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A Recap: Heuristics, Biases, Values, and Other Challenges to Communicating Science

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Abstract and Keywords

This synthesis chapter summarizes the central themes from the essays in Part VI of the handbook. The uniting refrain of this section is the important role of the audience, and specifically how audience choices, attention, biases, and heuristics affect interpretation of complex scientific topics. We first summarize what we term “phenomena of selection” and describes empirical insights indicating that audience and communicator choices can cause diverging views. The second focus is how audiences reason about scientific information, with particular attention to some of these biases and motivations relied on in these contexts. The unique challenges these phenomena pose to the field are then discussed, including (a) how communicators can effectively condense scientific information while retaining accuracy and the interest of audiences and (b) how science communication must accommodate for audiences’ use of values and cognitive shortcuts to make sense of these issues.

Keywords: heuristics, biases, values, selective exposure, confirmation bias, selective judgment, scientific information, audiences

The authors of the chapters in this handbook analyze the role of media, spokespersons, and other intermediaries in communication about, or as part of, the political debates that surround science, the applications of emerging technologies, and the ethical, legal, and social issues involved in integrating science into policy. In this section, we turn to focus on *audience* perspectives—that is, the significance of individuals’ information choices, cognitive biases, and their use of heuristics and values as instrumental mechanisms to the science of science communication. The effects of these audience-level phenomena are profound because they directly impact the views of policymakers and the public and contribute to and may contaminate the uses of science in the everyday lives of citizens and in policymaking (see Chapter 38).

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The audience-level features associated with public perceptions of science can be grouped into two sets of (related) phenomena that unite the chapters in this part of the handbook. The first is phenomena of *selection*: audience interpretations of information are related to (a) what information sources they themselves choose (Festinger 1957) and (b) the way in which those sources selectively present information (Scheufele 1999).[1] The second is phenomena of *reasoning*: information filtered and processed through the cognitive heuristics, biases, and values, of the audience members such that the same information can be interpreted by different individuals to mean very different things (Kunda 1990). Together, these phenomena present challenges to the communication of science and thus make up a crucial layer of science of science communication research.

(p. 456) Phenomena of Selection

One crosscutting refrain in this handbook is the need for communication scholarship to navigate an increasingly fragmented and politicized media landscape. New information environments put more responsibility in the hands of audiences to choose what information they see, to judge its validity, and to decide how much attention to pay to it. However, these judgments are also influenced by selections made on the part of the sources themselves. That is, a source's choices about what information to present and how to present it (e.g., issue framing) heavily influence audience interpretations.

Selective Exposure and Selective Attention

Audiences' tendencies to privilege certain sources or attend to specific parts of a message are the foundation of the theory of selective exposure, described in Natalie Jomini Stroud's chapter in this section (Chapter 40). Selective exposure occurs when individuals' prior beliefs and/or values determine what sources and information they choose to attend to and to deem credible. One oft-cited example is the politicized US cable news environment; while progressive Americans' favor left-leaning news channels like MSNBC, conservative Americans prefer right-leaning sources like Fox News. These instances of selective exposure and selective attention are explained as coherency mechanisms that enable individuals to affirm currently held beliefs and avoid cognitive dissonance (Festinger 1957).

Information Selection and Framing

Upon exposure to a particular piece of information (whether deliberate or by happenstance), audiences' evaluation of the material is influenced by the choices made by the communicator, or source, when presenting the information. One of these choices is how information is framed. Framing is a broadly used term in communication research, which ties (media) portrayals of issues to individual-level interpretations of information (Scheufele 1999). James Druckman and Arthur Lupia (Chapter 37) describe how media frames affect audience processing of scientific information. Drawing on work in sociology that conceptualizes frames as broader "interpretive packages" (Gamson and Modigliani 1989), Druckman and Lupia conceptualize framing as the essential process of distilling complex information by emphasizing certain details, which has also been referred to as *emphasis* or *issue framing* (Cacciatore et al. 2016). By restricting what information is provided, emphasis frames in media messages signal the details of the issue that are worthy of focus, which in turn affects the audience's related judgments. For instance, news outlets can select the beginning and end points of trend data (e.g., suicide rates, changes in global temperature over time) to report in ways that leads the audience to come to certain conclusions (see Chapter 42).

Similarly, frames that emphasize how politically polarized an issue is, such as stressing the political polarization over a particular energy bill, can induce people to merely adopt the side consistent with their ideology rather than weigh all the information before drawing a conclusion. Meanwhile, emphasizing cross-partisan support for the same bill can deter this effect (Bolsen et al. 2014). Of course, it is not always possible to emphasize cross-partisan support, particularly when there is a strong tendency in politics "to cast certain scientific claims in a polarized light" (p. XX). Indeed, cues embedded in messages that emphasize scientific uncertainty or political disagreement, whether intentional or unintentional, lead audiences to dismiss credible evidence (see Chapter 37). Yet the converse is equally problematic—questionable or inaccurate scientific information can persist in influencing public beliefs about a particular issue (also discussed throughout Part II of this handbook). One such instance is the perception that the MMR vaccine causes autism. As described by Natalie Jomini Stroud, Nan Li, and Kathleen Hall Jamieson (Chapter 45), empirical work provides an explanation for the persistence of such beliefs. In the case of the MMR vaccine, the perception of a causal link likely endures because it is a deeply personal issue for some, the study making the link was provocative and widely publicized, the claim resonates with pre-existing negative schema about vaccines, and there is no other clear cause of autism available to replace this misperception.

Phenomena of Reasoning

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As alluded to already, different people can interpret the same piece of information in disparate ways (e.g., Kahan et al. 2009). Although the way a piece of information is processed by audience members is, partly a function of the message (e.g., source types, emphasis frames, polarizing cues), the interpretation of that information is also influenced by individuals' cognitive biases and heuristics and is processed through the lens of their personal beliefs and values (e.g., Liang et al. 2015; Brossard et al. 2009).

(p. 457) In the dual-system model of information processing, intuitive judgments made using heuristics and biases are often aligned with System 1, the fast, intuitive, and emotional information processing system, as opposed to System 2, the slow, deliberative, and logical system (Kahneman 2011). Everyone is inclined to process information heuristically at one time or another, including seasoned experts (Tversky and Kahneman 1974), and doing so is not necessarily a defect. On one hand, cognitive shortcuts provide a way of making quick decisions efficiently, but on the other, heuristics tend to yield more inaccurate conclusions than deliberative and effortful processing of information. When we process communication about science issues, as Kate Kenski argues,

> our tendency toward heuristic processing of information, through the cognitive shortcuts we employ to understand the world, makes it difficult at times to reject our initial feelings about scientific topics and consider the evidence at hand, especially when that evidence runs counter to what we already believe or want to believe. (p. XX)

The technical nature of many scientific issues, their increasing tendency to be politically polarizing, and the fact that science communication usually involves complex data and numbers, are all factors that promote the use of heuristic processing (Chapter 41).

Confirmation Bias

When audiences evaluate information about a host of social and political issues, several particular heuristics and biases are commonly applied. For instance, Kenski describes how *confirmation biases* lead audiences to prioritize or favor information that is consistent with (confirms) their existing beliefs, while dismissing disconfirming evidence. This is the same process Stroud refers to as "selective judgment," in which "confirmatory messages are readily adopted and integrated into one's mental framework and contradictory ones are dismissed out right or subject to enhanced scrutiny that can minimize their impact on one's beliefs and attitudes" (p. XX). In fact, confirmation bias/selective judgment are also often referred to in the literature using the broader term of *motivated reasoning*.

Bias Blind Spot

In addition to the conformation bias, Kenski also discusses the influence of the *bias blind spot* (Pronin et al. 2002), which refers to individuals' tendency to recognize systematic biases in others' judgments but not their own. Because bias blind spot influences misunderstandings, mistrust, and the ability to find common ground, it is a particularly important challenge to overcome at the intersection of science and society.

Quantitative Heuristics and Biases

The numeric information and statistical data often embedded in scientific messages make interpretation of them particularly susceptible to heuristics and biases. Bruce Hardy and Jamieson (Chapter 42) highlight interpretive biases that are specific to numeric trendlines. Cross-disciplinary work reveals that individuals are more influenced by particular data points, often focusing on and overweighting the high points and final points (*peak and end* rule) or most recent data (*recency effect*), each of which distorts inferences made about the data. Ellen Peters notes that people who have lower numeracy capacities may be more prone than the more numerate to lean on these heuristics to navigate numeric, scientific information (Chapter 41).

Heuristics and Biases Under Fear and Uncertainty

Identifiable heuristics and biases also are cued when audiences interpret scientific information relaying risks and uncertainties. As Michael Siegrist and Christina Hartmann note, *risk* communication should "provide information that enables people to make informed decisions" (p. XX). And, as alluded to in Part IV of this handbook by Jeffery Morris (Chapter 21), the general public and other stakeholders tend to desire certainty regarding risk assessments, which cannot be given. Nonetheless conveying *uncertainty* focuses on communicating how some risks are unknown or even unknowable. Interpretation depends on individuals' numeracy skills, biases and heuristics, and relevant self-ascribed personal interests and values.

Robert Lull and Dietram A. Scheufele (Chapter 43) hone in on several types of heuristics associated with genetic modification. The authors discuss how such fears elicit the use of several types of heuristics and biases, including the *availability heuristic*, making judgments using the evidence that most easily come to mind; the *affect heuristic*, using "feelings" for making judgments as opposed to knowledge; and the *naturalistic fallacy*, the belief that what happens in nature is inherently better (e.g., what is is what ought to be; **(p. 458)** Moore and Baldwin 1993). This final bias is particularly relevant to communicating about issues of biotechnology. The authors propose that the "unnaturalness" fear is rooted in religious or moral convictions, cultural worldviews, environmental values, or a personal sensitivity to disgust. Lull and Scheufele also attribute the reliance on this heuristic to specific interest groups or sources' motivation to propagate a view of this technology as risky, which then further engages the use of heuristics surrounding fear and uncertainty.

Common Themes and Future Research

The chapters in this section provide a summary of scholarship on the informational cues, heuristics, values, and biases that challenge science communication, specifically focusing on how the audience's interpretation of information is influenced by various heuristics, biases, values, and predispositions. The chapters underscore the challenges that these varied dispositions and biases pose for science communication, both in theory and in practice. Here we highlight two of these challenges and propose future directions for research.

Challenge 1: Selecting, Compressing, and Framing Scientific Information

Perhaps the most fundamental challenge for any science communicator is condensing complex information in a way that stays true to the scientific evidence. Oversimplification can be misleading, as James Druckman and Arthur Lupia point out in Chapter 37. Yet it remains unclear how to reliably frame an issue in a way that values scientific principles, conveys the evidence accurately, and appeals to diverse audiences. Audience members are also easy to lose. If information is too simplistic, precision is lost and the audience's intelligence is underestimated. On the other hand, if information is too complex or contains too much jargon, audience members will stop reading. As former Guardian science editor Tim Radford (2011) suggested in number 7 of his *25 Commandments for Journalists*, "If in doubt, assume the reader knows nothing. However, never make the mistake of assuming the reader is stupid. The classic error in journalism is to overestimate what the reader knows and underestimate the reader's intelligence." (para. 11).

The challenges can be magnified by uncertainty (whether real or perceived) and/or false causal beliefs related to the topic. Scholarly work provides some evidence-based strategic responses to this dilemma. Communicating about scientific retractions, for example, can follow the principles outlined by Man-pui Sally Chan, Christopher Jones, and Dolores Albarracín (Chapter 36). Some of these include issuing retractions and corrections promptly and widely while also developing, supporting, and publicizing alert systems for misinformation across domains. Peters also shares approaches for conveying highly complex information: identify communication goals, give numeric information (rather than withhold it), reduce the cognitive burden on the audience (the communicators should "do the math"), incorporate affective meanings to help people process numeric information, and, if compelled to give a lot of numeric information, help the reader by drawing attention to what is most important. Lull and Scheufele draw on precedents set by dissemination of other food technologies to provide some strategies for overcoming an unnaturalness perception about genetically modified food.

There is still work to be done in this area. The efficacy of specific message structures is particularly relevant in an increasingly diverse and fragmented media environment, which Druckman and Lupia note. Hardy and Jamieson propose some techniques for communicating numeric data that work well in new media environments. Chan et al. and Li et al.'s chapters call for more investigation into how selectivity processes in the current media environment propagate misinformation and mischaracterizations of science. Li et al. suggest that researchers hone in on how errors in logic associated with false causal beliefs can be dismantled, such as (mis)understandings of necessary and sufficient causes (a common example being an assumption that smoking is a necessary precondition for lung cancer). These authors also suggest experimental analysis of false-cause messaging in the presence of *correct beliefs* or the effect when a correction violates personal beliefs. Siegrist and Hartmann urge testing the effects of numeracy, value similarity in messages, knowledge, and trust affect perceptions of risk. Chan et al. also propose research into the role of conspiratorial thinking in communicating information about retractions.

Challenge 2: Implementing Communication Methods that Work with Heuristics, Biases, and Values, Rather than Ignoring Them

In a similar vein, this section offers practitioners directives that can harness the values and heuristics commonly applied to interpreting science issues, (p. 459) including correcting false causal attribution and misinformation. In line with Peters and Chan et al.'s suggestions, Jamieson and Hardy describe ways to overcome the influence of biases that are commonly used when processing numeric data, including leveraging credible sources, analogizing and visualizing the data, and involving audiences to systematically process the information. Overall, these chapters provide evidence that, for example, personal narratives, central processing of data trends, and value congruence are some strategies for improving the efficacy of communication about science.

These chapters also highlight the need for work investigating *normative* influences in the interpretation of scientific information. Stroud notes that fostering a desire to be correct may lead audiences to be less selective in their informational choices and judgments. Jonathan Baron makes a similar argument in Chapter 38, suggesting that publics be familiarized with "actively open-minded thinking" and its influence in science and other domains, as it can help people challenge their pre-existing beliefs and conclusions. Stroud indicates that self-affirmation may also make people more open to information that conflicts with their views. Whether these strategies are more effective or realistic than others will be an important area for future work, as will be identifying new strategies (normative and informational) to minimize information selectivity and belief reinforcement. At the same time, Siegrist and Hartmann as well as Baron warn that messaging strategies can backfire when they are perceived as paternalistic or as indoctrination. Empirical work that accounts for failed attempts to educate or promote accurate judgments should also be documented.

In light of an increasingly diverse, political, and sophisticated media landscape, the field of science communication must continue to make sense of the effects of greater personal choice and the social and political nature of many scientific issues (Scheufele 2013). Some suggest these phenomena are ushering in a new era of media effects research that is largely based on information tailored toward individual preferences (Cacciatore et al. 2016; Bennett and Iyengar 2008). These ongoing changes to the media landscape can facilitate the dissemination of false information and further reinforce pre-existing tendencies by audiences to opt into “echo chambers” (Jamieson and Cappella 2008) or “filter bubbles” (Pariser 2011) of homogeneous content.

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Notes:

(1.) A related literature focuses on the influence of a communicator’s, or teacher’s, *intentional selection* of information examples on the interpretations that people make when learning (Landrum et al. 2015; Shafto et al. 2012).

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