

Testing Public (Un)Certainty of Science: Media Representations of Global Warming

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Paper: Introduction

Public understanding of science and technology is critical for a society increasingly affected by scientific developments and policies influenced by scientific expertise (Nelkin, 1987; Miller, 1986). For most citizens, knowledge about science comes largely through mass media, not through scientific publications or direct involvement in science. As Nelkin stated, the public understands science "less through direct experience or past education than through the filter of journalistic language and imagery" (1987, p. 2).

This is especially true for unobtrusive or "invisible" issues where a person lacks real-world experiential conditions that could help shape opinion and understanding, such as global climate change. Even if a person lives through "the hottest summer on record," record drought, or severe forest fires (weather events that occurred in the U.S. in 1988 and 2002), it is the media that attempt to connect such events to scientific evidence. Bell (1994) found that the media were the sole source of information on climate change for New Zealanders, and Wilson (1995) reported that the media (especially television) were the primary information source in the U.S.

For the phenomenon of global climate change (often referred to by journalists as global warming), communication research has focused on media portrayals, public opinion and understanding, and how both scientists and journalists construct scientific certainty and/or ignorance. However, research is lacking that directly tests audience responses to journalistic discourse – in particular the media's portrayal of (un)certainty – of global warming. That is the goal of this research.

Literature Review

Media Coverage of Science, Global Warming

Like news coverage generally, media reporting of science is tied to classic definitions of news and is often event-driven, using the occasion of a scientific meeting or publication in a major scientific journal to spur attention to an issue. According to Wilkins, science coverage emphasizes discoveries and "firsts in science," is tied to discrete events, and emphasizes an elite group of scientists (1993, p. 74). Often missing in science stories are the contexts (social, economic, political, and historical), as well as information about how science and the scientific process are conducted (Nelkin, 1987).

Other elements also play a role in bringing science news to the public through the mass media. Scholars have demonstrated that some scientists have "used" the media to advance their own careers or agendas (Nelkin, 1987; Dickson, 1984), or to popularize certain areas of science such as medicine (Logan, 1991). For the topic of breast cancer, Corbett and Mori (1999) identified two-way relationships between the amount of media attention, number of scientific journal publications, and medical research dollars. As Mazur and Lee (1993) found, human drama and other components of a "good story" play a part in bringing science topics to the news. They discovered that widespread media coverage of several environmental issues – ozone holes, global warming, rainforest destruction, and species extinction – was the result of the interplay of prominent news sources, extraneous events, attention by prominent national news media, and human drama, not primarily the scientific discoveries involved. Greenberg, Sandman, Sachsman, and Salamone (1989) similarly found that TV news coverage was more influenced by a story's dramatic value than the inherent risk, while McComas and Shanahan (1999) concluded that media narratives on climate change were driven by dramatic considerations.

Numerous studies have focused specifically on media coverage of climate change, including the role of reporters and story construction. In a study of print coverage from 1987-1990, Wilkins (1993) found underlying values of progress, innocence, and an institutionalization of knowledge in scientific and governmental bodies. She argued that these values reflect a dominant frame that emphasizes technological "fixes" for global warming rather than human behavior change. Trumbo (1995) conducted a longitudinal analysis of climate change coverage and discovered that reporting first peaked in 1988 and declined in the early 1990s; Ungar (1995) attributed this decline to the topic's lack of dramatic crisis. Coverage resurfaced on news pages beginning in late 1997 (Wilson, 2000).

In early reporting on global warming, scientists were the primary sources of information, but later, politicians and interest groups (both industry and environmental) entered the discourse (Trumbo, 1996). Wilkins (1993) reported that even by 1990, the balance of sources cited in global warming stories had shifted from scientists to politicians and interest groups. A shift in the discussion from one dominated by science to one in the policy and industry arenas may have contributed to the confusion – both by reporters and the public – regarding the certainty of climate change (Williams, 2001).

In a study of reporters' knowledge of global climate change, Wilson (2000) found that many reporters were confused about the basic science involved and the scientific certainty of the greenhouse effect. Reporters who primarily used scientists as sources and who worked the science or environment beat full-time had the most accurate climate change knowledge. Bell (1994) identified several different types of inaccuracies in climate change reporting: scientific or technical inaccuracies, misquotations, significant omissions, exaggerations, and distortions of emphasis. Tankard and Ryan (1974) documented that science reporting overall had greater numbers of errors and inaccuracies than did general news reporting.

Public Understanding of Global Warming

Public awareness and understanding of global warming has increased dramatically over the last two decades. Questions about climate change appear more frequently on surveys about environmental and social issues and have become popular topics for social science research. For example, an issue of *Public Understanding of Science* in 2000 was devoted to social science research on climate change.

According to Bord, O'Connor, and Fisher (2000), surveys of public attitudes toward global warming have revealed several patterns: "public concern, particularly for the future; beliefs in specific negative outcomes such as ocean level rise, more frequent storms, and possible water shortages; and general agreement that this is a serious or potentially serious problem" (p. 205). But research also has documented the limits of public concern and knowledge, as well as fluctuations in concern and apprehension. Ungar (1992) noted that public anxiety peaked in hot, dry summers (as did media attention). Krosnick, Holbrook, and Visser (2000) showed that the debate surrounding the Kyoto treaty attracted people's attention and strengthened their beliefs and attitudes, however, produced almost no changes in public opinion.

In 1981 only 38% of the public had heard of global warming, which increased to 40% by 1987, to 86% by 1990 (polls reported by Trumbo, 1995), and to near-saturation levels of 88% in 1997 (Stamm, Clark, & Eblacas, 2000). When respondents are asked if they believe global warming is real, lower percentages have been reported. A survey by the National Science Foundation in 2001 found that 77% of adults believed that global warming was real, a percentage that increased according to level of education ("Public belief in global warming," 2001). A Gallup poll in March 2001 found that 61% of respondents believed that the phenomenon was occurring, up from 48% in 1997 ("Gallup polls on environmental issues," 2001).

The numbers are lower still for people's understanding of the scientific process of global warming. Bord, O'Connor, and Fisher (1998) concluded that global warming is poorly understood by the public and is not a salient issue for them. Stamm, Clark, and Eblacas (2000) found that

people were aware in a general sense of global warming but had a limited understanding of the particular causes, possible consequences, and solutions. The good news, they reported, was that both mass media and interpersonal communication appeared to make a positive contribution to understanding, although it also helped perpetuate some popular misconceptions. In a later study, Bord, O'Connor and Fisher (2000) attempted to assess the importance of actual knowledge about global warming in explaining people's intentions to do something about it; they reasoned that an intent to behave responsibly requires a concrete knowledge of causes. In their large survey of Americans, they found that knowing what causes climate change and what does not was indeed the most powerful predictor of stated intentions to take voluntary actions.

So why, if public awareness is so high, are understanding and certainty so low? Ungar (2000) hypothesized that as an issue global climate change lacks the currency and day-to-day relevance necessary to motivate individuals to obtain information. He argued that there is an "attention economy" in which scientific claims must compete, and when "entry costs" are high, individuals need to be motivated to undertake scientific literacy. When it came to understanding the ozone hole, people could easily understand the metaphor of dangerous rays penetrating an ozone shield, and could personally and immediately apply the pragmatic advice about sunscreen and exposure. Although individuals may be motivated to learn about global warming as "good citizens," Ungar said the issue is presented as future-oriented and lacks "social utility of knowledge," or is not information that is in demand in particular social situations. The Communication and Perception of Certainty

From the research on media coverage of global warming and public understanding of it, we can conclude that media attention has ebbed and flowed, and that journalists themselves are not well versed in the science of global warming and at times have injected more uncertainty or controversy than was warranted. It is not surprising, then, that while public awareness of global warming has increased dramatically, so has public confusion. Media coverage of this issue has not found resonance and immediate pragmatic utility for the public as other environmental issues have.

A growing number of scholars have begun to focus not just on certainty and "knowledge" but also on "ignorance," particularly as it relates to science (Smithson, 1993). Broadly defined, "ignorance" can include an absence of knowledge, uncertainty, incompleteness, bias, error, and irrelevance (Stocking & Holstein, 1993). While a key goal of the scientific process is to whittle away at ignorance study by study, built into scientific practice are a variety of legitimated uncertainties, such as interpretive claims, site or subject selection, and acceptable levels of statistical error. Some have argued that assessments of certainty and scientific "fact" originate in the social world (Pinch, 1981), and that representations of certainty do not reflect a given "reality" or state of objective knowledge but are constructed in particular situations and with certain effects (Shackley & Wynne, 1996, Stocking & Holstein, 1993). For matters of controversial science, various scientific factions may actually use uncertainty as a rhetorical tool (Dunwoody, 1999). As Einsiedel and Thorne (1999) maintained, "Uncertainty is a social construction, one that is negotiated among actors in a social system that includes various publics. Seen in this light, uncertainty is manifested by individuals in a number of different ways, for different reasons, and with varying outcomes" (p. 44).

When journalists report scientific work, they have the discretion to pass along the caveats and uncertainty claims presented by the scientist, or to exclude such claims. As noted by Shackley and Wynne (1996), when the consequences of science have significance for a range of policy actors, "the scientific community no longer has full autonomy to decide whether and how scientific uncertainty is presented to outsiders" (p. 278), such as the press. In the case of global warming, reporters have both overplayed and underplayed the level of certainty attached to particular findings (Zehr, 2000; Wilson, 2000). In his analysis of popular press articles about global warming from 1986–1995, Zehr maintained that scientific uncertainty was used to maintain a rhetorical boundary between scientists' and lay knowledge about climate change.

If we recognize that journalists play a role in the presentation of scientific uncertainty to the public, in what specific ways is uncertainty conveyed in news stories? Researchers have suggested a variety of factors, such as the omission of scientific caveats, single-source stories, giving equal weight to fringe and non-scientists as much as scientists, focusing on novel research and drama, and popularizing science (Stocking, 1999; Zehr, 2000; Dearing, 1995). Rogers (1999) asked focus group participants to read or view news stories about AIDS and global warming and to discuss story characteristics that inhibited their understanding. Participants mentioned insufficient information, lack of context, story structure, visuals, and story framing. Two factors seem to have gained particular notice for their ability to convey uncertainty in science stories: the use of controversy and the lack of context.

Scientific uncertainty can be constructed by interjecting or emphasizing controversy or disagreement among scientists. Not only does conflict fulfill traditional news values and add drama, it may provide journalists with a pretext of objectivity by presenting multiple sides. Zehr (2000) argued that "controversies tend to make dramatic reading and often are important to public concerns. On occasion, journalists may develop controversy where none previously existed, or sustain it by soliciting opposing arguments by expert scientists" (p. 86). This practice has been interpreted as a means to construct journalistic objectivity and for creating drama in one's account (Stocking & Holstein, 1993).

When sources offer conflicting claims, reporters use one of two strategies: try to be objective or try to balance the story (Dunwoody, 1999). The result of the routine media practice of quoting conflicting "sides" may be to treat the various scientists and the sides they represent as having equal weight, even though the majority of evidence or opinion may fall clearly to one side (Stocking, 1999) or one side may consist of industry-supported or otherwise fringe scientists (Wilkins, 1993). Dearing (1995) noted in his analysis of media reporting on "maverick science" that the journalistic function of "balance" functioned to make the fringe claims more credible. As Stocking (1999) concluded: "Sometimes, particularly in science addressing contentious public issues, journalists have been found to pit scientist against scientist, with little discussion of the reason for disagreements, and often without mention of the relative degree of scientific acceptance of the differing views. The resulting accounts of science give equal, but unequally deserving, weight to 'dueling experts,' thus making the science appear more controversial and more uncertain than the bulk of scientists believe it to be" (p. 29).

Media coverage can send the message to readers and viewers that the science is uncertain without ever mentioning the word uncertainty in stories. All that may be necessary to deliver that perception are competing scientific views without any sense of how the evidence lines up (Dunwoody, 1999). The message of the traditional balanced account may be, "Well, who knows what's true?" even when a story reports on a controversy in which both science and society have agreed that truth lies more firmly on one side than on the other. Wilson (2000) concluded that journalists have done just this in the coverage of climate change, accentuating the scientific debate by creating "an ersatz balance" (p. 11) and underplaying the consensus that exists.

Another factor that may influence the certainty with which scientific results are treated in media stories is the lack of context (Rogers, 1999; Dearing, 1995). When a new study departs from or extends prior research, or represents a flip-flop that appears to contradict prior findings (Stocking, 1999), journalists need to provide historical context within the body of scientific knowledge. Tankard and Ryan (1974) cited "continuity of research with earlier work ignored" (p. 221) as a primary problem in science reporting. Wilkins (1987) noted that coverage of events are often stripped of their social, economic and political context.

Although scholars have pointed to controversy and a lack of context for heightening uncertainty surrounding uncertain science, do these factors actually affect uncertainty in the minds of readers? So far as we know, no one has tested or isolated these factors and tied them directly to audience perceptions of uncertainty. As Van Dommelen (2002) concluded, a pragmatic and fundamental methodology for understanding scientific (un)certainty in different

practical contexts needs to be put in place. While the current research into uncertain science and the media presentation of it has provided a rich background, crucial missing links are tests of factors that might contribute to or inhibit perceptions of uncertainty in the minds of readers.

If we extend the findings of media content studies to media audience perceptions, we would expect controversy in a global warming story to decrease certainty about global warming, while context in a global warming story should increase certainty. As an initial test of these largely unexplored factors, we hypothesized the following relationships of controversy and context to readers' perceptions of scientific (un)certainly about global climate change.

Hypothesis 1: The readers of newspaper stories that include context will be more certain of scientific claims (contained in the story) than those who read the article with controversy only.

Hypothesis 2: The readers of newspaper stories with both context and controversy will have more certainty than controversy alone, and less certainty than context alone.

One final factor to isolate and explore is the relationship between environmental ideology and perceptions of uncertainty regarding global warming. Bord, O'Connor, and Fisher (2000) surveyed 1,218 Americans to investigate what drove their behaviors and intentions to address global warming with personal actions. They reported that "general pro-environment beliefs and perceptions" helped explain behavioral intentions (p. 205). Other researchers also have found measures of environmental ideology related to pro-environmental stances or intentions (Beedell & Rehman, 2000; Corbett, 2002; Grob, 1995; Trumbo & O'Keefe, 2000). It is reasonable to assume that individuals who identify themselves as having a stronger environmental ideology will have a stronger prior certainty about global warming. However, when asked to rate the certainty portrayed within a particular news story about global warming, we would expect these individuals to likewise be affected by the treatments and ! rate uncertainty accordingly.

Hypothesis 3: The stronger the individuals' environmental ideology, the stronger their prior certainty about the existence of global warming. Methods Operationalization

Experimental design provided the most appropriate test of the hypotheses because it enabled us to test degree of certainty with different manipulations, here, news stories that included controversy, context, both controversy and context, and neither controversy nor context (control group).

The four treatment stories were based on actual scientific findings that were reported about four months prior: a scientific journal published a study by scientists who found that a portion of the Antarctic ice sheet was thickening. This subject was chosen because it introduced uncertainty about global warming (since the thickening of ice would be counterintuitive to the presence of global warming), providing a more stringent test of the effects of controversy and context.

Information for the controversy and context treatments was gathered from other news articles about studies conducted on the Antarctic ice sheet and was integrated into the news article about the ice-thickening study to be as realistic as possible. "Controversy" was operationalized according to journalistic standards and involved a paragraph that presented scientists who disagreed with the journal article findings. "Context" was operationalized by the inclusion of a paragraph that put the journal article findings in context with a wider body of research, including previous studies that had found Antarctic ice to be thinning. The controversy and context treatment included both paragraphs.

All of the treatments were designed to resemble an actual newspaper story in layout and text format. The affiliation of the reporter was listed as Associated Press. Each story treatment had approximately the same amount of text. Because the controversy and context treatments each involved an additional paragraph, story length was equalized in shorter story treatments by

including "boilerplate" material about the ice sheet and simple facts related to its size and formation. Administration

The surveys were administered to two undergraduate communication classes at the University of Utah on March 13 and 14, 2002. This convenience sample was considered to be appropriate for two reasons. First, belief in global warming increased with level of education in a National Science Foundation survey ("Public belief in global warming", 2001), which we were able to control with this sample. Second, because we could find no prior tests of readers' perception of scientific uncertainty based on news story construction, this study could be considered exploratory and a convenience sample is more acceptable.

Each student received a clasped envelope with the consent form taped on top. After a brief oral introduction of the study, students were asked to read and sign the consent form before opening the packet, reading the news story, and answering the short survey. Treatments were randomly distributed in each class. Of the 209 participants, 54 students received the controversy treatment, 51 students received the context treatment, 51 students received the controversy-and-context treatment, and 53 received the control treatment (neither controversy nor context). To maintain anonymity, consent forms were collected separately from completed surveys.

Responses of the two undergraduate communication classes did not significantly differ ($F = .004$, $p = .95$) for any of the hypothesized variables.

The survey consisted of 19 questions, four of which generated demographic information. All other response choices were presented as six-point Likert-type scales. Two questions tested the dependent variable of scientific certainty (scaled, $\alpha = .71$):

"According to this news story, global warming is a scientific certainty."

"In this article, scientists are unsure whether global climate change is occurring." (scaling reversed)

Respondents' environmental ideology was operationalized with four questions used repeatedly in the U.S. General Social Survey that have demonstrated validity as tests of environmental opinions and attitudes (scaled, $\alpha = .61$):

"When humans interfere with nature, it very rarely produces bad consequences." (scaling reversed)

"Economic growth should be given priority even if the environment suffers to some extent." (scaling reversed)

"Would you say that the amount of money we spend as a nation is too little, too much or about the right amount?" (scaling ordered)

"The balance of nature is delicate."

For Hypothesis 3, one question at the end of survey assessed prior certainty:

"Before you read this article today, how sure were you that global climate change was taking place?" Results

Figure 1 presents the results of the first two hypotheses. The treatments differed significantly in terms of perceptions of certainty (One-way ANOVA, $F=12.59$, $p=.00$). The means are in the expected direction, with context producing the highest level of certainty regarding global warming in the story and controversy producing less certainty. Readers of the control treatment about the thickening ice (without controversy or context) were least certain about global warming. In this case, introducing controversy meant quoting scientists who disagreed with the thickening-ice hypothesis, or who in other words supported the existence of global warming.

As predicted in Hypothesis 1, readers of newspaper stories that included context were more certain of global warming than those who read stories with controversy or stories with neither context nor controversy (control). The average certainty rating by readers of the context treatment was 4.1 (6 being the most certain), which differed significantly (Bonferroni post-hoc comparison test, $p=.00$) from readers of the controversy treatment, which was 3.1. Readers of the context treatment also rated certainty significantly higher ($p=.00$) than readers of the control treatment (mean=2.7), but did not differ significantly from the combined controversy-context treatment.

Hypothesis 2 predicted that readers of newspaper stories with both context and controversy would perceive their story as more certain than controversy alone, and less certain

than context alone. While the means are in the expected positions, the differences between them were not significant. The controversy and context treatment did differ significantly from the control treatment (neither controversy nor context) (Bonferroni post-hoc comparison test, $p=.00$).

Tests of the third hypothesis found a significant positive correlation between environmental ideology and prior certainty about global warming ($r=.35$, $p=.01$). There was, however, a slight interaction effect between treatment and environmental ideology upon certainty as portrayed in the news stories ($F=1.64$, $p=.03$), suggesting that environmental ideology (and perhaps existing knowledge) mitigated in some way the affect of the treatments on readers' perceptions of certainty. However, environmental ideology did not have a main effect on the dependent variable of certainty expressed within the news story, which suggests that respondents were able to differentiate to a certain degree between their prior certainty about global warming and certainty as portrayed in the treatments. No other interaction or main effects were discovered for certainty and political ideology, environmental activism, age, gender, newspaper readership, or number of hours worked per week.

Discussion

While researchers have inferred from content studies of media coverage of global warming the ways in which uncertainty is constructed and conveyed by scientists and journalists, an important piece of the puzzle is whether these uncertainties are apparent to readers. This research was an initial attempt to test whether simple, common elements in news stories – controversy and context – influenced readers' perceptions of scientific uncertainty.

In our experiment, the inclusion of contextual information significantly contributed to readers' certainty of the scientific claims contained in the story. Context is obviously important for assessing any complex issue, scientific, political or social. But in many ways, journalistic news routines work against the inclusion of context. For example, the story we used to construct our treatments most likely was the result of publicity sent to the media by the scientific journal where the study appeared. It would be unlikely that a reporter would spend much extra time (particularly if there were no full-time science or environmental reporter on staff) to educate him/herself in order to be able to put this one study in context. As Wilson (2000) pointed out, many journalists – even members of the Society of Environmental Journalists whom he surveyed – lack sufficient background knowledge of global climate change. Wilson found that reporters were confused, exaggerated the debate, and underplayed the consensus around global climate change, making it unlikely they could accurately convey scientific context.

An anecdotal posting from a member of the SEJ list-serve in the fall of 2001 exemplifies this. The reporter wrote:

"One of our editors implored me to 'not treat global warming as if it is definitely going to happen.'...Is it or is it not true that the overwhelming scientific consensus around the world is that global warming will be a reality.....Or is there not yet a consensus?"

Our test of controversy influenced readers' perception of scientific uncertainty. Ordinarily, one would expect the introduction of controversy to heighten uncertainty. However, because we chose an authentic scientific study that made global warming appear extremely uncertain (ice getting thicker rather than thinner), our introduction of controversy (scientists who found the opposite – ice thinning) resulted in less uncertainty. It would be interesting to repeat the experiment with the opposite finding – ice thinning – and compare the results of controversy on readers' perceptions.

The long-standing journalistic tradition of bringing in opposing "sides" is an attempt to provide balance and objectivity. However, it is problematic to introduce dissent into an area where science largely agrees, particularly for readers unable to evaluate where the balance of evidence lies. Wilson (2000) argued that "By creating an ersatz bala

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