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Using Frames to Make Scientific Communication More Effective

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Abstract and Keywords

Science can serve as a valuable foundation for the making of public policy. For science to have this effect, it must be effectively communicated to individuals, organizations, and institutions. Effective science communication often involves frames that highlight particular aspects of a scientific finding or issue. This chapter discusses ways in which frames can be used to facilitate effective scientific communication—particularly we explore the impact of frames with regard to attention limitations, political polarization, and the politicization of science. We also highlight unanswered questions and challenges. The main lesson of this chapter is that there are certain conditions under which choosing particular frames yields more effective communication. While understanding these conditions does not guarantee success, it can help science communicators avoid common mistakes.

Keywords: framing, polarization, politicization, attention

Science can do many valuable things for individuals, communities, and nations. It can clarify important properties of the natural world. It can help individuals, organizations, and institutions understand consequences of current or potential actions. It can give public service providers knowledge that they can use to improve others' quality of life.

Science's ability to have any of these effects depends not just on the content of research activity but also on how effectively this content is communicated. A challenge facing science communicators comes from the relationship between human attentive capacity and the often-complex content of scientific information. When compared to all of the information that a scientific community can generate, human attentive capacity is quite limited.

Indeed, people can pay attention to only a very small amount of information at one time. While measurements of these limits vary, one commonly cited estimate places this limit as five to nine "chunks" of information (Miller 1956). In this parlance, a "chunk" is a concept or relationship that a person can bring to memory without requiring further effort to understand what the concept or relationship means. To understand new information, people must make a dedicated effort to analyze the information and relate its content to the content of their existing chunks.

For scientists who seek to convey insights gleaned from studies of complex phenomena, the reality of limited attentive capacity forces them to make choices about how to convey what they know. Scientists often struggle to make these choices effectively. Their struggle arises from the fact that many scientific phenomena have many describable attributes. Since prospective learners cannot pay attention to all extant facts about complex phenomena, science communicators must make choices about what parts of their subject to emphasize.

This is not the only challenge facing science communicators. The scientific process is itself a complex phenomenon. Consider, for example, how a researcher examines climate change. When (p. 352) studying climate change, a researcher chooses which attributes of climate will be the focus of the research. With this focus in mind, a researcher chooses where, when, and how to gather evidence. A researcher also chooses what metrics to use to characterize observations. For example, when measuring ocean temperatures, a researcher can offer a continuous metric or a discrete metric. The metric can characterize very small parts of an ocean or very large parts. With measures in hand, a researcher then chooses how to analyze the observations. In many cases, researchers choose a particular statistical model—a choice that includes not only what potential explanatory variables to include or exclude but also whether to use the log or square root of a particular value. Attempts to understand the full meaning of a scientific finding can depend on knowledge of how the finding was produced.

Because scientific phenomena and methods can be complex, science communicators are forced to choose the information about the studied phenomena and the research process to convey to prospective learners. Science communicators must decide what aspects of the topic and research design to describe first and which aspects to convey later. They must decide which aspects to include in footnotes or technical appendices and which to exclude. Science communicators who make these choices are involved in acts of *compression.* They are seeking a means of converting high-dimensional research phenomena and multifaceted research processes into language that is accessible and meaningful to their target audiences.

This chapter synthesizes an emerging research literature on how to make these communicative choices more effectively. In it, we review relevant and actionable findings from research on *framing*. We focus on what scholars call "emphasis" or "issue" framing, whereby an actor (e.g., a scientist, candidate, interest group, media outlet, opinion leader) highlights a subset of potentially relevant considerations about a technology, politician, issue, or event (Druckman 2001; also see Chong and Druckman 2007, 104). This emphasis, in turn, can alter the considerations that others use in constructing their opinions (i.e., a framing effect). For example, in discussing nanotechnology, the media may frame it in terms of scientific and economic benefits, which might lead news consumers to focus on such positive aspects and support nanotechnology development (Scheufele and Lewenstein 2005). This type of framing is distinct from equivalency or valence framing, popularized by Kahneman and Tversky—in that case, the focus is on whether alternative but logically equivalent characterizations of an issue or event affect attitudes (e.g., framing a food item as 95% fat-free or 5% fat; see Cacciatore et al. [2016] for discussion).

All science communicators engage in framing (e.g., Nisbet 2009; Nisbet and Mooney 2007; Scheufele 2006). Whenever they decide to emphasize one attribute of a scientific phenomenon over another and whenever they choose aspects of their research design to highlight, they are engaging in framing—they are making a decision that can direct prospective learners' attention in ways that affect their subsequent thinking about the topic in question. The same is true of media outlets that cover science; for example, in covering stem-cell research, media have employed frames such as morality, regulation, and scientific application, *inter alia* (Nisbet et al. 2003).

Framing is sometimes seen as a method of manipulation (for discussion, see Druckman 2001); however, as explained, framing is inevitable in acts of compression and is a core component of human communication, crucial for communicating meaning via shared schemas. Indeed, the choice of a particular frame can be the key to conveying vital scientific information effectively. In what follows, we draw on the existing literature to describe how framing decisions can produce better learning outcomes. To make this information more useful to science communicators, we focus on how framing can help science communicators in three challenging, but increasingly common, types of communicative environments.

The first is characterized by *competition for attention*. The emergence of the Internet and related social changes ensure that many potential audiences for scientific information have an uncountable number of things other than science to which they can pay attention. A question for science communicators becomes how to break through. We describe studies that reveal a strategy for doing so. We use, as an example, attempts to correct common, but false, beliefs about the relationship between climate and weather. In this case, a relatively simple framing decision can make important corrective information more available to prospective learners. This gain in availability, in turn, prompts many people to rethink their initial beliefs and better reconcile their subsequent ones with established scientific content.

The second environment is characterized by *political polarization*. In the United States, for example, views of climate science tend to be correlated (p. 353) with people's long-standing partisan affiliations (e.g., Kahan 2015). Republicans tend to be more skeptical of many aspects of climate science, while Democrats are more accepting. On other topics, such as fracking, it is the Democrats who are suspect (e.g., Davis and Fisk 2014). More generally, polarization has caused people to view scientific topics through an increasingly partisan lens (also see Chapter 3 in this volume for a discussion of polarization). We describe framing methods that can be used to stimulate greater attention to the informational content of science-based messages. This attention to information can, in turn, help people better reconcile their subsequent beliefs with scientific consensus.

The third environment is characterized by *politically-induced status quo bias*. As science has become more influential in the private and public sectors, it has also become more controversial and politicized. When controversy emerges many people seek comfort in maintaining the status quo (Mullainathan 2007). Status quo biases have proven problematic in attempts to give the public information about new technologies or vaccines. We describe studies that show how framing, at distinct times, can be used to counter politically-induced status quo biases. These studies show how framing can induce people to form opinions that are more consistent with the underlying science.

In sum, we show how science communicators can use the framing literature's insights to more effectively convey important information when competition for attention, political polarization, or status quo bias is present. At the same time, it is critical to point out that framing is not an elixir. Many framing attempts have failed to produce the types of learning outcomes that many science communicators sought. In the course of this chapter, we discuss important limits of framing. The main lesson of this chapter is that there are certain conditions under which choosing particular frames yields more effective communication. While understanding these conditions does not guarantee success, it can help science communicators avoid common mistakes. Avoiding these mistakes, in turn, can increase the range of circumstances in which science communicators can help others make better decisions.

Frames and Effective Scientific Communication

In this section, we present exemplars of how frames can change science communication outcomes in three common circumstances: when there is competition for attention, when there is political polarization, and when there is politically-induced status quo bias.

Our first case concerns how individuals make decisions in a saturated information environment where there is substantial *competition for attention*. In such contexts, individuals rely on heuristics—pieces of information that can take the place of other (typically more extensive) information—to simplify decision-making. One such tactic is called "attribution substitution." This occurs "when an individual assesses a specified *target attribute* of a judgment object by substituting another property of that object—*the heuristic attribute*—which comes more readily to mind" (Kahneman and Frederick 2002, 53; italics in original). For instance, when voters evaluate an incumbent presidential candidate's success in managing the economy, they may intend to assess his performance over his initial four years in office. Yet, attempting to gather relevant memories from this entire period tends to be difficult. Hence, many voters use recent economic information, which is cognitively available, to represent the longer period (Healy and Lenz 2014; also see Scruggs and Benegal [2012] on relations between short-term economic conditions and climate change opinions). The psychology at work here is similar to memory accessibility or an unconscious priming process (which is psychologically distinct from framing, which tends to be more conscious).

Similar such processes affect reactions to scientific information. One of the more notable cases is called the “local warming effect.” This effect occurs when particularly warm days shape individuals’ beliefs about longer-term climate trends.[1] In particular, when people perceive the day’s local temperature to be warmer than usual (i.e., an easily available piece of information), they tend to overestimate the number of warm days throughout the past year. These people, in turn, tend to express increased belief in, and concern about, global warming (e.g., Zaval et al. 2014; Egan and Mullin 2012; Lewandowski et al. 2012; Li et al. 2011; Risen and Critcher 2011; Joireman et al. 2010). Some scholars find this effect troubling. Egan and Mullin (2012, 806) state that the fact that “[people] use fluctuations in local temperature to reassess their beliefs about the existence of global warming … should trouble anyone interested in engaging the public in a thoughtful debate about global warming” (also see Weber and Stern 2011, 318).

Yet, there is a framing strategy that can counteract the local warming effect (see (p. 354) Healy and Lenz 2014). The key is to employ a frame that brings to mind variations in climate. This strategy can mitigate the local warming effect by severing connections between a given day’s temperature and longer-term phenomena. Indeed, Druckman (2015b, 176) conducted an experiment on an unusually warm autumn day in a location whose previous winter was bitterly cold. He randomly exposed half the respondents to the following frame: “When thinking about temperatures over the last year, remember that temperature patterns vary; indeed consider last winter compared to today. Thus think not only of the feeling today but also how you felt throughout the year.” He found that the local warming effect disappeared among those exposed to this “over-time frame.” Respondents exposed to this frame did not base their assessments of warm days over the past year on perceptions of the present day’s temperature, and their perceptions of the present day’s temperature did not correlate with beliefs about the existence and salience of global warming. In contrast, the local warming effect remained among participants not exposed to the frame. Another study replicated this finding and also showed that the local warming effect did not reappear in a follow-up questionnaire administered one week later (Druckman and Shafranek 2015). This work suggests that a frame that brings to mind (i.e., makes available) variations in climate can have an enduring effect on mitigating the effect of daily temperatures on global warming attitudes.

We now turn to the role of framing in affecting scientific communication in *politically-polarized* circumstances. A growing body of evidence shows that people interpret many policy-relevant types of information through a partisan perceptual screen. Scholars have documented instances where Democrats view a policy as effective (e.g., a new economic stimulus plan) when it is described as a "Democratic" plan but judge the exact same policy as less effective when it described as "Republican" (e.g., Druckman and Bolsen 2011). Others have found that Democrats (Republicans) tend to report viewing economic conditions favorably during a Democratic (Republican) administration but express the opposite view when their party is not in power (e.g., Lavine et al. 2012; Bartels 2002).

Scholars have found similar results on topics where science plays a more central role, such as energy production (Kahan in press). For example, Druckman and colleagues (2013) studied support for the drilling for oil and gas off the Atlantic Coast and in the eastern Gulf of Mexico. Respondents were randomly assigned to receive arguments that varied the quality of their factual information and the extent to which policies were described as supported or opposed by particular parties. In many cases, the authors find that respondents focus on the quality of the arguments that they are offered. A notable exception occurs when respondents are told explicitly that the parties are polarized on the issue. When this happens, partisans are significantly more likely to follow their party, *regardless* of other qualities of the argument. In other words, Democrats (Republicans) who are told about "polarization" are significantly more likely to reject as ineffective arguments that other Democrats (Republicans) accepted when polarization was not mentioned (also see Dietz 2013).

The nature of contemporary politics in the United States produces many attempts to cast certain scientific claims in a polarized light. Recent studies show how science communicators in polarized environments can increase the odds that their message will be heard. One experimental study by Bolsen and colleagues (2014b) focused on the Energy Independence and Security Act of 2007. This act requires automakers to boost gas mileage for passenger cars, funds research and development for biofuels and solar and geothermal energy, and provides small business loans for energy efficiency improvements. The act was supported by both parties at different points in the law-making process (e.g., was initially sponsored by a Democrat but signed into law by Republican President Bush).

The two factors varied in the experiment were which parties supported the act and a prompt for respondents to justify their opinions. Specifically, respondents were randomly assigned to receive no endorsement, an endorsement stating the act was being supported by Democrats, an endorsement stating the act was being supported by Republicans, or an endorsement stating the act was being supported by some, but not all, representatives of both parties (i.e., a "cross-partisan" frame).[2] In addition, some respondents were told they should view the policy from various perspectives and would have to later justify their policy views—that is, a "justification" frame.[3]

The authors find that when individuals received their own party's endorsement (e.g., Republican respondents received the Republican endorsement) without the justification frame, they were strong motivated reasoners—they followed their party and increased support for the policy, relative to a control group that received no endorsement and (p. 355) the justification frame. They were also motivated reasoners in situations where they received an out-party endorsement frame (e.g., Republican respondents received the Democratic endorsement)—here they became less supportive (going against the out-party endorsement). Taken together, then, partisans supported or rejected *the identical policy* based only on the endorsement frame. However, when told that members of both parties supported the act (i.e., the cross-partisan frame), respondents displayed careful analysis of the content of policy, mimicking the behavior of respondents who did not receive an endorsement but were encouraged to justify their responses.

Of course, using a cross-partisan frame is often not an option for issues where parties strongly disagree. The same research shows that frames can still prove productive in this circumstance—as respondents who received the justification frame displayed *no* evidence of partisan motivated reasoning, *regardless* of what they were told about party support. For example, Democrats who were told only of Republican support or only of Democratic support analyzed the content of the policy and expressed views consistent with the content of the factual information. Partisan motivated reasoning disappeared (for a general discussion of motivated reasoning, see Kahan in press).

From a practical standpoint, the results accentuate the potential power of framing scientific issues and/or technologies in ways that motivate citizens to consider content. Other work shows that frames emphasizing the local impact of issues (Leeper 2012) can increase respondents' engagement with those issues. Indeed, Scannell and Gifford (2013) report that, relative to a control group, those exposed to frames that emphasize how climate impacts one's particular local area became substantially more engaged in climate change issues (e.g., seek out climate change information; also see Spence et al. 2012). Scannell and Gifford (2013, 63) explain that such local frames are "more captivating than global impacts" (cf. Spence and Pidgeon 2010).

We now turn to how framing can affect science communication outcomes in the presence of *politically-induced status quo bias*.[4] Politicization occurs when an actor exploits "the inevitable uncertainties about aspects of science to cast doubt on the science overall … thereby magnifying doubts in the public mind" (Steketee 2010, 2; see Oreskes and Conway 2010; Pielke 2007; Jasanoff 1987, 195). The consequence is that "even when virtually all relevant observers have ultimately concluded that the accumulated evidence *could* be taken as sufficient to issue a solid scientific conclusion … arguments [continue] that the findings [are] not definitive" (Freudenburg et al. 2008, 28; italics in original). To cite an example—in response to the release of the *Climate Change Impacts in the United States* report that stated a scientific consensus exists that global climate change stems "primarily" from human activities (the report reflected the views of more than three hundred experts and was reviewed by numerous agencies including representatives from oil companies), Florida Senator Marco Rubio stated, "The climate is always changing. The question is, is manmade activity what's contributing most to it? I've seen reasonable debate on that principle" (Davenport 2014, A15). The consequence of politicization is that individuals are apt to stick to the status quo and less willing to accept new ideas, policies, or technologies (Korobkin 2000; also see Dietz 2013, Mullainathan 2007, 98).

With such dynamics in mind, Bolsen et al. (2014a, 5) explain that "frames that highlight politicization introduce uncertainty regarding whether one can trust science-based arguments" (cf. Bolsen and Druckman 2015). In one experiment on the role of politically induced status quo bias on nuclear energy attitudes, they (10) told some respondents that

> many have pointed to research that suggests alternative energy sources (e.g., nuclear energy) can dramatically improve the environment, relative to fossil fuels like coal and oil that release greenhouse gases and cause pollution. For example, unlike fossil fuels, wastes from nuclear energy are not released into the environment. A recent National Academy of Sciences (NAS) publication states, "A general scientific and technical consensus exists that deep geologic disposal can provide predictable and effective long-term isolation of nuclear wastes."

When respondents received just this information (which did in fact come from an NAS report), support for nuclear energy increased. Yet, support for nuclear energy fell when the information was proceeded by a *politicization frame* that stated "it is increasingly difficult for non-experts to evaluate science—politicians and others often color scientific work and advocate selective science to favor their agendas." The authors present evidence that the decreased support stemmed from increased anxiety about using nuclear energy. The results suggest that a politicization frame has the potential, if not the likelihood, of causing individuals to not know **(p. 356)** what to believe, which leads them to dismiss otherwise credible evidence and results in a significant status quo bias.

One way to neutralize the effect of a politicization frame is to employ a direct counterframe that emphasizes, when appropriate, that there is in fact a scientific consensus. Being told about the consensus can induce individuals to consider the content on its merits. Bolsen and Druckman (2015) found such an effect, albeit with a twist. They argue that timing matters—that is, a scientific consensus frame is most effective if it comes before a politicization frame. They test this conjecture in experiments on carbon nanotechnology (CNTs) and fracking. As in the nuclear energy study, they show that when descriptions of these technologies are accompanied by a politicization frame, status quo biases kick in and support for these activities declines. In these experiments, however, some respondents are randomly selected to receive an early "warning," (755) stating, for example, "the assessment of CNTs should not be politicized; a consensus of scientists believes CNTs are better for the environment than other energy production methods." The authors find that the (early) scientific consensus frame stunts the impact of politicization and support for the given technology actually increases relative a control group.[5] In short, the frame stimulates individuals to overcome a status quo bias.

The key point is to frame science in terms of consensus when such a consensus exists. As van der Linden and colleagues (2015, 2, 6) explain, "people are likely to use consensus among domain experts as a heuristic to guide their beliefs and behaviors." Indeed, van der Linden et al. find that when individuals receive a climate science message framed in terms of the true scientific consensus associated with the message, their subsequent beliefs about the information and the topic are more consistent with the content of the science. The authors find that Republican subjects (who typically are less likely to believe in climate change) respond particularly well to scientific consensus messages, and provide evidence that the consensus frame mitigates partisan motivated reasoning.

Limitations of Framing and Counterframing

We would be remiss if we failed to acknowledge limitations of framing in the context of science communication. Consider, for example, consensus frames. There are many cases where consensus frames will be difficult to use and other cases where their use may be considered unethical. Consensus frames will be difficult or impossible to use when discussing the many scientific topics for which consensus does not exist or for which consensus is difficult to define (Druckman 2015a). In other cases, claims about consensus will be derived from frameworks that are not well understood by potential recipients of consensus messages. Consider, for example, that scientific research typically entails uncertainty in measurement as well as findings that depend on certain assumptions or theoretical frameworks. Failure to articulate these dependencies can cause consensus claims to be misleading (Dietz 2013; Leiserowitz 2007). In general, science communication entails choosing frames that produce understandings that are consistent with the actual content of the research. Even when this is done, consensus frames may not work. Indeed, another basic challenge of using consensus frames is that there are circumstances under which individuals misperceive consensus based on their partisan priors—this occurs particularly when the scientific claims involve politicized issues on which clear positions are taken (Kahan et al. 2011).

Another limitation of framing, particularly when it is used to mitigate psychological tendencies such as partisan motivated reasoning and status quo biases, is that these tendencies are not always bad for the people who rely on them. Put another way, one should not conclude from our review of the literature that effective framing strategies ensure more reasoned opinions. The reason is that science offers one way of understanding concepts and relationships, but it is not the only socially or personally relevant way of knowing. While science can clarify consequences of current or potential beliefs and actions, science cannot determine which choice people *should* make absent normative criteria, which are influenced by personal circumstances and broader moral and ethical precepts. In some cases, partisan motivated reasoning and status quo biases help people increase their own quality of life or quality of life for others (see, e.g., Kahan in press; Lupia 2016; Druckman 2014). In some circumstances, relying fully on one's political party may be the most efficient way to achieve an important normative or technical goal (Sniderman and Stiglitz 2012).

Another limit of framing comes from competition (e.g., Chong and Druckman 2013). Most existing framing research evaluates specific frames in a controlled environment. In reality, science communication efforts compete with many other stimuli for attention. This competition may limit (p. 357) the impact of any particular frame. Bernauer and McGrath (2016, 3) explain that "citizens are exposed to many competing claims (frames and counter-frames) … This information abundance means … identification of significant framing effects [are] less likely." This accentuates the need for future work to isolate the extent to which framing results documented in laboratories or on surveys are robust in the presence of the types of competition found in many communicative environments (see, e.g., Albertson and Busby 2015; Aklin and Uperlainen 2013; Druckman and Leeper 2012). Which frames win the competitive framing battle? Some work suggests frames that appeal to morals seem particularly effective; however, that in turn can depend on the type of moral appeal and the nature of other frames in play (see, e.g., Clifford et al. 2015; Nisbet et al. 2012; Feinberg and Willer 2012).

Understanding the effect of competition and the conditions under which certain types of frames and counter-frames remain effective can be hastened by engaging other literatures that seek to improve science communication outcomes. One such literature focuses on source credibility (see, e.g., the reviews in Druckman and Lupia 2016; Lupia 2016). Credibility is an important asset for science communicators. It can help draw attention to effectively framed arguments. Yet many scholars and science communicators have false beliefs about how credibility is built and maintained, particularly in competitive and politicized environments. Specifically, many science communicators believe that elements of a speaker or writer’s true character, demographic attributes, or academic pedigree (e.g., “I have a PhD” or “other academics have cited my work hundreds of times”) are sufficient for a person to be considered a credible source of information. These assumptions are incorrect. While there are conditions under which such factors correlate with source credibility, the literature shows that these elements (e.g., true character) do not determine source credibility.

Source credibility is more accurately described as *a perception that is bestowed by an audience*. Source credibility represents the extent to which audience members *perceive* a communicator as someone whose words or interpretations they would benefit from believing. Lupia and McCubbins (1998) used a series of experiments and mathematical models to demonstrate the essential role that two factors play in establishing and maintaining a source’s credibility. One factor is *perceived commonality of interests*—the extent to which a prospective learner perceives a speaker as communicating for the purpose of achieving outcomes that benefit the listener. The other is *perceived relative expertise*—the extent to which a prospective learner sees a speaker as knowing things about the consequences of the listener’s choice that the listener does not know. A wide range of studies shows that when an audience’s perception of a speaker differs from the speaker’s true attributes, the perception, and not the reality, determines the extent to which prospective learners will believe what they are reading, seeing, or hearing (also see Pornpitakpan 2004). At the intersection of studies on this topic and studies on framing is the potential for extensive new clarity about the combinations of context and content that can help science communicators more effectively use frames to convey critical information to important audiences.

Conclusion

By many measures, scientific research on a range of socially relevant topics is more rigorous and reliable than ever before. This work has great potential to improve quality of life for individuals, organizations, and societies around the world. At the same time, however, science communicators face new challenges. Advances in electronic communication technologies have produced an explosion in the number and range of objects to which people can pay attention. At the same time, changes in culture and politics have led to increased skepticism of science in some places.

Many of today's scientists are ill-equipped to respond effectively to the new challenges. In previous eras, there was little training in science communication and little or no incentive to develop communication skills that could help scientists convey important ideas in competitive or politicized environments. Because science has so much to offer society, science and scientists should be motivated to learn effective communication skills. Understanding how framing affects communicative outcomes can help science communicators offer more insight to more people. If science communicators can choose frames that draw prospective learners' attention, while staying true to the actual conduct and principles of the underlying research, they can provide great value to audiences.

Working together, framing researchers and scientists of all kind have the potential to clarify the conditions under which certain frames are necessary or sufficient to help target audiences learn new facts about the natural and social world. While understanding these conditions does not guarantee **(p. 358)** success, it can increase the range of circumstances in which science communicators can help others make better decisions.

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References

Aklin, Michaël, and Johannes Urpelainen. (2013). Debating clean energy: frames, counter-frames, and audiences. *Global Environmental Change*, 23(5), 1225–1232.

Albertson, Bethany, and Joshua William Busby. (2015). Hearts or minds? Identifying persuasive messages on climate change. *Research and Politics,* 2(1), **http://dx.doi.org/10.1177/2053168015577712**.

Bartels, Larry M. (2002). Beyond the running tally: partisan bias in political perceptions. *Political Behavior*, 24(2), 117–150.

Bolsen, Toby, and James N. Druckman. (2015). Counteracting the politicization of science. *Journal of Communication*, 65, 745–769.

Bolsen, Toby, and James N. Druckman, and Fay Lomax Cook. (2014a). How frames can undermine support for scientific adaptations: politicization and the status quo bias. *Public Opinion Quarterly*, 78, 1–26.

Bolsen, Toby, James N. Druckman, and Fay Lomax Cook. (2014b). The influence of partisan motivated reasoning on public opinion. *Political Behavior*, 36, 235–262.

Bernauer, Thomas, and Liam F. McGrath. (2016). Simple reframing unlikely to boost public support for climate policy. *Nature Climate Change*, 6, 680–683. doi:10.1038/nclimate2948.

Cacciatore, Michael. A., Dietram A. Sheufele, and Shanto Iyengar. (2016). The end of framing as we know it … and the future of media effects. *Mass Communication and Society*, 19(1), 17–23.

Chong, Dennis, and James N. Druckman. (2013). Counter-framing effects. *Journal of Politics*, 75, 1–16.

Chong, Dennis, and James N. Druckman. (2007). Framing theory. *Annual Review of Political Science*, 10, 103–126.

Clifford, Scott, Jennifer Jerit, Carlisle Rainey, and Matt Motyl. (2015). Moral concerns and policy attitudes: investigating the influence of elite rhetoric. *Political Communication*, 32(2), 229–248.

Davenport, Coral. (2014). Miami finds itself ankle-deep in climate change debate. *The New York Times,* May 7. **http://www.nytimes.com/2014/05/08/us/florida-finds-itself-in-the-eye-of-the-storm-on-climate-change.html**

Davis, Charles, and Jonathan M. Fisk. (2014). Energy abundance or environmental worries? Analyzing public support for fracking in the United States. *Review of Policy Research*, 31(1), 1–16.

Dietz, Thomas. (2013). Bringing values and deliberation to science communication. *Proceedings of the National Academy of Sciences*, 110, 14081–14087.

Druckman, James N. (2015a). Communicating policy-relevant science. *PS: Political Science & Politics,* 48(Suppl. S1), 58–69.

Druckman, James N. (2015b). Eliminating the local warming effect. *Nature Climate Change*, 5, 176–177.

Druckman, James N. (2014). Pathologies of studying public opinion, political communication, and democratic responsiveness. *Political Communication*, 31, 467–492.

Druckman, James N. (2001). The implications of framing effects for citizen competence. *Political Behavior*, 23, 225–256.

Druckman, James N., and Toby Bolsen. (2011). Framing, motivated reasoning, and opinions about emergent technologies. *Journal of Communication*, 61, 659–688.

Druckman, James N., and Thomas J. Leeper. (2012). Learning more from political communication experiments: pretreatment and its effects. *American Journal of Political Science*, 56, 875–896.

Druckman, James N., and Athur Lupia. (2016). Preference change in competitive political environments. *Annual Review of Political Science*, 19, 13–31.

Druckman, James N., Erik Peterson, and Rune Slothuus. (2013). How elite partisan polarization affects public opinion formation. *American Political Science Review*, 170, 57–79.

Druckman, James N., and Richard M. Shafranek. (2015). The conditional nature of the local warming effect. Working Paper, Northwestern University.

Egan, Patrick J., and Megan Mullin. (2012). Turning personal experience into political attitudes: the effect of local weather on Americans' perceptions about global warming. *Journal of Politics*, 74(3), 796–809.

Feinberg, Matthew, and Robb Willer. (2012). The moral roots of environmental attitudes. *Psychological Science*, 24(1), 56–62.

Freudenburg, William R., Robert Gramling, and Debra J. Davidson. (2008). Scientific certainty argumentation methods (SCAMs), science and the politics of doubt. *Sociological Inquiry*, 78(1), 2–38.

Healy, Andrew, and Gabriel S. Lenz. (2014). Substituting the end for the whole: why voters respond primarily to the election-year economy. *American Journal of Political Science*, 58(1), 31–47.

(p. 359) Jasanoff, Sheila S. (1987). Contested boundaries in policy-relevant science. *Social Studies of Science,* 17(2), 195–230.

Joireman, Jeff, Heather Barnes Truelove, and Blythe Duell. (2010). Effect of outdoor temperature, heat primes and anchoring on belief in global warming. *Journal of Environmental Psychology*, 30(4), 358–367.

Kahan, Dan M. (in press). The politically motivated reasoning paradigm. *Emerging Trends in Social & Behavioral Sciences*. Forthcoming.

Kahan, Dan M. (2015). Climate-science communication and the measurement problem. *Political Psychology,* 36(Suppl. 1), 1–43.

Kahan, Dan N., Hank Jenkins-Smith, and Donald Braman. (2011). Cultural cognition of scientific consensus. *Journal of Risk Research*, 14, 147–174.

Kahneman, Daniel, and Shane Frederick. (2002). Representativeness revisited: attribute substitution in intuitive judgment. In: Thomas Gilovich, Dale Griffin, and Daniel Kahneman, eds., *Heuristics and biases: the psychology of intuitive judgment*. New York: Cambridge University Press, 49–81.

Korobkin, Russell. (2000). Behavioral economics, contract formation, and contract law. In: Cass R. Sunstein, ed., *Behavioral Law & Economics*. New York: Cambridge University Press, 116–143.

Lavine, Howard, Christopher Johnston, and Marco Steenbergen. (2012). *The ambivalent partisan*. New York: Oxford University Press.

Leeper, Thomas J. (2012). Essays on political information and the dynamics of public opinion. PhD diss. Northwestern University.

Leiserowitz, Anthony. (2007). Communicating the risks of global warming: American Risk perceptions, affective images, and interpretive communities. In: Susanne C. Moser and Lisa Dillin, eds., *Creating a climate for change: communicating climate change and facilitating social change*. New York: Cambridge University Press, 44–63.

Lewandowski, Gary W., Natalie J. Ciarocco, and Emily L. Gately. (2012). The effect of embodied temperature on perceptions of global warming. *Current Psychology*, 31(3), 318–324.

Li, Ye, Eric J. Johnson, and Lisa Zaval. (2011). Local warming: daily temperature change influences belief in global warming. *Psychological Science*, 22(4), 454–459.

Lupia, Arthur. (2016). *Uninformed: why people know so little about politics and what we can do about it*. New York: Oxford University Press.

Lupia, Arthur, and Matthew D. McCubbins. (1998). *The democratic dilemma: Can citizens learn what they need to know?* New York: Cambridge University Press.

Miller, George A. (1956). The magical number seven, plus or minus two: some limits on our capacity for processing information. *Psychological Review*, 63(2), 81–97.

Mullainathan, Sendhil. (2007). Psychology and development economics. In: Peter Diamond and Hannu Vartiainen, eds., *behavioral economics and its applications*. Princeton, NJ: Princeton University Press.

Nisbet, Matthew C. (2009). Framing science: a new paradigm in public engagement. In: LeeAnne Kahlor, and Patricia Stout, eds. *Communicating science: new agendas in communication*. New York: Routledge.

Nisbet, Matthew C., Dominique Brossard, and Adrianne Kroepsch. (2003). Framing science: the stem cell controversy in an age of press/politics. *Harvard International Journal of Press-Politics*, 8, 36–70.

Nisbet, Matthew C., Ezra M. Markowitz, John E. Besley. (2012). Winning the conversation: framing and moral messaging in environmental campaigns. In: Lee Ahern, and Denise Sevick Bortree, eds., *Talking green: exploring contemporary issues in environmental communications* (pp. 9–36). New York: Peter Lang.

Nisbet, Matthew C., and Chris Mooney. (2007). Framing science. *Science,* 316, 56.

Oreskes, Naomi, and Erik M. Conway. (2010). *Merchants of doubt: how a handful of scientists obscured the truth on issues from tobacco smoke to global warming*. New York: Bloomsbury Press.

Pielke, Roger S. Jr. (2007). *The honest broker: making sense of science in policy and politics*. Cambridge, UK: Cambridge University Press.

Pornpitakpan, Chanthika. (2004). The persuasiveness of source credibility: a critical review of five decades' evidence. *Journal of Applied Social Psychology*, 34(2), 243–281.

Risen, Jane L., and Clayton R. Critcher. (2011). Visceral fit: while in a visceral state, associated states of the world seem more likely. *Journal of Personality and Social Psychology*, 100(5), 777–793.

Scannell, Leila, and Robert Gifford. (2013). Personally relevant climate change: the role of place attachment and local versus global message framing in engagement. *Environment and Behavior*, 45(1), 60–85.

Scheufele, Dietram A. (2006). Five lessons in nano outreach. *Materials Today*, 9, 64.

Scheufele, Dietram A., and Bruce V. Lewenstein. (2005). The public and nanotechnology: how citizens make sense of emerging technologies. *Journal of Nanoparticle Research*, 7, 659–667.

Schuldt, Jonathon P., Sarah H. Konrath, and Norbert Schwarz. (2011). "Global warming" or "climate change"? Whether the planet is warming depends on question wording. *Public Opinion Quarterly*, 75(1), 115–124.

Scruggs, Lyle, and Salil Benegal. (2012). Declining public concern about climate change: Can we blame the great recession? *Global Environmental Change*, 22(2), 505–515.

Sniderman, Paul M., and Edward J. Stiglitz. (2012). *The reputational premium: a theory of party identification and spatial reasoning*. Princeton, NJ: Princeton University Press.

Spence, Alexa, and Nick Pidgeon. (2010). Framing and communicating climate change: the effects of distance and outcome frame manipulations. *Global Environmental Change*, 20, 656–667.

Spence, Alexa, Wouter Poortinga, and Nick Pidgeon. (2012). The psychological distance of climate change. *Risk Analysis*, 32(6), 957–972.

Steketee, Mike. (2010). Some skeptics make it a habit to be wrong. *The Australian*, November 20. **http://www.theaustralian.com.au/national-affairs/some-sceptics-make-it-a-habit-tobe-wrong/story-fn59niix-1225956414538?nk=88273c4b51f7681ad3c1847e54436548**

van der Linden, Sander L., Anthony A. Leiserowitz, Geoffrey D. Feinberg, and Edward W. Maibach. (2015). The scientific consensus on climate change as a gateway belief: experimental evidence. *PLoS One,* 10(2), e0118489.

Weber, Elke U., and Paul C. Stern. (2011). Public understanding of climate change in the United States. *American Psychologist*, 66(4), 315–328.

Zaval, Lisa, Elizabeth A. Keenan, Eric J. Johnson, and Elke U. Weber. (2014). How warm days increase belief in global warming. *Nature Climate Change*, 4, 143–147.

Selected Readings

Clarke, Christopher E., Philip S. Hart, Jonathon P. Schuldt, Darrick T.N. Evensen, Hilary S. Boudet, Jeffrey B. Jacquet, and Richard C. Stedman. (2015). Public opinion on energy development: the interplay of issue framing, top-of-mind associations, and political ideology. *Energy Polic*y, 81, 131–140.

Druckman, James N. (2015). Communicating policy-relevant science. *PS: Political Science & Politics,* 48(Suppl. S1), 58–69.

Kahan, Dan M. (in press). The politically motivated reasoning paradigm. *Emerging Trends in Social & Behavioral Sciences*. Forthcoming.

Lupia, Arthur. (2013). Communicating science in politicized environments. *Proceedings of the National Academy of Sciences*, 110, 14048–14054.

Lupia, Arthur. (2016). *Uninformed: why people know so little about politics and what we can do about it*. New York: Oxford University Press.

Nisbet, Matthew C. (2009). Framing science: a new paradigm in public engagement. In: LeeAnne Kahlor, and Patricia Stout, eds. *Communicating science: new agendas in communication* (pp. 40–67). New York: Routledge.

Scheufele, Dietram A. (2014). Science communication as political communication. *Proceedings of the National Academy of Sciences*, 111, 13585–13592.

Suhay, Elizabeth, and James N. Druckman. (2015). The politics of science: political values and the production, communication, and reception of scientific knowledge. *The Annals of the American Academy of Political and Social Science*, 658, 6–306.

Notes:

(1.) Schuldt et al. (2011) show that opinions differ depending on whether the term "global warming" or "climate change" is used; however, Zaval et al. (2014, 144) find that the local warming effect is not contingent on such terminology.

(2.) Another condition stated the act was supported by both parties; the results of that condition suggest that respondents view such a consensus frame as being akin to an in-party frame.

(3.) Another justification condition described the environment as being highly partisan such that government is divided and fellow partisans rarely agree and said that later the respondent would have to explain reasons for his or her partisan affiliation. This was similar to the polarized conditions in the previously discussed experiment, and the results in these conditions suggested strong partisan motivated reasoning.

(4.) Parts of this discussion come from Druckman (2015a).

(5.) The authors also explore whether the scientific consensus frame can counteract politicization if received later, after the politicization frame is received. They find that such a later "correction" can work, particularly when individuals are highly motivated.

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