). The current study contributes to the body of literature on science communication by examining the language of science journalism, specifically the 'stance' taken up by journalists and the 'stance' taken up by the actors that the journalists quote in their articles. Below, I introduce the concept of 'stance' and describe this study's research questions.

2.2. Stance and popularizing science

Despite the outwardly impersonal appearance of scientific writing, writers must subtly insert their attitudes, judgements, and evaluations into texts in

order to persuade their audience of their perspective. Put simply, academic writers express personal opinions in their writing, and such expressions have been examined by scholars in a number of ways. The linguistic means by which writers make such evaluations have been examined under the heading of 'evaluation' (Hunston, 1994), 'metadiscourse' (Hyland, 2007), 'appraisal' (Martin & White, 2005), and 'stance' (Conrad & Biber, 2000), among other terms. While these schools show certain differences, at their core they examine the interpersonal dynamics of writing and speaking beyond the transfer of purely informational content.

Hyland's construct of 'metadiscourse' and Biber's 'stance' are particularly relevant because they are frequently adapted for corpus-based studies of written communication, which this study also employs. As Hunston (2010) notes, both scholars often highlight the lexical and grammatical features that can be used to express the writer's viewpoint. For example, Hyland's (2007) book on disciplinary variation in academic writing examines features marking attitude (e.g., *hopefully, I agree*), hedging claims (e.g., *could, doubt*), and boosting claims (e.g., *I believe, indeed*). While the metadiscourse model has often been adopted to examine disciplinary variation in academic writing, work adopting the stance model often examines how linguistic features are used across culturally recognized text varieties, also known as register variation (Biber & Conrad, 2019).

With regard to written science communication, several studies have investigated features pertaining to stance and metadiscourse. In particular, researchers have been interested in whether science writers express greater certainty in their claims, in turn increasing the newsworthiness of their articles, or greater tentativeness, in turn protecting themselves from making false claims. In other words, these works largely approach stance from the perspective of epistemic modality, or the degree of certainty or commitment given to claims (see Marín-Arrese, 2015). These studies have reported somewhat mixed results. Both Hyland (2010) and Adams-Smith (1987) argue that popularizers avoid tentativeness to increase a story's newsworthiness. Adams-Smith (1987) states that editors must present conclusions in definite terms, which misrepresents the original research. Similarly, Hyland (2010, p. 124) writes,

> For the science journalist, hedges simply reduce the importance and newsworthiness of a story by drawing attention to its uncertain truth value, but in glamorizing material for a wider audience, popular science texts do not help readers see how scientific facts can be questioned.

Hyland offers some excerpts from popular science articles that suggest that these articles remove the tentativeness present in the original published research. For Hyland, journalists may want to avoid tentative language in an effort to make the content of the article important to the reader. Myers (1989) argues that the lack of tension between writer and reader in popular science allows the writer greater space in expressing certainty. That is, since these articles are not evaluated by an academic community, hedging is less necessary as an interpersonal discoursal feature.

However, some empirical evidence points in another direction. Fu and Hyland (2014) examined the use of several metadiscoursal features, including hedges, boosters, attitude markers, and more, in popular science magazines and newspaper opinion articles. The researchers conclude that popular science writers "attempt to mirror the cautious, tentative style or professional science," which gives articles a "veneer of academic validity" (pp. 16-17). Larsson's (2019) quantitative analysis, which includes a sub-corpus of popular science non-fiction books, offers support for this conclusion. This analysis of stance adjectives (e.g., *it is possible that*…) across several written registers revealed the non-fiction books to use more stance expressions than research articles but fewer than newspaper articles, marking a kind of mid-way point between research writing and news writing. Similarly, Varttala's (1999) investigation of popular science magazines and their matching research articles concludes that "hedging devices are… commonly used in the popularization of medical research" (p. 190).

Thus, while the motivations for avoiding tentative language in popular science are known, some studies have complicated the notion that science journalism must make news newsworthy by presenting itself as unduly certain. This issue is made more complex when taking into account the fact that some genres or registers are multi-voiced. That is, the stance found in a given text may be attributed to different speakers, such as a science journalist or the scientist herself, having implications for our understanding of who popularizers science. The current study seeks to contribute to this literature by examining how the stances taken up by the different voices in popular science writing compare and contrast. I describe this in more detail in the next section.

2.3. Motivation for the current study

Science can be popularized and communicated to broad audiences through many different genres and registers. This heterogeneity can also be found

within texts. For example, science journalism values, and often calls on, the opinion of subject area experts in their reporting of science news (Calsamiglia & Ferrero, 2003). As a result, these articles contain multiple sources of information, including not only the potential stance of the writer but also that of other actors interviewed or quoted in the article. This multi-voicedness has implications for our understanding of the ways science journalism presents science to broad audiences.

The guiding question that this study seeks to answer is: How does the stance expressed by science writers differ from the stance expressed by the actors quoted in their articles?

I attempt to answer this question by examining a corpus of science news articles written by science journalists and freelance writers. I separate articles into the content attributable to the writer and the content attributable to the quoted actors. I then use computer software to identify a finite list of frequent grammatical stance features and compare their rates of occurrence across the corpora. I explain these methods in more detail in section 3.

3. Methods

For this study, I adopt a corpus-based approach to discourse analysis. As Mautner (2022) explains, while once corpus linguistics and discourse analysis were seen as diametrically opposed, they are now frequently employed together. To this end, I employ computational and quantitative methods to collect, manage, and analyze a corpus of texts, but I also approach these texts by recognizing that they stem from socially situated contexts, which necessarily inform their interpretation. For example, the status of the writer, their relationship to the audience, the context in which the information is communicated, and more, influence the linguistic organization of texts (Biber & Conrad, 2019). Practically speaking, this usually involves substantial review and presentation of exemplars (or 'concordance lines') from one's corpus (Mautner, 2007). Thus, I seek to provide both a sense of the frequency of certain items and qualitative interpretations of those items. Below, I describe the corpus used in the study, the stance features chosen for analysis, and the method of analysis.

3.1. Corpus

The science news articles collected for this study were collected with three main criteria in mind. First, the articles must cover recently published research (i.e., within the past five years at the time of collection), usually one or two research articles. Thus, their main purpose should be to report on recent academic research. Second, the articles must be written by journalists or freelance writers and not by the researchers themselves. Finally, the articles must be representative of the topics frequently attested in science news generally. That is, I was sensitive to collecting texts written about the subject matter that could be considered representative of topics typically covered by other similar publications.

To identify articles meeting these criteria, I browsed a large social media forum regularly used to share and discuss science and research. I examined recent posts to identify the sources of articles frequently shared there and reviewed these sources to identify those meeting the criteria. From this review, I selected eight news organizations from which to collect articles. Review of these organizations suggested that four topical domains were most common, including health/medicine, mental health/psychology, space/physics, and the environment. From each of these four domains, I collected 50 articles from two different sources, resulting in a corpus of 400 articles published by eight news organizations across four topical domains. Features of the corpus are displayed in Table 1.

Domain	Source	Date Range	# of Texts	# of Words
Health/	*NewAtlas*	2018-2021	50	23,842
medicine	*ScienceNews*	2019-2021	50	32,871
Psychology/	*PsyPost*	2017-2021	50	24,304
mental health	*The Academic Times*	2019-2021	50	45,153
Space/	*Astronomy*	2018-2021	50	41,592
physics	*Inverse*	2018-2021	50	44,431
Environment	*Science Alert*	2017-2021	50	33,128
	ZME Science	2018-2021	50	36,141
Total		**2017-2021**	**400**	**281,444**

Table 1. A description of the science news article corpus

Table 1 shows that the corpus consists of about 280,000 words published between 2017 and 2021. The corpus shows strong internal consistency, as

texts are of similar length (M = 700 words, SD = 245 words), are authored by a single writer, and share the purpose of reporting on recently published research. Thus, the articles are appropriate and representative of the variety of science communication that this study seeks to examine.

3.2. Separating quoted speech from non-quoted speech

The purpose of this study is to examine the stance of science writers and the actors that they quote. Thus, following collection of the corpus, I separated parts of the texts including direct quotations from those parts that did not. To do this, several issues had to first be addressed.

First, not all language placed within quotation marks is quoted speech. Some names or technical terms, for example, can be used within quotes. A qualitative review of the articles suggested that instances wherein quotations including 4+ words were often genuine instances of quoted language. I used the programming environment R to write scripts that separate the quoted from non-quoted material and store it in separate files.

Second, some non-quoted language can appear very much like quoted language. For example, certain sentences with verbs of communication often appeared like indirect quotations of the actor's original words. To examine this concern further, I reviewed several articles to determine whether to include or exclude such indirect reports in the corpus of non-quoted language. From this review, it became clear that the verbs *say* and *tell* followed by a *that* complement clause were the clearest examples of such borderline cases. Consider the following sentence from one of the articles:

> Burdet says that these participants live in a world designed for people with five fingers, which can lead to interesting adaptations.

Here, a researcher (*Burdet*) is named as the subject of the verb *says*, which is followed by a *that* clause reporting what *Burdet* said. Cases like these represent a gray area between the two kinds of discourse that I intend to study, so I removed sentences like these (i.e., instances of *say*/*tell* + *that* clause) from the analysis of writer stance. The final word count for the corpus of quoted speech was 52,847 words, and the final word count for the corpus of non-quoted language was 224,223 words.

Finally, in order to accurately characterize the source of the quotes, I had to determine whether these quoted actors were typically scientists and

researchers or more heterogenous. Previous research has shown that some science news may include quotes from mainly non-scientists such as politicians (Calsamiglia & Ferrero, 2003). However, a review of this study's articles suggested that researchers were overwhelmingly the quoted actors. Thus, for the remainder of this study, I refer to the quoted voices as 'researchers' to refer to the subject-area experts quoted in the articles.

3.3. Selection and identification of stance features

It is widely acknowledged that stance is contextual and can be found nearly anywhere in a text. No single study can identify, quantitatively or qualitatively, all stance of a corpus. A promising start, however, is selecting identifiable features that consistently and explicitly mark stance. In this study, I borrow from Biber (2006) in selecting four grammatical features commonly used to mark stance, namely stance verbs controlling *that* complement clauses (1), stance adjectives controlling *that* complement clauses (2), modal verbs (3), and stance adverbials (4). Examples of these features are given below (from Biber, 2006, Ch. 5):

(1) I **doubt** that there will be a lot on the test. (stance verb + *that* clause)

(2) We are **certain** that the theory has far reaching implications. (stance adjective + *that* clause)

(3) Both of those things **might** be true. (modal verb)

(4) **Unfortunately** it's not a matter of what we decide. (stance adverbial)

In each instance, the word in bold type expresses the writer's perspective on the certainty, likelihood, or attitude toward the content of the sentence. The writer/speaker of (1), for example, expresses their doubt that a test will have many questions, be particularly difficult, etc., while the writer of (4) paints a particular scenario as being unfortunate using the adverb *unfortunately*.

These features are useful for a study of stance for at least two reasons. First, they can be reliably identified by computer software. Second, they are frequent features of English written communication (Biber et al., 1999), and thus offer a substantial contribution toward the description of stance in science news writing. Appendix A lists the specific verbs, adjectives, and adverbials included in this study.

To identify these stance features in texts, I wrote scripts in the computer language Python utilizing the natural language processing (NLP) package *spaCy*. *spaCy* is a fast and accurate NLP tool that reported 98% tagging accuracy and 95% parsing accuracy on a training corpus. For each article of the corpus, the script breaks the article into sentences, part-of-speech tags and syntactically parses the sentence, and then calculates counts for the desired features.

3.4. Analysis

Given the comparatively small amount of quoted language and the overall purpose of this study, I do not adopt any statistical test. Rather, I provide normalized rates of occurrence for features to allow for comparable descriptive counts across the corpora of quoted and non-quoted speech.

Frequency normalization is a common technique used in corpus studies when comparing rates across corpora of different sizes (Biber, 2006). To normalize counts, one divides the raw frequency of a feature by the word count of the corpus, which is then multiplied by a normalization number (e.g., 1,000, 100,000, or 1,000,000). In this study, all normalized frequencies are to the tune of 'per 100,000 words', or phtw. For example, the modal verb *could* occurred 136 times within quoted speech. Thus, 136 / 52,847 * 100,000 = 257.35 times phtw.

4. Findings and discussion

4.1. Frequency of stance features

Figure 1 illustrates the normalized frequencies of the four grammatical stance features across the writers' and researchers' language. Modal verbs have been separated into three semantic categories, namely possibility modals (*can, could, may, might*), prediction modals (*will, would, be going to*), and necessity modals (*must, should, have to, got to*) (Biber et al., 1999, Ch. 6). 'st_vb_that' refers to stance verbs controlling *that* clauses, 'st_adj_that' stance adjectives controlling *that* clauses, and 'st_advbls' stance adverbials. Finally, the red bars represent the words of the researchers and the blue bars the words of the writers.

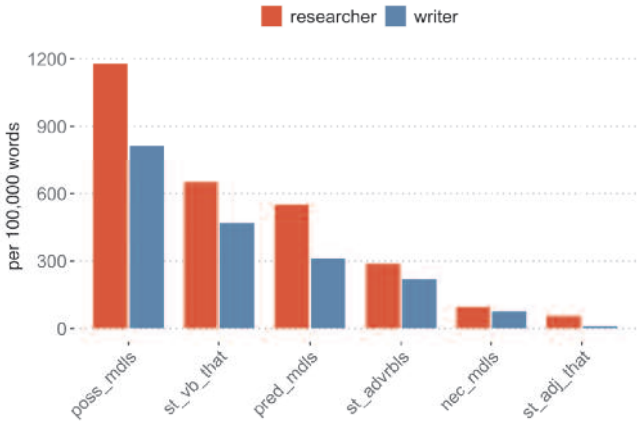

Figure 1. A bar plot illustrating the normalized rates of six grammatical stance features in the corpus

The bar graph shows two clear trends. First, both quoted and non-quoted language show similar preferences among the six stance features. For example, both use possibility modals the most often, while stance adjectives controlling *that* clauses are least frequent. Second, the quoted researchers make greater use of stance features overall. For each feature, the red bar is taller than the blue one, meaning the quoted material reported higher normalized rates than non-quoted material.

Below, I explore these features and their use in discourse in more detail. I begin with discussion of stance words controlling *that* clauses before moving to modal verbs and stance adverbials.

4.2. Stance verbs and stance adjectives controlling that clauses

Complement *that* clauses can be controlled by stance verbs, adjectives, or nouns. This study focuses only on stance verbs and adjectives. To begin a discussion of these features, I list the five most frequent verbs and adjectives found in these positions across the two corpora (Table 2).

Stance verbs				Stance adjectives			
Researcher		Writer		Researcher		Writer	
verb	freq phtw	verb	freq phtw	adjective	freq phtw	adjective	freq phtw
think	164.63	*find*	102.44	*likely*	9.46	*sure*	3.49
show	90.83	*suggest*	84.13	*aware*	5.68	*aware*	0.87
suggest	77.58	*show*	54.49	*convinced*	5.68	*confident*	0.87
know	75.69	*mean*	30.51	*worried*	5.68	*hopeful*	0.87
find	73.8	*think*	22.23	*certain*	3.78	*likely*	0.87

Table 2. The five most frequent stance verbs and adjectives controlling that clauses across the corpora

The normalized counts in Table 2 reflect the fact that stance words controlling *that* clauses were more frequently used by researchers in general (see Figure 1). The most frequent verbs and adjectives displayed in Table 2 also reflect what those researchers expressed stance toward. For example, the high frequency of *find* among the writers' prose suggest an emphasis on reporting study findings, while the presence of adjectives like *convinced* and *worried* suggest an emphasis on conveying the researchers' attitudes and emotions in their language.

As Hyland and Tse (2005) note, the grammatical subjects of sentences including these stance features are attributed the evaluation of the verb or adjective. With that in mind, it is notable that stance is attributed to different kinds of subjects across the corpora. While researchers often spoke from the first-person perspective, resulting in more subjects including *I*, *we*, and *our*, writers often wrote from the third person perspective, attributing stance to subjects like *they, the team,* and *the authors*. Consider the following two examples to illustrate this point, the first from the writers' prose (1) and the second from the researchers' talk (2):

(1) Overall, *the authors* **suggest** that evidence of class privilege threatens a person's sense of personal merit, which leads to rationalizing success through the perseverance of difficult tasks and hardships. [Writer, article #241]

(2) "They were recorded in the megahertz as well as gigahertz range, which is what you can find with terrestrial lightning emissions. *We* **think** the reason we are the only ones who can see it is because Juno is flying closer to the lightning than ever before." [Researcher, article #169]

The writer in (1) chose the tentative reporting verb *suggest* to attribute an argument to the study's authors. The researcher in (2), on the other hand, uses *think* to attribute an explanation to the research team which also includes the speaker. The greater presence of *think* among the researchers' talk relative to the writers' is also noteworthy because it refers to a mental process, which is less common in research writing relative to research-oriented verbs like *find* and *show* (Hyland, 2007). By contrast, *find* was the most common stance verb in the writers' discourse, used to report findings of a study rather than the cognitive acts of scientists.

Stance adjectives controlling *that* clauses were comparatively less frequent, especially in the writers' prose. Researchers employed a variety of adjectives, including those referring to likelihood (*likely*), certainty (*certain*), and attitude (*convinced, worried*), while only *sure* occurred somewhat often in the writers' prose. Often, *sure* was accompanied by negative or tentative language decreasing the level of assurance associated with the proposition. Consider the following example (3):

> (3) The study, as noted by researchers, should be considered in light of certain methodological limitations. First and foremost, a relatively small sample size of 14 participants limits the study's generalizability. There was also no control group, which is unfortunate, as this makes it difficult to be **sure** that the observed changes were, in fact, a result of the meditation practice, and not some other, external factor. [Writer, article #30]

Example (3) reflects the use of *sure that* to express epistemic certainty. However, other language in its context reduces the level of certainty expressed. For instance, the fact that *sure that* is placed in a complement of the adjective *difficult* (i.e., *difficult to be sure that*…) communicates that the level of assuredness is somewhere in between complete and absent. That is, something which is *difficult* to do is between impossible and very easy.

Moreover, characteristic of writer stance in this study's corpus, the writer of (3) is also quick to attribute some or all of their stance to researchers, by way of the short clause *as noted by researchers* in the first sentence. Thus, *sure that*, along with other stance marks like *should*, *foremost*, *unfortunate, difficult*, and *in fact* are attributed to researchers rather than the writer.

4.3. Modal verbs

Combined, modal verbs were by far the most frequent stance feature used across the corpora. Those expressing the meanings of possibility, permission, and ability were particularly frequent (see Figure 1). Again, to begin this discussion, I first offer the most frequent items within this category to give insight into where the overall frequency differences stem from (Table 3).

Researcher		Writer	
modal	freq phtw	modal	freq phtw
can	575.25	*can*	307.31
would	270.59	*could*	224.06
could	257.35	*would*	172.62
will	236.53	*may*	171.75
may	215.72	*will*	132.52

Table 3. The five most frequent modal verbs across the corpora

Given that the class of modal verbs is fairly small in general, it is perhaps unsurprising that the items shown in Table 3 are not dissimilar across the researchers' and writers' language. Both relied on *can, would, could, will,* and *may* most to express stance. The most notable differences in frequency were in the greater use of *can*, *would,* and *will* in the researchers' talk, while *could* and *may* showed comparatively similar rates across the researchers and writers.

The particularly high frequency of *can* overall reflects the registers present in the corpora. While *will* and *would* are most frequently attested across general English, *can* is particularly salient in both conversation and academic prose (Biber et al., 1999, Ch. 6). Thus, the writers' higher use of *can* likely reflects the fact that they write about academic topics, while the researchers' substantial use of *can* likely reflects the fact that much of their language was spoken rather than written.

Rhetorically, another reason *can* may be useful in science news is because it lends itself to the rhetorical appeal of application (Fahnestock, 1986), which helps communicators demonstrate the value of science through emphasizing how it can be applied to practical problems. Examples of this kind of appeal can be found in both the researchers' and the writers' language. Consider the following examples (4-5):

(4) "now we have a tool to precisely map the number and crown area of each tree, which certainly will help to better understand the environment and carbon cycle of dry areas," Brandt adds. *The method* **can** be applied in other settings, Brandt notes. Anywhere you have satellite data with 0.5 meters resolution, it could be applied—although the algorithm does need to be retrained for every particular objective. [Writer, article #358]

(5) "Many people who are diagnosed have a hard time finding the right treatment, and that leads to people becoming frustrated, because they try too many different treatments and each might have different side effects," Ging-Jehli said. "*It* **can** be bothersome, time-consuming, costly and frustrating for patients. That, I think, would be a huge benefit - if *we* **can** make more informed decisions of which treatment to try first." [Scientist, article #87]

Examples (4) and (5) show three uses of *can*, as well as several uses of other modal verbs. The writer in (4) uses *can* to state how a new method for counting trees in difficult-to-reach areas can be applied to studies of new regions. Notably, the writer again is quick to attribute the stance of the sentence to researchers by way of tacking on *Brandt notes* at the end of the sentence. Moreover, in contrast to the researchers' use of *can*, the sentence's subject is inanimate and its application by humans is only implied. By contrast, the second instance of *can* in (5) (the first instance expresses possibility and not application) attributes stance unto the speaker-researcher via the comment clause *I think* and subject *we*, arguing from their perspective that new methods for detecting ADHD may improve overall treatment.

The second class of modal verbs more frequent in the researchers' talk is the prediction/volition modals *will, would,* and *be going to*. When these verbs are used with inanimate subjects, they generally serve to make logical predictions, a function frequent in academic writing (Biber et al., 1999, Ch. 6). In the researchers' talk, *would* often functioned to speculate on hypothetical scenarios and *will* on future scenarios. Consider the following examples from the researchers' talk (6-7):

(6) One limitation of the model, however, is that it doesn't reproduce non-active regions of the Sun with weak magnetic fields, which Ulrich says **would** be necessary to get a comprehensive picture of the Sun's magnetic field at any given moment, past or present. Though he admits it might not be possible to solve, he adds "it certainly **would** be worth checking out." [Researcher, article #119]

(7) "Hopefully this means that it **will** be more effective at reducing poverty, providing stability and improving child and family health, and we'**ll** have to make sure to do studies to ensure it's working as it should." [Researcher, article #234]

Sentences like those in (6) and (7) frequently had two characteristics in common. First, they were placed near the ends of news articles, where they were used to consider possible implications of study findings. For example, the second instance of *would* in (6) indicates an area of future research that would improve the study's model, and the uses of *will* in (7) express desired future outcomes of a tax credit program and how future research could investigate its impact. Second, the predictions proposed by these verbs tended to be attributed to study researchers, whether found in quotations (7) or paraphrases, as the first instance of *would* in (6) illustrates.

4.4. Stance adverbials

The final set of features to review here is stance adverbials. 'Adverbial' is a function, like 'subject' and 'object', rather than a form. Thus, different kinds of phrases and clauses, like adverbs and prepositional phrases, can perform the role of adverbial. They express meanings related to circumstance (e.g., *today*), logical relationship (e.g., *however*), and stance (e.g., *in fact*) (Biber et al., 1999, Ch. 10). As noted in section 3, this study only focuses on a subset of stance adverbials. Table 4 provides the five most frequent stance adverbials across the corpora.

Scientist		Writer	
adverbial	freq phtw	adverbial	freq phtw
really	35.91	*according to*	87.18
actually	34.06	*actually*	16.56
kind of	28.38	*in fact*	13.51
maybe	24.6	*of course*	10.46
probably	22.71	*always*	7.85

Table 4. The five most frequent stance adverbials used across the corpora

In section 4.1, I showed that the researchers used more stance adverbials than the writers, though that difference was less severe than with other stance features like modal verbs. Table 4 suggests other differences as well. Most notable, writers relied largely upon *according to*, a type of epistemic

adverbial that marks the source of information. Consider the following example from a writer (8):

> (8) A few days' exposure to ambient air pollution was associated with increased risk of death from asthma **according to** a team of researchers Sun Yat-sen University, Hubei Provincial Center for Disease Control and Prevention, National Meteorological Information Center, Huazhong University of Science and Technology, and the Institute of Chronic Noncommunicable Disease Control and Prevention in China. [Writer, article #378]

Example (8) is the first sentence of its respective article. As was shown in the previous sub-sections, the science writers in this study's corpus were often quick to attribute stance to external sources, in particular to study researchers, which *according to* also serves to do. Arguably, this function serves two related purposes. First, it adds credibility to the writing by indicating that statements of findings, implications, and interpretations stem from subject-area experts. Second, it shields the writer from making undue claims. The greater proportion that an article relies on the researchers' words and interpretations, the less need there is for inserting the writers' own.

By contrast, the researchers relied on several different adverbials more or less evenly, all of which expressed epistemic stance. Rather than marking the source of knowledge, the researchers' adverbials spoke to the reality (*really, actually*), certainty (*maybe, probably*), and imprecision (*kind of*) of statements. Sentences including these adverbials were suggestive of Gilbert and Mulkay's (1984, Ch. 3) notion of the 'contingent repertoire'. The contingent repertoire is a style of discourse that contrasts with the stereotypically impersonal and objective tone of research writing. Rather, it presents science as a subjective, human activity motivated by personal inclinations and thus imbued with subjectivity. To illustrate this point, consider the following example from a researcher (9):

> (9) "I was worried that we might find these kinds of evaluations of jobs that were much more negative for gender equal workplaces," said Clark, pointing to the fact that women of his mother's generation in the U.K. were often forced to leave their jobs when they got married. "I did wonder if there would be some echo of [sexism]," he said. "The implications are **actually** quite jolly for once." [Researcher, article #127]

(9) involves three direct quotations given by the researcher. In contrast with research writing (the 'empiricist repertoire'), the researcher here uses several stance markers to offer a very different perspective on their work, including their thoughts, worries, and emotions. When communicated through this kind of stance language, communicating research is not simply reporting facts uncovered from a knowable world but expressing what one's worries, hopes, and attitudes were before, during, and after the process.

Similar examples can be found in the context of the imprecision adverbial *kind of*, which was more frequent in the researchers' talk. *Kind of* is particularly notable because it reduces the precision of statements, which would seem to be counterintuitive for the typically highly precise nature of research writing. Yet, the researchers still adopted it when discussing their work with writers. Example (10) illustrates two instances of this adverbial:

> (10) "It's a very simple idea. It's **kind of** one that's a little counterintuitive," Spoelma said. "And it, hopefully, **kind of** energizes research in this area and positive forms of gossip in organizations." [Researcher, article #123]

Like (9), the uses of *kind of* in (10) are also surrounded by other markers of stance, such as *hopefully, a very simple idea,* and more. These are perspectives less common (and perhaps less acceptable) in published research writing. Moreover, this study suggests that they are also not as frequent in writers' account of academic research. Adding such accounts of academic research contributes an alternative perspective on science that simply summarizing or directly quoting the originally published written work would not.

5. Conclusion

In this study, I sought to examine the ways that researchers' talk, introduced into science news articles by way of direct quotation, compares with the language of the writers of the articles in terms of stance expression. In doing so, I intended to contribute to the current literature on stance in popular science, as well as contribute novel observations by examining the different stances expressed *within* science news articles rather than between articles and genres. Below, I reflect on the findings presented in section 4 and what they might suggest about stance and communicating science to diverse audiences.

5.1. Researchers substantially contribute to the stance of science news articles

The counts of stance verbs, stance adjectives, stance adverbials, and modal verbs found in this study support the conclusion that the actors quoted in science news articles—typically subject-area experts like academic researchers—contribute substantially to the overall stance present in science news articles. Indeed, the language found within direct quotations (i.e., the researchers' talk) showed a greater use of four sets of stance features than did the language found outside of the quotations (i.e., the writers' prose).

The greater use of these stance markers in the researchers' talk suggests that these researchers were compelled to express stance when popularizing their research with science writers. There are several possible explanations for this. First, the nature of interviews likely played a role in their expression of stance. Thus far, I have presented the researchers' talk as the result of their personal desire or intent to express genuine stance, but this may not entirely be the case. Rather, it is likely that the nature of their interviews shaped the researchers' responses. Put another way, seeing such interviews as 'interview-as-social-practice' (McGregor & Fernandez, 2019) highlights the roles that each participant plays in constructing the recorded responses. The types of questions asked and the ways writers and editors incorporate interviewee quotes into articles may emphasize the researcher's stance. Second, register also plays an important role. That is, speech and writing are registers influenced by substantially different situational characteristics, so the spoken nature of many of the quotes shown in the news articles also impacts the amount and kind of stance expressed. Specifically, spoken contexts have been shown to produce a denser use of stance markers than written contexts (e.g., Biber, 2006, Ch. 5; Biber et al., 1999, Ch. 12), and this study further confirms this finding.

5.2. Researchers' talk uses many 'hedges' and 'boosters'

Various scholars have argued that science popularizers avoid hedging and increase boosting in order to make science more newsworthy (e.g., Hyland, 2010; Myers, 1989), while others have indicated that these writers may hedge in a similar fashion as research writing to convey a credible, scientific veneer (Fu & Hyland, 2014; Varttala, 1999).

The current study contributes to this discussion in two ways. First, science news articles, as one variety of popular science, are multi-voiced, containing

both the writer's stance and the stance expressed by quoted actors. Thus, the overall stance expressed in these articles must be considered in light of the different voices within them. Indeed, as section 5.1 summarized, the voice of the quoted researchers arguably contributed most substantially to the articles' overall stance. This alone complicates the notion that popular science, as a field adjacent to the 'genuine' producers of scientific knowledge, distorts science in order to make it more newsworthy (cf. Hilgartner, 1990).

Second, there is evidence that the greater amount of stance expressed by the researchers' talk includes its fair share of 'boosters', or stance expressions emphasizing certainty (Hyland, 2007). If we classify this study's stance features as those hedging and boosting claims (based on Hyland, 2005, 2007; see Appendix B for lists of this study's features), the picture becomes clearer. While the researchers' talk includes somewhat more hedging language than in the writers' prose (1012 phtw vs. 823 phtw), it includes substantially more boosters relative to the writers' prose (804 phtw vs. 424 phtw). Some of the primary drivers of this discrepancy is the greater use of stance verbs controlling *that* clauses, in which researchers express their perspectives using expressions like *I/we think/show/know that*….

Although stance expressions should be considered in their wider contexts for accurate interpretations of their functions in discourse (see, e.g., example (3) in section 4.1), the data presented here point toward researchers acting as co-participants in the construction of the 'newsworthiness' of science by contributing most substantially to the grammatical stance present in online science news articles, and suggests that the science writers offer limited expression of stance with regard to the features highlighted in this study.

5.3. Researchers' talk offers an alternative perspective on research activities

Finally, it is worth considering what the voices of subject-area experts add to science news articles. The most obvious function, which has already been noted, is that they add credibility to an article. Communicating science is a complex task requiring attention to myriad variables. Science, and academic research generally, is rarely written with lay readers in mind, so experts can help recontextualize their work for broader audiences while maintaining accuracy (Palca, 2006). But science stories often present more complications than just translating jargon. As the National Academies of Sciences,

Engineering, and Medicine (2017) highlights, the general public is often presented with conflicting opinions on scientific issues, so writers are also encouraged to include multiple different perspectives on a single topic in an article (Palca, 2006). In short, expert input is about more than fact-checking the writer's understanding.

This study supports the idea that expert voices in science news writing offer more than translating information. Indeed, the high frequency of stance language suggests that their discourse is laden with opinions, judgements, and attitudes. The fact that such perspectives come from researchers is interesting, given the stereotypically impersonal style of research writing (Halliday & Martin, 1996). However, previous work on the discourse analysis of scientists' talk has shown that experts can call on different discourse 'repertoires' for different purposes (Gilbert & Mulkay, 1984). For example, researchers can rely on more personal repertoires to critique others' work as originating from subjective factors like bias and incompetence (McKinlay & Potter, 1987).

In the context of science news articles, personal accounts of the actions and beliefs that constitute research activities are not used (mainly) to critique others' work but to personalize the otherwise impersonal nature of research reporting. The excerpts shown in this study show that researchers' talk often calls on evaluative language that is less frequent or less accepted in research writing. Thus, their presence in science news written for diverse audiences offers an alternative perspective on research activities that may, among other reasons, make reading about research more interesting and relatable.

5.4. Limitations

Though I believe that this study contributes to the relevant literature in useful ways, there are at least two related limitations to highlight, which relate to corpus-based research of stance and the set of stance features adopted here.

I adopted a fairly common approach to corpus-based research of stance in written discourse. I selected a finite set of stance features attested in previous research (e.g., Biber, 2006; Biber et al., 1999; Hyland, 2005, 2007) and then counted the rates of those features in a corpus of texts. While this approach has its historical support, it also offers only limited insight into the full range of stance expressions in discourse. As Hunston (2010, p. 3) notes,

> Evaluative language presents difficulties in analysis because there is no set of language forms, either grammatical or lexical, that encompass the range of expressions of evaluation. It is true that adjectives and adverbs frequently express evaluative meaning […] but this does not mean that every adjective and adverb marks evaluation or that all evaluation can be identified in this way. In fact, evaluation is frequently expressed cumulatively and implicitly.

Indeed, Biber (2006), the source from which this study's stance features were collected, states that some stance features are more explicit than others. Given the shape-shifting nature of stance in discourse, I adopted a conservative approach by examining only a limited set of explicit markers of stance. While this approach has its usefulness in quantifying stance, its drawbacks should also be acknowledged. For instance, discourse analysts (more skilled than I) could closely and manually examine the language of the researchers' talk and writers' prose reported on in this study and find incisive and insightful conclusions (e.g., Myers (1989), in my opinion, is an excellent example of this). Thus, future research may seek to take up this approach to complement studies like the current one.

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Appendix A

Stance futures used in the study (see Biber, 2006, pp. 92-93)

Complement clauses

Stance verb + (*that*) cl

Epistemic certainty
conclude, demonstrate, determine, discover, find, know, learn, mean, notice, observe, prove, realize, recognize, remember, see, show, understand

Epistemic likelihood
assume, believe, doubt, gather, guess, hypothesize, imagine, predict, presuppose, presume, reckon, seem, speculate, suppose, suspect, think

Attitude
agree, anticipate, complain, concede, ensure, expect, fear, feel, forget, hope, mind, prefer, pretend, require, wish, worry

Communication
announce, argue, assert, claim, contend, declare, emphasize, explain, imply, insist, mention, promise, propose, recommend, remark, respond, state, suggest

Stance adjective + (*that*) cl

Epistemic certainty
apparent, certain, clear, confident, convinced, correct, evident, false, impossible, inevitable, obvious, positive, right, sure, true, well-known

Epistemic likelihood
doubtful, likely, possible, probable, unlikely

Attitude/emotion
afraid, amazed, aware, concerned, disappointed, encouraged, glad, happy, hopeful, pleased, shocked, surprised, worried

Evaluation
amazing, appropriate, conceivable, crucial, essential, fortunate, imperative, inconceivable, incredible, interesting, lucky, necessary, nice, noteworthy, odd, ridiculous, strange, surprising, unacceptable, unfortunate

Modal verbs

Possibility/permission/ability modal verbs
can, could, may, might

Necessity/obligation modal verbs
must, should, have to, got to

Prediction/volition modal verbs
will, would, be going to

Stance adverbs

Epistemic certainty
actually, always, certainly, definitely, indeed, inevitably, in fact, never, of course, obviously, really, undoubtedly, without doubt, no doubt

Epistemic likelihood

apparently, evidently, kind of, in most cases/instances, perhaps, possibly, predictably, probably, roughly, sort of, maybe

Attitude
amazingly, astonishingly, conveniently, curiously, hopefully, even worse, fortunately, importantly, ironically, rightly, sadly, surprisingly, unfortunately

Style
according to, confidentially, frankly, generally, honestly, mainly, technically, truthfully, typically, reportedly, primarily, usually

Appendix B

Stance features expressing hedging and boosting (see Hyland, 2005, pp. 218-224)

Hedges

apparently, usually, generally, possibly, maybe
doubtful (that), likely (that)
assume (that), suggest (that)
could, may, might, should, would

Boosters

actually, always, certainly, definitely, in fact, indeed, never, no doubt, obviously, of course, undoubtedly, without doubt
believe (that), find (that), know (that), show (that), think (that)
certain (that), clear (that), sure (that), well-known (that)
must, will