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The Language of Uncertainty and Political Ideology of News Sources in Climate Communication

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Abstract

Communicating information about future events and outcomes is challenging when there is much uncertainty. This is evident in everyday discourse about climate change, including language in the popular media. What words are used to connote different degrees of certainty in varied news sources and how often do they occur? Different political ideologies vary when it comes to how they discuss issues around climate change. In this paper, we analyzed how progressive and conservative news sources express certainty when talking about climate change. We constructed a corpus of 18,906 news articles about climate change from 23 different news websites varying in political ideology. Our prediction was that if language use differs depending on the certainty represented for an issue, we should observe differences across news sources as a function of political ideology. The results show a bias in the expression of certainty, whereby progressive media show more certainty in linguistic form than do conservative media, providing insights into how language use reflects our underlying conceptual understanding of climate change. We discuss the implications of these results for conceptual models of language use and also applications to science communication.

Introduction

How do people talk about climate change, which is riddled with unknowns related to what will happen, when it will happen, and what impact it will have? Of interest to us is how uncertainty is conveyed in climate messages in the popular media. Given that climate change has become highly polarized, we are interested in possible differences across different political orientations. This paper explores the language of uncertainty and certainty in media associated with different political ideologies. We focus on the use of *will*, *must*, *should*, and *would*, modal auxiliaries that express varying degrees of certainty in discourse about future events. In such discourse, states, or outcomes, the modal auxiliary *will* is associated with a high degree of certainty, as in *Tom will give the lecture*. The word *must* is associated with less certainty, as in *Tom must give the lecture*. And the words *should* and *would* signal even less certainty, as in *Tom should give the lecture* (for discussion of the semantics of English modal auxiliaries and how they imply varying degree of certainty in English, see Collins, 1994; Fleischman, 1982; Frawley, 1992; Nuyts, 2006; Palmer, 2001; Papafragou, 2006; Portner, 2009; Sweetser, 1990). Gaining a better understanding of how issues surrounding climate change are described in the popular media, especially uncertainty, will give us a better understanding of what people's everyday conceptions of risk are, and how they reason about one of the most important issues faced by everyone.

In recent years, more and more research on climate communication is appearing (for review, see Moser, 2010; Nerlich, Koteyko, & Brown, 2010). Some studies focus on “high-level” questions, such which terms are used to frame the phenomenon itself (e.g., “climate change”, “global warming”) (e.g., Gann & Matlock, 2014; Jaskulsky & Besel, 2013; Sagi, Gann, Matlock, 2014). Other studies examine metaphors that frequent discourse about climate change

(for general discussion, see Lakoff, 2010; Larsen, 2011); for instance, adaptation strategies are framed as battles or races (Flusberg, Matlock, & Thibodeau, 2017).

Surprisingly little work has focused on the expression of uncertainty and risk in popular reporting of climate change, including how it varies across different political contexts. One reason for this variability is that journalists and scientists have very different ways of thinking and talking about uncertainty and risk. This naturally makes sense given that uncertainty and risk are abstract, a matter of degree, and therefore, difficult to characterize (see Ashe, 2013; Painter, 2013). Another challenge is that uncertainty and risk are discussed in different ways across cultures. Media reports in the US, for instance, focus on *problems* related to climate change, whereas in the UK, they focus on *solutions* (see Nerlich, Forsyth, & Clarke, 2012). In addition, words for expressing uncertainty and valence differ between Spanish and American English (e.g., words for negative valence are more common in Spanish media) (Bailey, Giangola & Boykoff, 2014). In the US, partisan biases shape how scientific findings are reported. For instance, conservative TV media tend to focus on uncertainty about the existence of human-caused climate change (Feldman, Maibach, Roser-Renouf & Leiserowitz, 2012). Here it is worth noting that frequent exposure to conservative media outlets leads to skepticism about climate change (Hmielowski, Feldman, Myers, Leiserowitz & Maibach, 2014). Despite these and other challenges in studying uncertainty in the media, it is useful to study particular linguistic forms that express uncertainty and their frequency across varied media sources. It is important to consider how specific linguistic content can affect reasoning (for general discussion of framing, see Chong & Druckman, 2007; Matlock, 2012). Some research suggests that even a tiny grammatical shift in political messages can differentially affect attitudes toward politicians and the probability of winning an election. Fausey and Matlock (2011) showed that attitudes toward

a politician and his likelihood of winning could shift from nothing more than a change in linguistic aspect, i.e., *was VERB+ing* versus *VERB+ed* (e.g., *was accepting hush money*, *accepted hush money*). In this same vein, the way climate messages are framed can cause people to form opinions that align with their own personal political preferences (see Boykoff & Boykoff, 2004; Boykoff, 2008; Entman, 1989; Gans, 1979; Kahan, 2015). They can also cause people to tune out and ignore critical climate information (see Patchen, 2010) or to alter their perceptions of risk (see Flusberg, Thibodeau, & Matlock, 2017). This has the potential to lead to a better public understanding of what climate change is and what can be done about it (see Morton, Rabinovich, Marshall, & Bretschneider, 2011; see also Spence & Pidgeon, 2010).

The framing of uncertainty in reporting scientific findings about climate change is challenging. How should uncertainty be interpreted by non-experts, including journalists and the general public? Science is naturally replete with uncertainty. The issue of scientific uncertainty can lead climate communicators to highlight either (1) an impetus to action or (2) a roadblock for mitigation, completely avoiding or delaying proactive regulations (Freudenburg & Muselli, 2013, Lewandowsky et al., 2014a,b). It is therefore important to better understand how language is actually used in news media, including linguistic markers of certainty and uncertainty, and to consider how these linguistic markers vary across political ideology.

This study specifically targets whether language about the future and the degree of certainty about climate change varies depending on a news source's perceived political ideology. Our study is observational because we constructed a corpus of published news articles and did not directly manipulate any variables. The issue of climate change provides a timely testbed for studying the semantics of certainty for a number of reasons. First, in the United States, there is a well-documented partisan divide between attitudes and opinions about the existence of climate

change and global warming. For example in a 2017 Gallup Survey including 1,108 adults found that 66% of Democrats and 18% of Republicans ‘worry a great deal’ about global warming/climate change (Norman, 2017). Second, as discussed, the framing of climate messages is known to cause people to form opinions that align with their political preferences (Boykoff & Boykoff, 2004). Third, climate discourse occurs frequently among different news sources across the ideological spectrum.

Our analysis of climate change discourse focuses on language about the degree of certainty about the future. We chose to examine the frequency of the modal auxiliaries *will*, *must*, *should*, and *would* in the entire body of text across different news sources because they are used to indicate varying degrees of certainty about future states, events, and outcomes. As suggested, *will* conveys much certainty, as in “It is very likely that hot extremes, heat waves and heavy precipitation events will continue to become more frequent” (IPCC, 2007), and *would*, less certainty, as in “About twice as much warming (0.2°C per decade) would be expected if emissions are within the range of the SRES scenarios” (IPCC, 2007).¹ Because there is less certainty expressed in the second example, it could lead to some measure of skepticism about how much warming could occur, or even about whether it would occur at all. Such language might also influence how much support people are willing to consider when it comes to policy. For example “Focused adaptation to climate change and/or economic development would provide greater health benefits at lower costs than climate mitigation policies” (“Report: Global Warming Policies May Be Bad For Your Health”, 2012; Goklany, 2012) or “If sunspots were responsible for the warming cycles, then there would be little justification for government money to subsidize the scientists to find ways to stop it” (Utley, 2009). Clearly, the context and

¹ The modal auxiliary *would* is also used for past habitual, as in “After walking us to school, Mom would walk back home” (see Comrie, 1976; Dahl, 1985).

truthfulness of such statements is critical to how people will interpret future outcomes. Here we analyze a large corpus analysis to see how subtle grammatical differences in language use may vary across political ideologies, with the ultimate goal of studying what impact it may have on reasoning.

It is possible that progressives and conservatives will not differ much in their lexical choices concerning certainty of events, which could mean little or no difference between the use of *will*, *must*, *should*, and *would*. However, differences in frequency of these modal auxiliaries suggest political bias influences not only higher level constructs like discourse, but can be indexed by lexical markers as well. The latter outcome is what we predicted, primarily for two reasons: (1) Given that conservatives are more inclined than progressives to reinforce the status quo (Eidelman & Crandall, 2012), we expected that conservative texts would be more likely to include proportionally more instances of uncertain language about the future, precisely, more frequent use of *would* and *should*, and (2) given that progressives are generally more inclined to be prospective and less pre-occupied with potential risks (Alterman, 2008), we predicted that progressive texts would be more likely to include proportionally more instances of certain lexical markers, i.e., increased use of *will* and *must*.

Importantly, the opposite direction of this effect could be found, where conservatives would express more *will* and *must* than *would* and *should*. The logic behind the competing hypothesis is that conservatives are more likely to express skepticism and uncertainty about issues surrounding climate change, and thus, they may need to overcompensate by expressing more certainty about their views than progressives. Indeed, to assure others they have the facts, using markers of certainty may help to persuade others even without concrete facts. This could also be to the results of progressives reporting scientific uncertainties more often than

conservatives. Medimorec and Pennycook (2015) recently reported results that support this alternative hypothesis, specifically, in the style of language used in scientific reports on climate change. Thus, the possibilities are (1) no difference in modal verb frequencies, (2) lexical markers of certainty higher for progressive media outlets, or (3) lexical markers of certainty lower for progressive media outlets. The main goal of this study is to see if there is a relationship, and to provide evidence for certainty and political-bias being indexed by lexical decisions.

Methods

Corpus Construction

We created a corpus of 18,906 climate articles from 23 different news websites based in the United States. All the articles we collected had been published between January 1, 2008 and December 31, 2012. Inclusion of a publication depended on whether or not the publication had high exposure (i.e., high circulation) and added ideological diversity to the corpus. All publications are accessible to the public through the Internet. All contained the phrase *global warming* or the phrase *climate change* in the body of the text. After we tokenized words and removed all misspellings and punctuation marks, we did tallies for *will*, *must*, *should*, and *would* in every article.

Ratings of Political Ideology

To quantify perceptions of political ideologies (i.e., how conservative or progressive) in our news sources (e.g., *National Review*, *Mother Jones*), we ran a survey on Amazon Mechanical Turk. A total of 206 English-speaking participants were asked whether they were familiar with or had read each publication. For affirmative responses, people were asked (on a separate page of the survey) to provide an ideological rating for the publication. The rating system was a 1-to-7

likert-style scale, where “1” corresponded to “*very conservative*” and “7” corresponded to “*very progressive*”. See Figure 1 for average political ideology ratings for each news source. The average political ideology rating for each news source was used in subsequent analyses. An important limitation of the ratings is that we did not require that participants were normal readers of the publication and therefore, the ratings are based on a general perception of the rated publication. Finally, it is important to note that the ratings are based on perceptions of political ideologies of participants familiar with the publications, and might not completely conform to a particular publication’s perceived affiliation.

Fig. 1. (Left) Mean political ideology ratings for the 23 news sources used in the corpus. Brackets provide total respondent count for each news source. (Right) Predicted counts for each word as a function of ideology rating. The x-axis corresponds to the ideology ratings where lower values indicate a more conservative rating and higher values indicate a more progressive rating. Error bars represent 95% confidence intervals.

Analysis and Results

For our analysis, the average unigram count for our corpus was 855.36 ($SD=955.18$). In our corpus, 14,005 articles had at least one instance of “will”, 4190 articles had at least one instance of “must”, 7156 articles had at least one instance of “should”, and 12,175 articles had at

least one instance of “would”. For articles with at least one instance of “will”, the average count of “will” was 4.29 ($SD=5.99$). For articles with at least one instance of “must”, the average count of “must” was 1.81 ($SD=2.06$). For articles with at least one instance of “should”, the average count of “should” was 2.03 ($SD=2.38$). For articles with at least one instance of “would”, the average count of “would” was 3.44 ($SD=4.12$). The unigram count represents the total word count across the entire article and does not consider adjacent words or additional lexical context information, i.e., concordance.

We used zero-inflated Poisson (ZIP) regression models to predict word count as a function of political ideology. Zero-inflated Poisson (ZIP) regression can be used to model count data with excess zero counts (Long, 1997). A ZIP model has two components: a Poisson count model and a logit model that is used to predict excess zeroes in the corpus that are not eligible for a true zero count. For example, if there was a zero count for the unigram “will” in an article, was this because the author chose to not use “will”, or were there other linguistic constraints that influenced the non-zero count of “will”? This is a difficult question to answer, and a ZIP model does not *directly* answer this question. However, a ZIP model does allow for a prediction of the probability of a non-zero count. The two components of the ZIP model are independent models, and therefore because we only have a detailed hypothesis tested using the count model, we omit the report of the logit model component for the current study. In other words, for the present study, we only interpreted the Poisson count model, which, when implemented in a ZIP model, does not require that the mean equals the variance, i.e., allows for overdispersion (Long, 1997). ZIP regression was implemented using the `pscl` R package (Zeileis, 2007). $\text{Log}(\text{total word count})$ was used as an offset variable to control for the high variability of total word count observed

within the corpus². The nature of data – word count with excessive zeros, does not meet the requirements of standard linear regression and therefore included our decision to implement ZIP models.

Word count estimate computation

To estimate predicted word count (PWC) as a function of ideology ratings we used the following computation,

$$\text{PWC} = \exp(\beta_{\text{intercept}}) * [\exp(\beta_{\text{coefficient}}) * \text{Ideology Rating}_{1-7}] * \exp(1 * \log(\text{total word count})). \quad (1)$$

Model fitting

We briefly describe the model fitting procedure here, but see appendix for details for statistical details about model fitting. For each modal auxiliary, we first tested a Poisson regression model against a null intercept model with no predictors using a chi-squared test on the difference of log-likelihoods. For both, the Poisson regression model was an improvement over the null model. We then tested the Poisson regression model against the ZIP model using a Vuong test (Vuong, 1989, see Greene, 1994). The Vuong test for both modal auxiliaries suggested the ZIP model was an improvement over the Poisson regression model. Finally, because it was possible for the count data from the corpus to be overdispersed (i.e., when the variance is greater than the mean), we tested the ZIP model against the zero-inflated negative binomial (ZINB) regression model. The ZINB model failed to converge when predicting logit model estimates for *Would*. However, for the converging models, the ZINB model was an improvement over the ZIP model. Because we did not get total convergence for all models, we decided to use the parameter estimates from the ZIP model in the present study. It should be noted that the parameter estimates from the

² For example code and data, please see: [at EC's request, this information has been omitted for anonymity]

convergent ZINB models were consistent with the parameter estimates from the ZIP models and the overall pattern of results do not change nor lose statistical significance.

Effect size measure

ZIP models do not allow for a straightforward computation of effect size so we created an adjusted likelihood-ratio-index, which is a type of pseudo adjusted R^2 measure (Mittlbock & Schemper, 1996).

$$\text{Adj-}R^2 = R^2 / [1 - \exp(2 \log L(\text{null model})/n)] \quad (2)$$

where,

$$R^2 = 1 - \exp\{2[\log L(\text{ZIP model}) - \log L(\text{null model})]/n\}. \quad (3)$$

Results

We report the results from the count model component of the ZIP models. Note that ZIP model coefficients reflect the count coefficient for *will*, *must*, *should*, and *would*. The predicted occurrence of *will* increased with progressive ideology ratings ($\beta = 0.03$, pseudo $\Delta R^2 = .004$, 95% CI = [0.02, 0.04], $p < .001$). The predicted occurrence of *must* did not vary across political ideology ratings ($\beta = -0.03$, pseudo $\Delta R^2 = .0007$, 95% CI = [-0.05, 0.002], $p = .07$). The predicted occurrence of *should* increased with conservative ideology ratings ($\beta = -0.09$, pseudo $\Delta R^2 = .005$, 95% CI = [-0.11, -0.07], $p < .001$). The predicted occurrence of *would* increased with conservative ideology ratings ($\beta = -0.04$, pseudo $\Delta R^2 = .004$, 95% CI = [-0.05, -0.03], $p < .001$). See Figure 1 for the count estimation results. An example entry of a news article from a source rated as highly progressive (*Think Progress*) using “will” is, “These stronger storms will bring higher winds and higher storm surges to coastal areas of Alaska and the Arctic over the remainder of the 21st century, resulting in increased erosion and flooding of low-lying areas” (Masters, 2011). An example entry of a news article from a source rated as highly conservative (*Fox News*) using

“would” is, “The waters would have a tempering influence on temperatures in the area, all of which weren't nearly as high as the record temperature” (“New World’s Hottest Temperature”, 2012)³.

Discussion and Conclusions

Our results indicate that climate change is discussed differently across news sources with varied political ideologies. Progressive news sources appear to have a greater proportion of certainty language (i.e., phrases with *will*), and conservative news sources appear to have a greater proportion of uncertainty language, i.e., phrases with *would* and *should*. This reveals a striking difference between the language use of certainty and uncertainty in the body of text of progressive and conservative media when discussing climate change. This would support the idea that conservatives news sources express less certainty about climate change, perhaps communicating the potential for many different possible events that could happen in the future.

The current study used zero-inflated Poisson (ZIP) regression modeling to predict word count in a large linguistic corpus. We chose to use this type of regression model because our corpus had a large proportion of zero-counts across the collection of news articles and was overdispersed. Many real-world count datasets, including word counts in news corpora, are characterized by overdispersion and high frequencies of zeros. Therefore, future work using linguistic corpora with similar data properties might consider using zero-inflated modeling and expand statistical techniques for parameter and effect size estimation.

Although some previous research has looked into the language of certainty in climate communication (Budescu, Broomell, & Por, 2009; Medimorec & Pennycook, 2015), those efforts targeted the specific language of the IPCC report rather than the language used in the

³ The first author handpicked the two examples after data analysis was completed to exemplify the overall pattern of results.

popular media. Our work provides preliminary evidence that the semantics of certainty vary as a function of news sources with differing political ideologies. These results are significant for developing future conceptual models of language use for representing certainty and how these decisions affect perceptions. For example, previous work has shown that manipulating grammatical markers can influence people's perceptions of important civic issues like the electability of a politician (Fausey & Matlock, 2011). There is a potential for many different grammatical markers interacting to influence political ideology or persuade people during argumentation. Future research on the different modal auxiliaries in different tenses and in different contexts might yield unexpected interactions and greatly influence people's political beliefs and ideological leanings.

It is important to emphasize that the results presented in the current study are specific to climate change discourse in the media. Other researchers have investigated the language in scientific reports and found differences in style across climate change proponents and skeptics. For example, Medimorec and Pennycook (2015) recently analyzed the language style of two scientific reports issued by the Intergovernmental Panel on Climate Change (IPCC) and the Nongovernmental Panel on Climate Change (NIPCC). The NIPCC was formed by the Heartland Institute, which is a conservative think tank. The authors hypothesized that the language styles of the two scientific reports would reflect consequences of the politicization of climate science. Specifically, the authors suggested that because climate change skeptics accuse climate scientists of being 'alarmists', climate scientists, and specifically, authors of the IPCC, are actually overly conservative (see Brysse, Oreskes, & O'Reilly, 2013). Medimorec and Pennycook found that IPCC authors used less certain language relative to NIPCC authors, such as using more tentative language and passive constructions. They also found that NIPCC authors used less formal

language relative to IPCC authors, for instance, a greater number of emotional words, highly frequent concrete words, and simpler syntactic structure. Medimorec and Pennycook's results point to a difference in the discourse goals of various publication outlets. The divergence of results across Medimorec and Pennycook's (2014) investigations into the language style of scientific reports and our investigations into news media outlets provide an interesting perspective on the normative role of uncertainty across discourse goals.

The observation that language style and levels of communicated uncertainty differ as a function of discourse goals across communicative media – news media outlets vs. scientific reports – points to an important challenge for consumers of climate change information. Kahan (2015) recently observed that consumers of climate change information across political identities perform equally on a climate science comprehension test that aimed to control for (and not invoke) a person's cultural identity and affective orientation towards climate change. This result points to the problematic competition between a desire to be a 'collective knowledge' acquirer and a 'cultural-identity' protector (Kahan, 2015). Indeed, this competition is likely enhanced (and not mitigated) by the news sources consumers choose to follow.

Future work on climate change communication in new sources could be done to expand the linguistic scope of the analyses presented here. The current study was only a preliminary analysis of a much broader area of potential research for assessing the certainty and uncertainty of an article's perspective of climate change. Our analysis simply investigated the frequency of particular modal verbs within news articles that mentioned "climate change" or "global warming". Despite these coarse-grained markers of certainty/uncertainty – frequency of items within a body of text – the predictors were reliable in our models, albeit with small effect sizes. Future work could combine lexical and semantic levels of analysis and pinpoint keywords and

topics associated with issues around climate change (e.g., storms, drought, extreme weather), and then investigate the occurrence of modal auxiliaries and other linguistic forms in a particular proximity. Greater attention could also be given to degree of certainty, for instance, by looking at a number of modals in English, for instance, *could*, *might*, and *may*. Moreover, future directions should include an in-depth investigation into topical statements that include specific modal auxiliaries. Finally, it is possible that the sources of certainty and uncertainty differ across political ideology and also that markers of certainty/uncertainty are consistent across a number of topics. Future directions should include a focused investigation of the stability of linguistic markers of certainty/uncertainty across political ideology and across specific topics.

This study explored the semantics of certainty in news reports about climate change. The news sources we analyzed varied in terms of political ideology. They ranged from conservative to progressive. Looking at degree of certainty in language about climate change is informative because political ideology is known to influence attitudes and opinions on climate change (Leiserowitz et al., 2014). These results have consequences for the public consumption of information about climate change. In particular, people who read progressive media are exposed to a greater amount of certain language about climate change and people who read conservative media are exposed to a greater amount of uncertain language about climate change. The next step will be to investigate the connection between people's perceptions of certainty of climate change issues via their preferred news source and the decision-making that unfolds as a consequence.

Table 1. Model fits for Poisson vs. Zero-inflated Poisson regression

Parameter	<i>Poisson Regression</i>		<i>Zero-inflated Poisson (ZIP)</i>	
	<i>Estimate</i>	<i>z-value</i>	<i>Estimate</i>	<i>z-value</i>
Will				
<i>Intercept</i>	0.84(.02)	48.79***	-5.62(.02)	-303.40***
<i>Coefficient</i>	0.07(.004)	19.39***	0.03(.004)	6.65***
2LL for Null Model < ZIP				***
Vuong test of Poisson < ZIP				-24.05***
Would				
<i>Intercept</i>	0.80(.02)	40.73***	-5.65(.02)	-259.91***
<i>Coefficient</i>	-0.002(.004)	-0.39	-0.04(.004)	-8.22***
2LL for Null Model < ZIP				***
Vuong test of Poisson < ZIP				-21.04***
Must				
<i>Intercept</i>	-7.79(.05)	-160.83***	-.49(.13)	-102.89*
<i>Coefficient</i>	0.03(.01)	2.75**	-0.03(.03)	-3.66
2LL for Null Model < ZIP				**
Vuong test of Poisson < ZIP				-11.22***
Should				
<i>Intercept</i>	-0.15(.12)	-1.28	-0.15(.12)	-1.28
<i>Coefficient</i>	-0.17(.03)	-5.90***	-0.09(.009)	-10.06***
2LL for Null Model < ZIP				*
Vuong test of Poisson < ZIP				-14.21*

***= p<.001, ** = p<.01, * = p<.05

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