Article

Contested Science in the Media: Linguistic Traces of News Writers' Framing Activity

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Abstract

Science reporting in the media often involves contested issues, such as, for example, biotechnology, climate change, and, more recently, geoengineering. The reporter's framing of the issue is likely to influence readers' perception of it. The notion of framing is related to how individuals and groups perceive and communicate about the world. Framing is typically studied by means of content analysis, focusing primarily on the "stories" told about the issue. The current article, on the other hand, springs from an interest in writer behavior. I wish to investigate how news writers strategically exploit their rhetorical competence when reporting on contested issues, and I argue that text linguistics represents a fruitful approach to studying this process. It is suggested that genre features may serve as a basis for identifying key framing locations in the text, and that the notion of evaluation plays an important part in writers' framing activity. I discuss these aspects through a case study involving six news reports on a geoengineering experiment.

Keywords

Science communication, news discourse, framing theory, text linguistics, genre, evaluation

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> For most people, the reality of science is what they read in the press. They understand science less through direct experience or past education than through the filter of journalistic language and imagery. The media are their only contact with what is going on in rapidly changing scientific and technological fields, as well as a major source of information about the implications of these changes for their lives.
>
> —Nelkin (1995, p. 2)

The two decades that have passed since this observation was made have seen the rapid development of new information and communication channels for mediating science issues to nonexpert audiences, such as the blog network ScienceBlogs (scienceblogs.com; see also Colson, 2011; Luzón, 2013) and initiatives like the university-based scientific news portal Futurity (futurity.org). However, traditional media sources such as newspapers still seem to represent important providers of news to the general public (e.g., Pew Research Center, 2013), and the material analyzed in the current study belongs in this category. Science reporting by the media often involves complex and contested issues characterized by risk and uncertainty. In addition, economic, political, and ethical aspects as well as even broader social and values-based considerations may be involved. Cases in point are nuclear power (e.g., Bickerstaff, Lorenzoni, Pidgeon, Poortinga, & Simmons, 2008; Peoples, 2014), nanotechnology (e.g., Cobb, 2005; Cutcliffe, Pense, & Zvalaren, 2012), biotechnology (e.g., Holmgreen & Vestergaard, 2009; Nisbet, Brossard, & Kroepsch, 2003), climate change (e.g., Boykoff, 2011; Trumbo, 1996), and, more recently, the related phenomenon of geoengineering (Shepherd et al., 2009; see below for further references). The news reporters' mediation—or, more specifically, their particular framing—of the issues is likely to have an impact on how readers perceive them. The importance of such issues to the future of humanity makes it particularly relevant to study the interaction of science and society as negotiated between news writer and readers. The current article wishes to study such framing activity by means of a text linguistic approach, focusing specifically on the news writer's perspective.

The notion of framing is related to how individuals and groups perceive and communicate about the world. Research on perception (e.g., Spence & Pidgeon, 2010) has demonstrated that events and issues are not experienced in the same way by all involved parties. What are perceived as the important aspects of the event/issue will depend on a range of contextual factors. In his seminal article on framing, Entman (1993) states,

> To frame is to *select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and /or treatment recommendation* [italics original] for the item described. (p. 52)

From a writing perspective, framing may thus be considered as a process that implies a strategic (conscious or subconscious) choice of angle (frame) by the text producer. The chosen framing implies selecting specific aspects of the issue/event at hand, making these particular aspects salient to readers. Considered in this perspective, framing clearly relates to persuasion. It thereby shares concerns with classical rhetoric, for example, the notion of special topic, which deals with the specific content of an argument through deliberative, forensic, or epideictic oratory. Fahnestock (1986) shows how scientific knowledge, presented through forensic (validating) arguments in scientific reports, is accommodated in popularized accounts to a new rhetorical situation through a shift to mainly epideictic (celebratory) rhetoric. However, with contested scientific issues of the kind mentioned above, there may also be traces of deliberative rhetoric (involving choice and preferred action). As media play such a vital role in science communication (cf. the quote from Nelkin, 1995, rendered above), journalists' framing of these issues is likely to have a substantial impact on public opinion and ultimately action or nonaction related to the issues.

Studies on framing have been undertaken in various disciplines and epistemological contexts, even though different scholars have different understandings of the concept/term (de Vreese, 2005; Entman, 1993; Vliegenthart & van Zoonen, 2011). Entman (1993) observes that "[d]espite its omnipresence across the social sciences and humanities, nowhere is there a general statement of framing theory that shows exactly how frames become embedded within and make themselves manifest in a text" (p. 51). While framing may also take place through visuals (e.g., Bednarek & Caple, 2012; Oddo, 2013), verbal representation is the key focus in most framing studies (see the next section for examples).

The current study is to some extent inspired by the frustration I as a text linguist have experienced when reading interesting and well-argued discourse-based framing papers emanating from other research traditions (see the next section for some examples). Always hoping to find details of the elements considered in the analysis, I eventually came to realize that as a text linguist primarily interested in the text producer's point of view and by implication the linguistic traces of framing activity, I would have to deal with the notion of framing by means of my own research tools. I therefore here focus on writer behavior and argue that text linguistics offers a systematic approach

to addressing the question of how frames "make themselves manifest in a text" (Entman, 1993, p. 51). A text linguistic approach will enable a more fine-grained analysis of individual texts (e.g., considering attitudes expressed in sources' statements and the journalist's framing of these) than allowed for in traditional framing studies undertaken by means of content analysis or survey-based studies (see below).

Thus, based on linguistic principles pertaining to the macro level (text structure/genre) and the micro level (sentence and word), text linguistics seems particularly well suited to study how writers exploit available linguistic resources for framing purposes.[1] More specifically, I intend to approach this issue by considering, first, framing location. While framing clearly may take place by means of linguistic choices made by writers throughout the text, which locations are likely to be particularly important for framing? Second, I consider framing indicators. How are linguistic resources exploited to make certain aspects of the issue salient to readers? The article suggests that genre features (e.g., Bell, 1991; Berkenkotter & Huckin, 1995) may serve as a point of departure for identifying key text locations involving framing activity (see also Tankard, 2001), and that the notion of evaluation (e.g., Hunston & Thompson, 2000; Martin & White, 2005; White, 2012) plays an important part when writers engage in such activity. I discuss these aspects through a case study involving six news reports on the contested phenomenon of geoengineering, and thus, by implication, climate change. The reports all relate to the same "trigger event" (Buck, 2013), the publication of a scientific article. In this respect, the case study may be considered as a naturally occurring framing experiment and hence very well suited to undertake a framing analysis as recommended by Entman (1991):

> Comparing media narratives of events that could have been reported similarly helps to reveal the critical textual choices that framed the story but would otherwise remain submerged in an undifferentiated text. Unless narratives are compared, frames are difficult to detect fully and reliably, because many of the framing devices can appear as "natural," unremarkable choices of words or images. (p. 6)

My material thus allows for such a comparison, including some considerations related to intertextual borrowing, through comparison with two "trigger texts" (the scientific article and a press release; see the case study below for details).

As the framing literature is so extensive, the literature review section for reasons of space mainly focuses on studies dealing specifically with climate change and geoengineering. Next, I outline the proposed text linguistic

approach to framing. I then go on to illustrate the application of such an approach through the case study. A concluding section assesses the contribution that text linguistics may offer to framing research and points to aspects to be considered in future studies.

Framing Studies Involving Climate Change and Geoengineering

Framing studies are particularly prevalent within media and communication science (see Anderson, 2009, for an overview) and political science (e.g., Chong & Druckman, 2007). The intention in such studies is broadly speaking to unveil—typically by means of the quantitative method of content analysis—patterns of meaning in the text material under study. From such research, we gain insight into how society or specific groups within it "talk about" a particular issue. The patterns observed are linked to the stories and participants in the debate and are valid for specific locations (local/national/global) and periods in time. An alternative approach is cognitively based framing research, where psychological experiments and survey studies have been able to demonstrate, inter alia, differences in effects on respondents to similar or apparently equivalent linguistic expressions. The alternatives *climate change* and *global warming* are cases in point (Schuldt, Konrath, & Schwarz, 2011; Whitmarsh, 2009; see also Cockerill, 2003). Koteyko, Thelwall, and Nerlich (2010) undertake a quantitative and qualitative linguistic investigation of what they term creative carbon compounds (e.g., *carbon footprint*) and their role as framing devices. Other linguistically oriented framing studies are found within the tradition of critical discourse analysis. Many of these studies involve climate change in the news (e.g., Boykoff, 2011; Carvalho, 2007; Olausson, 2009).

Much more recently, the closely related phenomenon of geoengineering has started to attract scholarly—and public—attention (Corner, Pidgeon, & Parkhill, 2012; Pidgeon et al., 2012). Geoengineering has been defined as *deliberate large-scale intervention in the Earth's climate system, in order to moderate global warming* (Shepherd et al., 2009). The techniques involved are divided into two main categories. The most controversial is solar radiation management, intended to make the Earth absorb less solar radiation. The other, involving carbon dioxide removal, comprises a range of more or less controversial techniques to remove CO_2 from the atmosphere. Among these we find ocean iron fertilization. This specific technique is the topic of the texts discussed in the case study (below). So far, few framing studies of news discourse related to geoengineering have been undertaken. Published studies that I am currently aware of are Nerlich and Jaspal (2012), a qualitative

exploration of the framing of geoengineering through metaphors; Luokkanen, Huttunen, and Hildén (2013), a qualitative/quantitative study investigating to what extent the light a technology is presented in ("for"/"against"/"neutral") has an effect on the choice of metaphors; Buck (2013), a quantitative content analysis of voice and authority in media texts on geoengineering and the storylines that emerge; Porter and Hulme (2013), a qualitative study identifying key media discourses on geoengineering since the term started to appear in the U.K. press; and Scholte, Vasileiadou, and Petersen (2013), a qualitative/quantitative study undertaken to identify the common news frames posited for geoengineering, also considering whether the diversity in frames becomes greater or smaller during the observed period (2006-2011).

In addition to the already noted divergence in the understanding and application of the notion of framing, another problematic aspect of framing research is the lack of compatibility across studies in terms of suggested frame categories (de Vreese, 2005; Hertog & McLeod, 2001). Each new study tends to develop its own more or less unique frame set. In an attempt at developing a more unified application of framing as a process, de Vreese (2005) suggested a media frame typology consisting of generic and issue-specific frames. Porter and Hulme (2013), however, make the observation that "[e]ven in the seemingly unique context of geoengineering, journalists employ similar framings to those used for a diverse range of other issues" (p. 351). Several of the frames that have been posited for geoengineering are of a clearly generic nature, for example, *innovation* and *economics* (Porter & Hulme, 2013), *ambivalence, benefits for society*, and *norms & values* (Scholte et al., 2013), and *war and fight* (Luokkanen et al., 2013). Others, like *controllability* (Luokkanen et al., 2013) and *messing with nature* (e.g., Corner, Parkhill, Pidgeon, & Vaughan, 2013, a survey-based study of public perceptions), tend toward the issue-specific, even if they, too, may apply to other issues than geoengineering, for example, nuclear power and biotechnology. Perhaps the clearest proposed label for a geoengineering-specific frame is *plan B* (posited as an independent frame in Nerlich & Jaspal, 2012, as a subframe of the *controllability* frame in Luokkanen et al., 2013, and as a subframe of the *avoiding catastrophe* frame in Scholte et al., 2013). The issue of frame categories will be further considered below.

A Text Linguistic Approach to Framing

Content analysis and metaphor studies (uncovering the "stories" told), experiments and surveys (showing how the "stories" are being perceived), and critical discourse analysis (focusing on ideological effects on discursive practices) are obviously relevant analytical approaches to studying framing. However, I believe that a text linguistic approach can add to our

understanding of framing by providing insight into how writers exploit their rhetorical competence to strategically frame the issue at hand in the communicative context within which they operate.

Irrespective of methodological approach, a crucial first step in any empirical study is to define the relevant units of analysis. According to Entman (1993), the framing researcher needs to look for "the presence or absence of certain key words, stock phrases, stereotyped images, sources of information, and sentences that provide thematically reinforcing clusters of facts or judgments" (p. 52). Similar lists of framing elements are suggested in the geoengineering-related studies involving news discourse briefly introduced above, for example, policy recommendations, headlines, and lexical choices (Porter & Hulme, 2013, p. 344), mentions of . . ., any material that . . ., and statements (Buck, 2013, p. 171), or sentences and phrases referring to . . . (Scholte et al., 2013, p. 7). As indicated in the introduction, a text linguistic analysis of framing will have to involve a systematic linguistics-based approach to the selection of features to be considered in the analysis. In the next sections, the aim is therefore to outline such an approach to investigate news writers' framing activity.

Key Framing Locations

As already indicated, I here suggest that genre features may serve as a point of departure for identifying key framing locations. News texts tend to be classified into two broad categories, news and comment/opinion (e.g., Bell, 1991),[2] each with its own genre or register repertoire (e.g., hard versus soft news [White, 1998] and comment in the shape of, for example, feature articles or editorials). Headlines and leads are considered to be genre defining text features of news reports, where they serve the pragmatic functions of marketing and attention grabbing as well as information structuring and summarization (e.g., Cotter, 2010). Another defining feature of news reports is sources' statements, which, inter alia, serve the function of authenticating the information and making it more "objective" (Cotter, 2010), but which may also serve the news writer's own "mission" (Calsamiglia & López Ferrero, 2003) and mediate a specific value position (White, 2012).[3] All these functions appear compatible with the notion of framing. It is therefore assumed that headline, lead, and sources' statements are likely to represent important text locations for framing activity.

Framing Indicators

When it comes to news writers' exploitation of linguistic resources for framing purposes, lexis reflecting semantic field (e.g., science, politics, economics;

or risk, uncertainty, ethics) serves as an important indicator of which aspect (or aspects) of a potentially multifaceted phenomenon the journalist has chosen to make salient to his or her readers in a given context. In addition, it is suggested that the notion of evaluation offers a fruitful basis from which to study the framing process. Even if news reports are typically considered impersonal and "objective", it has been demonstrated (e.g., White, 2012; see also Oddo, 2013) that there, too, attitudinal mechanisms are at work, serving to advance specific value positions. Evaluation is a complex notion that has been discussed within a variety of analytical frameworks (see, e.g., Hunston & Thompson, 2000). The analysis here draws on Martin and White's (2005) conceptually based appraisal framework. Martin and White establish a framework of appraisal resources related to attitudes, feelings, and values, used to construe interpersonal meaning. The framework comprises three interacting domains: *attitude* (involving emotions, judgment, and appreciation), *engagement* (relating to the writer's stance toward his or her own and others' value positions), and *graduation* (involving gradability in terms of force [high/low intensity] or focus [core/marginal category membership]).[4] The next section presents a case study intended to illustrate how a qualitative framing analysis based on the principles outlined above—linked to framing location and framing indicators—may be carried out.

Case Study

I start with a description of the material, including a brief overview of the context in which the texts were produced. I then go on to analyze framing activity, first in headline and lead, and then through sources' statements.[5] Next, I discuss the outcome of the analysis, drawing together framing information from each text in a table. This information in turn serves as a basis for undertaking a frame classification of the analyzed texts.

Material

As indicated, the material for this case study consists of six news items that all report on a scientific study involving one of the very few geoengineering experiments carried out outside the scientific drawing board. The experiment was presented in the article "Deep Carbon Export from a Southern Ocean Iron-Fertilized Diatom Bloom" (Smetacek et al., 2012), published in *Nature* (online) on July 18, 2012. The six texts have not been not arbitrarily selected. In August 2012, as I was Googling for information on geoengineering, I accidentally came across two reports on the *Nature* experiment, published in the *Guardian* and the *Daily Mail*, respectively. The reports seemed to draw

attention to different aspects and implications of the experiment. This spurred me to carry out further web searches—based on combinations of the search strings "geoengineering," "climate," "Smetacek," "ocean iron fertilization/fertilisation," and "Nature"—with the purpose of identifying more texts on the same event. My intention was to establish a corpus that could serve as a basis for a text linguistic framing analysis. The six texts to be analyzed here represent the only English-language written news items reporting on the study that I was able to identify through this search process.

As already indicated, the experiment involves ocean iron fertilization (OIF), a geoengineering technique that implies lacing the sea with iron. The iron stimulates the growth of blooms and plankton that sequester CO_2, and the most important novelty feature of the research is the recording of what actually happens to the fertilized biomass as it sinks deep into the ocean. On July 18, AWI—the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany, the home institution of the lead researchers—issued a press release on the article. The *Nature* article refers to geoengineering in its general motivation for undertaking the study: "The issue is currently receiving broad attention because OIF is one of the techniques listed in the geoengineering portfolio to mitigate the effects of climate change" (Smetacek et al., 2012, p. 313). Interestingly, the press release does not mention geoengineering at all, and motivates the importance of the study in the lead paragraph as follows: "These results . . . provide a valuable contribution to our better understanding of the global carbon cycle" (AWI, 2012). The six news items were published on the same day as the scientific article and press release, or the next, indicating that they may be responses to an embargoed text offer by the research institution to the media.

The analyzed texts come from the following sources (online versions): the U.S.-based *Scientific American* (SA), *New York Times* (NYT), and *Washington Post* (WP), and the U.K.-based *Guardian* (GUA), *Daily Mail* (DM), and *BBC News* (BBC). In the following, the source abbreviations SA, NYT, WP, GUA, DM, and BBC will be used to indicate the texts or text producers. As for the American texts, SA appeared in the Energy and Sustainability News section of the popular science magazine, while NYT and WP are blog posts, from the NYT Green—A Blog About Energy and the Environment (discontinued in March 2013) and WP's Wonkblog, respectively. As for the British texts, GUA appeared in the Environment section of the newspaper, DM in the Science section, while BBC appeared on the broadcaster's website section Science and Environment. The six journalists are all environment and/or science reporters.

Four of the texts—SA, GUA, DM, and BBC—thus are news reports, while NYT and WP are newspaper blog posts. However, in terms of overall

Table 1. Headlines of the Six News Reports.

Text	Headline
SA	Controversial Spewed Iron Experiment Succeeds as Carbon Sink (David Biello, July 18)
NYT	A Way to Trap Carbon Deep in the Ocean (Rachel Nuwer, July 19)
WP	Could plankton help us tackle climate change? (Brad Plumer, July 19)
GUA	Dumping iron at sea can bury carbon for centuries, study shows (Damian Carrington, July 18)
DM	Could dumping iron in the oceans cure climate change? First "geo-engineering" trial is hailed a success (Rob Waugh, July 18/19)
BBC	Climate ocean tech fix "can work," research suggests (Richard Black, July 18)

structure, the texts appear quite similar in that they all have a headline, a lead element, and sources' statements. As for intended readership, it also seems reasonable to assume that readers of news reports found in the Science/Environment section of a newspaper/popular science magazine (interested nonspecialist) are likely to share crucial features of readers of the dedicated Green blog (NYT). A cursory reading of the WP blog post indicated that the treatment of the issue/event reported on was also targeted at nonspecialists interested in climate-change-related issues. Hence, on the basis of textual and contextual features (including the journalists' field of expertise), the texts were considered sufficiently similar for current purposes to be discussed together. They will all be referred to as news reports.

Framing Activity in Headline and Lead

News text headlines (and in some cases also leads; e.g., Cotter, 2010) have been described in terms of, for example, linguistic form (Bell, 1991), communicative function (Dor, 2003; Ifantidou, 2009), and their importance in framing a story (Pan & Kosicki, 1993). As regards news media practices, it is common knowledge that headline and lead are typically not produced by the reporting journalist, but by a subeditor (Bell, 1991; Cotter, 2010). This might lead to a different frame being exploited in headline/lead that in the body of the text. Readers will in such cases be left to negotiate potentially diverging messages. Whether there are instances of this kind in the current material will be addressed in the discussion below. The headlines for the six reports are given in Table 1, which also includes reporter name and publication date. The more extensive leads can be found in the appendix.

As Table 1 shows, the headline producer of four of the texts makes use of lexis that refers to a research activity, marking this as the selected frame: *experiment* (SA), *study* (GUA), *trial* (DM), and *research* (BBC), while the producers of two blog post headings only do so implicitly (NYT: *a way to trap carbon*; WP: *plankton . . . tackle climate change*). Three of the headline producers (WP, DM, BBC) refer to the broader context (the climate issue), while the other three (SA, NYT, GUA) refer to the substance involved in the experiment, *carbon*, which is also the focus of the title of the *Nature* article (see the previous section).

Only the DM headline makes a reference to the phenomenon of geoengineering. The term *geo-engineering* appears in single quote marks. They may have a pragmatic function, indicating that the headline producer acknowledges that the word may not be well known to the newspaper's readers. The fact that just one text mentions geoengineering in the headline—the most powerful audience attention grabber—may be similarly interpreted as reflecting the news writers' perceived lack of awareness in the public about the concept. The BBC headline producer makes use of the expression *tech fix*. As an alternative to the established scientific term *geoengineering, tech fix* contributes to a positive appreciation of the research reported on (see below), even though the engagement marker *can* (which in the phrase *can work* indicates medium probability) modifies the expectations associated with the research, along with the attribution phrase *research suggests*, which also represents a heteroglossic utterance (opening up for alternative viewpoints). Evaluation is not necessarily linked to specific linguistic items (Hunston & Thompson, 2000; Martin & White, 2005; White, 2012). However, explicitly attitudinal lexis like *controversial* (SA), *succeed* (SA), and *success* (DM) clearly reflect framing activity. In the SA headline, the juxtaposition of the negative *controversial* and the positive *succeed* (both instances of unattributed appreciation) may be seen as a rhetorical device used to catch the reader's attention, as well as an indication of the writer's perception of the issue. The choice of the adjective *controversial* may have been inspired by a quote from the lead author of the *Nature* article, Professor Victor Smetacek, in the press release, and thus represent a manifestation of intertextual borrowing:

> "The **controversy** surrounding iron fertilization experiments has led to a thorough evaluation of our results before publication," comments the marine scientist as an explanation for the long delay between the experiment to the current publication in Nature. (AWI, 2012)

There is no elaboration in the press release of what the controversy implies. The SA headline thus through field-specific lexis (*spewed iron experiment,*

carbon sink) indicates that the text will focus on a scientific experiment, but by combining unattributed negative (*controversial*) and positive (*success*) appreciation, the message is given a particular slant: Even if the experiment as such was a success, the headline producer frames geoengineering research as controversial.

The NYT, GUA, and BBC headlines, too, indicate that a scientific experiment will be the main focus of the text. Of these, only the NYT headline appears as primarily descriptive. The BBC headline, as already pointed out, includes the attributed statement *tech fix "can work," research suggests*, which infuses both the experiment and geoengineering in general with a positive value (a potential solution to the problem of climate change, incorporating the presupposition that climate change is a problem that can be solved). In the GUA headline, the attributed temporal expression *for centuries, study shows* contributes to a positive framing of the experiment through intensifying the duration of the effect of the reported CO_2 sequestration. It has been questioned whether OIF may offer significant carbon capture in a long-term perspective (e.g., Keith, 2000, p. 270), and being able to conclude on the time aspect is emphasized in the *Nature* article (albeit with scientific caution expressed through the low-intensity modal *may* rather than the more assertive attributed claim *can bury . . . study shows* of the GUA headline; cf. Fahnestock, 1986):

> Thus, iron-fertilized diatom blooms **may** sequester carbon **for timescales of centuries** in ocean bottom water and **for longer** in the sediments. (Smetacek et al., 2012, abstract)

Finally, it may be noted that the DM headline, like the BBC one, frames the experiment as a solution to climate change, here expressed by the verb *cure* (see Nerlich & Jaspal, 2012) and the positive attributed appreciation *is hailed a success*, while the WP headline adopts an explicitly interpersonal angle through the grammatical form of a question, starting with a low-intensity engagement marker assessing the probability that the experiment may address climate change ("*Could . . . ?*"). The verb phrase *help us* suggests a positive, human interest story (Cotter, 2010).

As for the leads (see the appendix), the two blog posts NYT and WP do not have a typographically marked lead element, found in the other four texts. However, NYT starts with a one-sentence paragraph that seems to serve the traditional lead function of providing a synopsis of the issue/event reported on. WP, on the other hand, has an opening paragraph that exploits a rhetorical strategy not typically found in news reports. It starts off with a first sentence outlining the background for the experiment. Through negative judgment and

amplification (*dreaming up, all sorts of zany*), the scene is set for a science-fiction-like account of proposed geoengineering techniques (see Buck, 2013): *Artificial volcanoes to cool the air! Giant mirrors in space to deflect sunlight! Fertilizing the ocean with iron to mop up that carbon!* Having first placed OIF among the *zany geoengineering schemes*, the experiment is reframed (indexed through the counter-expectancy marker *actually*) in a new paragraph that brings the reader back to the real world: *As it turns out, that last idea might actually work.* Despite the weakening of the argument through the engagement marker *might*, the phrase *might actually work* may be interpreted as the journalist accepting the experiment as relevant for addressing global warming.

The conventional lead paragraphs of SA, GUA, DM, and BBC focus on the process involved in the OIF experiment. The GUA lead paragraph reads as a descriptive summary of the experiment (*. . . creates algae blooms that . . .*, *taking the absorbed carbon deep towards the ocean floor*). The BBC and DM leads, on the other hand, convey attributed positive evaluation, with BBC drawing attention to the time aspect discussed above (*can lock carbon away for centuries, research suggests*), and DM repeating the information in the headline that the experiment has been *hailed a success.* Similarly to the WP introductory element, the BBC lead also draws readers' attention to the broader relevance of the described process (*to combat climate change*). The SA lead, on the other hand, conveys a more negative message through the disclaimer *but only*, pointing to the fact that the experiment's success is linked to the specific research design, which may limit the usefulness of the technique in general (*stimulates blooms of diatoms . . .—**but only** under the right conditions*).

Framing Activity in Sources' Statements

In addition to fulfilling pragmatic functions such as to authenticate a story and making it more "objective," sources' statements (in the form of direct quotes or reported speech) have the potential to be a powerful framing tool for news writers, enabling them to give salience to specific aspects of the reported event or issue. The choice of source may in itself indicate a specific framing (Bellamy, Chilvers, Vaughan, & Lenton, 2012; Calsamiglia & López Ferrero, 2003). In the present material, the scientific "sophistication" of the phenomena reported on makes it natural for the journalist to look to expert sources for comments. The main source is, unsurprisingly, the lead author of the *Nature* article, Professor Smetacek. The WP journalist has only included a reported statement from Smetacek:

(1) For a variety of reasons, Smetacek has said he doesn't favor large-scale fertilization without further testing. (WP)

The other five texts also include direct quotes by Smetacek. In all the texts the journalist lets him comment on the experiment. The NYT and BBC journalists have him explain the actual research process through quite detailed, person-focused (*I/we*) descriptions (a common popularization approach; e.g., Adams Smith, 1987; Fahnestock, 1986), with intensified force (*very fast, very excited, like a big cloud, right down to*), as in Examples 2 and 3:

(2) "While the experiment was going on, **we saw** the stocks start to sink—they went down **very fast**," he said. "**I was very excited** to see this happening." . . . "**We could see** the bloom developing and increasing in size **like a big cloud**," Dr. Smetacek said. (NYT)
(3) "**We had instruments** that **we could deploy right down to** the seafloor, which is at 3,800m depth," said Victor Smetacek, lead researcher on the new paper. (BBC)

However, through most of the included quotes by Smetacek, the journalists retain focus on the research (e.g., Examples 4 and 5) and the broader picture involved in the geoengineering debate (also alluded to in Example 1). DM presents quotes by Smetacek where the researcher emphasizes the positive aspect of the experiment:

(4) "Such controlled iron fertilization experiments in the ocean **enable us to test hypotheses** and **quantify processes** that cannot be studied in laboratory experiments. The results **improve our understanding of processes** in the ocean relevant to climate change" says Smetacek. (DM)

SA, on the other hand, draws attention to the uncertainty and risk involved, both through the journalist's choice of negative attitudinal lexis (*backfire, toxic, oxygen-depleted "dead zones"*) and his own categorical (monoglossic) claim (*have no way to*), backed by a similarly forceful statement from Smetacek (*cannot be controlled*):

(5) In fact, these iron-seeding experiments could **backfire** by producing **toxic** algal blooms or **oxygen-depleted "dead zones**.". . . At present, **scientists have no way to ensure** that the desired species of silica-shelled diatoms bloom. In short, Smetacek says, the type of bloom—and therefore the ability to sequester CO_2—"**cannot be controlled** at this stage." (SA)

In BBC, Smetacek is quoted as admitting to the modest effect the studied geoengineering technique can in fact have on CO_2 levels, expressed through the counter *even if . . . could only*:

(6) Prof Smetacek's own analysis is that **even if** it were deployed on a vast scale, ocean fertilisation **could only** take up about a quarter of the extra carbon dioxide being deposited in the atmosphere by humanity's industry, transport and agriculture. (BBC)

The GUA journalist, through his key source, introduces the dilemma felt by some that it is already too late to mitigate sufficiently to avoid dangerous climate change (an increase in temperature above the 2°C target). Smetacek undertakes a moral evaluation of the current situation (negative judgment: *doing nothing . . . the worst option*). If we choose to do nothing, this might in fact turn out to be the riskiest path to take:

(7) But Prof Victor Smetacek, at the Alfred Wegener Institute for Polar and Marine Research in Germany, who led the new research, said: "The time has come to differentiate: some *geoengineering* techniques are more dangerous than others. **Doing nothing is probably the worst option**." (GUA)

Except for NYT, all the texts also include statements by other scientists, both named and unnamed ones. None of these sources argue against geoengineering as such, but none of them endorse it unequivocally, either. Some focus on the scientific uncertainty associated with the experiment (SA, GUA, BBC), also touched on by Smetacek (Example 5); some, also like Smetacek (Example 7), see the need for geoengineering (SA [Example 10, below], WP, GUA). One scientist (GUA, Example 8) acknowledges the value of the research (*It is important that we continue*), but counters this (*but*) by bringing up the aspect of governance, indicating that geoengineering research needs to be closely monitored due to its controversial nature:

(8) Prof John Shepherd, chair of the [2009 Royal Society] report [on geoengineering], said on Wednesday: "**It is important** that we continue to research these technologies **but** governance of this research is vital to protect the oceans, wider environment and public interests." (GUA)

The positively presented finding linked to the temporal aspect involved in the technique, referred to in the GUA headline and the BBC lead (see the previous section), is also found in sources' statements in all the texts, with the

exception of SA. In SA, the journalist himself provides a negative downscaled assessment of the sequestration period (***But** such fallen carbon **only** resides in the deep **for a few centuries at best***), thus countering the positive upscaled interpretation provided in the *Nature* article (Smetacek et al., 2012, quoted in the previous section). A similar but even more downscaled assessment of the time element (*only for decades to centuries*) is made in a named source's statement in GUA (Example 9), also including a downscaled assessment of the amount of carbon that may be captured (*just a fraction*).

(9) "The ocean's capacity for carbon sequestration in low-iron regions is **just a fraction** of anthropogenic CO_2 emissions, and such sequestration is not permanent—it lasts **only for decades to centuries**," said Ken Buesseler, at the Woods Hole Oceanographic Institution in the US. (GUA)

Most of the sources' statements are introduced by the neutral reporting verb *say*, typical of English-language news texts (Cotter, 2010; Dahl & Fløttum, 2014; White, 2012; cf. Examples 1-5, 7-9), by which the journalist just acknowledges the proposition by the external voice. However, reporting verbs indicating the journalist's stance toward the source's statement (either endorsing it or distancing himself or herself from it) are also seen, as in Example 10, from SA:

(10) And such techniques might be capable, at best, of sequestering one billion metric tons of carbon dioxide per year (based on the extent of iron-deficient waters around the globe), compared with annual human emissions of more than eight billion metric tons and rising. "There is massive uncertainty in this figure, and until much more research is done no serious scientist should express any confidence in such estimates," of iron fertilization's geoengineering potential, **cautions** oceanographer Richard Lampitt of the National Oceanography Center in England, who also **argues** that more research into such potential geoengineering techniques is needed due to the failure of global efforts to curb greenhouse gas emissions. (SA)

The journalist's choice of the first reporting verb, *cautions*, implies that he "stands with" the statement (White, 2012). The journalist uses the attributed statement to back the unattributed claim that *such techniques might be capable, at best, of. . . .* As regards the second reporting verb, *argues*, its attitudinal value is less clear. There are also occurrences of evaluative reporting verbs in WP and GUA, but only in combination with genericized (Calsamiglia & López Ferrero, 2003) sources:

(11) **Yet other scientists warn** that even if this plankton scheme worked, it would likely only play a small part of any effort to tackle climate change. (WP)

(12) What's more, **some scientists are still worried about** the consequences of artificially mucking with ocean ecology in this way. (WP)

(13) Geoengineering—technologies aimed at alleviating global warming—are [*sic*] controversial, with **critics warning of** unintended environmental side effects or encouraging complacency in global deals to cut carbon emissions. (GUA)

In each of these cases, the journalists' choice of reporting verb may again be interpreted as signaling association with the source's statement, further indicated in Example 11 by the downscaled amount of CO_2 that may be captured (*likely only . . . a small part*) and in Examples 12 and 13: negative appreciation (*artificially mucking with; unintended . . . side effects, complacency*). In Example 13, the attributed statement serves as an elaboration of, and support for, the journalist's own categorical claim, expressed in the first part of the sentence, that geoengineering is controversial.

Discussion

Previous framing studies have suggested that it is not always possible to characterize texts by single frames, but rather in terms of frame sets (e.g., Buck, 2013; Porter & Hulme, 2013; Van Hout, Pander Maat, & De Preter, 2011). To assess which frame(s) each of the six texts analyzed here may be related to, Table 2 sums up the main aspects of the event (experiment) and issue (geoengineering) that were made salient through the news reporter's use of framing indicators in the three framing locations.

There are, as one would expect, reflections of intertextual borrowing (shared linguistic material) between the trigger texts (*Nature* article and press release) and the six news items.[6] The reporting of a scientific study is clearly the foundation in both trigger and news texts. However, the text linguistic analysis, the outcome of which is condensed in Table 2, seems to corroborate the claim that a news text may draw on multiple—and sometimes divergent—frames. In the context of the broader issue of employing geoengineering techniques to moderate global warming (Shepherd et al., 2009), the research reported on is considered either as progress (conveying a techno-optimistic view of science), as a necessary evil, or as potentially dangerous interference with nature. As Table 2 illustrates, all the texts except DM to varying degrees refer to the complexity of the phenomenon of geoengineering. SA, NYT, WP, GUA, and BBC draw

attention to several of the aspects currently reflected in the scientific community as well as in society at large, such as the need for a plan B, moral hazard (complacency with regard to mitigation), messing with nature (the uncertainty associated with unknown side effects), and governance (cf. Corner et al., 2012). DM, on the other hand, keeps strictly to the science. This may be further demonstrated through Example 14, where the journalist draws attention to the very modest amount of CO_2 that may be captured through this technique, also alluded to in BBC (Example 6), GUA (Example 9), SA (Example 10), and WP (Example 11). However, in DM this, too, is framed in an optimistic scientific progress context through a countering clause:

(14) At present, the technique could **only** be used to "mop up" around a tenth of global carbon emissions—**but scientists continue to investigate.** (DM)

In a similar vein, the NYT journalist, while letting lead author Smetacek concede (*Of course*) that such mitigation techniques could play only a rather modest role, also lets him counter this (*Still*) with a statement alluding to future potential through positive appreciation (*useful*):

(15) **Of course**, the ocean's capacity for carbon sequestration would mitigate only a fraction of the world's current annual carbon dioxide emissions, Dr. Smetacek said. **Still**, it could eventually be **a useful geoengineering technique** for alleviating climate change, he suggested. (NYT)

The issue of frame categories and labels was touched on in the review of the framing literature. On the basis of the framing information identified through the analysis of framing indicators in the three locations of headline, lead, and sources' statements (Table 2), I suggest that in the analyzed material, the text producers have exploited three main frames in their reporting on the geoengineering experiment: *scientific progress, plan B*, and *messing with nature. Scientific progress* denotes a positive, generic (de Vreese, 2005) frame, *plan B* is an ambivalent, issue-specific (de Vreese, 2005) frame, while *messing with nature* represents a negative, issue-specific frame. The classification in Table 3 shows that four of the texts (NYT, WP, DM, and BBC) are considered to primarily exploit the *scientific progress* frame, while one text (SA) is seen as mainly exploiting the *messing with nature* frame. One text (GUA) is posited as drawing on all three frames.

DM is the clearest representative of the *scientific progress* frame. The main focus of the journalist is on the scientific experiment and OIF as a

Table 2. Key Framing Information for All Six Texts.

Framing location	SA	NYT	WP	GUA	DM	BBC
Headline and lead	Controversial research; scientific experiment successful, but success dependent on research design	Successful scientific experiment	New science to tackle climate change	Successful scientific experiment	Successful geoengineering experiment; potential solution to climate change	Geoengineering may mitigate climate change; technological fix for climate change
Statements by Prof. Smetacek	The science; side effects	The science; potentially useful climate change mitigation technique; plan B; side effects	Further research should wait	The science; plan B; economic aspect (OIF cheaper than other techniques)	The science	The science; cutting emissions first priority
Statements by other sources	Uncertainty; plan B	N/A	Uncertainty; side effects	The science; side effects; moral hazard; uncertainty; plan B; governance; futile technique to address CO_2 issue	The science	The science; uncertainty; side effects

Table 3. Frame Classification of the Six Texts.

Frame	*scientific progress*	*plan B*	*messing with nature*
Text	NYT, WP, GUA, DM, BBC	GUA	SA, GUA

geoengineering technique. The research is outlined in mainly positive terms in all three framing locations. As for NYT, WP, and BBC, traces of other frames are present, but *scientific progress* remains the dominant frame. In SA, the journalist clearly focuses on the science, but not within a *progress* frame. Rather, it is made abundantly clear that the success of the experiment depends heavily on specific research conditions, and that any CO_2 sequestration is of a very modest and temporary nature. The potential for a negative impact on the ocean environment is conveyed as the final message of the text (Example 5), contributing to the classification of the text into the *messing with nature* category. Finally, GUA may be seen as drawing on all the three suggested frames. It is the only text that exploits one frame in the headline and lead and other frames through the sources' statements, a situation probably caused by the institutional practice of having different text producers for headline/lead and body. In headline and lead, the focus is on the scientific experiment and its success in showing that this OIF technique has the potential to remove CO_2 from the atmosphere for a significant period. This implies a *scientific progress* framing. However, through sources' statements in the body of the text, the journalist draws attention to the dilemma inherent in geoengineering research: Yes, geoengineering may be dangerous and have uncertain consequences, but doing nothing may be the worst option. This position is mediated through a fairly balanced exploitation of the two frames *messing with nature* and *plan B*. Such a dual framing is currently also present in public debates on climate change and was expressed by Professor Piers Foster, a lead author of the recently published Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). In a comment on geoengineering techniques, discussed for the first time in Working Group I's Summary for Policymakers, he stated that "[t]he policy relevance of the information is that if you do not start mitigating tomorrow we will have to start to consider these unattractive options" (Cressey, 2013).

Conclusion

Framing is a notion that has proved its relevance in discourse-related research through a large number of studies undertaken in a variety of epistemological contexts. The basic meaning of the notion seems intuitively easy to grasp, as it

is associated with cognitive processes we all engage in as language users, in relation to both text production and text reception. However, to pin it down as a concept to be operationalized in text analysis is a different matter. The current study took its point of departure in Entman's (1993) definition of framing as related to *selection* and *salience* and his observation that "nowhere is there a general statement of framing theory that shows exactly how frames become embedded within and make themselves manifest in a text" (p. 51). After a brief overview of the framing literature related to news text studies involving the contested and many-faceted phenomena of climate change and geoengineering, I suggested that text linguistics may be an important methodological contributor to the field, which has so far been dominated by studies within the tradition of quantitative content analysis, typically aiming to identify the "stories" told about the phenomenon under study. Being primarily interested in writer behavior, I argued that a qualitative analysis based on systematically applied linguistic principles—linked primarily to genre and the notion of evaluation—can provide valuable insight into how written news texts reflect journalists' strategic framing activity. The complex and coherent appraisal framework (Martin & White, 2005), was used as a basis for a case study involving a small corpus of six news texts that were all related to the same trigger event, the publication of a scientific article on a rare real-life geoengineering experiment. The discussion of linguistic material, identified in the genre elements of headline, lead, and sources' statements, confirmed that the journalists did undertake important framing activity at these locations in the text, through framing indicators revealing what aspects of the phenomenon reported on they had decided to make salient to their readers. Lexemes belonging to a specific semantic field (e.g., *experiment, research, governance*) obviously served as important framing indicators, as did explicitly evaluative items like *succeed* or *controversial*, indicating the journalist's alignment with or distancing from posited claims and statements. An example of this was the rendering of the temporal dimension of carbon sequestration, an important aspect of the scientific study (*may sequester carbon for timescales of centuries*). This was presented with varying degrees of positive intensification in four of the texts (e.g., *possibly for centuries, for many centuries*), as both positive and negative in one text (*for many centuries or longer, only for decades to centuries*), and as only negative in one text (*for a few centuries at best*). The fine-grained text linguistic analysis also made it possible to distinguish between a positive (e.g., DM) and negative (SA) science-related frame, a distinction that might have been more difficult to identify through a quantitative content analysis. The same applies to the discussion of sources' statements and how they contributed in the journalist's framing activity.

Future work on writers' framing activity along the lines pursued in the current article should involve other languages and writing cultures, ideally

complemented by interviews with news reporters to uncover additional linguistic features and contextual considerations involved in their framing activity. Brüggemann (2014), in a discussion of journalistic framing practices and the notions of "frame setting" (personal interpretation of the issue) and "frame sending" (relaying interpretations by various public actors), notes that

> [j]ournalism is not only the result of individual decision-making. It is the result of a process of collective sense-making within the newsroom and a negotiation of meaning between journalists and sources. . . . With this in mind, journalistic products will only partly reflect the frames of an individual author. Instead, journalists will always practice some degree of frame setting *and* [italics original] frame sending when assembling bits of information into news stories. (pp. 65-66).

Input on this distinction from news writers in various cultures may complement the linguistic approach to framing activity demonstrated here, along with considerations regarding the interplay between the journalist's own framing and the overall newsroom frame (Scheufele, 2006), embodying editorial policy. In discussions of news reports on contested phenomena like climate change and geoengineering, the news source's overall position on the issue is clearly of relevance (e.g., Boykoff & Boykoff, 2004; Carvalho, 2007).

The review of previous framing studies and the current discussion of the case study texts indicate that it would be helpful if more unified frame sets (and labels) were agreed on in the field of framing studies. I am of course not advocating for establishing a static frame set for a particular phenomenon, but as indicated by Porter and Hulme's (2013) observation (quoted earlier), even framings identified for the specific issue of geoengineering tend to be similar to those used for a number of other phenomena. If framing studies made a habit of indicating which generic frame(s) the material under investigation may be related to, in addition to developing more specific issue frames, this could create more common ground among framing researchers. This would be especially relevant for investigations of contested scientific issues, as they tend to attract attention from a variety of disciplines and methodological traditions. More compatible frame categories would thus make a valuable contribution to multi- and interdisciplinary research initiatives involving such issues.

Appendix

Lead Element of the Six News Texts

Scientific American. Dumping iron into the ocean stimulates blooms of diatoms that pull down carbon dioxide in the atmosphere—but only under the right conditions.

New York Times. After an eight-year analysis, an international team of scientists has announced a breakthrough in the understanding of how algae and iron interact to sequester atmospheric carbon.

Washington Post. As carbon emissions keep rising each year, with no end in sight, scientists have begun dreaming up all sorts of zany geoengineering schemes for slowing down the rate at which the planet's heating up. Artificial volcanoes to cool the air! Giant mirrors in space to deflect sunlight! Fertilizing the ocean with iron to mop up that carbon!

Guardian. Iron fertilisation creates algae blooms that later die off and sink, taking the absorbed carbon deep towards the ocean floor.

Daily Mail.

- Iron stimulates plankton growth
- Plankton bind carbon dioxide and sink it to ocean floor
- Tests in Southern Ocean hailed a success

BBC News. Fertilising the oceans with iron to combat climate change can lock carbon away for centuries, research suggests.

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Notes

1. See Oddo (2013) for an interesting discussion of the benefits of exploiting discourse analytical tools in rhetorical analysis.
2. Martin and White (2005, p. 165) suggest three, adding "analysis."
3. Sources' statements may in addition be used to make the story more unique (e.g., Cotter, 2010). This is a function that may be relevant for the current case study material, as it consists of texts inspired by what was likely a widely distributed press release.
4. For a systematic introduction to the appraisal framework and its implementation in text analysis, see http://www.grammatics.com/appraisal.
5. Even though the corpus consists of only six texts, a full qualitative analysis of the material would be quite time- and space-consuming. Even the analysis of

headline, lead, and sources' statements presented here does not purport to be exhaustive, but focuses on what I consider to be particularly relevant for illustrating framing activity.

6. Text DM stands out in this respect, with a very high percentage of sentences that are identical to those found in the press release. This has led to the inclusion of information that seems far too detailed for the intended audience, as illustrated by the following sentence: "The maximum biomass attained by the bloom was with a peak chlorophyll stock of 286 Milligram per square metre higher than that of blooms stimulated by the previous 12 iron fertilization experiments." One can only speculate about the reason for this "copy-paste" approach. Time constraints experienced in the media today seems an obvious candidate; the lack of science training among journalists may be another.

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