Science & the Authoritarian:

Deference to Scientific Authority & How It Disables Democratic Deliberation on Controversial Science Issues

By

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Abstract

The concept *deference to scientific authority* captures how beliefs about science as authoritative knowledge can become a type of authoritarianism, with more deferent people believing that scientists, and not citizens, have authority in decision-making concerning scientific issues—even when those issues concern societal and moral questions beyond what science can answer. Because democratic deliberation depends on citizens willingly participating and accepting others' viewpoints as legitimate, deference to the point of authoritarianism can disable such deliberation on how we want to use science and technology in society.

Few studies examine deference to scientific authority, however, and large gaps exist in our understanding of the concept's core theoretical features. These include how deference compares to trust in scientists and the cultural authority of science and limit our ability to capture deference and its implications for science communication and decision-making. This dissertation provides the first empirical look at those gaps by focusing on three main questions:

1) what is the scope of deference—does it predict anti-democratic views even in decision-making on science's societal implications?

2) what does it mean "to defer"—respect for expertise or authoritarianism?

3) where does deference come from—what makes some people more likely to defer to scientific authority?

Examining this last question involves the first look at how deference relates to broader beliefs in science as an authoritative way of knowing the world and builds on work on the cultural authority of science.

Results indicate that existing deference to scientific authority items do predict anti-democratic views on decision-making on science's societal impacts and relate to a narrow, idealized view of "science." Deference, therefore, is distinct from trust in scientists and also from just believing that science is authoritative knowledge. Existing deference items, however, suffer from validity and reliability issues. This work ends with a proposed model for capturing more complete pictures of deference. It ends with discussion on how we can research what the optimal level of deference to scientific authority is across different decision-making contexts—from scientific questions to normative questions—and better understand its implications for how we use scientific information and applications in society.

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Chapter 1. What Is Deference to Scientific Authority, and Why Does It Matter for Deliberative Democracy on Issues in Science & Society

Introduction—Democracy & Science in the U.S.

In the U.S., we increasingly see democratic deliberation and public engagement as necessary pieces of decision-making on controversial science issues, especially decision-making concerning normative questions of how we want to use particular scientific information and applications in society (National Academy of Sciences & National Academy of Medicine, 2017; Panel on Public Participation in Environmental Assessment and Decision Making, 2008; Sarewitz, 2015). At the same time, we often hold as self-evident that science is one of, if not the, best forms of collecting quality information to understand the world and key to incorporating into decision-making (Jasanoff, 1990, 2011b), a concept often captured by the idea of the "cultural authority of science" (Bauer, Pansegrau, & Shukla, 2018). The rationale behind beliefs in the importance of democratic decision-making are often that having more people in the decision-making process makes a decision normatively, practically, and epistemically "good" (see, for example, Bohman, 1996; *Deliberative democracy: Essays on reason and politics*, 1997; Estlund, 2012; Gutmann & Thompson, 1996; Hedrick, 2010). Beliefs in science's importance in such decision-making often connect to believing that science offers an authoritative picture of the true nature of the world—a view that, when widely held in a society, is captured by the concept "the cultural authority of science" (*The cultural authority of science: Comparing across Europe, Asia, Africa and the Americas*, 2018; Hurlbut, 2017; Jasanoff, 2005).

In practice, of course, we see more cases than not where decision-making falls short of democratic ideals (Bohman, 1996; Fishkin, 1991; Gutmann & Thompson, 1996; Jasanoff, 2005). Many limitations in our ability to successfully organize democratic deliberation stem from logistic and structural barriers, particularly in large, pluralistic, and complex societies such as the U.S. (Bohman, 1996; *Deliberative democracy: Essays on reason and politics*, 1997; Fishkin, 1991; Gutmann & Thompson, 1996; Merkel, 1996). Some of the barriers, however, are due to citizens' own views of democratic processes and what is appropriate decision-making. Many people, even in democratic societies, hold authoritarian (i.e. antidemocratic) views of governance (Altemeyer, 1996; Rokeach, 1960). Additionally, many other people, even if supportive of democracy, tend to not want to be personally involved in the most of the decision-making involved in democratic governance (see, for example, Hibbing & Theiss-Morse, 2004).

Interestingly, this type of barrier that stems from citizens themselves holding views that hinder democratic engagement can also emerge when beliefs in the importance of science in decision-making run into conflict with beliefs about democratic processes. Seeing science as authoritative knowledge can, in some cases, translate into authoritarian tendencies to privilege scientific expertise over citizen involvement in decision-making, particularly on issues related to science and technology in society. This phenomenon of how views of science's authority translate into authoritarian views of decision-making is captured by the concept *deference to scientific authority*, and it is the focus of this dissertation.

Deference to scientific authority emerges from ideas tied to the cultural authority of science that refer to how we, as a society, see science as an epistemically, socially, and politically privileged way of understanding the world (Bauer et al., 2018; Brossard & Nisbet,

2007) (as will be further delineated in this introduction and following chapters). Deference to scientific authority theoretically goes beyond just seeing science as authoritative knowledge, however, to holding authoritarian views that privilege scientists' knowledge over that of other citizens in deciding what kinds of knowledge and expertise should count in decision-making concerning science (Brossard, 2002; Brossard & Nisbet, 2007). The result is that people who are more deferent hold anti-democratic views of the roles of citizens in decision-making concerning scientific issues—even when those issues have societal implications and moral conflicts that go beyond the scope of what science can answer (Anderson, Scheufele, Brossard, & Corley, 2012; Brossard, 2002; Brossard & Nisbet, 2007). Because deliberative democracy only works with if citizens participate in the process in good faith, willing to accept the legitimacy of others' standings and perspectives on an issue (Bohman, 1996; Elster, 1997), such authoritarian views can pose a serious limitation to the success of the deliberative process and any outcomes.

This concept of deference to scientific authority as an authoritarian tendency in decision-making on science issues holds vital information, therefore, for understanding power and authority in issues in science and society. Theoretically, it offers a way to understand individuals' views of scientific expertise, democratic ideals, and how the two intertwine in assumptions and decisions about what the world is and should be. Often, however, we do not sufficiently capture or account for it in social science research. Since the initial development of the deference items, research has not more systematically examined them to see if we are capturing the concept and if it behaves as it theoretically should. This dissertation, therefore, provides a first look at some of the key gaps in our understanding of deference to scientific authority to better understand the concept and its implications for science communication and decision-making.

As this dissertation will trace, the gaps in our understanding of deference to scientific authority are mainly in three key areas related to theoretical but untested claims about the nature and implications of the concept. The first is whether deference indeed stems from views of the authority of science as a way of knowing the world. The second is whether deference also occurs in situations in which decision-making explicitly involves the societal implications of science, rather than in contexts that are more directly concerned with scientific decision-making in lab or research settings. The third is whether deference to scientific authority goes beyond deference as respect for authority to deference as more authoritarian views and letting another decide in one's place.

The following chapters empirically and conceptually examine those aspects of deference to scientific authority to further our ability to capture and apply the concept in science communication, engagement, and policy research. The rest of this introduction first traces the concept of deference as it emerged in science communication research and outlines its apparent and theoretical characteristics and implications. It then describes in greater detail the key gaps that remain for better understanding deference, as mentioned above, to see where it comes from, why it matters, and how to capture it. It ends with an overview of how each of the dissertation chapters addresses those gaps. The broader goal of examining deference to scientific authority and its scope and implications is to better understand views on science and decision-making and what those mean for how we choose what information, and from whom, will shape decision-making on morally and technically complex issues in science and society.

Why Care About Deference to Scientific Authority?

As introduced above, deference to scientific authority is the extent to which one not only holds science as an authoritative and exceptional process for producing knowledge about the world, but sees scientists as the rightful authorities in decisions on science and its societal impacts (Brossard & Nisbet, 2007; Brossard & Shanahan, 2003). Theoretically, deference develops in the U.S. through the educational system and culture surrounding science's place in society. In the U.S., the cultural image of science typically portrays an exceptional field that should be left mostly free from regulation and political control—a view that is representative of the "cultural authority of science" (Bauer et al., 2018; Jasanoff, 2011a; Shapin, 2007).

What exactly is meant by "science" is typically not addressed in literature on the cultural authority of science (Latour, 1991; Shapin, 2007), and, in fact, what counts as falling under this monolithic and abstract umbrella of science is often part of what is up for debate in actual cases of conflicts over how we use scientific information and applications (Gieryn, 1999). For this reason, I will regularly use the word "science" in a broad and somewhat abstract sense. Unless otherwise specified, I am not referring to a specific discipline, application, or step in a research process but instead to the often implicit ideas that we attach to this word and to its power as a way of collecting knowledge. This scope of use of the term also includes "science" as a societal institution that we dedicate resources to, in the sense of funding and freedom to operate, and that produces knowledge that we use to shape our choices and structures in society, through the information it provides for decision-making and the applications that effect our options and actions in society. I will expand on aspects of each of these features of "science" throughout this dissertation, but that very broad scope in how I use the word is important for setting the context for this work.

Conceptually, deference is a version of authoritarianism based on belief in the authority of science. It goes beyond just believing that science is authoritative knowledge to not only seeing scientists as the authorities on science issues and but also holding authoritarian views of who should be involved in decision-making on science issues (Brossard, 2002; Brossard & Nisbet, 2007). People who are more deferent are not only theoretically more supportive of emerging science but also more likely to believe that the public should not be involved in decision-making around science, even when decision-making concerns societal impacts of science and technology (Anderson et al., 2012; Brossard & Nisbet, 2007). In past research, those who were more educated tended to be more authoritarian in this way, in contrast to general or right-wing authoritarian personalities, which research typically finds relate to lower levels of education (Brossard & Shanahan, 2003). Researchers interpreted these findings on the relationship between views of scientists as authorities and anti-democratic views concerning decision-making on scientific research as evidence of a unique type of authoritarianism operating only for science-related issues (Brossard & Shanahan, 2003).

Deference for Understanding Views of Science

Most of the research since deference's initial development has focused on deference's relationships to support for science in general, however, rather than its relationships to decision-making on scientific issues in particular. Individuals who are more deferent consistently hold more positive views of emerging, controversial, or societally relevant science and technologies. This often takes the form of perceiving lower risk and higher benefit from that science or technology (Kim, Yeo, Brossard, Scheufele, & Xenos, 2014), or lower risk relative to the perceived benefit (Brossard, 2002; Ho, Brossard, & Scheufele, 2008; Ho, Scheufele, & Corley, 2011), and being more supportive of the science or technology overall (Akin et al., 2017; Brossard & Nisbet, 2007; Ho et al., 2008; Ho, Scheufele, & Corley, 2010; Kim et al., 2014; Lee & Scheufele, 2006; Liang et al., 2015). These findings have held across studies of views of different emerging or controversial technologies, such as synthetic biology (Akin et al., 2017), agricultural biotechnology (Brossard, 2002; Brossard & Nisbet, 2007), embryonic stem cell research (Ho et al., 2008), and nanotechnology (Ho et al., 2010, 2011; Lee & Scheufele, 2006; Liang et al., 2015). These studies might also be part of why deference can be confused with trust in scientists, as the two concepts behave similarly in these cases: predicting greater support for and perceived benefit from emerging technologies and lower perceived associated risk.

Deference for Understanding Views of Democratic Decision-making

Deference's impact on views of who should be involved in decision-making around science has been less examined (for exceptions, see Anderson et al., 2012; Brossard & Shanahan, 2003), and this is arguably where deference to scientific authority could be most useful, as a unique concept for helping us understand communication and decision-making on controversial or emerging science and technology issues. As mentioned above, deference originally emerged as a way to capture authoritarian views toward decision-making in science, with Brossard's work on how views of the role of scientists in decision-making relate participatory views of the role of the public in decision-making around agricultural biotechnology in particular (Brossard, 2002). This work was reproduced in a study examining the relationship between deference and views of the role of scientists and the public in decision-making around nanotechnology, which also found that this is where the concept of deference was distinct from trust, as trust did not relate to views of the role of the public in decision-making while deference predicted greater belief that the public should not be involved (Anderson et al., 2012).

Unfortunately, research since then has tended to detach deference from views concerning decision-making on science issues. This detachment occurred primarily through a lack of empirical analyses, even though work often still described deference as mattering because of its theoretical relationship to authoritarian views of science and scientists. This disconnect between deference and its original conceptual value holds back further development of the concept and understanding of its implications: namely its role in not only relating to positive views of science and technology but in going further to predict such authoritarian views of who should be involved in deciding the development and implications of that science and technology. A goal of this dissertation is to reconnect the concept of deference to its theoretical roots and implications for views of decision-making on science issues.

First, though, it is worth describing why we would care about authoritarian views of who should be involved in decision-making on science. Why is democratic deliberation a desirable feature for decision-making in issues of science and society? And what role might views of the authority of science have in shaping views of such deliberation?

The Rationale for Democratic Decision-Making in Science Issues

Key to understanding why deference matters is understanding 1) why we care about democratic participation in decision-making (and therefore about anti-democratic views such as deference to scientific authority) in the first place, and 2) why the perceived value of democratic participation extends to decision-making on science issues in society.

Democratic Philosophy and the Role of Deliberation

The concern with having public involvement in decision-making stems from a history of western political philosophy that not only values democracy but increasingly sees public deliberation as key to quality democratic governance—particularly on issues for which we have deep social and moral conflicts, i.e., when we see situations that everyday regulation and governance does not seem to be able to effectively address (Bohman, 1996; Hansen & Rostboll, 2015; Hedrick, 2010; White, 2012). Deliberative democratic governance relies on decision-making that is 1) shaped by citizens 2) through compromise and mutual understanding 3) reached through inclusive deliberation that is representative of both the people and the scope of relevant ideas (Hedrick, 2010; Hurlbut, 2017; White, 2012). This dissertation focuses on how views of science fit within and shape those views of democratic decision-making. But first, it helps to have a definition of deliberative democracy and a brief overview of what those democratic ideals are and where they come from, before moving to why they matter for decision-making on science issues as well.

The history of democratic ideals is long and global (Isakhan & Stockwell, 2015) but deliberative democracy in particular is primarily a part of recent western political philosophy and theory, especially literature on and from the U.S. (Bohman, 1996; *Civic engagement in American democracy*, 1999; Fishkin, 1991). It emerged largely through the work of the political philosophers Jürgen Habermas and John Rawls, building on earlier work by many others, such as Immanuel Kant, G.W. F. Hegel, and John Stuart Mills (Arendt, 1968; Bohman, 1996; Hedrick, 2010; Hibbing & Theiss-Morse, 2004). At its core, the idea of deliberative democracy is that, “when citizens or their representatives disagree morally, they should continue to reason together to reach mutually acceptable decisions” (Gutmann & Thompson, 1996, p. 1). The justification, from an ethical standpoint, is that, because decisions that connect to moral conflicts are ones in which the choices of an individual will impact the lives of others, these decisions should be based on a shared, public process that is aimed at resolving such conflicts through having participants be accountable to and learn from the rationale and justifications of others (Bohman, 1996; Elster, 1997; Rawls, 1997). This deliberation depends on individuals communicating their reasoning to each other. The idea is that such shared, public reasoning has normative, instrumental, and epistemic value largely because of how it creates opportunities to combine diverse, individual needs and perspectives with big picture societal views and goals (Bohman, 1996; Gutmann & Thompson, 1996).

For deliberation to be fair, productive, and “good” in these normative and instrumental senses, it needs to be based on what others would deem reasonable claims and concerns, even if others do not agree with the particular substance of the claim itself (Gutmann & Thompson, 1996; Hansen & Rostboll, 2015; Hedrick, 2010; Rawls, 1997). The principles for accomplishing this, as described by Gutmann & Thompson (1996), involve both the process and the content of deliberation. The content involves deciding on fundamental shared concerns such as basic liberty, basic opportunity, and fair opportunity (Gutmann & Thompson, 1996). The process for deciding on this content, meanwhile, must include or strive for reciprocity, publicity, and accountability (Gutmann & Thompson, 1996). Reciprocity refers to the ability of each participant to be able to recognize another’s moral argument as being worthy of respect, even if one does not agree with it (Gutmann & Thompson, 1996). Publicity refers to both the ability to access and contribute to the process and to the reasons given for justifying claims (Bohman, 1996; Gutmann & Thompson, 1996; Young, 1997). Finally, accountability ties to both publicity and reciprocity by how referring to how the openness of the process and the back-and-forth of rationale among participants provide a way to check the assumptions and reasoning of each participant and of the ultimate decision reached (Gutmann & Thompson, 1996; Young, 1997).

Science as a Societal, Political Issue

The value of this type of democratic deliberation extends into issues concerning science for several reasons, the most basic of which is that many issues that involve science also involve political and moral conflicts that impact people's liberty and opportunities. Many theorists see public reasoning as necessary in political decision-making whenever society is faced with questions that deal with what Rawls (1997) calls "constitutional essentials"—fundamental shared concerns of equality in liberty and opportunity (Gutmann & Thompson, 1996)—and moral disagreements or conflicts connected to these essentials (Bohman, 1996; Gutmann & Thompson, 1996; Young, 1997). This concept of democratic deliberation matters for issues concerning science and technology because science issues are political and moral issues, as a large body of work from science communication and science and technology studies (STS) has shown (Jasanoff, 1990; Latour, 1991; Scheufele, 2014).

Although science might have never been separate from politics and society (for an example, see Schaffer & Shapin, 1985), governments and publics increasingly recognize science as integrated with and expected to respond to public policy and to societal values (see, for examples in the U.S., Holbrook & Frodeman, 2012; Lubchenco, 1998; National Academy of Sciences & National Academy of Medicine, 2017; Panel on Public Participation in

Environmental Assessment and Decision Making, 2008). Additionally, many of the large issues facing individuals and society today in the U.S. and in global communities involve science and technology as a cause of the issue, source of information, potential solution, or all of the above (Leshner, 2003; Lubchenco, 1998). Recognizing these connections between science and society has led to extending democratic ideals to decision-making around science and its impacts (Holbrook, 2005; Holbrook & Frodeman, 2012; Panel on Public Participation in Environmental Assessment and Decision Making, 2008).

NSF & science as a national priority. Increased recognition of science and society as intertwined is due in part to overlapping changes in society, policy, and science itself. Following the end of World War II, science became a national priority in the U.S. as prominent scientists and policy-makers such as Vannevar Bush stressed that supporting science in peace time was necessary and required support from the U.S. government and citizens (Bush, 1945; Dennis, 2015). As seen in Bush's famous treatise, *The Endless Frontier*, this push for public and political support for science connected the value of "basic" or fundamental research to its potential for producing applied scientific developments and technologies that would strengthen the country (Bush, 1945). The Cold War added weight to the perceived importance of advanced scientific research as a way of ensuring national security and progress (Dennis, 2015).

The ties between advances in science and advances in society became stronger and more apparent when Congress established the National Science Foundation (NSF) in 1950, dedicated to supporting basic research that met national needs (National Science Foundation, 2017). Congress created the NSF in 1950 with the purpose of advancing "the progress of science" and, through that progress, the security, "health, prosperity, and welfare," of the country (National

Science Foundation, 2017). The NSF mission statement explicitly connects support for "basic research" with allowing people to "create knowledge that transforms the future" (National Science Foundation, 2017).

Establishment of the NSF highlights several factors that since the 1950s have led to the increasingly widespread belief that science and society are co-dependent. Science has explicitly become a national priority funded by the federal government and, as such, by citizens as taxpayers. Because NSF funds research with public money, it awards funding to research that seems to "be the most fruitful investment of taxpayer dollars." It does this by requiring that any awarded research projects connect basic research advances with societally relevant outcomes and impacts through satisfying NSF's intellectual merit and broader impact review criteria (National Science Foundation, 2017). These two criteria capture, essentially, how well the scientific project advances overall and discipline-specific scientific knowledge and how well it furthers broader societal goals, respectively. In the past two decades, the NSF has added emphasis to the importance of the broader impacts of funded research by requiring that a separate section of applicants' proposals specifically address the potential for greater societal reach and gain through their research (Holbrook, 2005; Office of Budget Finance & Award Management, 2014).

As funder of approximately one-fifth of U.S. research in academic institutions and the dominant funding source for several disciplines (National Science Foundation, 2017), the NSF's increased focus on broader impacts means a greater amount of scientific research has to explicitly connect to societal outcomes that are directly relevant to and engaged with the U.S. public. Many of these motivations for engaging the public in science were often more one-directional—motivated by the idea that if the public knew more about science, they would understand its importance for society and continue to support it socially and financially (Conant, 1947; Rowe & Frewer, 2016). Similarly, this one-directional impact of science on society was also often tied to goals of developing greater science education to increase scientific prowess by recruiting and cultivating the next great scientific minds and reaching as many as possible (Bush, 1945; Hamlin, 2016).

Science's social contract. Views of scientific research needing to have a broader societal impact, however, were also often tied to an idea of the responsibility or duty of science to meet these societal needs for society's, rather than explicitly for science's, sake. Because of the reach of science in social issues and its dependence on social funding, scholars increasingly referred to a "social contract" of science and scientists in which scientists must devote resources to urgent societal issues in exchange for public funds, with focus on particular issues dedicated in proportion to the importance of those issues (Lubchenco, 1998). The idea of a social contract stemmed from belief that society had changed to a point where it had large, complex problems that science, as an largely unchanging process focused on discovery and use of knowledge, was uniquely suited to address (Lubchenco, 1998).

The idea that it is society and not science that has changed, however, is too simple and misleading a picture. Science throughout the past century—in part because of the continued public support it has received—has developed into a financial, institutional, and epistemic power in shaping daily life. As the following sections will further illustrate, there is substantial evidence that the intertwining of modern society and scientific research and applications affects not only society but also science, in ways that justify democratic deliberation on issues concerning science and society. Essentially, there are also numerous reasons why science's social contract includes not just a moral duty for science to benefit society but also increasingly depends on citizens having power to shape how we use science and technology in society.

Science as an epistemic and institutional authority. Science gained more power and authority in modern society, particularly in the U.S. and other western democracies through the 1900s, leading to several factors that increased calls for citizens to have a greater role in deciding what types of science research and applications are appropriate. The first is that more and more often developments, especially in the bio- and information sciences, involve great implications for society and no certain answers for the best way to proceed policy-wise (Funtowicz & Ravetz, 2003). Research on genetic engineering or artificial intelligence, for example, involve high uncertainty and potential risks and benefits—both from technical standpoints and from more clearly value-laden standpoints (Jasanoff, Hurlbut, & Saha, 2015; Scheufele, 2014). These characteristics of what is sometimes called "post-normal" science (Funtowicz & Ravetz, 2003) mean that many aspects of decision-making concerning science go beyond scientific decisions, answerable through scientific research and expertise, and become societal decisions.

Alongside these developments in views of science and its connection to society, science and technology studies (STS), especially beginning in the 1970s and '80s, started to highlight how scientific research, as a human process, is inseparable from values, assumptions, and certain ways of seeing the world (Haraway, 1991; Kuhn, 1996; Latour & Woolgar, 1986). Such work stressed that science not only had societal impacts but was intertwined with society in a way that meant that science grows from and reflects—as well as creates and reinforces—societal views and structures. This concept is captured with the term "co-production" (Jasanoff, 2004).

Co-production emphasizes how decisions in science and society rarely emerge linearly, or from distinct lines between cause and effect. Instead, a web of intertwining scientific and societal factors constructs what issues emerge and how we see and further shape them. This process in turn adds to this web by reinforcing some of its features and creating new pathways for shaping future perspectives and decisions (Jasanoff, 2004). The “co” in this sense refers not just to the fact that science produces societal developments and society produces scientific developments. It also highlights that these developments simultaneously occur, with a change in one both emerging from and updating the other (Jasanoff, 2004), with the result that often “emerging science and social context do not exist before the other” (Latour, 1991, p. 31).

Normative Ideals for Democratic Deliberation on Science Issues

These changes in the relationships between science and society led to greater justification for public deliberation in decision-making on issues concerning science and its roles in society. To start, because of the co-production of science and society and because of the power scientific findings can have in the U.S. and other western societies, the STS literature raised concerns with treating contemporary science as purely objective—and therefore privileged— truth (Haraway, 1991; Jasanoff, 1990, 2011b). Such a view runs the risk of leading to authoritarian views of decision-making in science, with scientific expertise and language defining who gets to have a say in shaping science and, therefore, society (Cohn, 1987; Hurlbut, 2017; Jasanoff et al., 2015). As Cohn’s (1987) study on technical language in discussions about nuclear threats during the Cold War illustrated, overly relying on a particular expertise and language for decisions that have wide-reaching implications not only limits the number of people who can contribute but also limits the scope of what we discuss and how we think about an issue.

Scientific expertise and language has value in science fields because of its precision and depth. But in discussions of broad societal impacts that go beyond what scientific expertise can answer, this same precision and depth can result in narrowness that, if not supplemented, can be a weakness for capturing a full measure of potential real-world implications. Additionally, scientists and academic researchers still are overwhelmingly white and male in the U.S. (see, for example, Monroe et al., 2014), which means that even when they speak for scientific research, that research and expertise predominantly is accessible to demographic groups that already hold most of the power in U.S. society. If scientific information stands in as authoritative on normative debates on conflicts in how we use a particular piece of scientific research or technology then, that risks adding further voice to groups that are already likely to disproportionately have power in decision-making.

Assigning too much weight to science at the cost of space for broader considerations also often can ignore that the scientific process depends on the belief that science is always incomplete and becomes closer and closer to approximations of truth by collecting as many viewpoints or observations as possible. Incorporating what the STS literature calls different modes of knowledge, such as different lay or cultural knowledge typically seen as outside of science or simply different experiences, is an important part of expanding the perspectives scientists rely on to interpret their work and ensuring more democratic outcomes in how we develop and use science (Haraway, 1991; Hurlbut, 2015; Jasanoff et al., 2015).

Pragmatic Considerations: Quality Assurance in Public & Private Sectors

The normative claims supporting increased public involvement in decision-making on science often overlap with beliefs that democratic involvement improves both the acceptability of the decision-making results and the quality of the decisions themselves. STS literature, for example, highlighted the importance of other types of knowledge—such as local and non-scientific experiential knowledge—for checking assumptions and capturing a full picture and understanding of an issue (Haraway, 1991; Wynne, 2011). As touched on in the previous section, more views can mean better decisions in the sense of decisions being less likely to be hindered by unexamined assumptions or incomplete understandings of an issues.

Because the culture of a country shapes how science and decision-making around science occurs, for the U.S. context it is also important to understand how these democratic ideals and views of the role of public input in decision-making overlap with market decisions and effects. In the U.S., the tendency is to let the market place and free inquiry of science determine scientific research and societal outcomes of that research (Jasanoff, 2005). Market forces drive much of the scientific advancement in the U.S. in general and for recent science and societal issues such as biotechnology and gene editing in particular (Jasanoff, 2011c). Additionally, private-sector actors and consumer choices, albeit aided by government decisions, shape the development of these new technologies and fields (Jasanoff, 2005, 2011c; Rai & Cook-Deegan, 2017). This connection between scientific development and the market place in the U.S., however, does not need to preclude public deliberation on science and technology issues as they emerge in the public arena and private markets.

In fact, some major potential market failures that relate to complex science and societal issues could be at least partly addressed through greater opportunities for public deliberation in decision-making. Market failures refer to an inefficiency in a market—where there is waste of resources because of a mismatch between demand and supply. The effectiveness of competitive markets in the U.S. is traditionally measured in comparison to the standard of Pareto efficiency, which is the ideal that goods are distributed by a market in such a way that one person could not become better off without making at least one person worse off. When this ideal is not met, it is considered a market failure (Weimer & Vining, 2011). Most modern science and technologies have features that can lead to potential market failures due to inefficiencies concerning the public good nature of scientific information as well as due to potential information asymmetries between consumers or citizens and producers or policy-makers that lead to unaccounted for costs from uncertainty and risk.

First, because the federal government is such a large funder of scientific research, there are moral and practical market-based arguments for increasing public deliberation as an opportunity not only to decide what types and uses of scientific research are acceptable, but also to share and generate new information. Information is an especially important input and output of modern economies and one that is vital for development of scientific research and applications. Information is considered a public good because it is typically non-rivalrous and non-excludable, in economic terms, or not a zero-sum product and not a good that can be easily kept from others, in more vernacular terms (Weimer & Vining, 2011). Information is also unique in that it is both an input and output in its own production cycle (Benkler, 2006). It also only needs to be created once (Benkler, 2006) and usually does not depreciate (Weimer & Vining, 2011). Thanks to access through online sources, it is also easier to consume and produce information than it had been in previous communication environments (Benkler, 2006). Additionally, in today's economy, information is also particularly important to creating opportunities for increasing current and future production overall and for enhancing national wealth (Benkler, 2006; Weimer & Vining, 2011).

For all of these reasons, information is an especially important public good. Additionally, in its role as a funder of scientific research, the U.S. national government affects who produces information, technology, and applications and arguably affects private-sector growth as well, as the industry researchers can build on the publicly-available information created through public-supported research. The U.S. government's role in determining patent awards also plays a part in the information economy by shaping the flow of future information and technology production (see, for example, Benkler, 2006; Jasanoff, 2005, chapter 8; Rai & Cook-Deegan, 2017). Because of the strong federal financial support for scientific research, involving the views of citizens in decision-making could encourage access to and the spread of publicly funded information, which, as described previously, helps achieve normative democratic ideals.

This access to information, however, also has real world consequences for who is able to participate in future decisions and action in both the public and private sectors, which has implications for equality of opportunities and practical implications of future market growth. Having more information and spread of that information gives more people opportunities to participate in the market, often through generating new information. This in turn continues the cycle of moving information from output to input and further production and growth. In the case of science and technology, this potential growth is similar to the claims that Vannevar Bush and others made for increased science education at the start of the Cold War—more brains working on an issue can mean faster and stronger scientific development that can translate into economic and social developments (Bush, 1945).

Similarly, public deliberation can also improve practical decision-making and have an insurance-like role by addressing information asymmetry between researchers/producers and citizens/potential consumers of technology. Sharing information can help ensure that people are informed about the technology while also avoiding inefficiencies by reducing the costs of uncertainty and risk and helping ensure that demand represents true demand for a given technology. Inefficiencies arise when markets have to deal with uncertainty, and public perceptions of uncertainty and risk can translate into costs and inefficiencies. Research on the social and psychological aspects of risk, for example, highlights how people's perceptions and actions in the face of risk depend on a number of qualitative considerations, including how familiar or known a risk is and how controllable it seems (for examples, see Renn, 1992a; Slovic, Fischhoff, & Lichtenstein, 1979). These perceptions translate to real costs because they change people's preference and behavior, which translates into decisions that have effects on demand (Kasperson et al., 1988; Weimer & Vining, 2011).

Additionally, while traditional, rational-choice models of economics rely on a rather static and naïve view of how individuals' expressed preferences translate into market behavior, social science research increasingly finds that the idea of "true" and "given" preferences is often not observed in practice (Elster, 1997). Beyond normative claims that decisions that affect society should be based on more than just the expressed preference and self-interest often of focus in Pareto-optimal economic models, it seems increasingly clear through social science research that preferences are context dependent and changing, often for non-substantive or well-elaborated reasons (Elster, 1997). Tversky & Kahneman's (1984; 1981) work on the effect of framing for shaping preferences between two substantively identical outcomes illustrated this, as did their and others' work on the ways that we all rely on heuristic short-cuts to make decisions with seemingly little of the idealized rational, conscious, reasoning at play (Bruner & Minturn, 1955; Tetlock, 2000; Trumbo, 2002; Tversky & Kahneman, 1973, 1974).

Public deliberation, therefore, can matter for market behavior because it offers a way to combine individual preferences into more complete and potentially less limited understandings of desired outcomes, as well as a way to elucidate and even produce preferences through the back-and-forth that it requires of participants. Such a deliberative process is also insurance of sorts, both by making more clear what preferences are and by creating the opportunity for greater buy-in of the outcomes and decision-making process, even if not all stakeholders agree with the outcome. As a large body of literature on risk perceptions illustrates, access to decision-making and perceptions of the accountability of decision-makers can help address some of the major contributors to increased perception of risk, such as lack of familiarity with an issue and perceived lack of control or choice over options to avoid or alleviate a risk (Fischhoff, Slovic, & Lichtenstein, 1979; Kasperson, 1986; Satterfield, Mertz, & Slovic, 2004; Slovic, 1997; Slovic et al., 1979). From a practical perspective, then, public deliberation can alleviate future inefficiencies and costs—whether in the market sense or otherwise—by providing more comprehensive assessments that incorporate public perceptions (Weimer & Vining, 2011) as well as offering an outlet for people to feel greater control over the decision-making process, familiarity with the uncertainty or risk, and trust in producers and managers of that risk (Kasperson, 1986; Sclove, 1982).

As the links between scientific research and societal implications have become more apparent, people have become more insistent on having a say in shaping those outcomes. We see this through the development of research on public perceptions of risk (see, for examples, Kasperson et al., 1988; Renn, 1992a, 1992b; Slovic, 1997) and case studies of citizen groups and communities inserting themselves into decision-making processes that they felt they had been unjustly left out of with the result of what they perceived as deleterious effects in the quality of decision as well (Fowlkes & Miller, 1987; Tesh, 1988; Weart, 1991). Incorporating public deliberation from the beginning of the emergence of a new issue in science and technology, then, can be a sort of insurance against disruptive actions from people taking political actions after a decision has been made and against potential blindsides to other features of the issue itself.

Returning to Deference: Why Views of Science Matter for Public Deliberation

Deference to scientific authority matters, then, because of how it makes it more likely that people will not support public deliberation on questions that, although connected to scientific issues, are not ones that science can answer. When science impacts society, which it increasingly does given how intertwined science and society are today, many of the questions that concern how we should use or support particular pieces of scientific information or types of applications are questions tied to normative and moral concerns. These are the same questions that democratic deliberation is better suited to address, both for legitimacy reasons, as well as epistemically and practically (Bohman, 1996; Gutmann & Thompson, 1996; Young, 1997).

This dissertation focuses on the potential conflict between democratic deliberation on societal implications of science and views of science as authoritative knowledge in that deliberation, as captured by deference to scientific authority. The goal of examining these ideas concerning science and decision-making is to understand how to more effectively create opportunities for true deliberation around the normative claims tied to issues in how we act on scientific information and use and develop scientific applications in society. By true deliberation, I mean deliberation not bounded by overly narrow ideas of what counts as reasonable (particularly with scientific justifications for particular actions seen as representing "reason" and non-scientific justifications as not) but also with the goal of drawing on diverse information, experiences, and goals to be able to have these discussions on complex issues and what we should do about them.

Being deferent to scientific authority can have negative effects on the decision-making process if the result is decision-making that too often bypasses elucidating assumptions and values to resolve moral conflicts because it instead decides that science has the privileged rationale for decision-making on such conflicts. Such unbounded deference also can have negative impacts of views of the value of science. As I describe in greater detail in the concluding chapter, if science, broadly interpreted, is seen as delving too often and with too much power into normative questions for which it cannot really provide answers, it can also lose its legitimacy and value as a way of testing descriptive claims about the world that can inform and help us achieve normative and practical goals.

Defining Deference: What We Still Need to Learn about the Concept

Because of the normative and practical considerations shaping the perceived importance of democratic deliberation on issues in science and society, deference to scientific authority and its anti-democratic implications are especially relevant for understanding not only views of emerging science but also of how development and decision-making on those science issues should proceed. As described at the beginning of this chapter, however, we still have a long way to go to be able to better understand and apply the concept in social science research. Tracing out and addressing some of the major gaps limiting our ability to capture deference to scientific authority is the focus of the research that forms the rest of the chapters in this dissertation.

The literature on deference to scientific authority typically understands the concept as, more or less, the belief that "scientists know the truth for all scientific matters (even those. . .with ethical and social implications) and that the public should not have a say in decision-making related to science" (Anderson et al., 2012, p. 226). As seen in this definition, three major features of deference matter for understanding the concept and its relevance in modern western society, particularly in the U.S. Deference should mean 1) that one holds more authoritarian views of who should be involved in decision-making around science, 2) that one holds those views even when that decision-making concerns societal impacts, and 3) that deference stems from views of the authority of science, which are transmitted through culture, particularly in public science education (Akin et al., 2017; Anderson et al., 2012; Brossard, 2002; Brossard & Nisbet, 2007).

Very few of these three aspects, however, have been studied empirically. The result is that a theoretically important concept is largely underused or is imprecisely used when it does appear in the literature. These three theoretically important but empirically under-examined aspects of deference in turn relate to three open questions, which drive the focus of this dissertation. I will expand on each below and in the chapters that follow. Briefly, however, these questions are:

1) Does deference to scientific authority matter for views of decision-making even for those "science matters. . . with ethical and social implications"?

2) How is deference best understood: as a form of respect for scientific expertise or as a form of authoritarianism regarding views of who should participate in decision-making on science?

3) How does deference to scientific authority relate to views of the authority of science as a way of knowing the world, or where does deference come from?

Answers to these three questions will be intertwined throughout this dissertation. I separate them here for the sake of clarity and organization, and, for those same reasons, each chapter focuses more heavily on one than the others, as I describe below.

Deference in Decision-making on Societal Impacts of Science

Existing research illustrates how deference to scientific authority predicts views that scientists should be free to make decisions that they think are best in scientific issues, often along with views that citizens should not have a say in such decisions (Anderson et al., 2012; Brossard, 2002; Brossard & Shanahan, 2003). Research typically does this through examining the battery of deference items asking about views of appropriate actions of scientists with a battery of what are called "participatory views" items, asking about what actors should be participating in this decision-making that are listed in Table I.

Table I: Original batteries of items capturing 1) deference to scientific authority and 2) participatory views toward science, developed by Brossard (2002).

Item #	**Items capturing "deference to scientific authority"**
D1.	Scientists know best what is good for the people [*often replaced with* public]
D2.	Scientists should do what they think is best, even if they have to persuade people that it is right
D3.	Scientists should make the decisions about the type of scientific research on [science issue]
D4.	It is important for scientists to get research done even if they displease people by doing it
	Items capturing "participatory views toward science"
P1.	It is important to have public participation in making scientific decisions, regardless of people's knowledge of the issues involved [*Reverse coded (R) to represent non-democratic views*]
P2.	The actions of the scientific community should always reflect the will of the majority [*R*]
P3.	Public opinion is more important than the scientists' opinions when making decisions about scientific research [*R*]
P4.	Scientists should pay attention to the wishes of the public, even if they think citizens are mistaken or do not understand their work [*R*]

These items, however, either do not specify a particular decision-making context (items D1 and D2, and items P1 through P4) or they suggest that such decisions are decisions in a lab or research setting (items D3 and D4)—settings that are more removed from societal implications and societal decision-making contexts and settings in which, even if decisions are tied to particular values and moral views, the decisions are often more legitimately and more completely reliant on scientific expertise, rationale, and answers. Of course, as the earlier discussion outlined, even decisions in a lab are decisions shaped by society—whether through shared values or societal support and funding—and decisions that will in turn shape society through resulting knowledge and applications. For a survey item, however, it is reasonable to expect that many people taking the survey will do so with a firmer boundary in mind between "scientific" decisions—as in decisions in a lab or research setting—and "societal" decisions—such as what we as a society want to do with a particular line of research or application.

Despite the fact that none of the items explicitly refer to decision-making in cases where scientific research and outcomes have more direct connections to societal outcomes, research describes the items as though they do capture deference in these contexts (Anderson et al., 2012). It makes sense that deference theoretically should matter because it shapes views of decision-making in those more directly societal contexts. It is also, however, an empirical question that has as of yet been unexamined. This dissertation will provide the first test of the extent to which deference does in fact predict authoritarian views of decision-making on science in more explicitly societal contexts.

What Does It Mean to "Defer"?

Similarly, deference to scientific authority originally developed as one dimension of authoritarian views of science, paired with the participatory items listed in Table I. Together, these two concepts illustrated authoritarianism by capturing views of the authority in science issues (the deference items) and views of democratic decision-making on science issues (the participatory views items) (Brossard, 2002). There is some theoretical reasoning and empirical evidence that the two concepts of deference to scientific authority and participatory views are distinct (Brossard, 2002), but they both are often conflated since their original conception, sometimes with participatory items being analyzed as a part of an index capturing deference (Binder, Hillback, & Brossard, 2016) but more often with researchers defining deference as also encompassing the concept of participatory views (Akin et al., 2017; Brossard & Nisbet, 2007; Lee & Scheufele, 2006), sometimes even while concurrently highlighting that deference and participatory views are distinct (Anderson et al., 2012).

Either option—deference as needing to be paired with participatory views or deference as distinct—could be true and useful for understanding and applying the concept of deference to scientific authority in research. What seems to be part of the issue is confusion between the two definitions of what it means to "defer." To defer can be "to accept another person's opinion, usually because you respect the knowledge or experience of that person" (Cambridge Dictionary, 2018). It can also be "to let another person decide" (Cambridge Dictionary, 2018).

The deference items as they usually appear in research (namely, items D1 and D2 in Table I) at face value seem to primarily tap the former definition—deference as respect for expertise of scientists in the scientific decision-making domain. The participatory items appear at face value to primarily tap the latter—deferring to the extent of letting someone else decide for the public. Both conceptualizations of deference also emerge in literature on judicial deference, for example, where courts can defer in the sense of recognizing the authority of other governmental bodies and can also go beyond that to defer in the sense of letting a particular governmental body make the decision for the issue (Chan, 2017; Daly, 2012).

In the literature on deference to scientific authority, however, it has never been clear what type of "deference" the deference items capture on their own, and often the two levels of deference are conflated. Parsing out what definition of "defer" is most useful for capturing and understanding an accurate and intuitive definition of deference to scientific authority will be the second goal of this dissertation. This will include testing how much the existing deference items capture authoritarianism by directly comparing them to items of more general authoritarian and dogmatic tendencies, to explore how best to capture "deference" and the extent of its reach from respecting scientific authority to holding authoritarian views toward that authority.

Deference and Views of the Authority of Science

Finally, the last large theoretical question unexamined in the literature on deference to scientific authority is where deference comes from. As I described earlier, deference to scientific authority theoretically stems from cultural views of the authority of science, passed down through ideas that permeate our culture and education systems in the U.S. and other countries where deference is more prevalent (the only non-U.S. country for which there is research on deference to scientific authority is Singapore) (Brossard & Nisbet, 2007; Liang et al., 2015). As a large body of literature describes, the cultural authority of science encompasses beliefs that science is an authoritative way of acquiring knowledge about the world—both in its ability to capture a "true" picture of the world and in its apparent separation from what are seen as more fallible and biased human endeavors, such as politics or religion (Bauer et al., 2018; Brossard & Nisbet, 2007; Gauchat, 2011; Gieryn, 1999; Hurlbut, 2017; Jasanoff, 2005; Latour, 1991; Shapin, 2007).

No research, however, has examined the relationship between deference and views of the authority of science. As seen in Table I, the deference to scientific authority items focus on views of "scientists," with interpretation of the items often taking for granted the untested assumption that respondents are viewing those scientists as representatives of this broader endeavor or institution of science (Akin et al., 2017; Anderson et al., 2012; Brossard, 2002; Scheufele, 2013). In fact, very little research has items that more directly measure views of the authority of science as a way of knowing the world (for an exception, see Bauer, Petkova, & Boyadjieva, 2000). Even in the literature on cultural authority, as I will expand on in later chapters, very rarely do measures, at least at face value, more directly tap such views of the authority of science as a way of knowing about the world.

Instead, research commonly relies on measures such as trust in scientists, attention to science news, science knowledge, interest in science, and views of the impact of science—potential positive and negative outcomes and concerns of whether it "moves too fast"—as indicators of the authority of science (see, for examples, Bauer et al., 2018; Besley, 2018; Gauchat, 2011). At best, these items capture narrow side effects of, or proxies for, broader cultural views of science's authority, such as trust in scientists as authorities in particular issues. At worst, these measures capture phenomenon that are separate from and/or unnecessary for the current or continued authority of science. It is not clear why, if science is truly an authoritative way of understanding the world, levels of personal interest in or knowledge of science would capture that authority. If something is truly authoritative, and at a cultural level, one likely does not need direct interest in or experience with specific fields or processes of science to believe that scientific information is different from other types of information. The exception could be in how interest and knowledge overlap with education, through which such authority of science is likely perpetuated. If that is the case, capturing aspects of education rather than interest in science, for example, seems to be one possibly more appropriate and encompassing way to understand relevant aspects of individuals' experience with science as authoritative knowledge. We could also more directly ask people about how they see science relative to other types of knowledge production or institutions.

In this dissertation, I test this latter approach and provide the first look at items developed to capture one aspect of the authority of science, through the degree to which people see science as a distinct, valuable way of knowing the world. I examine these items as they relate to and are distinct from deference to scientific authority to understand why, of all the people who see science as authoritative knowledge, only some become deferent to that knowledge to the extent of holding authoritarian beliefs. This examination includes assessing how deference to scientific authority and belief in the authority of science relate to general authoritarian or dogmatic tendencies. I also discuss and examine how these items fit in with this larger discussion around the cultural authority of science and with the views of the nature of knowledge in general and scientific knowledge in particular, as captured through the literature on epistemic beliefs.

Alongside examination of these key areas outlined above, this dissertation will also further our understanding of how deference relates to—and, in particular, is distinct from—trust in scientists. A few studies have examined trust alongside deference (Akin et al., 2017; Anderson et al., 2012; Brossard & Nisbet, 2007). Conceptually, however, the wording of some of the deference items, with their focus on "scientists" rather than "science," can make it difficult for people to understand how these broader views of science and of the role of scientists—as the deference items should capture—are distinct from trust in scientists. This confusion is likely exacerbated by the fact that, as I previously mentioned, most of the research on deference to scientific authority examines it in how it relates to positive views of particular technologies and lines of research, in which it behaves similarly to trust in scientists. Understanding how deference is distinct from trust (or if the existing deference items do not appear to be distinct enough from trust) will help inform how to better understand and capture deference.

Overview of the Chapters

The purpose of this research is to better understand deference to scientific authority and how to capture and apply it in social science research. This dissertation does this by examining the areas of focus described above, to satisfy two broader goals that encompass the overall research questions of each chapter. The first goal is to help us better understand deference and views of science and its authority as theoretical concepts, including their interrelationships with antecedents, effects, and other related concepts shaping views of science and decision-making on science. The second, and related, goal is to provide information that we can apply to better capture those concepts in quantitative social science research. This is to ultimate be able to develop more accurate, precise, reliable, and valid items to parse out the distinct ways in which deference and broader views of the authority of science appear and are best measured.

Together, this work is to advance our ability to theoretically understand and operationally capture the concept of deference to scientific authority and views of the authority of science. This will allow us to better see how deference and views of science matter for understanding perceptions of emerging and controversial science and technology issues and of who should have a say in shaping those issues as they move through societal and public arenas, from the labs to the marketplace. These views of science and its role in decision-making have significant practical implications for how we shape our present and future in modern science and society.

For the most part, the chapters follow the order in which I posited the three theoretical and empirical questions that I examine. Chapter 2 focuses on deference to scientific authority as it matters for decision-making that is more explicitly connected to the societal implications of science. It provides the first empirical examination of that question, using the context of views of the emerging issue of human gene editing and of who should be involved in guiding the development and regulation of research and applications of that technology. The chapter briefly introduces new items capturing belief in the authority of science and provides the first analysis explicating how the authority of science relates to but is distinct from deference to that authority. It also provides what is only the second empirical examination of how deference is distinct from trust (Anderson et al., 2012), and is the first to examine this distinction for decision-making that directly concerns the societal impacts of science.

Overall, the results illustrate that deference to scientific authority does predict more authoritarian views toward decision-making, even when those decisions concern the societal impacts of science and technology. This authoritarian tendency is also how deference to scientific authority is distinct from just believing in the authority of science and from trust in scientists. All of those concepts predict positive views of scientists and of emerging science and technology, such as human gene editing. Only deference, however, predicts anti-democratic views of who should be involved in shaping that science and technology.

Chapter 3 then addresses the question of what it means to "defer." It does so by examining the relationship between deference to scientific authority and participatory views of decision-making in science, as conceptualized by Brossard (2002), across several nationally representative datasets addressing different emerging science and technology issues. Through a combination of reliability testing, factor analyses, and regression models, I illustrate how the concepts appear to be distinct but related and discuss considerations for moving forward with applying and interpreting the deference items and their implications for views of participation in decision-making. The analyses also examine for the first time how deference to scientific authority and participatory views relate to and reflect more general dogmatic tendencies, such as authoritarianism and close-mindedness.

Chapter 4 builds on the results of Chapters 2 and 3 to focus on the role of the authority of science for understanding deference. It also does so by examining how both concepts relate to epistemic beliefs—both epistemic beliefs in general and about the nature of scientific knowledge in particular—and dogmatic or general authoritarian tendencies. As previously stated, the purpose of these analyses is to understand why, out of the larger pool of people who believe in the authority of science, only some become deferent to that authority to the extreme of becoming authoritarian in their views of decision-making on the societal implications of science and technology.

Results largely indicate that belief in the authority of science is distinct from but related to epistemic beliefs about the nature of knowledge and of knowing. Deference, perhaps not surprisingly, is more closely related to dogmatic beliefs than is belief in the authority of science. Deference to scientific authority also relates to a narrower set of epistemic beliefs than does belief in the authority of science. Individuals who are more deferent are highly likely to believe that science can provide an absolute and true picture of the world that will eventually be accessible to scientists, but these views seem to be removed from seeing value in aspects of the scientific process as a form of information collection and assumption testing in general. The results suggest that people who are more deferent to scientific authority could hold more idealized and/or naïve views of ideas behind the concept of “science” than do people who just see science as an authoritative form of knowledge but are not extremely deferent toward that authority. For people who are deferent, such views of science could be working in tandem with greater general tendencies toward authoritarianism, resulting in those who are more deferent being less likely to believe that citizens should have a role in discussions of how we use science and technology in society.

The concluding chapter synthesizes these results and highlights the questions that these analyses raised but left incompletely answered, including how to best capture deference to scientific authority and belief in the authority of science going forward. Based on the results and remaining questions, I discuss what these findings mean for understanding deference and its implications in communication and decision-making on normative questions in science issues. I end with a proposed model and areas for future research to capture a more complete, intuitive, and clear picture of deference to scientific authority.

Chapter 2. The Reach of Deference: Decision-making on Societal Implications of Science

Introduction

Deference to scientific authority plays a large role in public opinion of emerging science and technology, with more deferent individuals more supportive of the technology and placing greater value on scientists' expertise over citizens' opinions in decision-making around science issues (Brossard & Nisbet, 2007; Brossard & Shanahan, 2003). When scientific research and applications have substantial social and ethical implications, scientific expertise does not translate into expertise on aspects such as non-technical risk and benefit and ethical concerns nor does it provide the answer for decisions on how acceptable technical risks, benefits, and potential applications are. More deferent individuals, however, are theoretically more likely to believe that science and its implications should remain the purview of the scientific community and not part of larger democratic discourse. Because of this, deference has implications for science communication and policy, through its role in public perceptions of science and of decision-making on science issues. Deferent individuals are more likely to not only more supportive of emerging science and technology, as well as see less risk relative to the perceived potential benefit from those issues, but to also believe that lay publics should not be involved in decisions to define and manage those risk and benefits.

Despite the significant role of deference in such opinions, research in science and risk communication rarely includes items capturing deference to scientific authority. Additionally, understanding the concept and its effects is further hindered by the fact that the small body of literature that does include deference is not consistent in how it measures deference and tends to make theoretical claims that do not yet have empirical support. For example, deference is often defined as predicting more authoritarian views of decision-making around science issues that have direct societal implications. Yet no empirical research has examined decision-making in contexts that is more clearly about societal and ethical concerns rather than about the types of science decision-making that researchers make every day in their labs. Similarly, deference is defined as stemming from broader views of the cultural authority science and as being distinct from trust in scientists, yet only one study has compared deference to trust (Anderson et al., 2012) and none have examined it alongside views about the authority of science.

Using a U.S. nationally representative survey, this research analyzes these gaps in our understanding of deference to scientific authority through the context of the emerging issue of human gene editing, a field with large societal and ethical implications. This research examines two main questions concerning the role of deference in decision-making contexts. The first is, how does deference relate to views of citizen and scientist roles in decision-making concerning societally implications of human gene editing? In particular, I examine deference's effect after controlling for the items that are typically included in research on views of human gene editing, such as religiosity and knowledge of gene editing, to better understand deference's unique, comparative contribution for understanding views in science and risk communication contexts. Second, to further clarify the concept, I also assess how deference compares to trust in scientists and to belief in the authority of science when it comes to views concerning human gene editing and decision-making on the issue.

Literature Review

Deference to Scientific Authority & Decision-making on Science

Deference & views of emerging science. Literature on deference to scientific authority typically defines the concept of deference as capturing the belief that "scientists know the truth for all scientific matters (even those. . .with ethical and social implications) and that the public should not have a say in decision-making related to science" (Anderson et al., 2012, p. 226). This definition represents how most of the literature on deference to scientific authority defines it (for examples, see Akin et al., 2017; Brossard & Nisbet, 2007; Lee & Scheufele, 2006; Scheufele, 2013). But, although that definition captures the broad ideas of what deference is, or theoretically should be, it overreaches what the items capture. As described in the introductory chapter, this mismatch between theory and operationalization occurs through primarily gaps in understanding 1) whether deference does matter in more explicitly societal (vs. more explicitly scientific) decision-making contexts, 2) whether the deference items alone, without including its partner authoritarian participatory views items, capture anti-democratic views, and 3) what the relationship is between deference and broader views of the authority of science. This chapter focuses primarily on the first two points, but does so partly through providing the first examination of the third point as well.

Deference to scientific authority theoretically emerges from cultural views in the U.S. that see science as an exceptional form for knowledge and that, therefore, the scientific community and decisions they make regarding science issues should be free from government and citizen oversight (Brossard & Nisbet, 2007). The primary way that this cultural view, at least theoretically, transmits is through the educational system, which often focuses on science as an act of progress and of discovery of truths, unbiased by political or personal views and goals (Brossard & Nisbet, 2007; Jasanoff, 2005). This cultural view overlaps with what work in science and technology studies (STS) describes as the cultural authority of science, but research on the two concepts—deference to scientific authority and views of the authority of science—have never been examined together in a study.

What literature on deference to scientific authority typically focuses on is how the concept relates to levels of support for particular lines of research or technologies, and it consistently finds that deference has a significant and large relationship to positive views related to the science or technology itself (Anderson et al., 2012; Brossard & Nisbet, 2007; Ho et al., 2008; Ho et al., 2010, 2011). As described in the introductory chapter, individuals who are more deferent consistently hold more positive views of emerging, controversial, or societally relevant science and technologies. This often takes the form of perceiving lower risk and higher benefit from that science or technology (Kim et al., 2014), or lower risk relative to the perceived benefit (Brossard, 2002; Ho et al., 2008; Ho et al., 2011), and being more supportive of the science or technology overall (Akin et al., 2017; Brossard & Nisbet, 2007; Ho et al., 2008; Ho et al., 2010; Kim et al., 2014; Lee & Scheufele, 2006; Liang et al., 2015). These findings have held across different science and technology issues, including views of synthetic biology (Akin et al., 2017), agricultural biotechnology (Brossard, 2002; Brossard & Nisbet, 2007), embryonic stem cell research (Ho et al., 2008), and nanotechnology (Ho et al., 2010, 2011; Kim et al., 2014; Lee & Scheufele, 2006; Liang et al., 2015).

Filling in the Gaps in Conceptualizing and Capturing Deference

Although the overwhelming majority of research on deference to scientific authority focuses on how the concept predicts support for emerging and controversial science and technologies, the concept theoretically is more concerned with views of who should be involved in decision-making on how we use that science and technology in society. Deference emerged from dissertation work and two subsequent publications by Brossard and colleagues that examined the prevalence of authoritarian views in the U.S. concerning decision-making around science issues with large societal implications, particularly agricultural biotechnology (Brossard, 2002; Brossard & Nisbet, 2007; Brossard & Shanahan, 2003). Brossard predicted that because of the culture or “myth” surrounding science in the U.S., in which science is truth-making and should be separate from political and other non-scientific influences, some individuals would believe that scientists should be the authorities in decision-making around science-related issues, even when those issues explicitly involve decisions on societal implications and concerns that go beyond what science can answer (Brossard, 2002). Such beliefs would operate as a form of authoritarianism, in which one holds that scientific knowledge is the authoritative knowledge and therefore scientists, and not citizens, are the authorities and only necessary decision-makers when it comes to the effects of scientific research (Brossard, 2002).

Brossard developed items capturing 1) attitudes toward science as “*the* authority that matters” and 2) attitudes toward democratic processes in decision-making around science—what became “deference to scientific authority” (Brossard & Nisbet, 2007) and “participatory views toward science,” (Anderson et al., 2012) or “authoritarian attitudes toward democratic processes in science” (Brossard & Shanahan, 2003), respectively. The full batteries for these two concepts are listed in Table II. When examining responses to these items, Brossard found two results that relate to the focus of the present study. First, she found that the deference items positively related to the items capturing participatory views toward science. Second, contrary to most findings on general authoritarianism, more educated individuals were more likely to hold authoritarian views toward science in decision-making (Brossard, 2002). This latter finding supported Brossard's (2002) hypothesis that such views emerge from cultural views and images portraying the authority of science, which especially permeate formal science education.

Table II: Original batteries of items capturing 1) deference to scientific authority and 2) participatory views toward science, developed by Brossard (2002).

Item #	**Items capturing "deference to scientific authority"**
D1.	Scientists know best what is good for the people (*often replaced with* public)
D2.	Scientists should do what they think is best, even if they have to persuade people that it is right
D3.	Scientists should make the decisions about the type of scientific research on [science issue]
D4.	It is important for scientists to get research done even if they displease people by doing it
	Items capturing "participatory views toward science"
P1.	It is important to have public participation in making scientific decisions, regardless of people's knowledge of the issues involved *(Reverse coded to represent non-democratic views)*
P2.	The actions of the scientific community should always reflect the will of the majority *(R)*
P3.	Public opinion is more important than the scientists' opinions when making decisions about scientific research *(R)*
P4.	Scientists should pay attention to the wishes of the public, even if they think citizens are mistaken or do not understand their work *(R)*

It is unclear, however, if the deference survey items relate to decision-making on issues that are seen as connecting more directly to social and ethical implications of how we use science and technology. Instead, the items that have been examined for capturing deference and for capturing its relationship to participatory views of science could be interpreted as focusing on decisions similar to those that researchers daily make when conducting their research. The majority of research on deference relies on only two of the original items—items D1 and D2 in Table II (and in the case of Ho et al., 2008, just item D1) (Akin et al., 2017; Anderson et al., 2012; Binder et al., 2016; Ho et al., 2008; Ho et al., 2010, 2011; Kim et al., 2014; Liang et al., 2015)—neither of which do not clarify a particular context in which scientists are acting.

Research has also rarely examined deference alongside participatory views of science since Brossard's (2002) initial work, with only one other study examining the relationship between an index of D1 and D2 and an index of participatory views captured by P3 and P4 (Anderson et al., 2012). As seen in Table II, these participatory items also do not explicitly mention decision-making taking place in more clearly societal contexts. P1 through P4 mention "scientific decisions" (P1), "decisions about scientific research" (P4), or refer to scientists paying attention to the wishes of the public or of the majority, without specifying a clear decision-making context. This ambiguity leaves open the possibility that survey respondents are answering these questions either in doubt on what exactly the question is asking or with a context in mind that is not directly related to implications for decision-making around the social and ethical implications of science.

Of course, a clear boundary between science and society, and therefore between decisions concerning either science or society, is artificial, as a large body of research in science and technology studies highlights (see, for examples, Ezrahi, 1990; Jasanoff, 1990; Latour, 1991). Decisions even within a lab regarding what research to pursue and how to do so rely on values that emerge from, are shaped by, and, in turn, shape society. In modern society, however, we still often think of decisions in scientific research and decisions about science in society as distinct (for a more in-depth discussion on this point, see Latour, 1991). Therefore, survey items that do not make clear in which arena decision-making concerning science occurs are difficult to interpret. Making a more explicit distinction between types of science-related decision-making, then, can help us better understand the extent of deference to scientific authority's effect on views of who should be involved in those decisions.

Focus of this chapter: Tracing the extent of deference on views of decision-making. In this study I address this gap by examining beliefs about decision-making contexts that more explicitly involve the societal impacts of science. I use items capturing 1) whether citizens or the general public should be involved in regulatory decisions concerning research and applications of human gene editing and 2) whether scientists should consult with the public before applying gene editing to humans. These concepts more clearly capture science-related decision-making in directly policy- or societally relevant contexts than did the existing participatory and deference items listed in Table II. I examine how deference to scientific authority relates to views of the role of citizens and of scientists in the development of human gene editing and in decision-making around its societal applications. I also examine, however, some related and understudied relationships between deference and items such as trust in scientists and views of the authority of science, as explained below.

Deference to scientific authority as distinct from views of authority of science and trust in scientists? As previously described the existing literature on deference to scientific authority, there are two additional claims that have limited empirical research supporting them. The first, as mentioned in the previous section, is that deference to scientific authority stems from belief in the authority of science, or belief that science is authoritative and privileged knowledge about the world. The second, is that deference to scientific authority, and the way that we capture such deference in research, is distinct from trust in scientists.

Deference and the cultural authority of science. For the first point, there is a logical but as of yet empirically unsupported jump from seeing science as authoritative knowledge to deferring to scientists as authorities on that knowledge. The literature ascribes the origin of deference to scientific authority to the former. The authority of science, researchers often state, stems from the institutional factors that shape science—such as the norms of the scientific community and expectations laid out through the scientific process (Brossard & Nisbet, 2007; Scheufele, 2013)—and ideas that science is an exceptional and privileged form of knowledge obtained by discovering the “truth” about the world (Anderson et al., 2012; Brossard, 2002; Brossard & Nisbet, 2007). This concept of science as authoritative knowledge overlaps with a broader pool of research that focuses on the cultural authority of science. Such work examines how cultures grant scientific knowledge authority in understanding phenomenon and making societal-level decisions (see, for examples, *The cultural authority of science: Comparing across Europe, Asia, Africa and the Americas*, 2018; Epstein, 2008; Gauchat, 2011; Gauchat, 2015; Shapin, 2007). Deference to scientific authority, then, presumably emerges from these views of science as authoritative knowledge, which exist because of the culture surrounding science in the U.S. Deference, however, has never been examined alongside measures of views of the cultural authority of science, partly because of a lack of items that more explicitly capture views of science as authoritative.

The literature on cultural authority of science usually relies on measures such as interest in and knowledge of science and trust in scientists to stand-in as indicators of the cultural authority of science (Bauer et al., 2018; Besley, 2018; Gauchat, 2011). Such concepts arguably are distinct from views of the cultural authority of science, per se, although they could overlap as side-effects of seeing science as authoritative and stand in as partial proxies for views of that authority. At face value, however, even if they overlap with views of science as authoritative, they do not seem to explicitly or cleanly capture such views. Interest in and knowledge of science, for example, do not seem to be necessary for capturing the authority of science, as the definition of a cultural authority (Bauer et al., 2018) would suggest that such authority extends beyond particular interest groups who happen to be more personally invested in science itself. Additionally, as researchers examining cultural authority consistently theorize and studies in science communication consistently find, knowledge plays a limited and inconsistent role in shaping views of science and science issues (Allum, Sturgis, Tabourazi, & Brunton-Smith, 2008; Besley, 2018; Rose et al., 2019).

Trust, on the other hand, appears to be a likely side-effect, or perhaps a necessary condition, for science's continued cultural authority. But trust also tends to be a more narrow, context-dependent concept and therefore measured with items focused on particular scientists and particular science issues rather than on science as a broader endeavor (Gauchat, 2011; Ho, Scheufele, & Corley, 2013; Metzger & Flanagin, 2013; Priest, Bonfadelli, & Rusanen, 2003; Siegrist, Connor, & Keller, 2012; Siegrist, Gutscher, & Earle, 2006). A few studies on cultural authority of science use more broadly focused items on views of science as a whole, whether as an institution (Bauer et al., 2000) or as producing particular outcomes (Gauchat, 2011). Even these, however, tend to ask people about their views of potential outcomes of science applications, such as whether such applications create more opportunities or more risks (Gauchat, 2011). Whether these applied results of science are enough to justify the cultural authority of science overall is something that many scholars in cultural authority of science literature and STS question (see, for an introduction, Bauer et al., 2018; Shapin, 2007). Instead, the idea that seems to be most pervasive in discussions of the cultural authority of science is that of science's perceived ability to provide a complete and reliable—and therefore intrinsically better—picture of the world, especially compared to other forms of collecting and sharing information (Jasanoff, 2005; Latour, 1991; Shapin, 2007).

The Bauer et al. (2000) study made the furthest progress into capturing views of science as an authoritative way of understanding the world with an index of items capturing views of science as "rational and objective," "good," and working toward an achievable goal of offering "the true picture of the world." All of these items focus on science as a broader entity and as one that offers a version of truth that is true and therefore morally good. These are two aspects—the connection to truth and the connection to moral value—that seem to more strongly overlap with the general idea of science's cultural authority.

In this study, I examine two newer items capturing aspects of how science could be seen as authoritative knowledge, which I will refer to as items that capture *belief in the authority of science*. These ask about the extent to which one agrees that "science is the best way to understand the world" and is "the best way that we have for producing reliable knowledge." These two beliefs capture features of science's value but differ slightly in extremity in terms of what they claim that science offers. They are distinct from the existing items that have stood for proxies of the cultural authority of science in that they place a relative weight on science: that it is not only objective or accesses truth(s), but that it is also better than other ways of knowing. These items differ from more the more general concept of epistemic beliefs in this way, too, as items used in research to capture epistemic beliefs—beliefs about the nature of knowledge and knowing—do not appear to place a relative weight on one type of knowledge over another (DeBacker, Crowson, Beesley, Thoma, & Hestevold, 2008; Schraw, Bendixen, & Dunkle, 2002).

This positioning of science relative to other fields or ways of knowing the world, such as politics and religion, seems key to understanding its authority. Conversations on the authority of science and whether it is waning or waxing use as a reference point the standing of science compared to non-scientific knowledge (see, for example, Bauer et al., 2018). That said, the two items described above are new and therefore in need of further testing and development, which this dissertation will start. In this chapter, I will do so by using them to examine for the first time how deference to scientific authority relates and compares to belief in the authority of science.

Deference versus trust. This study will also provide one of the few examinations of deference alongside trust in scientists. This is to help clarify a more common confusion in intuitive understandings of the deference items, which is that they are just capturing versions of trust. Part of this confusion seems to stem from the wording of the current deference items, as they primarily focus on claims about scientists' appropriate actions (as seen in Table II). It is possible that by focusing on scientists, the existing deference items are difficult to distinguish from the concept of trust in scientists. A larger factor in the confusion, however, is likely because, as described earlier, almost all of the literature on deference to scientific authority focuses on it in contexts in which it behaves extremely similarly to trust in scientists—namely, in how it predicts positive views of science and technology.

Although both trust in scientists and deference to scientific authority typically relate to holding positive views of science, the two, in theory, are distinct from each other in terms of their sources and the durability of each within individuals' belief systems (Anderson et al., 2012; Brossard & Nisbet, 2007). Similar to deference, trust in scientists often has a large significant relationship to individuals' perceptions of the levels of risk and benefit associated with science and technology, which in turn relate to individuals' levels of support for or opposition to the science or technology itself—with greater risk perception predicting less support and greater benefit perception predicting more support (Bronfman & Vazquez, 2011; Flynn, Burns, Mertz, & Slovic, 1992; Liu & Priest, 2009; Midden & Huijts, 2009; Siegrist, 2000; Siegrist et al., 2012; Siegrist & Cvetkovich, 2000; Siegrist, Keller, & Kiers, 2005; Wachinger, Renn, Begg, & Kuhlicke, 2013; Whitfield, Rosa, Dan, & Dietz, 2009). Trust, however, is theoretically less stable than deference, operating as a disposition rather than a strongly-held predisposition (Anderson et al., 2012; Brossard & Nisbet, 2007), although research has not examined the stability of deference to scientific authority. This distinction, however, comes partly from the observation that trust is likely to be more context dependent—particular to a certain issue, actor, piece of information, and events. As seen in polls of public trust in scientists, trust can be relatively stable overtime (Krause, Brossard, Scheufele, Xenos, & Franke, forthcoming), but also fluctuates in terms of which particular science actor one trusts and for what issue, ebbing and flowing depending on how individual characteristics interact with events and information (Kasperson, Golding, & Tuler, 1992; Peters, 1996; Poortinga & Pidgeon, 2004; Sjöberg, 2001). Deference, as described earlier, is a broader belief that applies across particular science issues and settings and is likely developed through cultural experience with science rather than being as dependent on the characteristics or behavior of a particular actor, issue, or event (Anderson et al., 2012; Brossard & Nisbet, 2007).

Only a few studies have examined the relationship between trust and deference. Those studies posit that deference operates indirectly on support for controversial or emerging science issues such as agricultural biotechnology and nanotechnology through increased trust in scientific actors (Anderson et al., 2012; Brossard & Nisbet, 2007) or that deference moderates the effect of trust on levels of support, with more deferent but low-in-trust individuals more supportive of synthetic biology than are less deferent low-in-trust individuals (Akin et al., 2017). This study builds on that work, in particular by first comparing how deference to scientific authority, belief in the authority of science, and trust in scientists relate to views of the risks and benefits associated with human gene editing and to overall support for the technology. It then examines how trust in scientists and belief in the authority of science compare to deference when it comes to predicting democratic views toward decision-making on science issues. Theoretically, we would expect differences in how the trust in scientists and deference to scientific authority relate to views of democratic participation in decision-making around science. Deference, based on the definitions provided in much of the literature, should relate to the belief that scientists and not citizens should be the decision-makers in issues concerning science. Trust in scientists, however, we would expect to shape views of scientists in decision-making, but not necessarily beliefs that citizens should not also be involved.

Work by Anderson et al. (2012) is the only study to explicitly examine whether deference to scientific authority and trust in scientists are in fact distinct in their relationships to views of decision-making around scientific issues. That study found results that align with expectations of the distinctions between the two concepts. Deference significantly predicted higher trust in scientific actors, but trust had no significant relationship to views of participation toward science (Anderson et al., 2012). This study replicates, to an extent, the findings of Anderson et al. (2012). It goes beyond that work, however, to examine the third major gap in understanding of the operationalization and implications of deference to scientific authority: whether such deference affects views toward decision-making on science issues involving explicit societal impacts. Because Anderson et al. (2012) used the participatory views items that I described previously and that are listed in Table II, it is not clear if responses were capturing views of the role of citizens in decision-making on the societal implications of scientific research. In this research, I examine how deference to scientific authority and trust in scientists relate to views of the role of the public and of citizens in shaping how we use scientific research and technology in society, using the case of human gene editing. Before moving to the specific research questions and hypotheses, therefore, it is helpful to have some context for why human gene editing offers a useful case for examining deference to scientific authority and its relationship to views of decision-making on the societal impacts of science.

Deference and human gene editing. Human gene editing is a tool for changing people's genetic material through adding, deleting, or otherwise altering what genes are present and how those genes lead to different physical characteristics or effects in our bodies (National Academy of Sciences & National Academy of Medicine, 2017). Research in the field has quickly advanced over the past decade, especially with the development of the CRISPR-Cas9 editing tool and research into additional CRISPR-Cas technologies (National Academy of Sciences & National Academy of Medicine, 2017).

Given deference to scientific authority's consistently strong relationship to support for emerging and controversial science issues, the emerging and value-laden issue of human gene editing offers an especially useful case for examining deference and its implications for understanding views of science, trust in scientists, and opinions concerning decision-making around science. Gene editing is tied to many ethical considerations, especially around the possibility of treating or preventing serious genetic illnesses (Mullin, 2018; National Academy of Sciences & National Academy of Medicine, 2017; Netburn, 2017), issues of equity in access to gene editing applications and in shaping development of gene editing (Braun & Dabrock, 2016; Jasanoff et al., 2015), and potential discrimination against those with edits or not (National Academy of Sciences & National Academy of Medicine, 2017), sometimes tied to concerns about eugenic outcomes (Krishan, Kanchan, & Singh, 2016; National Academy of Sciences & National Academy of Medicine, 2017; Regalado, 2015). In part because of these concerns, scientists in the field and members of the larger public have called for greater public discourse around decisions concerning potential applications of gene editing on humans (Burall, 2018; Jasanoff et al., 2015; Lancet Editorial Board, 2017; National Academy of Sciences & National Academy of Medicine, 2017; Scheufele et al., 2017). Because of these widespread calls for democratic decision-making around human gene editing, the issue offers a timely and illustrative case for examining the role of deference in views of both the technology and of who should be involved in decision-making around its development and use.

Hypotheses and Research Questions

Based on the open questions described throughout the literature review, this study focuses on the relationships between deference to scientific authority, trust in scientists, and belief in the authority of science in two parts. The first part examines how each of these concepts relate to views of human gene editing, such as support for applications of the technology and perceptions of associated risks and benefits. The second then examines how each predict (anti)democratic views of who should be involved in decision-making around the more explicitly societal implications of human gene editing research and applications.

Part 1: Views of human gene editing. For the first past, based on available literature summarized above, I predict that:

> H1a: Deference to scientific authority will significantly relate to more positive views of human gene editing, as captured by lower risk perceptions, higher benefit perceptions, and greater support.

Given the large body of literature on trust, and because belief in the authority of science and trust in scientists capture positive views toward science and scientists, I expect both trust in scientists and belief in the authority of science to behave similarly to deference to scientific authority in how they relate to positive views toward human gene editing. I, therefore, predict that:

> H1b: Trust in scientists and medical professionals will significantly relate to more positive views of human gene editing, as captured by lower risk perceptions, higher benefit perceptions, and greater support.
>
> H1c: Believing in the authority of science will significantly relate to more positive views of human gene editing, as captured by lower risk perceptions, higher benefit perceptions, and greater support.

Part 2: Views of decision-making on human gene editing. For the second part of the study, I examine views of the role of scientists and of non-scientists in shaping regulation and development of human gene editing. Because deference, trust, and belief in the authority of science likely all predict "pro-science" views, I expect that when it comes to views of scientists in decision-making:

> H2a: Higher levels of deference will predict greater levels of belief that scientists are capable of responsibly guiding the development of new technology, like human gene editing.
>
> H2b: Trust in scientists and in medical professionals will significantly relate to believing that scientists are capable of responsibly guiding the development of new technology, like human gene editing.
>
> H2c: Believing in the authority of science will significantly relate to believing that scientists are capable of responsibly guiding the development of new technology, like human gene editing.

Theoretically, then, the distinctions between deference to scientific authority, trust in scientists, and belief in the authority of science will emerge not in how each relates to positive views of science and scientists but in how they distinctly predict (or do not predict) authoritarian views of the role of citizens in decision-making. Although we do not have literature examining deference in explicitly societal decision-making contexts, based on theory, I predict that deference will relate to more authoritarian (i.e. anti-democratic or participatory) views. I test whether:

> H3a: Deference will predict being less likely to believe that scientists should consult with the public before applying gene editing to humans, and being less likely to believe that citizens should be involved in making regulation around human gene editing.

We have less information on the roles of trust in scientists and of views of science as authoritative knowledge in shaping views of democratic decision-making around science issues. So, although I expect them to not predict anti-democratic views, it is unclear whether that will be in the form of no relationship to democratic views or in the form of a positive relationship. Based on the work of Anderson et al. (2012), I expect that trust in scientists will not relate to whether or not the public and citizens should be involved in decision-making concerning human gene editing. Although no work has examined whether views of science as authoritative knowledge relate to views of public involvement in decision-making on the societal implications of science, I do not see theoretical reasons to believe such views would relate to views of democratic involvement in such decisions. As both of these predictions are in the direction of the null hypothesis of no relationship, I do not formally state them here.

Methods

These analyses use data from a nationally representative survey of U.S. adults, conducted by YouGov in December 2016 to January 2017 (N = 1600; completion rate (AAPOR RR6): 41.7%; (Callegaro & Disogra, 2008)). YouGov included a sample weight to adjust the sample to population parameters, which was applied to all analyses.

Analysis

To examine the hypotheses and research questions, I ran hierarchal ordinary least squares (OLS) regression models for each of the two parts of the study, plus one binary logistic regression for one of the dependent variables that was categorical (dichotomous). For the first part, the set of analyses includes four models that capture the relationships between the independent variables and 1) risk and 2) benefit perceptions of and 3) support for human gene editing for treatment and 4) for enhancement purposes. The second part includes three regression analyses capturing relationships between the independent variables and views concerning 1) scientists as responsible in developing new technology, 2) whether scientists should consult the public before applying gene editing to humans, and 3) whether citizens should be involved with regulation of human gene editing research and applications. This last variable is dichotomous, as described below, so was predicted using a logistic regression model. All models were hierarchical, with independent and control variables enter the model in blocks grouped by type of variable and generally in assumed causal order (Cohen, Cohen, West, & Aiken, 2003).

The survey also included an experiment in which survey respondents received one of five conditions with information about gene editing prior to answering the depending variables of interest in this study. The experiment is not the focus of this study, so block zero of the regression models includes four dummy variables to control for what condition each respondent received. All analyses were run through IBM's software SPSS, version 25.

Measures

Independent variables. Block one includes as controls demographic variables that often relate to public opinions on scientific issues: age (Boudet et al., 2014; Scheufele et al., 2017), gender (Bord & O'Connor, 1997; Finucane, Slovic, Mertz, Flynn, & Satterfield, 2000; Flynn, Slovic, & Mertz, 1994; Howell et al., 2017), race (Finucane et al., 2000; Flynn et al., 1994; Johnson, 2002), and education (Brossard & Nisbet, 2007; Howell et al., 2018). *Age* is the respondents' age in years (*M* = 46.7; *SD* = 16.74). *Gender* is coded as 1 = "female" and 0 = "male" (51.5% female). *Race* is a dichotomous variable coded as 1 = "white" and 0 = "non-white" (66.9% white). The dichotomous nature is limiting, but, because race was not a focus of this study, I do not have large enough samples of each census category of race to analyze each separately. *Education* is the level of schooling respondents completed, coded as 1 = "No high school," 2 = "High school graduate," 3 = "Some college," 4 = "2-year college," 5 = "4-year college," and 6 = "Post-grad" (median = 3, some college).

Blocks 2 through 4 then include value-based predispositions relevant to perceptions of science. Block 2 includes *religiosity* and *political ideology*. *Religiosity* asks respondents to indicate on an 11-point scale, "How much guidance does religion provide in your daily life?" 0 = "No guidance at all;" 10 = "A great deal of guidance" (*M* = 5.8; *SD* = 3.65). *Political ideology* is a composite of two items asking respondents to indicate how liberal, moderate, or conservative they are on 1) economic issues and 2) social issues. Each item is measured on a 7-point scale from 1 = “Very liberal” to 7 = “Very conservative” (Economic: *M* = 4.3; *SD* = 1.59; Social: *M* = 4.0; *SD* = 1.68) The two items are highly significantly correlated (Pearson’s R = 0.79) and the composite variable was made by taking the average of an individual’s response to the two items (*M* = 4.1; *SD* = 1.55).

Block 3 introduces views on the *authority of science* captured through a composite of two items asking respondents to indicate on a 7-point scale, from 1 = “Strongly disagree” to 7 = “Strongly agree,” the extent to which they agree that 1) “Science is the best way that society has for producing reliable knowledge” (*M* = 4.7; *SD* = 1.53) and 2) “Science is the best way to understand the world” (*M* = 4.6; *SD* = 1.60). The two items are significantly correlated (Pearson’s R = 0.64) and were combined by averaging responses (*M* = 4.7; *SD* = 1.47).

Block 4 includes the *deference to scientific authority* composite variable, captured through two items asking respondents to indicate, on the same 7-point scale from “Strongly disagree” to “Strongly agree,” how much they believe that 1) “Scientists know best what is good for the public” (*M* = 3.4; *SD* = 1.58) and 2) “Scientists should do what they think is best, even if they have to persuade others that it is right” (*M* = 3.9; *SD* = 1.59). These two items are the ones that appear most consistently to capture *deference to scientific authority* in the existing literature (Akin et al., 2017; Anderson et al., 2012; Binder et al., 2016; Brossard & Nisbet, 2007; Ho et al., 2008; Ho et al., 2010, 2011; Lee & Scheufele, 2006; Liang et al., 2015). The two are significantly correlated (Pearson’s R = 0.73) and were combined by averaging responses (*M* = 3.7; *SD* = 1.45).

Trust enters in block 5 as *trust in scientists & medical professionals*, a composite of three items capturing, on a 5-point scale from 1 = “Do not trust at all” to 5 = “Trust very much” how much respondents trust 1) university scientists (*M* = 3.1; *SD* = 1.06), 2) industry scientists (*M* = 2.8; *SD* = 1.03), and 3) medical professionals (*M* = 3.3; *SD* = 0.97) for information, “when it comes to public controversies about scientific issues.” I include these three groups of actors to capture trust in this model because all three play a role in shaping the development of human gene editing. I averaged the three to create the composite trust variable (Cronbach’s alpha = 0.77; *M* = 3.1; *SD* = 0.85).

Although not a primary focus of this study, in the next two blocks I examine how information intake and knowledge, captured by attention to news and by both perceived and factual knowledge, relate to views of human gene editing and of decision-making around the technology after controlling for the (pre)dispositions of focus here. This is to better understand the relationships between news attention and knowledge on views of human gene editing and illustrate the relative weight of (pre)dispositions, information, and knowledge on views concerning human gene editing. In line with the large body of research on the relationship of knowledge to views of science issues (e.g. Allum et al., 2008; Brossard, Scheufele, Kim, & Lewenstein, 2009; Ho et al., 2008; Shih, Scheufele, & Brossard, 2012), I expect that value-related (pre)dispositions such as views of science, deference, and trust in scientists will have a stronger relationship to views of human gene editing than do information-intake and knowledge. I am interested, however, in capturing the exact relationships of attention to news and the knowledge variables to the dependent variables to see what relationship, if any, they have after controlling for these more personal, value-encompassing influences of the (pre)dispositions.

Block 6 includes *attention to news*, a composite of four items capturing how much attention respondents pay to a variety of political and science-focused news. Respondents indicated on a 5-point scale from 1 = "None" to 5 = "A lot," how much attention they pay to news stories about 1) national government and politics (*M* = 3.6; *SD* = 1.12), 2) science and technology (*M* = 3.1; *SD* = 1.0), 3) political or ethical implications of emerging technologies (*M* = 2.7; *SD* = 1.12), and 4) new scientific tools or developments (*M* = 2.3; *SD* = 1.05). The four were averaged together to create the composite variable (Cronbach's alpha = 0.83; *M* = 2.9; *SD* = 0.87).

Block 7 then includes two measures of knowledge about gene editing: *perceived knowledge* and *factual knowledge*. They capture distinct types of knowledge that can differently relate to views of science issues (see Allum et al., 2008; Rose et al., 2019 for overviews). *Perceived knowledge* is measured by asking respondents to indicate how informed they are about human gene editing, from 1 = "Not at all informed" to 5 = "Very informed" (*M* = 1.9; *SD* = 0.95). *Factual knowledge* is a composite of a battery of nine items concerning facts related to genetic processes and developments in gene editing. For complete wording and coding of each item, please see the supplementary material in Scheufele et al. (2017). I created the *factual knowledge* variable by summing the number of correct answers each respondent received, for a range from 0 to 9, with 9 reflecting that a respondent gave correct answers to all the questions (*M* = 4.4; *SD* = 2.58).

Dependent variables. The dependent variables are seven items: two capturing risk and benefit perceptions, two capturing support for human gene editing, and three capturing views of who should be involved in decision-making around human gene editing. *Risk to society* and *benefit to society* are each a single item asking respondents, "How risky/beneficial do you think human gene editing will be for society as a whole?" on a 5-point scale from 1 = "Not at all risky/beneficial" to 5 = "Very risky/beneficial" (Risk: *M* = 3.4; *SD* = 1.09; Benefit: *M* = 2.9; *SD* = 1.14). *Support for treatment* and *support for enhancement* are also both single items, asking respondents to indicate how much they agree with the statements, "Overall, I support the use of human gene editing to. . ." 1) "treat human medical conditions or restore health" (to capture *support for treatment*) and 2) "enhance or improve human abilities" (to capture *support for enhancement*). Each was captured on a 7-point scale from 1 = "Strongly disagree" to 7 = "Strongly agree" (Treatment: *M* = 4.8; *SD* = 1.64; Enhancement: *M* = 3.8; *SD* = 1.75).

Scientific community responsible captures whether respondents agree that, "The scientific community is capable of guiding the development of new technologies in a responsible way." It is a single item measured on a 7-point scale from 1 = "Strongly disagree" to 7 = "Strongly agree" (*M* = 4.4; *SD* = 1.48). *Scientists should consult the public* captures whether respondents agree that, "Scientists should consult with the public before applying gene editing to humans." It is also a single item measured on a 7-point scale from 1 = "Strongly disagree" to 7 = "Strongly agree" (*M* = 5.2; *SD* = 1.51). *Citizens in regulation* captures whether respondents agree that, "If there are new regulations in the U.S. for research and application of human gene editing" citizens "should have a say in the development of these regulations." It is a dummy variable, with 1 = "Yes" (indicating that citizens should have a say) and 0 = "No" (55.3% yes).

Results

The correlations listed in Table III provide initial evidence supporting each of the hypotheses. As seen in Tables IV & V, these relationships remain significant after controlling for the other variables in the OLS regression models. This section will describe, first, the results of the regression models predicting risk and benefit perceptions of human gene editing and levels of support for using gene editing for treatment or for enhancement purposes. It will then move to the second part, examining the models that predict views of scientists' and the public's roles in decision-making on research and applications of human gene editing.

Perceptions of Human Gene Editing—Risks, Benefits, and Support

As seen in Table IV, higher levels of deference to scientific authority, higher levels of trust in scientists and medical professionals, and greater belief in the authority of science were all significantly related to holding more positive views of human gene editing, supporting Hypotheses 1a, 1b, and 1c, respectively. Each of those three independent variables of interest related to perceiving lower risk to society from human gene editing, higher benefit to society, and higher levels of support for using human gene editing for both treatment purposes and for enhancement purposes. Religiosity remained a significant predictor after controlling for these three main variables science- and scientist-focused variables, with religiosity predicting higher levels of perceived risk, and lower levels of perceived benefit and support for human gene editing for treatment or enhancement purposes. Political ideology, however, remained significant only for predicting higher levels of perceived risk from human gene editing, with conservatives perceiving greater risk.

Attention to news was typically no longer significant after controlling for religiosity, political ideology, authority of science knowledge, deference to scientific authority, and trust in scientists. Perceived and factual knowledge sometimes had similar relationships to each other, such as in predicting higher levels of perceived benefit, but more often did not. In fact, they were opposite in how each related to support for human gene editing. Perceived knowledge predicted higher support and factual knowledge predicted lower. Interestingly, factual

Table III: Pearson's correlation between each independent and dependent variable, after controlling for experimental conditions. 2016 YouGov dataset.

Correlations	**Human gene editing risky to society**	**Human gene editing beneficial to society**	**Support for human gene editing for treatment**	**Support for human gene editing for enhancement**	**Scientific comm. responsible**	**Scientists should consult the public**	**Citizens should have a say in regulation**
	Pearson's correlation	Pearson's correlation	Pearson's correlation	Pearson's correlation	Pearson's correlation	Pearson's correlation	Pearson's correlation
Demographics							
Age	-0.09**	-0.01	0.03	-0.02	-0.08***	0.13***	-0.02
Gender (female)	0.13***	-0.10***	-0.09***	-0.09***	0.01	0.03	-0.11***
Race (white)	-0.10***	0.07**	0.09***	-0.02	0.00	0.06**	0.06**
Education	-0.05	0.11***	0.13***	-0.02	0.03	-0.02	0.07**
Values							
Religiosity	0.23***	-0.29***	-0.35***	-0.24***	-0.28***	0.13***	0.00
Political ideology (conservative)	0.17***	-0.23***	-0.25***	-0.15***	-0.33***	0.10***	0.06**
Views of science							
Authority of science	-0.30***	0.46***	0.49***	0.34***	0.62***	0.05*	0.03
Deference							
To scientific authority	-0.31***	0.41***	0.37***	0.38***	0.64***	-0.14***	-0.11***
Trust							
Scientists & medical professionals	-0.29***	0.48***	0.45***	0.31***	0.53***	0.01	0.03
Media attention							
Attention to news	-0.10***	0.24***	0.23***	0.08***	0.13***	0.10***	0.16***
Knowledge							
Perceived knowledge	-0.06*	0.17***	0.13***	0.10***	0.12***	-0.02	0.06*
Factual knowledge	-0.07**	0.24***	0.29***	0.05	0.17***	0.13***	0.18***

*p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001.

Table IV: OLS regression models predicting views concerning human gene editing. 2016 YouGov dataset

	Human gene editing risky to society	**Human gene editing beneficial to society**	**Support for human gene editing for treatment**	**Support for human gene editing for enhancement**
	Standardized coefficients β	Standardized coefficients β	Standardized coefficients β	Standardized coefficients β
Experimental conditions				
Incremental adjusted R²(%)	*1.3****	*0.5***	*0.4*	*1.9****
Demographics				
Age	-0.15***	0.06*	0.10***	0.06*
Gender (female)	0.09**	-0.03	-0.02	-0.03
Race (white)	-0.08*	0.03	0.00	-0.03
Education	-0.03	0.02	0.03	-0.04
Incremental adjusted R²(%)	*3.0****	*2.3****	*2.9****	*0.7***
Values				
Religiosity	0.13***	-0.13***	-0.18***	-0.15***
Political ideology (conservative)	0.05*	-0.01	-0.01	0.06*
Incremental adjusted R²(%)	*6.2****	*9.1****	*13.1****	*5.4****
Views of science				
Authority of science	-0.03*	0.13***	0.20***	0.10**
Incremental adjusted R²(%)	*3.3****	*11.1****	*11.6****	*6.7****
Deference				
To scientific authority	-0.17***	0.14***	0.07*	0.23***
Incremental adjusted R²(%)	*3.2****	*2.6****	*0.9****	*4.5****
Trust				
Scientists & medical professionals	-0.17***	0.28***	0.25***	0.15***
Incremental adjusted R²(%)	*1.6****	*6.4****	*4.9****	*1.3****
Media attention				
Attention to news	0.02	0.06*	0.03	-0.00
Incremental adjusted R²(%)	*0.1*	*0.7****	*0.3***	*0.0*
Knowledge				
Perceived knowledge	-0.04	0.05	0.01	0.07*
Factual GE knowledge	0.07	0.04	0.10***	-0.06*
Incremental adjusted R²(%)	*0.3**	*0.2**	*0.6****	*0.3**
Total adjusted R² (%)	**18.2**	**32.9**	**34.7**	**20.8**
Sample size (N)	1539	1535	1541	1544

*p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001.

knowledge related to both higher risk perceptions and higher benefit perceptions, although only significantly to benefit perceptions even though the coefficients for each are nearly identical (Table IV). Factual knowledge had a positive relationship to support for human gene editing for treatment and a negative relationship to support for enhancement. The size of these relationships, however, is small, and, especially given the large sample size, they could be false positives so should not be over-interpreted.

The models predicted from one-fifth to slightly more than one-third of the variance in each dependent variable, as seen in the total adjusted R^2 in Table 3, which is somewhat low given the large number of items included and significant relationships captured.

Authority of Science, Deference, & Trust in Decision-Making

Moving now to views of who should be involved in decision-making on human gene editing, being deferent to scientific authority, trusting scientists and medical professionals, and believing in the authority of science all significantly predicted positive views of scientists' role in developing the technology (Table V). These results support Hypotheses 2a, b, and c, respectively. Moving to the dependent variables capturing the public's role in decision-making, however, differences emerged across deference to scientific authority, belief in the authority of science, and trust. The models support, to an extent, the predictions that deference to scientific authority will behave differently than do belief in the authority of scientific knowledge and trust in scientists and medical professionals (Tables V & VI). As predicted in Hypotheses 1b and c, deference to scientific authority is significantly related to being less likely to believe that scientists should consult with the public before applying human gene editing to humans and less likely to believe that citizens should have a say in any potential regulations around research and applications of human gene editing. Believing in the authority of science, however, positively relates to believing that scientists should consult with the public and that citizens should have a say in regulations.

On its own, belief in the authority of scientific knowledge was highly and significantly correlated with views of the public and citizens in decision-making (see the correlations in Table III). This relationship largely emerged once the model controls for deference to scientific authority (Tables V & VI). This positive relationship goes against the prediction that belief in the authority of science would not relate to democratic views on decision-making in science. Trust in scientists and medical professionals behaved in line with the predicted null hypothesis, showing no significant relationship to such views (Tables V & VI).

Religiosity started out significantly correlated to each of the three dependent variables of interest in this part of the study, but remained significant only for predicting greater agreement that scientists should consult the public, after controlling for (pre)dispositions concerning science and scientists. Political ideology only remained significant for predicting that citizens should have a say in regulations, with more conservative respondents more likely to believe that citizens should be involved.

Attention to news and factual knowledge both significantly predicted higher levels of belief that scientists should consult the public before applying gene editing technology in humans and that citizens should have a say in regulation of the technology. Perceived knowledge, however, again behaved opposite of factual knowledge and significantly predicted less agreement that scientists should consult the public before applying gene editing to humans.

The model for whether or not the scientific community is capable of responsibly guiding the development of human gene editing accounted for 52 percent of the variance in responses to that variable. The models for the two items concerning democratic views regarding decision-making around human gene editing, as seen in Tables V and VI, explained only a small portion of the variances in responses: 10.8 percent for views concerning whether scientists should consult the public and 6.6 to 8.9 percent for views concerning whether citizens should have a say in regulations.

Table V: OLS regression models predicting views concerning participatory aspects of decision-making on human gene editing research and applications. 2016 YouGov dataset.

	Scientific community responsible	**Scientists should consult the public**
	Standardized coefficients β	Standardized coefficients β
Experimental conditions		
Incremental adjusted R^2(%)	*0.4**	*0.0*
Demographics		
Age	0.02	0.05
Gender (female)	0.07***	0.01
Race (white)	0.01	-0.02
Education	-0.04	-0.08**
Incremental adjusted R^2(%)	*0.5**	*1.7****
Values		
Religiosity	-0.03	0.18***
Political ideology (conservative)	-0.04	0.05
Incremental adjusted R^2(%)	*12.5****	*1.3****
Views of science		
Authority of science	0.27***	0.24***
Incremental adjusted R^2(%)	*25.0****	*1.9****
Deference		
To scientific authority	0.35***	-0.25***
Incremental adjusted R^2(%)	*9.4****	*4.3****
Trust		
Scientists & medical professionals	0.21***	0.05
Incremental adjusted R^2(%)	*3.1****	*0.1*
Media attention		
Attention to news	0.01	0.11***
Incremental adjusted R^2(%)	*0.0*	*0.3**
Knowledge		
Perceived knowledge	-0.02	-0.10***
Factual GE knowledge	0.02	0.10**
Incremental adjusted R^2(%)	*0.0*	*1.2****
Total adjusted R^2 (%)	**51.9**	**10.8**
Sample size (N)	1539	1532

*p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001.

Table VI: Logistic regression model predicting views concerning views of citizens' role in regulatory decision-making on human gene editing research and applications. 2016 YouGov dataset.

	B	**S.E.**	**Wald**	**Df**	**Odds Ratio**	**95% CI for Odds Ratio (lower-upper)**	**Cumu-lative pseudo R^2 *(%: Cox & Snell - Nagelkerk*)**
Experimental conditions	---	---	---	---	---	---	*2.0—3.0*
Demographics							
Age	-0.01	0.00	9.31**	1	0.99	0.98-1.00	
Gender (female)	-0.40	0.11	13.32***	1	0.67	0.54-0.83	
Race (white)	-0.05	0.13	0.14	1	0.95	0.74-1.23	
Education	-0.02	0.04	0.37	1	0.98	0.90-1.06	*1.8-2.4*
Values							
Religiosity	0.02	0.02	0.95	1	1.02	0.98-1.05	
Ideology (conservative)	0.10	0.04	5.89*	1	1.11	1.02-1.20	*2.3-3.1*
Views of science							
Authority of science	0.11	0.06	4.20*	1	1.12	1.01-1.25	*2.4-3.2*
Deference							
To scientific authority	-0.25	0.05	21.77***	1	0.78	0.70-0.86	*4.4-5.8*
Trust							
Scientists & medical professionals	0.11	0.08	1.78	1	1.11	1.11-0.95	*4.7-6.3*
Media attention							
Attention to news	0.24	0.08	9.09**	1	1.28	1.09-1.49	*5.5-7.3*
Knowledge							
Perceived knowledge	-0.15	0.07	4.30*	1	0.87	0.75-0.99	
Factual GE knowledge	0.10	0.03	17.30***	1	1.11	.06-1.17	*6.6-8.9*

N = 1554; *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$.

Discussion

Overall, the results align with the hypotheses that deference to scientific authority would relate to more positive views of human gene editing and to higher levels of beliefs that not only are scientists capable of guiding development of gene editing but that citizens and the public should not be involved in decision-making concerning use of the technology in society. This study is the first to find that the relationship between deference and more authoritarian views of decision-making appears even in contexts in which science directly affects society, and in which science cannot provide a complete answer for what we ought to or want to do. The results also support the expectation that views on the authority of science and trust in scientists would mirror deference in predicting positive views of human gene editing and of scientists but would diverge from deference in key ways on the issue of democratic involvement of citizens in such decision-making.

Limitations

Before moving into in-depth discussion of these main results, it is important to keep in mind a few limitations with the data in these analyses. First, I focused on only one science issue, human gene editing, and therefore the results could be particular to this issue at the time of the survey. It is encouraging that despite this narrowness in topic of focus, the findings align with empirical results from the body of literature on deference in deference's relationship to positive views of other science and technology issues. They also align with theoretical expectations for deference's relationship to authoritarian views of decision-making concerning the societal impacts of science. Given, however, that there is not only a dearth of research on deference to scientific authority but also that existing research, including this study, tends to concentrate on emerging science issues in general and biotechnologies and nanotechnologies in particular, it would help to have research that examines deference across a wider array of science issues and decision-making contexts.

Second, the indices capturing deference to scientific authority and belief in the authority of science should be improved. This study used the two deference items that exist across all the deference to scientific authority literature. But those are only two items to capture an abstract concept and, as described in the literature review, might not be cleanly capturing deference. Similarly, this is the first study to examine the two items capturing belief in the authority of science. We need more research developing the items to ensure they capture what they are intended to capture. There is not ample reason to believe that they are not capturing views related to whether or not science is an authoritative way of understanding the world. But how completely they capture this concept should be further examined and more items developed to capture such views of science and of scientific knowledge.

Third, the models predicting views of the role of citizens and the public in decision-making captured only very little of the variance in responses to those items. This study was interested in how deference to scientific authority, belief in the authority of science, and trust in scientists related to these views at all. Clearly, however, factors not captured here likely have a larger role in explaining views of democratic decision-making. Finally, because of the nature of the data, these analyses reveal only correlational relationships. Theory suggests there should be causal links between the independent variables and dependent variables of focus. These, however, cannot be determined from this study.

Authority of Science & Deference: Relationships to Ideology, Religiosity, and Knowledge

Although not a major focus of this study, it is useful to briefly discuss the findings surrounding the other included value-related predispositions—captured through religiosity and political ideology—and the items capturing news attention and knowledge concerning human gene editing. These results have important take-aways for understanding public views of human gene editing and help highlight the importance of including deference to scientific authority for understanding perceptions concerning scientific issues.

Religion, political ideology, and views of science. First, clear across the models was that political ideology does not have a substantial relationship to views of human gene editing, especially after accounting for belief in the authority of science and deference to scientific authority. Because political ideology did significantly negatively relate to belief in the authority of science and deference to scientific authority, however, it is possible we could see political divisions around human gene editing because of these divisions surrounding larger views of science and the authority of scientific knowledge. The exact appearance of divisions in such views of science will likely differ depending by science topic. For example, there are plenty of examples where conservative individuals are more likely to support a technology and liberal individuals are not, such as fracking (Howell et al., 2017). Important for understanding the results here, however, is that views concerning the authority of science and deference to scientific authority outweighed views concerning political ideological considerations.

Belief in the authority of science and deference to scientific authority also appear to account for some of the relationship between religiosity and views of human gene editing. Religiosity did still have a significant relationship to views on whether scientists should consult the public before applying gene editing to humans and predicted more negative views toward human gene editing. Although religiosity overlaps with deference to scientific authority and views on the authority of science—with religious individuals less likely to be deferent to scientific authority or to think that science is the best or more reliable way to understand the world—it appears there are still distinct considerations associated with religiosity that relate to views of human gene editing. More research examining aspects of different religious views in the U.S. and internationally can help us better understand the exact factors that shape those considerations.

That religiosity was no longer significantly related to views on whether scientists are capable of responsibly guiding development of human gene editing once views on science and scientists entered the model, however, suggests that part of religiosity's relationship to this view can be understood by religiosity's relationship to belief in the authority of science and deference to scientific authority. These findings provide additional insight into findings such as those from Scheufele et al. (2017) that indicated that religiosity plays a key role in views of scientists' and public involvement in decisions shaping human gene editing. Here we see that belief in the authority of science and deference to scientific authority could be part of what is driving views that research typically ascribes to religiosity. This connection in the U.S. between religiosity and views of the authority of science—with more religious people being less likely to believe that science is the authority on the world—might not be surprising. But it could be useful to separate out what aspects of religiosity's relationship to views of particular science topics are due to reactions to "science" in general and what are due to concerns tied to particular aspects of a science issue.

News attention and perceived and factual knowledge. After controlling for the effects of the value-based (pre) dispositions and perceived and factual knowledge in the regression models, news attention had little relationship to views of human gene editing. Greater news attention did remain significantly related to benefit perceptions and to support for using human gene editing for treatment until the knowledge variables entered the models, suggesting its relationship to views of human gene editing overlaps with knowledge. Attention to news also remained significant in its relationship to democratic views of decision-making, even after accounting for knowledge, with higher news attention predicting greater belief that scientists should consult the public and that citizens should have a say in decisions concerning human gene editing. Although factual knowledge also significantly related to these views in the same direction as did news attention, that news attention remained significantly related after controlling for factual knowledge could point to a democratizing function of news attention that operates beyond just increased factual knowledge of a topic. Although not a focus of this study, this finding could be evidence of the role of news attention for representing or reinforcing democratic principles in news seekers in the U.S.

Knowledge levels, in turn, have a complicated relationship to views of human gene editing and decision-making around gene editing depending on the particular dependent variable and the measure of knowledge. That perceived knowledge and factual knowledge often behave differently and sometimes oppositely from each other in the results here aligns with findings from previous research (Rose et al., 2019). Factual knowledge appeared to indicate greater ambivalence, in the sense of people with higher knowledge being more likely to see both higher risk and higher benefit associated with human gene editing (Binder, Scheufele, Brossard, & Gunther, 2011; Howell et al., 2018; Wallquist, Visschers, & Siegrist, 2010). Factual knowledge also related to caveats in support for human gene editing, with more knowledgeable people supportive of treatment uses and opposed to enhancement uses.

This latter finding is in line with scientists' own evaluations of human gene editing, as illustrated in the National Academies of Sciences and Medicine's report on human gene editing that encouraged research into treatment-based edits while warning against edits for enhancement purposes (National Academy of Sciences & National Academy of Medicine, 2017). Those with higher factual knowledge are also more likely to hold democratic views of decision-making around human gene editing, even after controlling for views on the authority of science, deference to scientific authority, and trust in scientists and medical professionals. Those with higher perceived knowledge, in contrast, seem to hold more positive views overall of human gene editing and more negative views of the public's role in decision-making concerning applications of human gene editing.

Perceived knowledge's behavior might be indicative of those who are advocates of gene editing feeling more informed about the technology but in ways that match their held opinions on the issue. As briefly described in Rose et al. (2019), this could be evidence of those individuals engaging in selective exposure—paying greater attention to information that matches their held opinions. It could also be indicative of motivated reasoning, if those individuals are processing new information in a way shaped by their held beliefs to disproportionately weigh opinion-consonant information and discount opinion-dissonant information (for an overview of motivated reasoning, see Kunda, 1990). Again, these relationships are small and could be false positives, given the large size of the sample in these analyses, so should be interpreted with that caveat in mind. If they hold across studies, however, the results highlight how, when it comes to the relationship of knowledge to beliefs, it highly depends on what type of knowledge, for whom, and on what issue.

Deference's Distinct Relationship to Authoritarian Views of Decision-making

Moving to the focus of this study, deference to scientific authority behaves similarly to views on the authority of scientific knowledge and trust in scientists when it comes to shaping positive views of the controversial emerging science issue, human gene editing. All three concepts related to lower risk perceptions of human gene editing, higher benefit perceptions, and higher levels of support for using human gene editing for treatment and for enhancement purposes. These results are in line with the two previous studies that examined both trust and deference to scientific authority (Anderson et al., 2012; Brossard & Nisbet, 2007), as previously outlined in this study. When it comes to positive views of the scientific community—that it is capable of responsibly guiding the development of human gene editing—once again, belief in the authority of scientific knowledge, deference, and trust in scientists all behave similarly. Each significantly and positively relates to greater views that the scientific community is responsible.

Where the distinctions between the overlapping concepts emerge, however, are in views of the role of citizens in that development. As predicted, deference to scientific authority is negatively related to democratic views: that scientists should consult with the public before applying gene editing to humans and that citizens should be involved in regulation of research and applications related to human gene editing. Belief in the authority of science, however, from which deference to scientific authority is theoretically supposed to stem, has the opposite relationship, predicting more democratic views. Trust in scientists and medical professionals has no significant relationship to views of the role of citizens in decision-making around science, in line with Anderson et al.'s (2012) findings. This study was the first to explicitly test a key claim of the definition of deference to scientific authority, that it shapes views of the public's role in decision-making concerning science's societal implications. The results indicate that deference does in fact shape views in the direction expected, even for decision-making concerning human applications of the science and societal-level regulations.

Although deference to scientific authority is conceptually supposed to emerge from belief in the authority of scientific knowledge, the results here indicate that the two are distinct in their relationships to views of decision-making in science. This distinction makes sense, as believing that science is authoritative knowledge is different than taking the next step to defer to that knowledge. Although the results are perhaps not surprising in hindsight, they do leave open additional questions. The apparent distinction between the two concepts suggests that some additional factor must be present to convert views of science as authoritative knowledge into deferring to that knowledge in decision-making to the extreme of letting scientific expertise stand in for public deliberation on decision-making about science and technology's societal impacts.

Elucidating the differences in the origins of belief in the authority of scientific knowledge and deference to scientific authority could help us better understand the process that is shaping levels of deference to scientific authority, beyond just the belief that science is the best form of knowledge. This work will be the focus of Chapter 4 of this dissertation, and will involve delving into the respective roles of education and science knowledge as well as views of epistemological beliefs. Epistemic beliefs are another conceptually and operationally messy area of research (Schraw, 2013), but broadly they refer to beliefs about the nature of knowledge: how absolute or relative it is, and where it emerges from (Kienhues, 2013). Capturing more specific epistemic beliefs could help understand views related to science that might reveal distinctions in how people view science as authoritative, where they believe such authority stems from, and what kind of contexts they believe it extends to, which could help us better understand why, for some, views of science as authoritative turn into deference and authoritarian views.

Conclusion

Clear from the results is that deference to scientific authority has a strong relationship to views of human gene editing, and in many cases that relationship is stronger than the relationships of concepts that science communication research typically focuses on, such as religiosity and political ideology. Not only does deference relate to more positive views of the emerging technology, it also predicts more negative views of democratic decision-making concerning the societal implications of that technology. Those who are more deferent are less likely to believe that the public should have an official role in helping define the development of gene editing technology: its risks, benefits, and what will be the acceptable paths forward for addressing those risk and benefits.

This study was the first to assess if this idea of deference as capturing deferring to scientists in decision-making translates even into areas of decision-making that more clearly concern societal regulation and public engagement around societal applications of science. It was also the first to develop and test how deference to scientific authority compares to broader views about the authority of science as a way of knowing or understanding the world.

Deference to scientific authority’s relationship to authoritarian views of decision-making is where the concept most clearly differs from overlapping concepts that predict positive views of science, such as belief in the authority of science and trust in scientists. Those with high trust in scientists and high levels of deference to scientific authority both want scientists involved.

But trust in scientists does not relate to views of whether citizens should also be involved, while deference strongly predicts more authoritarian views that citizens do not have a place in decision-making. Belief in the authority of science is also distinct from deference, with belief in the authority of scientific knowledge actually positively relating to support for democratic decision-making. This distinction suggests that although deference conceptually should emerge from belief in the authority of scientific knowledge, additional factors likely translate such views into then deferring to that authority. Future research can help us understand what causes some people to move from not only viewing science as a type of authoritative knowledge to then have authoritarian beliefs stem from that view.

Research examining perceptions concerning science and technology issues and decision-making on those issues will miss a potentially large part of the picture if it does not account for deference to scientific authority and belief in the authority of science. In these analyses, deference had as strong or stronger of a relationship to views of human gene editing than did religiosity, and the two concepts appear to overlap (as negatively correlated concepts) in how they relate to public perceptions. Deference also had a comparable, and in some cases stronger, relationship to views of science and decision-making as did trust in scientists—a concept that has been far more heavily examined and has become a standard to include in science communication and risk perception research. Research furthering our understanding of deference to scientific authority should include more studies in more contexts, particularly non-U.S. contexts as well to better understand the cultural component of deference. This work will help color in what appears to be a large and under-examined part of the picture shaping perceptions of emerging science and technology.

Chapter 3. Defining "Defer": Is Deference to Scientific Authority a Sign of Respect or of Authoritarianism?

Introduction

The results of the previous chapter indicated that why deference to scientific authority matters is not just that it predicts positive views of emerging and controversial science and technology issues but that it predicts less democratic views of how should be involved in shaping those issues as they emerge in society. The former point is typically the focus of existing literature on deference, although the latter point is typically offered as justification for why deference is theoretically important. As Chapter 2 illustrated, this latter point is also where deference is empirically distinct from trust in scientists and from belief in the authority of science. Deference predicted less democratic views of decision-making concerning science, and the analyses gave the first illustration that these non-democratic views among the more deferent apply even in regulatory and other decision-making settings that concern direct societal impacts of human gene editing.

This distinct feature of deference—that it does in fact predict anti-democratic views in decision-making contexts that are more explicitly connected to societal implications of science and technology—is arguably the more important aspect of deference than that deference predicts positive views of science issues. Deference to scientific authority not only provides a sense of why people see particular science issues as risky or beneficial. It gives insight into the normative and prescriptive views individuals hold for who should have a say in decisions that will ultimately shape those risk and benefit outcomes.

Although the analyses in Chapter 2 highlighted this relationship between deference and letting scientists make decisions in place of citizens, they left open the question of what exactly it means to be deferent to scientific authority. Put another way, what do the deference items actually capture? This chapter addresses that question by focusing less what the current deference items predict and instead on what "deference" and the items capturing the concept should encompass.

This question arises because there are two definitions of deference, both of which could realistically define current conceptualizations of deference to scientific authority but currently are conflated in theoretical understandings of the concept. One definition is to defer to someone in the sense of showing respect for their expertise (Cambridge Dictionary, 2018), such as the expertise and opinion of scientists. The other is to defer to someone in the sense of letting that person decide in one's place (Cambridge Dictionary, 2018), such as letting scientists decide in the place of broader public discourse. If the former definition is most appropriate for understanding deference to scientific authority, the items should distinguish between deference out of respect and deference as a more authoritarian act. If the latter definition is more useful and intuitive for current and future use of deference to scientific authority, then perhaps deference should be measured alongside items such as the participatory views items described in Chapter 2 that get more explicitly at the idea of deferring to scientists at the cost of citizen input in decision-making.

The rest of this chapter describes in greater detail this question concerning how we conceptualize and operationalize deference to scientific authority as it relates to views of democratic decision-making. It outlines the methods for concept explication—the process of determining what deference is and how we can capture it in survey research. The analyses then apply empirical steps of concept explication to examine both how well the deference items hold together to capture the concept and how distinct the concept appears to be from the related concept of participatory views of science. These analyses—combined with greater theoretical description of deference, its origins as a concept for understanding views of science, and deference in other political and decision-making contexts—can start to illustrate what it means to defer.

Deference & Participatory Views of Decision-making in Science

In the literature on deference, there is a blurred and largely unexplored conceptual line between items defined as deference to scientific authority and items capturing participatory views of scientists and the public in decision-making. The literature often treats the two as distinct concepts (Anderson et al., 2012; Brossard, 2002; Brossard & Nisbet, 2007; Brossard & Shanahan, 2003), which they might well be. One could argue that deferring to scientists for information on scientific matters does not necessarily mean not wanting public input in such matters. As mentioned above, to "defer to someone" can mean "to accept another person's opinion, usually because you respect the knowledge or experience of that person" (Cambridge Dictionary, 2018), which would not necessarily have to mean submitting to that person's decisions.

But to defer to someone also typically means "to let another person decide" (Cambridge Dictionary, 2018; "defer to," 2018), which indicates setting aside one's own considerations or opinions in decision-making, at least to a degree. If this meaning is the best definition for deference to scientific authority, then deference and participatory views of science would likely be more useful if combined into an index. That could ensure that we capture the extent to which deference means letting scientists decide at the cost of citizen involvement.

Many of the definitions of deference to scientific authority and discussions in the literature of why it matters center on this idea of deference implying that one will choose scientists' input over those of other stakeholders in science-related decision-making (Anderson et al., 2012; Brossard & Nisbet, 2007; Lee & Scheufele, 2006). Other studies, similarly, describe deference as emerging from the view that science should be free from regulation and political control (Binder et al., 2016; Brossard & Nisbet, 2007). These definitions on their own seem to combine ideas of deference as respect with deference as indicating participatory views of who has authority in deciding on science issues. Additionally, at least one study also groups participatory items and deference items (specifically items D2, P3, and P4 in Table VII below, along with an additional item asking if "we depend too much on science and not enough on faith") together in an index that they call deference to scientific authority, although they do not describe their reasoning for doing so other than that the items were significantly correlated (Binder et al., 2016).

A history of deference and participatory views. Beyond the Binder et al. (2016) study that grouped deference and participatory items together to capture deference to scientific authority, research has not compared deference to participatory views of science since Brossard first developed the items in 2002. In that work, as described in the previous chapter, Brossard (2002) created both the deference items and the participatory views items (as listed in Table II of Chapter 2, reproduced here as Table VII) as proposed dimensions of authoritarianism in science decision-making. What are now called the deference items were originally intended to capture "attitudes toward science as the authority" and what are now called the participatory views items were to capture "attitudes toward democratic processes in science" (Brossard, 2002, p. 86).

Table VII: Original batteries of items capturing 1) deference to scientific authority and 2) participatory views toward science, developed by Brossard (2002).

Item #	**Items capturing "deference to scientific authority"**
D1.	Scientists know best what is good for the people (*often replaced with* public)
D2.	Scientists should do what they think is best, even if they have to persuade people that it is right
D3.	Scientists should make the decisions about the type of scientific research on [science issue]
D4.	It is important for scientists to get research done even if they displease people by doing it
	Items capturing "participatory views toward science"
P1.	It is important to have public participation in making scientific decisions, regardless of people's knowledge of the issues involved *(Reverse coded to represent non-democratic views)*
P2.	The actions of the scientific community should always reflect the will of the majority *(R)*
P3.	Public opinion is more important than the scientists' opinions when making decisions about scientific research *(R)*
P4.	Scientists should pay attention to the wishes of the public, even if they think citizens are mistaken or do not understand their work *(R)*

Brossard conducted a principal component analysis (PCA) using an orthogonal, Varimax, rotation, that suggested that at least two concepts were present in the eight items (2002) (Reproduced in Table VIII). Most of the items, however, loaded more heavily on the same single factor and one of items (P4 in Table VII) loaded most heavily on its own on a third factor (Table VIII). The loadings at least somewhat matched the two concepts Brossard had been trying to capture. But because most loaded highly on both factors, Brossard decided not to shorten the scale or separate the two factors into distinct concepts.

Since that initial work, however, research did separate the two factors, without comparing them to each other again. In the studies following the creation of the deference and participatory views items, Brossard & Shanahan (2003) and Brossard & Nisbet (2007) then each examined only one of two factors: views of science as authoritative in the Brossard & Nisbet piece and views on citizen involvement in science decision-making in the Brossard & Shanahan piece.

The former became “deference to scientific authority” (Brossard & Nisbet, 2007) and the latter became “authoritarian views of democratic processes in science” (Brossard & Shanahan, 2003). Unfortunately, although this fork in the research disconnected the two factors from each other, the two continue to blur together in subsequent interpretations of deference, and we do not have empirical evidence or strong theoretical backing to support separating them.

Table VIII: Factor analysis results for the authoritarian views of science items (later “deference” and “participatory views.” Deference items and factor interpreted as representing deference (Factor 1) are highlighted in gray. From Brossard (2002); reordered by factor loading (Factors 1 through 3, with loadings within each ordered from greatest to least).

	Factor Loadings (after Varimax rotation)		
Item	*Factor 1*	*Factor 2*	*Factor 3*
Scientists should make the decisions about the type of scientific research on agricultural biotechnology **(D3)**	**.776**	**-.402**	.000
Scientists know best what is good for the people **(D1)**	**.726**	-.327	**-.440**
Scientists should do what they think is best, even if they have to persuade people that it is right **(D2)**	**.676**	.000	**.402**
It is important for scientists to get research done even if they displease people by doing it **(D4)**	**.747**	-.269	-.138
The actions of the scientific community should always reflect the will of the majority **(P2)**	**.508**	.356	-.257
Scientists should pay attention to the wishes of the public, even if they think citizens are mistaken or do not understand their work **(P4)**	**.480**	**.665**	-.222
It is important to have public participation in making scientific decisions, regardless of people’s knowledge of the issues involved **(P1)**	**.381**	**.428**	-.242
Public opinion is more important than the scientists’ opinions when making decisions about scientific research **(P3)**	.263	-.235	**.784**
Eigenvalue	*3.41*	*1.62*	*1.46*
% of variance (cumulative)	*28%*	*47.8%*	*64.8%*

As illustrated in Table VIII, the deference and participatory items had a high amount of overlap, with most of the items loading highly on both the “deference factor” (factor 1) and the “participatory views factor” (factor 2) (Brossard, 2002). In fact, the items that have survived through the body of research on deference and participatory views (namely, items D1, D2, P3, and P4) are some of the worst offenders in terms of not loading cleanly onto the predicted factors. As seen in Table VIII, P3 loads on almost entirely its own factor and barely has overlap with the other two factors of deference or participatory views. D1 behaves somewhat more as expected based on the conceptual definition of deference, by positively loading on the deference factor and negatively loading on factor three, which is P3's factor capturing belief in the importance of public opinion compared to scientists' opinions. P4 also behaves somewhat as expected, loading most heavily on the participatory views factor. But, similar to the other participatory items, it also loads moderately and positively on the deference factor. D2, however, while it loads heavily of the deference factor, has the opposite relationship of D1 to the public opinion factor, loading moderately on factor 3 as well. This is counter to what would be theoretically predicted if that item is measuring deferring to scientists at the cost of citizen input in decision-making on science issues.

Factor loadings are not the gospel in deciding how we define concepts, but they do provide a useful quantitative illustration of the conceptual overlap and uncertainty present in the existing batteries of deference to scientific authority and participatory views of science. Because these results mirror the blurring together of deference to scientific authority and participatory views of decision-making on science that appears in definitions of deference and of why it matters, they raise the question of how distinct the two concepts are and how useful that distinction is in practice. If the deference to scientific authority items are in fact distinct from the participatory views toward science items, it is not clear that we can claim that deference to scientific authority is a form of authoritarianism that captures believing that there should not be citizen participation in decision-making around science issues, although we saw in the analyses of the previous chapter that the existing deference items do predict such views.

Concept Explication—Determining the Meaning of "Defer"

This chapter will further examine that overlap between the concepts to assess whether deference to scientific authority is best captured as distinct from participatory views of science. It does so through concept explication of deference to scientific authority and participatory views of science: examining their relationships to each other, to theoretical antecedents, such as education, and to other conceptually similar items, such as general—non-science-specific—authoritarian tendencies.

Concept explication is the process of using theory and systematic analyses to examine the overlap and distinctions between concepts and the survey items used to capture those concepts. Part of this process involves examines the relationships between the items of interest and how they predict other items—such as the analyses in Chapter 2 did. This chapter, however, will take this examination of further and analyze primarily three aspects of the concepts of interest:

1) how well items that should capture the same concept empirically "hold together";
2) what the theoretical antecedents of each concept are, the extent to which they should be distinct across concepts, and whether analyses support those predicted relationships;
3) what the theoretical effects of each concept are (as examined in Chapter 2), the extent to which they should be distinct across concepts, and whether analyses support those predicted relationships.

The theory and methods behind concept explication. A value of social science research is the ability to empirically study the invisible and abstract concepts that shape human thinking and behavior. This, however, is also one of the primary difficulties of this research—creating useful, intuitive, agreed-upon, and true boundaries around complex, intertwined dimensions. Concept explication describes a systematic process for developing and mapping those boundaries: from defining useful concepts in a way that advances theoretical and empirical understandings of a particular idea to then operationalizing those concepts in reliable and internally and externally valid ways (McLeod, 1988a, 1988b). This process involves two bigger steps, as outlined by McLeod (1988a, 1988b): 1) meaning analysis and 2) empirical analysis.

Meaning analysis describes the theoretical work for developing useful and valid scientific concepts, such as deference to scientific authority. To be useful, a developed concept should balance the tensions between being "sufficiently abstract" while also being clear, precise, and capable of being operationalized (McLeod, 1988a). The abstractness of an item refers to its ability to appear in many different contexts and, therefore, to be useful for capturing and understanding phenomena across time and space. At the same time, to be able to actually apply and reliably capture the concept, it has to be clear and precise both in its definition and in the methods for capturing it. This ability to be applied—or the operationalizability—is the degree to which the definition of the concept can be translated into methods for observing and measuring that concept (McLeod, 1988a). The precision, then, includes how well once can communicate the intended meaning of the concept and how well the operational items capture the concept (as determined partly through empirical analysis, as will be described next) (McLeod, 1988a).

From the meaning analysis, one then conducts empirical analysis of the concept by establishing under what conditions one can expect to observe the concept and determining the methods and analysis for capturing and assessing the concept. In practice, meaning analysis and empirical analysis intertwine in an iterative process, but empirical analysis broadly describes the process of developing indices or scales from indicators of the concept and empirically evaluating those indices, scales, and individual indicators. The methods for this evaluation include broadly three steps: 1) assessing how the items relate to each other, 2) how they relate to items that should conceptually be distinct, and 3) how they relate to the theoretically or empirically determined antecedents and effects of the concept of interest.

At each point in the analysis, one has to decide if the homogeneity across items is high enough to overcome the heterogeneity between individual indicators. If items are too distinct, it could be evidence that they are separate dimensions of the concept—in which case, one could argue that they stay together to capture a single concept—or that they could be capturing distinct concepts and should be separate indices (McLeod, 1988b). Similarly, the discrimant validity of those items also rests on how well they are empirically distinguishable from theoretically different items: do the differences between the supposedly distinct concepts outweigh any overlap or correlations between them (McLeod, 1988b). Determining this includes assessing the antecedents and effects of the indicators for the concept of interest and for comparison indicators that should capture distinct concepts. The antecendents or effects should all relate similarly for each of the indicators capturing the same concept, and theoretically distinct concepts should have different antecedents or sufficiently different relationships to the same antecedent concepts.

Meaning analysis of deference: deference in other decision-making contexts. Much of the overview of what deference to scientific authority theoretically should be was summarized in the introductory chapter and Chapter 2. For this chapter's focus, I turn to the concept of deference in general and its implications for decision-making in other contexts, such as in more general politics and policy-making and in judicial decisions. Literature on deference in these contexts offers some meaningful basis for assessing whether deference to scientific authority is better understood as merely respecting scientific expertise—which then predicts holding more authoritarian views—or as believing that scientists should be the decision-makers on science issues—which would mean deference itself encapsulates participatory views.

Deference as a social phenomenon. Before moving to deference in decision-making contexts, such as in political and judicial contexts, a broad view of deference provides insight into how it is connected to authority, even when the concept just indicates deference as a form of respect to that authority. As the following overviews will illustrate, very little research systematically examines what we mean by "deference." Some early work, however, is from sociologist Erving Goffman, who examined how deference emerges in general in social settings (Goffman, 1997).

Goffman largely described deference as a form of respect but one that is based on particular social hierarchies. One can only be deferred to if they have a higher social status in the relevant social context. Others show deference by respecting that person because of their social position but also by providing space that allows the person to maintain any performance or façade that maintains their image as an authority (Goffman, 1997). The person on the receiving end of deference can do their best to conceal the less worthy parts of themselves that could ruin their social standing as someone worth deferring too, but otherwise they are not in control of their own image as someone who should be deferred to. Deference depends on their maintained social standing, which is granted and continually reaffirmed by others (Goffman, 1997).

The importance of Goffman's work here for broadly understanding the concept of deference is largely twofold. First, as mentioned above, deference is always tied to authority. This will become clearer in the examples from political and judicial deference described below. But, that means that even when described as a form of showing respect, deference has to be understood as granting respect to someone because of his or her standing as an authority in a particular social context.

Second, and related to the first point, is that this standing is based on both the individual being deferred to as acting in accordance with expectations for a person in their standing, as well as on views of the source of the authority they are supposed to represent. For example, in the case of deference to scientific authority, scientists' connection to science is what initially would grant them, as a group, authoritative social standing (at least in social or cultural contexts in which science is seen as authoritative). The deference granted to a particular scientist would then also depend on how well he or she meets the particular societal expectations for how one behaves as a scientist. Their behavior as "scientists" in ways that mirror images attached to science's authority—i.e., objective, separate from politics, etc.—is what would ensure that others continue to deem them as worthy of deference.

Alternatively, rather than choosing to not defer based on judgment of the behavior of an individual as a scientist, people could also stop believing in the source of the authority, or the legitimacy of science as authoritative in particular contexts. This would make it likely that they no longer defer to the people who represent that authority, similar to what occurs in political revolts when people decide that a particular form of governance, such as monarchy, is not truly legitimate and authoritative and therefore no longer respect monarchs. So, for deference to exist, one has to believe in the legitimacy of a particular type of authority and see a particular representative of that authority as truly representing it. I will come back to these ideas, but first, the literature on political and judicial deference helps tie ideas of deference and authority to more concrete contexts.

Political deference. In political science, deference to political authority is also not clearly developed, with researchers often using the term in more vernacular and differing ways without defining what exactly they mean by "deference" (see, for examples, Hillman, 2013; Laird, 1989; Olson, 2005). Researchers who do define deference, however, typically split it into multiple dimensions or types of indicators, although in different ways across studies. For example, work on political deference in China described deference as composed of cognitive, evaluative, and affective measures (Zhai, 2017). The cognitive measures capture beliefs about the rightful relationship between the government and citizens, with the extremely deferential (and authoritarian) beliefs being that citizens should have unconditional support for government. The evaluative measures refer to beliefs that government is the legitimate authority and, therefore, should decide what ideas can be up for debate in society. The affective measures capture feelings of affection for the government as an authority, such as whether one thinks of the government as similar to the head of a family (Zhai, 2017). Altogether, these items make up what the authors call deference. People with higher levels of deference, then, believe that ordinary people should not have a say in politics, that an authority should decide instead, and that that authority should be supported unconditionally (Zhai, 2017).

Although these measures make up the more authoritarian version of deference—deference as letting authorities decide in one's place—this concept of deference also encompasses respecting the opinion of that authority (Zhai, 2017). This overlap could suggest that deference as letting someone else decide will likely include as a component deference as respecting that person's or body's expertise and opinion. At least at face value, it seems likely that this relationship would not need to be true in the other direction: one could respect someone's authority without letting that person make decisions in one's place. In that sense, deference could be pictured as a series of steps of types of deference, with respect as the base steps and higher steps indicating moving toward greater deference in decision-making contexts and increasingly toward authoritarianism.

Before continuing to additional conceptualizations of deference, I will note that when it comes to rationale for letting others decide in one's place, one could also let others decide for them for less "deferential" reasons that do not build on respect of someone's authority, such as lack of interest in the topic or inability to actively participate, whether due to time or lack of other resources. I restrict the understanding of "deferring" here as the idea of deference as an active choice, i.e., not one based on inability to participate in decision-making. Factors such as lack of interest in participating matter in real-world participation in decision-making (see, for example Hibbing & Theiss-Morse, 2004, on why people often do not want to be involved in political decision-making). These factors might matter less so, however, in survey responses to the particular items of focus here. The deference items and participatory views items that I focus on likely capture more normative views of who should be involved in decision-making and not necessarily just indicators of one's own personal ability or desire to participate in decision-making. I will not dive further into these other possibilities for not wanting to be personally involved in decision-making other than to clarify that they exist and are distinct from "deference" as I use the term.

Returning to the literature on political deference, older research in Great Britain divided deference into two dimensions: the concept of political authority and views of the superiority of political elites (Erickson, 1977). The concept of political authority focused on the nature of authority in the sense of whether authority is expected to represent citizens or to govern based on decisions relying more on politicians own expertise. These views extend to views of whether citizens are passively involved (merely voting to express opinion on officials' judgments) or actively involved (in the sense of "interfering") in political decisions (Erickson, 1977, p. 574). The concept of the superiority of political elites regards the extent to which holding a public office "confers high status and public respect" on the office holder, which then translates into them being seen as a superior person (Erickson, 1977, p. 575). Beliefs along this second dimension would lean from egalitarian (less deferential) to hierarchical (more deferential).

When comparing the deference to scientific authority items to these definitions of deference, the participatory views items could fall more along the lines of the concept of political authority. Belief in the authority of science could also overlap with this concept, particularly if the primary idea is what type of governance (or in the case of science decisions, what type of knowledge) counts. I will come back to this potential overlap in the concluding chapter of this dissertation when discussing next steps for conceptualizing deference and the authority of science. For now, however, it also seems as though the deference to scientific authority items—particularly with their current wording that focuses on scientists in particular, rather than science in general—aligns more with the concept of the superiority of elites. If this is the case, they might offer an important component but incomplete picture of deference to scientific authority overall.

Judicial deference. The conceptualizations that are more easily comparable to deference of scientific authority, however, are in the literature on judicial deference. Judicial deference refers to the "latitude" that courts give legislative bodies in decision-making (Chan, 2017). In this sense, judicial deference is the opposite of judicial activism, in which justices try to expand the power of the court in decision-making by issuing rulings that move into territory traditionally held by other governmental bodies (Chan, 2017). We can understand deference in a particular context by understanding how views of the role of one's own group—whether that group is justices or citizens—in making a particular decision fall along a spectrum from activism to deference. This relationship to activism could also be useful for deciding what counts as deference among particular groups in particular decision-making settings. For example, it could help for examining whether it makes sense to capture deference to scientific authority among samples of scientists, or whether those views could best be categorized as "activism" in particular contexts.

One researcher further divides judicial deference into two types that overlap with the two general definitions of interest here: respect for another's opinion and letting another's decide in one's place (Daly, 2012). The first, Daly calls "epistemic deference," and it is the act of "paying respect. . .by means of according weight" to another body's perspective (Daly, 2012, p. 7). The second goes "beyond paying respect" to refer to "the allocation of authority"—namely, who has authority in shaping a court case (Daly, 2012, p. 8). This latter definition, Daly highlights, does not need to indicate giving absolute authority. That authority can be granted conditional on the presence of certain characteristics of the body that is granted authority or of its decision-making process. For example, doctrinal deference could be conditional on the presence of what the court considers "reasonableness" in the actions of the decision-making body that the court defers to (Daly, 2012). This idea of deference being conditional is similar to Goffman's (1997) point that deference is granted partly on how well a particular person meets expectations tied to their authoritative standing.

These two definitions of what it means to defer in court decision-making contexts seem particular applicable to understanding what we mean when we talk about deference to scientific authority. Bringing together the literature on judicial and political deference, we can think of the definitions and extent of deference as falling on a continuum from 1) respect for another decision-making body, perhaps because of its position in society or its approach to the issue, to 2) allowing that body a more bounded ability to decide in one's place because of respect for its position or approach, to 3) allowing that body increasingly less bounded ability to decide because of respect for its position or approach. These manifestations of deference increase in scope and extremity to increasingly more authoritarian stances. The distinction between the last two in particular is more in degree then kind, and a key determinant between the two is how much deferring to one body can result in loss of authority for others whom the resulting decision will affect.

Dimensions and contexts of deference. The question for capturing deference to scientific authority, then, is what aspects and outcomes of that deference are we interested in and in what contexts. Deference as it relates not just to respect for authority but to the potential for authoritarianism in decision-making seems to be a vital and useful dimension for capturing deference to scientific authority, particularly for understanding its implications in decision-making in controversial science issues. The concept of deference, initially combined with participatory views items, developed not as a way to capture respect for scientists' views, per se, but to capture how views of the authority of science—as transferred to scientists—could become authoritarianism views of the roles of scientists in decision-making on these types of issues where science has broad societal impacts and ethical implications (Brossard, 2002; Brossard & Nisbet, 2007; Brossard & Shanahan, 2003). Essentially, deference to scientific authority could be described as an example of how respecting scientists' authority on science issues can translate into authoritarianism when it comes to decision-making contexts where those science issues are intertwined with normative and societal questions—questions that require decisions for which scientists cannot have complete legitimate authority.

Based on the history of the concept and the literature on deference in political and judicial decision-making contexts, it makes sense, then, to have items capturing respect for scientists as distinct from necessarily letting them decide in one's place. It also makes sense, however, that context will matter for interpreting the items to understand the extent to which scientists are granted decision-making power and at what point that deference becomes more a version of authoritarianism than a version of respect. For capturing deference and when it turns into authoritarianism, a battery of deference items therefore, should likely include some measure of the magnitude of a particular act of deference (Chan, 2017). This could include having survey items that capture views of the roles of scientists and of the public in different decision-making contexts.

In more extreme contexts, such as those of focus in this dissertation, where the authority of scientists cannot provide the complete authoritative answer for how we move forward with science and technology in societally acceptable ways, deference to scientific authority would represent authoritarianism when it indicates deferring to scientists to the point of not seeing citizens as having legitimate standing in the decision-making process. Believing that both scientists and the public have a place in such decision-making—even if in varying degrees in terms of how much each group should contribute and how—would represent more bounded deference to scientific authority. The former level of deference could be a barrier to deliberation, while the latter—deferring in the correct amounts and areas to both scientists and fellow citizen's expertise and concerns—could be necessary for legitimate and complete deliberation on complex issues in science and society.

Empirical analysis of deference—deference and authoritarianism within and beyond science issues. At face value, however, the wordings of the current deference items do not clearly fall under either definition of "defer." We saw in Chapter 2, though, that the deference items do predict authoritarian views of the role of citizens and scientists in decision-making on complex issues in science and society. Here, I will more test how well the deference items each seem to capture authoritarianism by assessing their relationship to more general (non-science-specific) authoritarian traits. This, and how the deference items and items capturing authoritarianism overlap with the participatory views items, will be the main focus of the following analyses.

By translating these theoretical dimensions of deference and the concept's relationship to authoritarianism into empirical analyses, we can assess how well the existing deference items and participatory views items appear to be similar but distinct dimensions. We can see if the deference items appear to capture either respect or deference as granting decision-making power. We can also assess how well participatory views items appear to capture aspects of deference as granting decision-making power, and the extent to which these items and the deference items overlap with general authoritarian tendencies.

Research Questions and Hypotheses

Deference & general authoritarianism. I predict that deference to scientific authority and participatory views of science will have similar antecedents, such as education and dogmatic tendencies and beliefs. For testing the usefulness of the existing items, however, I am also interested in the distinctions between how these theoretical antecedents relate to each of the current deference items, D1 and D2, as well as how each of these deference items relate to the participatory views items. My research question driving this comparison is:

> RQ1: Are the two existing deference items similar in their relationships to education, dogmatic beliefs, and participatory views?

The purpose of this examination is to see if D1 and D2 appear to be capturing the same concept—even if that is at different levels of strength. Additionally, it is possible with the wording of D2— "scientists should do what they think is best. . ."—that at least some people respond to the item based on their view of what individuals (including individuals who happen to be scientists) should be able to do, rather than views of scientists as authorities of scientific knowledge. If that is the case, it is perhaps not a clean measure, at least on its own, of deferring to scientific authority per se, versus believing in the freedom of individuals. One of the datasets used in these analysis (the 2014 dataset described in the Methods section below) includes items that capture views of freedom of speech and whether individuals should be able to express themselves, even when others disagree with their views. I will assess how these views of the freedom of individuals to speak their minds relate to each of the deference items and predict that:

> H1a: Higher expressed support for free speech for individuals will relate to believing that scientists should do what they think is right, even if they have to persuade others.

And that this relationship will be stronger for item D2 than for item D1:

> H1b: The relationship between supporting free speech and believing that scientists should do what they think is right will be stronger than the relationship between supporting free speech and believing that scientists know best what is good for the public.

These comparisons will also include examining how much the authoritarianism items relate to each deference item. Because of available data and because of an interest in more general authoritarian tendencies, rather than authoritarianism tendencies along a right-left political spectrum, I rely mostly on items from a scale of dogmatism, developed by Rokeach in the 1950s and '60s (Rokeach, 1960). Much of the literature on authoritarianism in political contexts focuses on politically right-wing authoritarianism (Altemeyer, 1996, 2006; Rokeach, 1954, 1960). Altemeyer (1996; 2006) specifies that "right-wing" indicates believing that traditional authorities are the true authorities. In established communist regimes, this means that right-wing authoritarians would support the communist government, even though on a political spectrum we typically define communism as extreme left. In the U.S. context, however, right-wing authoritarianism occurs predominately among those who identify as politically conservative (Altemeyer, 1996, 2006; Rokeach, 1960). Although Altemeyer describes having great difficulty in finding left-wing authoritarians, theoretically authoritarians in general can be identified by the high degree to which they 1) submit to who they define as the authority, 2) show aggression to protect or display loyalty to that authority, and 3) have and value conventional behavior and thoughts (Altemeyer, 2006).

For the comparisons that I am interested in, the distinction between right- and left-wing authoritarianism is less important. Instead, of greater focus is general and cross-contextual authoritarian tendencies. Additionally, I am interested in the rigidity with which one holds those tendencies: believing that there is an absolute true way for seeing a particular issue and that authorities are the ones with access to that truth, respecting authority to the point of forfeiting one's own will or critical thinking on an issue, and being resistant to update one's stance to account for context and contingencies (Altemeyer, 1996; Rokeach, 1960). Rokeach (1960) developed a scale of dogmatism, which he treats as synonymous with "close mindedness," that captures the structure of one's belief systems, rather than necessarily the beliefs themselves. Closed belief systems, as defined by Rokeach (1960), lead to authoritarian tendencies, which he groups as a sub-dimension of dogmatic thinking, and he describes having created the scale to capture more general authoritarianism, instead of political right-wing authoritarianism.

Because Rokeach's (1960) dogmatism scale is theoretically more agnostic to specific belief content and it encompasses authoritarian tendencies, I use items from this scale to assess the existing deference and participatory views items in terms of how well they capture aspects of general authoritarianism. In Chapter 4, I go into greater depth on the particular features of dogmatism and with larger batteries of dogmatism items using a survey more specifically designed to examine dogmatism and deference. For now, however, I rely on items that happened to exist in earlier, more general datasets to examine how the two more commonly used deference to scientific authority items overlap with the participatory views items to indicate authoritarianism in decision-making in science and how each item relates to broader authoritarian and dogmatic tendencies in general.

Rokeach's (1960) items are not fool-proof, and Altemeyer describes many of the limitations of them, including issues of inter-item reliability (Altemeyer, 1996). For a start, however, by examining these items alongside the deference items we can start to see how well the existing deference items fare in terms of providing valid and reliable measures of deference, which can inform the conceptual work of deciding what we want deference to capture. Together, these meaning and empirical analyses will further the conversation of what edits to existing items or development of new items we need to more cleanly and completely capture deference to scientific authority, however it is best defined.

Deference & participatory views. Based on the results of Brossard's (2002) factor analysis and theoretical conceptual differences between the deference items and the participatory views items, I also test the hypotheses that:

> H2: Deference to scientific authority and participatory views of science will emerge as two distinct, but related, factors.

I am interested as well, in how well the items relate to each other: are the correlations between them high enough to suggest that they would combine well in an index of authoritarian beliefs toward decision-making in science? I will also examine how cleanly the existing participatory views items seem to load on a shared factor, given the results from Brossard (2002) that found the "public opinion is more important" item (P3 in Table VIII) to be more distinct in what it captures. The goal of these analyses is to see how well the items could capture a coherent picture of what it means to defer to scientists at degrees varying from respect to anti-democratic tendencies. Based on the overlap and distinctions between each of the items and concepts they represent, we can start to see how well each of the deference items capture their theoretical definitions and what areas of deference are missing that we should add in new items to further develop the concept.

Methods

Analysis

As mentioned above, for the examination of the relationships between the deference and the participatory views items, I used a combination of analyses of correlations as well as confirmatory factor analysis to assess the inter-relationships between the items intended to capture deference to scientific authority, those intended to capture participatory views, and items for general dogmatic or authoritarian views. I also ran regression models to examine the patterns of relationships between the deference and participatory views items of focus and items capturing theoretical antecedents, such as education and dogmatism.

Based on limitations of what variables exist in each available dataset, the analyses examined different aspects of the hypotheses and research question in each dataset, as I describe below. Examination of each of the three datasets that I used, however, included the same three steps. First, I examined inter- and intra-item relationships of the concepts of interest—deference and participatory views—and available antecedents, such as education and dogmatism. Second, to further assess the inter-relationships between the items of interest, I then ran exploratory factor analysis (EFA) on a randomly selected sample of half of the survey responses, including the deference items and (when available) participatory views items and dogmatism or authoritarianism items. On a second randomly selected sample of half of the responses, I then ran a confirmatory factor analysis (CFA) to assess how well the theoretically and empirically (from the EFA) suggested structure fit the data. Finally, I ran hierarchical ordinary least squares (OLS) regression models predicting each of the deference items and the participatory views items to compare the relationships between the items and theoretical antecedents. The differences across analyses of each dataset are based on what variables are available, as described below in the section on datasets and measures.

All analyses were run through IBM's software SPSS, version 25. Because CFA is not a standard option in IBM SPSS, I used the IBM AMOS Macro with SPSS to conduct the CFAs.

For the EFA, I ran two analyses: one using maximum likelihood (ML) modeling and one using principal axis factoring modeling (PAF, also called iterative principal axis modeling (IPA)) (Fabrigar & Wegener, 2012). The latter model can be more appropriate for data that has non-normal distributions and can often pull out weaker factors than does ML, while ML offers information on model goodness-of-fit (Fabrigar & Wegener, 2012). For both EFA models, I used a Promax oblique rotation to allow for correlations between the factors (Fabrigar & Wegener, 2012).

Datasets & Measures

These analyses relied on several datasets, described below. The wide range of included datasets was partly because particular datasets only have some of the items of interest in this analysis. It was also to see which patterns emerge across multiple analyses of data collected at different points in time. These analyses also used data that many of the previous studies that included deference to scientific authority relied on. Table IX lists the items of interest and the datasets they exist in. All are from surveys of nationally representative samples of U.S. adults.

Because of the variation in available items in each dataset, each set of analyses are organized by dataset and address particular questions of interest. As seen in Table IX, the analyses of the 2010 GfK data did not include dogmatism or general authoritarianism but provided data to test how well the existing deference items and participatory views items overlap, both in their inter-item correlations and factor loadings and in what antecedents predict them. The 2012 data provided data to test the deference items in their overlap with a small battery of dogmatism items as well as items that are not the original participatory views items, but that capture how much weight citizens and how much weight scientists should have in decision-making.

The 2014 dataset does not have participatory views items but was useful for additional analyses on the relationships between the existing deference items and dogmatism and general authoritarianism items. The 2014 data also offered insight into the extent to which the existing deference items could be capturing views of scientists as individuals versus as authorities. As described earlier, because of the wording of item D2, is it possible that respondents are responding to the item based at least partly on their views of what scientists as individuals should be able to do rather than of scientists as representatives of scientific knowledge. The 2014 dataset includes items capturing views of free speech, which can provide insight into how much D2 distinctly relates to views of the rights of individuals to speak their mind, or do what they think is right.

Table IX: Variables of interest available in each dataset.

	Dataset		
Variables	2010 KN	2012 GfK	2014 GfK
Education	**X**	**X**	**X**
Science education			
Science courses	---	**X**	**X**
Science degree	**X**	**X**	**X**
Dogmatism	---	**X**	**X**
Views on free speech	---	---	**X**
Deference			
Scientists know best (D1)	**X**	**X**	**X**
Scientists should do (D2)	**X**	**X**	**X**
Participatory views			
Public more important (P3)	**X**	---	---
Pay attn. to public (P4)	**X**	---	---
Other participatory items	---	**X**	---
Trust in scientists			
Trust in university scientists	---	**X**	**X**
Trust in industry scientists	---	**X**	**X**

2010 Knowledge Networks. The 2010 KN dataset is based on a nationally representative sample collected by Knowledge Networks from June to July 2010 on non-institutionalized U.S. adults, randomly sampled based on a probability-based web panel (N = 2,338; completion rate = 48.1% (AAPOR R6) (Callegaro & Disogra, 2008)).

2010 measures. The two deference items are D1 and D2 from Table VII: "Scientists know best what is good for the public" (*M* = 3.9; *SD* = 2.12) and, "Scientists should do what they think is best, even if they have to persuade people that it is right" (*M* = 4.9; *SD* = 2.41). The two participatory views items P3 & P4 from Table VII: "Scientists should pay attention to the wishes of the public, even if they think citizens are mistaken or do not understand their work" (*M* = 5.3; *SD* = 2.46) and, "Public opinion is more important than scientists' opinions when making decisions about scientific research" (*M* = 4.0; *SD* = 2.22). All four of these items are measured on a 10-point scale from 1 = "Do not agree at all" to 10 = "Agree very much."

For education, I included overall *education* and science-specific education, measured as whether or not a respondent has a *science degree* at the bachelor's level. Education is measured from one to four, with 1 = "Less than high school," 2 = "High school degree," 3 = "Some college," and 4 = "Bachelor's degree or higher" (median = 3; *SD* = 0.98). Science degree is a dichotomous variable, with 1 = "Has science degree" and 0 = "No science degree" (17.5% have science degree). The regression models also included *news attention*, which is a composite of two indices, one capturing attention to political news and one capturing attention to science news. Both are made of items captured on a 5-point scale from 0 = "None" to 10 = "A lot." Attention to political news is a composite of two items asking about attention to news on 1) "international affairs" and 2) "national government and politics," across online, newspapers, and television sources. Attention to science news is a composite of three items asking about attention to news on 1) “science and technology,” 2) “social or ethical implications of emerging technologies,” and 3) “scientific studies in new areas of research. . .” across the same three mediums. For both indexes, all the items were highly related (politics: Cronbach’s alpha = 0.90; science: Cronbach’s alpha = 0.93) and were averaged together to create each index. The two indexes were then averaged together to create a measure of total *news attention* for the regression models (Pearson’s R = 0.71; *M* = 2.6; *SD* = 0.85).

2012 GfK. The GfK 2012 dataset is based on a nationally representative sample collected by the GfK Group (formerly Knowledge Networks) from September 2012 to October 2012 on non-institutionalized U.S. adults, randomly sampled based on a probability-based web panel (n = 1,401; completion rate = 48.9%) (Callegaro & Disogra, 2008).

2012 measures. Similar to the previous dataset, the 2012 dataset includes deference items D1 and D2, this time measured on an 11-point scale from 0 = “Do not agree at all” to 10 = “Agree very much”: “Scientists know best what is good for the public” (*M* = 4.3; *SD* = 2.40) and, “Scientists should do what they think is best, even if they have to persuade people that it is right” (*M* = 5.1; *SD* = 2.69). None of the original participatory views items exist in the dataset, but items capturing views of how much scientists and citizens should be involved in decision-making are captured through two items measured on an 11-point scale, asking, “How much weight do you think each group should have when our society is faced with decisions about scientific issues?” (0 = “No weight at all” to 10 = “A lot of weight”). The two groups captured are how much weight scientists should have in such decision-making (*M* = 7.5; *SD* = 2.41) and how much weight average citizens should have (*M* = 6.8; *SD* = 2.53). These two groups are included to mirror the focus of the original battery of participatory views items listed in Table VII—namely, the respective roles of scientists and the public in decision-making on science.

In addition to the two deference items and two participatory views items, this analysis included measures of general authoritarian views and trust in scientists. *Trust in scientists* is captured through two variables, both measured on an 11-point scale from 1 = "Do not trust at all" to 11 = "Trust very much." Each asks, "which of the following sources of information. . . do you trust to tell the truth about the risks and benefits of technologies and their applications": 1) *trust in university scientists* (*M* = 7.1; *SD* = 2.40) and 2) *trust in industry scientists* (*M* = 6.0; *SD* = 2.47). For the regression analyses, I created an index using the mean of the two items (Pearson's R = 0.61; *M* = 6.6; *SD* = 2.18).

General authoritarian views are captured through four items adapted from Rokeach's dogmatism scale, which captures features of dogmatism, including authoritarian views (Rokeach, 1960). All are captured on an 11-point scale from 1 = "Do not agree at all" to 11 = "Agree very much." The four items are: 1) "The principles I believe in are quite different from those believed in by others" (*M* = 5.4; *SD* = 2.51), 2) "I often reserve my judgment until I have had the chance to hear the opinions of someone I respect" (*M* = 6.8; *SD* = 2.63), 3) "Most people just don't know what's good for them" (*M* = 5.5; *SD* = 2.78), and 4) "In the long run it is best to pick friends whose beliefs are the same as your own" (*M* = 4.8; *SD* = 2.70). The *general authoritarian* items had a low Cronbach's alpha (0.55) but were summed for the regression analysis.

Education is a continuous variable, asking respondents, "How many years of formal education have you completed?" (range: 0-27; *M* = 13.3; *SD* = 4.31). *Science degree* is a dichotomous variable, with 1 = “Has science degree” and 0 = “No science degree” (9.6% have science degree). *Science courses* is measured from zero to eight, with each number corresponding to the number of science courses a respondent took at the college level, with the exception of eight, which indicates “8 or more courses” (median = 1; *SD* = 2.80). The two science education variables are combined together for the regression analysis by dichotomizing each one so that having taken science courses = 1 and having a science degree = 2 and then summing the dichotomous variables and recoding so that “0” = 0, “1” = 1, and “2 and 3” = 2. The result is a *science education* composite variable where 0 = “no college-level science education,” 1 = “college-level science courses but not a science degree,” and 2 = “a science degree” (49.9%, 40.5%, and 9.6% of respondents, respectively).

News attention is again a composite of two indices capturing attention to political news and attention to science news. Both are made of items captured on a 5-point scale from 0 = “None” to 10 = “A lot.” Attention to political news is a composite of two items asking about attention to news on 1) “international and national affairs” and 2) “local government and politics,” across online, social media, newspapers, and television sources. Attention to science news is a composite of two items asking about attention to news on 1) “science and technology” and 2) “scientific studies in new areas of research” across the same four mediums. For both indexes, all the items were highly related (politics: Cronbach’s alpha = 0.85; science: Cronbach’s alpha = 0.90) and were averaged together to create each index. The two indexes were then averaged together to create the *news attention* variable (Pearson’s R = 0.74; *M* = 2.5; *SD* = 0.79).

2014 GfK. The 2014 dataset was collected in July 2014 by the GfK Group. Of the 6,537 members of a pre-recruited GfK panel who qualified for the survey, 3,748 completed the screener survey (57 percent) and 3,145 of those participated in the survey and were considered valid cases (48 percent). The respondents were sorted into four conditions, each focused on a different science issue: fracking, synthetic biology, nanotechnology, and climate change. Respondents also were sorted into experimental conditions, for a study not related to this one. I controlled for the potential effects of the experimental conditions on the deference items that followed the experimental exposure by saving the residuals of each item in the model after running an ordinary least squares (OLS) regression that assessed the relationship between the experimental conditions and the variable of interest. The analysis uses those saved residuals.

2014 measures. Analyses of the GfK dataset include the same two deference items captured in the 2010 and 2012 datasets. They are both measured on an 11-point scale from 0 = "Do not agree at all" to 10 = "Agree very much" and are residuals after controlling for the experimental conditions that respondents were exposed to before answering the items (D1: *SD* = 2.70; D2: *SD* = 2.92). *Trust in scientists* is captured with the same two items as in the 2012 dataset, both measured on an 11-point scale from 0 = "Do not trust at all" to 10 = "Trust very much," also both residuals after controlling for the experimental conditions. They each ask respondents, "how much. . .[do] you trust the following information sources when it comes to public controversies about scientific issues": 1) *trust in university scientists* (*SD* = 2.69) and 2) *trust in industry scientists* (*SD* = 2.64). For the regression analyses, the two are averaged to create the index *trust in scientists* (Pearson's R = 0.57).

General authoritarian views are captured through four items capturing authoritarian beliefs (Altemeyer, 1996; Rokeach, 1960). All are captured on an 11-point scale from 0 = "Do not agree at all" to 10 = "Agree very much." The items are: 1) "It is dangerous to compromise with our political opponents because it usually leads to the betrayal of our own side" (*M* = 3.5; *SD* = 2.84), 2) "Changing one's mind is a sign of weakness" (*M* = 1.8; *SD* = 2.39), 3) "I tend to classify people as either for me or against me" (*M* = 2.8; *SD* = 2.85), and 4) "Even though freedom of speech for all groups is a worthwhile goal, it is unfortunately necessary to restrict the freedom of certain groups" (*M* = 3.3; *SD* = 3.11). The first and fourth item of the *authoritarian* items also come from Rokeach's dogmatism scale (1960). All four items were averaged together for the regression analysis to create a composite authoritarianism variable (Cronbach's = 0.67; *M* = 2.8; *SD* = 1.99).

Two *free speech* items are also included from this dataset, captured on the same 11-point scale as the authoritarian items described above. The items are: 1) "No matter how controversial an idea is, an individual should be able to express it publicly" (*M* = 6.4; *SD* = 3.08), 2) "Everybody should have complete freedom to propagandize for what they believe to be true" (*M* = 5.3; *SD* = 3.17). The two are combined for the regression analyses by averaging responses (Pearson's R = 0.53; *M* = 5.8; *SD* = 2.73).

The index of *news attention* is again a composite of two indexes, one capturing attention to political news and one capturing attention to science news. Both are made of items captured on a 11-point scale from 0 = "None" to 10 = "A lot." *Attention to political news* is a composite of two items asking about attention to news on 1) "international affairs" and 2) "national government and politics," across online, newspapers, and television sources. *Attention to science news* is a composite of three items asking about attention to news on 1) "science and technology," 2) "political or ethical implications of emerging technologies," and 3) "new scientific developments. . ." across the same three mediums. For both indexes, all the items were highly related (politics: Cronbach's alpha = 0.92; science: Cronbach's alpha = 0.94) and were averaged together to create each index. To address multi-collinearity between the two indexes, the two were then averaged together to create a measure of total *news attention* for the regression models (Pearson's R = 0.82; *M* = 3.9; *SD* = 2.57).

Education is captured on a scale from zero to five, with 0 = "No high school," 1 = "Some high school," 2 = "High school degree," 3 = "Some college or associates," 4 = "Bachelor's degree," and 5 = "Graduate school" (median = 3; *SD* = 1.24). *Science degree* is a dichotomous variable, with 1 = "Has science degree" and 0 = "No science degree" (10.4% have science degree). *Science courses* is measured from zero to eight, with each number corresponding to the number of science courses a respondent took at the college level, with the exception of eight, which indicates "8 or more courses" (median = 1; *SD* = 2.87). The two science education variables were combined for the regression analyses in the same way described for the 2012 dataset items, where the resulting composite *science education* variable values are 0 = "no college-level science education," 1 = "college-level science courses but not a science degree," and 2 = "a science degree" (49.7%, 40%, and 10.4% of respondents, respectively).

Finally, in addition to the education variables, the regression models included *age* and *gender* as controls. In all the datasets, *age* captured how old a respondent is in years (2010: *M* = 47.3; *SD* = 16.31; 2012: *M* = 46.5; *SD* = 17.25; 2014: *M* = 46.7; *SD* = 17.33). *Gender* is a dichotomous variable, with "female" = 1 and "male" = 0 (2010: 50.6% female; 2012 GfK: 52.4% female; 2014 GfK: 51.8% female).

Results

The results illustrate that in some ways the deference items behaved as expected. They overlapped with but were distinct from participatory views and dogmatic beliefs, and they often related to education in general and science education in particular. Differences in how well these relationships emerged across the deference items and across the datasets also suggest that the items are not cleanly measured or easily interpretable and that they could be capturing different concepts. Even if both still capture aspects of deference to scientific authority, the results here indicate that lack of precision muddies their interpretability within items and their cohesion across the concept. Results by dataset are described below.

Most of the results addressed the broad Research Question 1, exploring the similarities and differences between the two existing, commonly used deference items to assess how well the two items relate to each other and appear to capture the same concept of deference to scientific authority. The analysis of the 2010 data assessed Hypothesis 2, on the relationships between the deference items and the participatory views items and whether they emerge as distinct but related concepts. The analysis of the 2014 data took a more fine-grained look at Research Question 1 by also examining the related Hypotheses 1a and 1b, concerned with whether item D2 in particular is capturing views of scientists as individuals rather than as scientists as representatives of science.

Overall, the results supported H1a and 1b, weakly supported H2, and revealed that the deference items appeared to relate to education, general authoritarianism, and anti-participatory views for science in particular. These relationships, however, varied from dataset to dataset. Some consistent differences revealed potentially key distinctions between the deference items that could suggest caution in how we interpret them separately and together as representing deference to scientific authority.

2010 KN Data: Deference and Participatory Views

Analysis of the 2010 dataset focused on deference items D1 and D2 and how they relate to and compare with participatory views items P3 and P4. The two deference items had a Pearson's correlation of 0.50, which is lower than in all the other datasets included in this dissertation. The participatory views items had a correlation of 0.48. The deference and participatory views items did load on different but correlated factors, but only for one of the three factor analyses. The maximum likelihood EFA model did not converge on a solution, ending up with negative degrees of freedoms, which suggests that single items were loading on their own factors. When I ran the same model using principal axis factoring (PAF) exploratory analysis two factors did emerge (Table X), providing some support for Hypothesis 2, that deference and participatory views would be distinct but related factors.

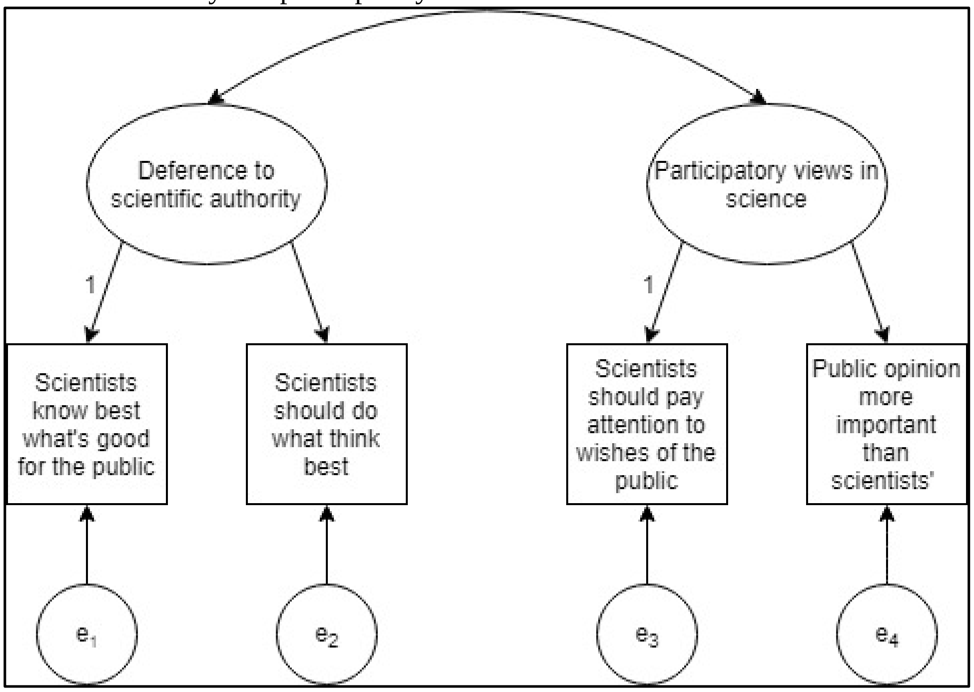
When I tried to replicate the results of the PAF exploratory factor analysis with a confirmatory factor analysis on a different sample of half of responses, the model failed to converge (proposed model in Figure I). Even after increasing the number of maximum iterations from 50 to 100 and then, when that also failed to converge, allowing the analysis to fit unspecified models, no model converged. Ideally, there should be three items per factor for analysis (Fabrigar & Wegener, 2012; Kline, 2005), so the few items available for these analyses is a limitation. These EFA and CFA results, however, combined with the correlation tables and regression models, described below (Table XI), suggest that the existing commonly used deference and participatory views items did not cleanly load onto common factors, providing only weak and inconsistent evidence for Hypothesis 2.

Table X: Exploratory factor analysis factor loadings of the deference and participatory views items. 2010 Knowledge Networks dataset; principal axis factoring with Promax rotation.

Pattern matrix[a] (Structure matrix loadings in parentheses) *Item*	**Factor Loadings**	
	Factor 1	***Factor 2***
Scientists know best what is good for the public (D1)	**0.721** (*0.711*)	0.088 (*0.000*)
Scientists should do what they think is best, even if they have to convince others that it is right (D2)	**0.712** (*0.723*)	-0.090 (-*0.177*)
Public opinion is more important than scientists' opinion when making decisions about scientific research (P3)	-0.033 (-*0.116*)	**0.676** (*0.680*)
Scientists should pay attention to the wishes of the public, even if they think they are mistaken (P4)	0.037 (-*0.046*)	**0.684** (*0.680*)
Eigenvalue (initial values in parentheses)	(*1.61*) 1.11	(*1.38*) 0.86
Cumulative % of variance	27.8	49.3
[a]Rotation converged in 3 iterations		
Factor correlation matrix	***Factor 1***	***Factor 2***
Factor 1	---	-0.122

Final betas for each of the four regression analysis—predicting D1, D2, P3, and P4—are listed in Table XI. As illustrated there, the deference items had similar relationships to predictors such as education, science education, and news attention but differed in their relationships to demographics and to the participatory views items. Higher levels of education in general and science education in particular, along with higher levels of attention to news, predicted higher agreement with both of the deference items. Only D2, however, was significantly related to either of the participatory views items.

Figure I: Proposed model for confirmatory factor analysis of deference to scientific authority and participatory views items.



Both participatory views items had similar relationships to their independent variables (Table XI). Interestingly, although both were negatively related to education, neither were related to science education. This result, combined with science education's significant relationship to the deference items, suggests that although science education predicted agreement with the deference items, it did not do so to the extent of also necessarily predicting more negative views about the role of the public in relation to scientists in decision-making on science. Overall, however, as seen in the total adjusted R-squared in Table XI, the models explained extremely little of the variance in the dependent variables. In the case of P4, they explained almost nothing. Complete models for each OLS regression analysis, with all upon-entry betas, are listed in the Appendix (Tables AII-AV).

Table XI: OLS regression results predicting deference to scientific authority and participatory views items. 2010 Knowledge Networks dataset.

	Standardized betas			
	Scientists know best (D1)	*Scientists should do (D2)*	*Public opinion (P3)*	*Pay attn. to public (P4)*
Age	-0.11***	-0.06**	-0.05**	0.02
Gender (female)	0.00	-0.07***	0.00	0.02
Education	-0.01	0.08***	-0.12***	-0.07**
Adjusted R^2 (%)	*1.4****	*4.8****	*2.4****	*0.4**
Science education	0.10***	0.09***	-0.02	0.00
Adjusted R^2 (%)	*1.0****	*1.0****	*0.0*	*0.0*
News attention	0.12***	0.19***	-0.03	0.05*
Adjusted R^2 (%)	*1.2****	*3.2****	*0.1**	*0.0*
Deference (*D1 & D2 averaged*)	-------	-------	-0.08***	-0.05*
Adjusted R^2 (%)			*0.6****	*0.2**
†Public opinion more important (*P3*)	-0.01	-0.114***	-------	-------
†Scientists should pay attention to public (*P4*)	0.00	-0.080***		
Adjusted R^2 (%)	*0.0*	*1.3****		
Total adjusted R^2 (%)	**3.7**	**10.3**	**3.1**	**0.6**
Sample size (N)	2288	2286	2301	2304

†Before-entry coefficients. *p≤0.05; **p≤0.01; ***p≤0.001.

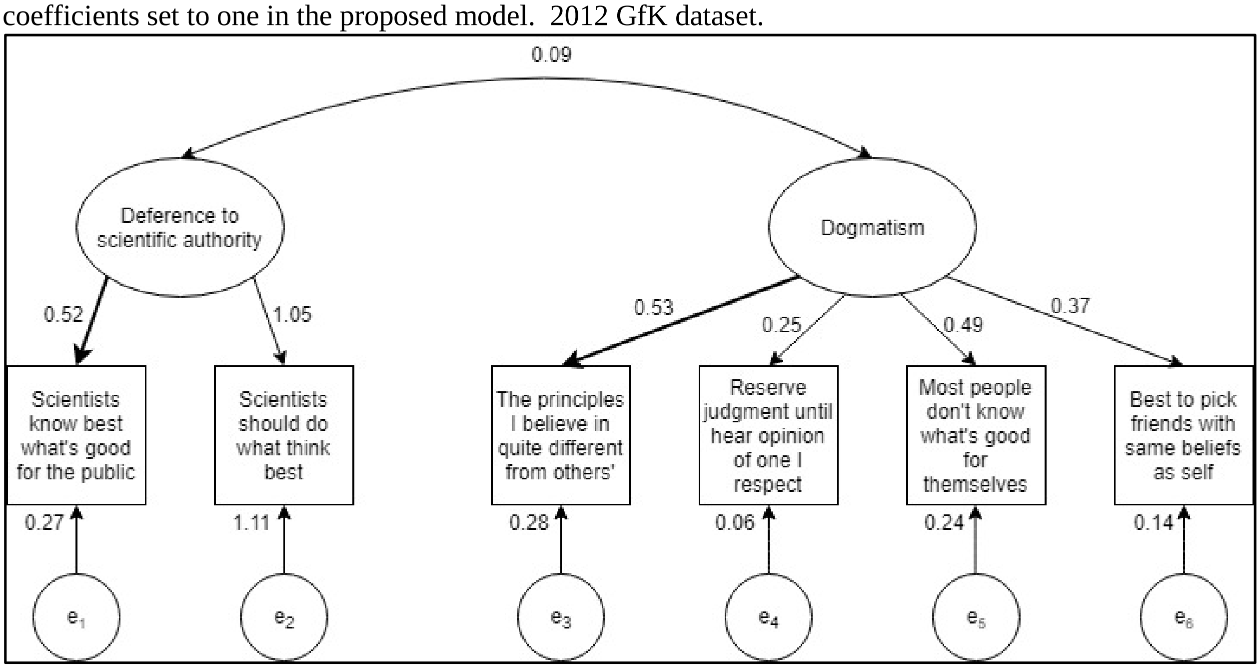
2012 GfK Data: Deference, Dogmatism, and the Role of Citizens in Decision-making

The 2012 dataset provided the first opportunity to assess how deference relates to dogmatic tendencies. As seen in the correlations in Appendix Table VI, D1 and D2 had a Pearson's correlation of 0.56, higher than they had in the 2010 data. Although the participatory views items did not exist in this dataset, an item asking how much weight citizens should have in decisions around science issues provided an alternative way to assess similar views, alongside an item asking how much weight scientists should have in those decisions. As seen in Appendix Table VI, both deference items positively related to believing that scientists should have weight in decision-making, but only D1 out of the deference items related to views of how much weight citizens should have—negatively predicting assigning citizens much weight.

The dogmatism items had varying degrees of relationships to each of the deference items, and, as seen in the results of the maximum likelihood EFA, they did not load cleanly onto a single factor (Table AVII). A PAF exploratory model confirmed the results of the ML model illustrated in Appendix Table AVII. Overall, both EFA models indicated that, broadly, the deference items loaded on a single factor, the two items focused more explicitly on decision-making—weight of scientists and weight of citizens—loaded on a factor, and half of the dogmatism items loaded on a factor, with the other two more spread across all or two factors (Table AVII). Based on these results, I ran a CFA testing the deference items, the decision-making items, and the dogmatism items as loading on their own but correlated factors. The model failed to converge after 100 iterations. After removing the weight of scientists item—in case it was loading more heavily on several factors—I reran the model and allowed it to also test unidentified models. The model still failed to converge, so I removed the weight of citizen input item and tested just the relationship between the deference and the dogmatism items to at least test how they related to each other, the results of which are illustrated in Figure II below.

The CFA provided only limited information on the relationship between the deference to scientific authority and dogmatism items. We see that the two factors had a weak but positive relationship. We also see, however, that the model had an ultra-Heywood case, with unrealistic coefficients for D2— "Scientists should do what they think is best"—where the coefficient exceeded 1. This means that result is largely uninterpretable and suggests caution in interpreting the results of the model overall (Kline, 2005). The goodness-of-fit statistics, however, mostly supported an acceptable model fit. The chi-square test was non-significant, and the CFI and TLI were both above the cut-off of 0.90 and 0.95, respectively. The RMSEA was under the cut off of 0.05 for good fit. The RMR, however, was well above the cut-off of 0.06 (χ^2 = 9.153, df = 8, p = 0.33; CFI = 0.994; TLI = 0.989; RMR = 0.229; RMSEA = 0.019) (Kline, 2005; Schreiber, Stage, King, Nora, & Barlow, 2006). Given the Heywood case, however, and the overall weak and inconsistent relationships between the dogmatism items themselves and how they relate to the deference items, as seen in the correlation table (Table AVI) and the EFA models (Table AVII), a safer conclusion is that deference did appear to relate to some aspects of dogmatism captured by the items in this dataset, but that overall the dogmatism items had too poor of inter-item reliability, perhaps partly due to measurement error, to cleanly extend the results to claims about any underlying concepts.

Figure II: Confirmatory factor analysis of deference to scientific authority items and items from Rokeach's dogmatism scale. Standardized regression coefficients. Bold arrow indicates that regression coefficient in proposed model was set to 1. e indicates error terms, all of which had regression coefficients set to one in the proposed model. 2012 GfK dataset.



The regression analyses further supported these general take-aways for interpreting the items, as seen in the combined results table (Table XII) below (complete regression tables separated for each dependent variable are listed in the Appendix: Tables AXIII—AX). In contrast to the results from the 2010 data, education and science education related only to D2 and not to D1 (Table XII). Education was significant for the D2 analysis until science education

Table XII: OLS regression results predicting deference to scientific authority items and views of citizens' involvement in decision-making on science issues. 2012 GfK dataset.

	Standardized betas		
	Scientists know best (D1)	*Scientists should do (D2)*	*Weight of citizens*
Age	-0.02	-0.05	0.01
Gender (female)	-0.02	-0.03	-0.02
Education	0.01	-0.03	0.03
Adjusted R^2 (%)	*0.0*	*1.2****	*0.0*
Science education	-0.01	0.17***	-0.01
Adjusted R^2 (%)	*0.0*	*3.1****	*0.0*
News attention	-0.03	-0.01	0.01
Adjusted R^2 (%)	*0.0*	*0.3*	*0.0*
Dogmatism (*sum*)	0.27***	0.27***	0.16***
Adjusted R^2 (%)	*9.2****	*9.3****	*1.5****
Deference	----------	----------	-0.21***
Adjusted R^2 (%)			*1.8****
Trust in scientists	0.28***	0.25***	0.21***
Adjusted R^2 (%)	*5.6****	*4.6****	*3.6****
Wt. citizens	-0.18***	-0.13***	----------
Adjusted R^2 (%)	*3.1****	*2.5****	
Total adjusted R^2 (%)	**17.9**	**20.0**	**6.9**
Sample size (N)	772	772	776

*p≤0.05; **p≤0.01; ***p≤0.001

entered the model, suggesting that science education was the stronger predictor of believing that scientists should do what they think is best. Contrary to what would theoretically be expected based on the deference to scientific authority literature, however, education and science education in particular did not relate to believing that scientists know best (item D1).

We also see that the dogmatism items related to all the dependent variables, which is consistent with the inter-item correlations in Appendix Table VI. They shared a much larger portion of the variance with the two deference items (approximately 9 percent), however, than with the item capturing weight of citizens in decision-making (1.5 percent). Both of the deference items significantly predicted believing that citizens should not have much weight in decision-making. This is in contrast to the Pearson's correlations in Appendix Table VI that illustrated that only D1 predicted these more anti-democratic views. It appears that this relationship emerged between D2 and views of the weight of citizens after controlling for the other variables in the regression analysis. Based on the upon-entry coefficients, it appears that this change in significance occurred when the dogmatism items enter the model.

2014 GfK Data: Scientists as Authorities or as Individuals?

The 2014 dataset results offered a much cleaner measure of general authoritarian views and insight into how they positively related to both the deference items. As seen in the correlation table in the Appendix (Table AXI), the four items capturing more authoritarian or dogmatic tendencies all had high inter-item correlations and positively related to both the deference items. The deference items had a stronger relationship to each other than they did in either of the previous datasets examined in this chapter, with a Pearson's R of 0.69. Both the deference items also positively related to education and science education in particular, while the dogmatism items negatively related to the education variables. This dataset unfortunately did not have any items capturing participatory views. It did, however, have the two items capturing views of free speech. In the bivariate correlations, these items both positively related to the deference items but appeared to have a stronger relationship to D2 in particular, providing some initial support for H1a and 1b, which the regression analyses provided further evidence for.

Both an ML and a PAF exploratory factor analysis indicated three distinct but related factors (ML model displayed in Table AXII; PAF model confirmed ML results), which the CFA supported (Figure III). In the CFA, dogmatism or general authoritarianism positively related to deference. The model had two ultra-Heywood cases, however: one for item D1, and the other for one of the free speech items. Again, this suggests that the model was not appropriate and limits its interpretability. The model fit indicators also suggested an unacceptable fit (χ^2 = 207.79, df = 17, p = 0.000; CFI = 0.923; TLI = 0.873; RMR = 0.556; RMSEA = 0.086).

The regression results indicated some interesting similarities and distinctions between what predicted each of the deference items. As seen in Table XIII, dogmatic tendencies positively predicted both D1 and D2. They appeared to have half of the effect size, however, for predicting D2 and they did for D1. Additionally, as predicted by Hypothesis 1a, supporting free speech predicted believing that scientists should be do what they think is right, even if they have to persuade others that it is right (D2). Supporting Hypothesis 1b, this relationship did not exist between support for free speech and belief that scientists know best what is good for the public (D1). Science education predicted both items, but general education did not predict D2 once controlling for science education and switched to negatively relating to D1 once news attention entered the model.

Figure III: Confirmatory factor analysis of deference to scientific authority items, support for free speech, and dogmatism items. Standardized regression coefficients Bold arrow indicates that regression coefficient in proposed model was set to 1. "e" indicates error terms, all of which had regression coefficients set to one in the proposed model. GfK 2014 dataset.

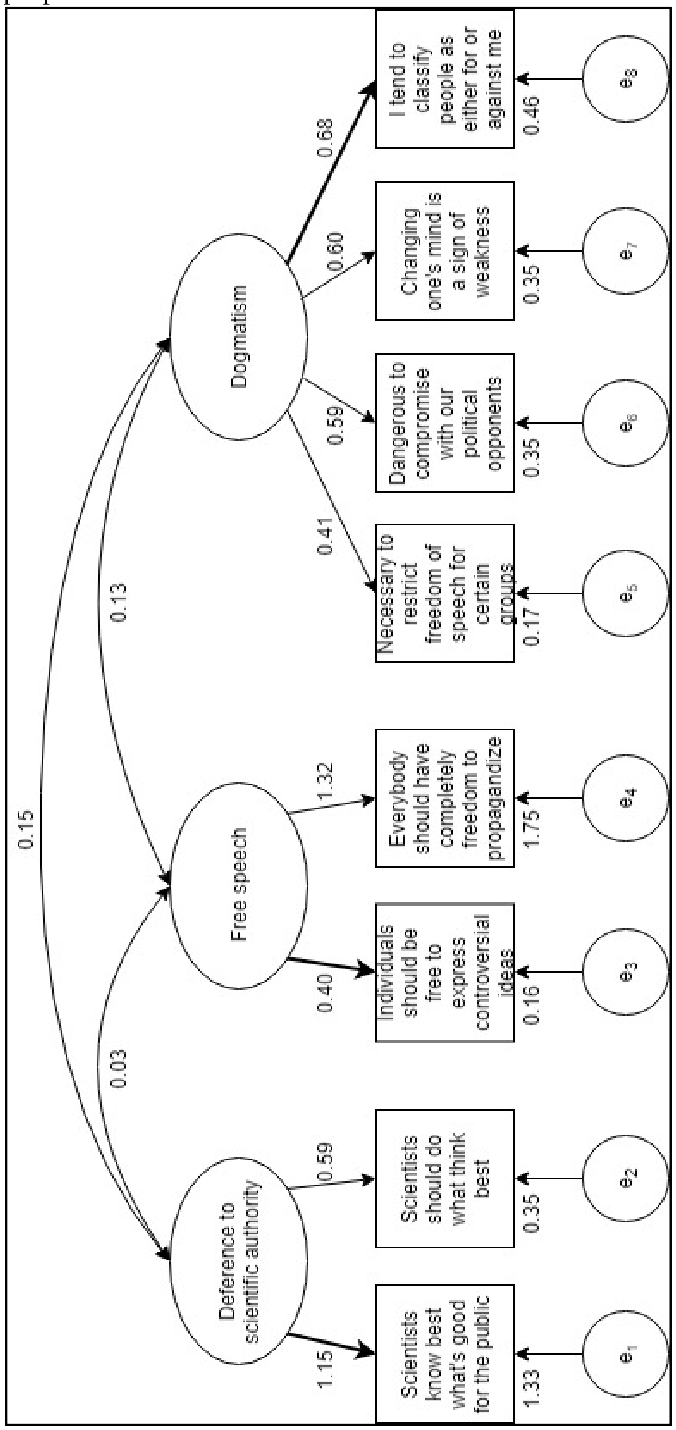


Table XIII: OLS regression results predicting deference to scientific authority items. 2014 GfK dataset.

	Standardized betas	
	Scientists know best (D1)	*Scientists should do (D2)*
Age	-0.08***	-0.01
Gender (female)	-0.01	-0.06***
Education	-0.07**	0.02
Adjusted R^2 (%)	*1.6****	*3.7****
Science education	0.08***	0.09***
Adjusted R^2 (%)	*0.6****	*0.8****
News attention	0.03	0.03
Adjusted R^2 (%)	*1.9****	*2.1****
Dogmatism	0.11***	0.05***
Adjusted R^2 (%)	*2.4****	*1.1****
Free speech	0.00	0.06***
Adjusted R^2 (%)	*0.3****	*1.3****
Trust in scientists	0.45***	0.46***
Adjusted R^2 (%)	*17.9****	*17.7****
Total adjusted R^2 (%)	**24.7**	**26.7**
Sample size (N)	3095	3088

*p≤0.05; **p≤0.01; ***p≤0.001

Discussion

Summarizing the literature review of different conceptualizations of deference and past definitions of deference to scientific authority with the results listed above, there are some key take-aways that we can draw for moving forward with a better understanding of what we currently do and do not capture of deference.

Deference & Participatory Views: An Incomplete Picture of Deference

Based on the original theoretical development of deference to scientific authority and its implications and the literature on political and judicial deference, the meaning analysis of deference suggests that the concept would be most completely captured, and in a way that matches intuitive and applied understandings of the concept, through an index of items that capture both views of scientists as having authority in science decisions (to capture respect for scientific expertise) and views of the extent to which scientists should make decisions in place of others (to capture deference as granting decision-making power in one's own place). Capturing this more complete picture of deference to scientific authority could be done by combining the original deference to scientific authority items and the participatory views items, which were originally developed to create an index of authoritarian views toward decision-making in science (Brossard, 2002).

As we saw with the analyses of the 2010 dataset, however, these items do not appear to be highly correlated and usually fail to load on to coherent factors. This appears to be due to low inter-item reliability between the items capturing each concept and the distinct relationships between pairs of items across the concepts. These results could be an artifact of the particular dataset. It could also be due to the original batteries of four deference items and four participatory views items being reduced down to two items to capture each concept. Given the broadness of the potential definitions of each concept, two items are unlikely to capture a full view.

Additionally, as we saw with the principal components analysis from Brossard (2002), it appears that even among the original eight items, there were inconsistencies in how well each relates to its theoretically similar items. This is perhaps exacerbated in the analysis of the 2010 dataset not only because the items have been reduced to only four, but because, as described earlier, those four also happen to be the ones that in the original 2002 analysis did not hold together well. As seen in Table VIII, belief that scientists should pay attention to the wishes of the public loaded on its own factor in the 2002 analysis and the two deference items had opposite relationships to the factor capturing participatory views. We found a similarly messy picture in the analysis of the 2010 data here. Only one of the deference items (D2) significantly, and negatively, related to the participatory views items in the regression analyses, which interestingly is the opposite of what Brossard's (2002) analysis found where D2 positively related to the participatory views factor while D1 negatively related to it.

Differences in the results between Brossard's (2002) analyses and the ones described here could be partly due to the differences in the analyses. As described earlier, Brossard (2002) used principal components analysis, which does not separate out common variance from unique variance, and a Varimax rotation, which assumes orthogonal relationships between the factors. I used factor analyses, which focus on the common variance separate from each item's unique variance, and used a Promax rotation, which starts out as a Varimax orthogonal rotation and then applies an oblique rotation that allows the factors to correlate if that appears to fit the data better (Fabrigar & Wegener, 2012). Although I made these analyses decisions based on recommendations as the field of factor analyses and dimension reduction has advanced over the past decades, they could explain part of why my models failed to converge compared to Brossard's (2002). It is very likely, however, that a larger contributor to the lack of convergence was the few items available, as I describe above, and the fact that the available items were also those that Brossard (2002) found were more distinct from each other. These items could have been loading onto their own factors, which would cause too many factors to emerge for the number of items, lowering the degrees of freedom and likely contributing to the ultra-Heywood cases.

Altogether, the regression models gave very little to almost no predictive power of responses to the deference or participatory views items, which also makes it difficult to determine what exactly the items capture. This also indicates that we are missing a big part of the picture in terms of where these beliefs come from, as well as the possibility that there are high levels of measurement error in the items that make it difficult to detect any real covariation in theoretically related concepts. The results suggest that although theoretically it could be beneficial to capture dimensions of deference as respect and deference as resulting in granting decision-making power, the existing deference items and participatory views items do not do that, at least without supplementing them with new items and editing the existing ones.

Deference & Dogmatism: Beyond Respect and Toward Anti-Democratic Beliefs

The results did provide some insight into the extent to which each of the deference items overlap with more general authoritarian tendencies beyond science contexts. As the results of the 2012 data illustrated, factor analysis suggests that the deference items do load onto a single factor, which is positively related to dogmatism. The dogmatism items in that dataset had low reliability, however, and seemed to relate to most items, as illustrated in the correlation table in the Appendix (Table AVI). This could be due to the fact that these items are only four pulled from the originally 60-item long scale capturing traits of dogmatic thinking (Rokeach, 1960).

As will be described in greater detail in Chapter 4, Rokeach (1960) developed those items to capture many sub-dimensions of three broader proposed dimensions representing the structural nature of dogmatic thinking. Of the four dogmatism items in the 2012 dataset, only two ("I often reserve judgment. . ." and "It is best to pick friends whose beliefs are the same. . .") are from the same dimension, which could partly explain the low inter-item reliability. Additionally, as mentioned previously, the low reliability could be indicative of greater issues with Rokeach's dogmatism scale overall, as Altemeyer has pointed out (Altemeyer, 1996). These include poor reproducibility across different studies and item wording that is all in the same direction (positive = more dogmatic) (Altemeyer, 1996). The latter issue could result in falsely boosting apparent inter-item reliability but could also result in the items being more likely to have positive correlations with any other items because of peoples' general tendencies to have a positive bias when answering survey questions (Altemeyer, 1996). This bias could have been further exacerbated in this case because people with more authoritarian personalities tend to have even stronger positive biases when responding to surveys, which can make it difficult to capture valid inter-item relationships (Altemeyer, 1996).

Fortunately, however, the 2014 dataset appears to offer a more reliable set of items capturing general dogmatic or authoritarian tendencies. From those analyses we see further support that the existing deference items do positively relate to authoritarian tendencies. This appears to particularly be the case for the item capturing belief that scientists know best what is good for the public (D1), which at face value seems to be the more extreme and therefore potentially more authoritarian of the deference items. This distinction could also indicate that item D1 is better capturing deference to scientific authority as the concept is typically conceptualized. We see further support for this in how item D2 appears to relate more strongly to support for free speech and in the inconsistencies between the two deference items in how they relate to the education items.

As Hypotheses 1a & 1b tested, it is possible that responses to item D2 are capturing not only deference to scientific authority but also views of scientists as individuals and, therefore, views of the rights of individuals to do what they think is best. That this item significantly relates to support for freedom of speech for all groups and individuals, while the deference item D1—scientists know best—did not, suggests that for a substantial portion of people, their response to D2 could be representing deference, as in respect, for the rights of individuals and not deference to scientific authority. Additionally, that the two deference items appear to have sometimes distinct relationships to education in general and science education in particular could provide further evidence of different underlying antecedents for each deference item. This could indicate that they are not purely capturing the same concept. The results from the 2012 dataset indicated that only D2 related to either general education or science education, while D1 had no relationship to either. This is contrary to previous literature that found a significant relationship between deference overall (as a composite variable) and general education and theorized that information about science passed down through public education in particular could explain the development of deferent beliefs toward science and scientists (Anderson et al., 2012; Brossard & Nisbet, 2007). The results from the 2014 dataset found that science education did significantly relate to both deference items, but they had distinct relationships to general education, with D1 having a negative relationship once controlling for science education and D2 having no relationship.

These results on their own are not damning for future use of the existing deference to scientific authority items. Again, these distinctions across the items could be indicators that they capture different levels of deference to scientific authority. In combination with the other results and the meaning examination of the concept of deference, however, these results could also indicate that together the items are not cleanly capturing deference to scientific authority as the literature typically conceptualizes it. This question will be further examined in Chapter 4, as well, with further analyses of the similarities and distinctions between how concepts such as education and general authoritarianism empirically relate to each of the deference items. Additionally, because analyses of these comparisons were somewhat hampered by the few general authoritarian items available in these datasets and their apparent low inter-item reliability, the next chapter includes analysis of new data collections with larger batteries of items from the dogmatism and authoritarian scales (Altemeyer, 1996; Rokeach, 1960). Overall, however, the analyses here suggest that while the existing items do capture authoritarian tendencies as predicted, they do not appear to cleanly or sufficiently capture deference to scientific authority as it is often defined and applied in the literature.

Conclusion

The results here suggest that the deference items and participatory views items that have lasted through most of the literature on these concepts for capturing authoritarian views of decision-making in science contexts are not be sufficient on their own for capturing complete and interpretable versions of their theoretical concepts. Additionally, we saw several points of evidence that the items within each concept could have substantial ambiguity in their interpretability and be capturing distinct concepts, even if overlapping with parts of their theoretical concepts. That the deference items do not both relate to the participatory views items, for example, could be evidence of difference in strength between the amount of deference D1 captures compared to D2. This also could add evidence of poor measurement of the underlying concept. The result would be that we are currently capturing an incomplete and ambiguous, and often inconsistent as a result, picture of deference with these two items.

Because neither of the later surveys examined here included the participatory views items, I mostly am relying on a one-time analysis of the 2010 dataset—in concert with interpretation of Brossard's (2002) principal components analysis—to judge the sufficiency of using just those items. That said, however, we see evidence from the 2012 and 2014 datasets as well that the deference items might be capturing different concepts even if they also partially capturing a shared idea related to deference. Examination of the item wordings both in this chapter and in the previous analyses in Chapter 2 highlighted ambiguity and potential conceptual overlap in wording of the existing items. As described in Chapter 2, the participatory views items do not specify a decision-making context. Additionally, as described in the review in this chapter and supported by the empirical analyses here, the deference items capture views of the role of "scientists" and not necessarily the authority of science or what scientists as representative of science know or ought to do. Item D2 in particular appears to be at least partly capturing views of the rights of individuals rather than of scientists in their roles as authorities on science issues.

We did consistently see, however, that the deference to scientific authority items—with whatever else they might be capturing—do relate to authoritarian tendencies, both in predicting less support for citizen or public involvement in decision-making on science (as seen in Chapter 2 and these results) and in positively relating to dogmatic or general authoritarian beliefs and tendencies. The next chapter will build on these analyses by introducing two additional concepts that until this dissertation had not been examined alongside deference to scientific authority:

belief in the authority of science and epistemic beliefs. It will examine the two deference items alongside these and larger batteries of general authoritarian or dogmatic items to better understand the reliability and validity of each of the deference to scientific authority items. Through these analyses, we can start to see how much the existing items capture not just views of scientists but how these views stem from greater beliefs about the nature of scientific knowledge and its authority.

Chapter 4. What is the Authority of Science? Views of Science and the Nature of Knowledge

Introduction

So far the analyses indicate that deference to scientific authority does appear to be a version of authoritarianism, as seen through its empirical overlap with items capturing dogmatism or general authoritarianism in the analyses in Chapter 3 and in how it predicts being less likely to believe that the public or citizens should have a role in deciding on the applications of science, as the analyses in Chapter 2 indicated. The results so far also indicate that although deference to scientific authority theoretically stems from and is empirically highly related to belief in the authority of science, it is distinct in how it predicts anti-democratic views of the roles of citizens, while just believing in science as authoritative actually predicted more democratic views. Here, I examine belief in the authority of science and deference to scientific authority more closely to better understand how they relate to each other and what makes some individuals, out of all of those who see science as authoritative knowledge, become authoritarian in their views of who should be involved in decision-making around science.

This examination has two parts. The first examines the belief in the authority of science items and the deference items through regression analyses to understand what theoretical antecedents and related concepts predict each, using the 2016 dataset examined in Chapter 2. The second part then analyzes a dataset that I designed to better elucidate the distinctions between the deference items and the belief in the authority of science items by including larger batteries of items capturing dogmatism and batteries of items capturing epistemic beliefs in general and as they relate to science in particular. Together, the analyses in the two parts illustrate where belief in the authority of science might stem from and in what ways deference to scientific authority overlaps with belief in the authority of science but is distinct in how it can emerge as an authoritarian tendency.

The Authority of Science

As described in the introduction and Chapter 2, deference to scientific authority theoretically stems from ideas attached to the cultural authority of science, which is the authority that scientific knowledge has from being seen as both privileged truth and an institution should be publicly supported and kept separate from political and social influence (Anderson et al., 2012; Bauer et al., 2018). Prior to the analyses in Chapter 2, however, deference to scientific authority had never been examined alongside items capturing beliefs in the authority of science. In fact, very few studies even have measures that at face value more directly capture views related to the authority of science. As described in Chapter 2, most empirical studies of the cultural authority of science focus primarily on trust in scientists, even while acknowledging that trust is likely only one indicator of science's cultural authority (see, for examples, *The cultural authority of science: Comparing across Europe, Asia, Africa and the Americas*, 2018).

To address this gap and better understand how deference to scientific authority relates to belief in the authority of science, for the 2016 dataset I created the two items capturing views of at least one aspect of science's authority: the perception that it provides the best and most reliable forms of knowledge about the world. These items ask about the extent to which one agrees that "science is the best way to understand the world" and is "the best way to produce reliable knowledge"—two overlapping perceived features of science's value that differ slightly in "extremity" in terms of what they claim that science offers. They are distinct from the existing items that have stood for proxies of the cultural authority of science in that they place a relative weight on science: that it is not only objective, but that it is therefore better than other ways of knowing. This gets more explicitly at science's authority compared to other ways of knowing the world. This comparison seems key to capturing the authority of science, and literature discussing whether the culture authority of science is waning or waxing use as a reference point the standing of science compared to non-scientific knowledge (see, for example, Bauer et al., 2018).

Deference to scientific authority versus authority of science. The two authority of science items described above are new and had not been systematically examined beyond the analyses in Chapter 2. This chapter further tests and develops them by focusing on what these beliefs in the authority of science relate to and how they differ from deference to scientific authority, beyond how each concept relates to views of who should be involved in decision-making on science issues. This analysis also continues the work of Chapter 3 in assessing how well the pairs of items—the two deference items and the two belief in the authority of science items—seem to reliably and validly capture the same concepts, respectively.

As mentioned above, the first part of the analyses here uses the 2016 dataset to see how variables such as demographics and trust distinctly relate to the deference to scientific authority items and the authority of science items. The second and main part of this chapter then replicates the regression analyses from the 2016 data with new data from a 2018 online survey that included larger batteries of dogmatism items. As we saw in Chapter 3, there are theoretical and empirical reasons to believe that deference to scientific authority relates to dogmatic, or general authoritarian, tendencies. We saw that, even with limited batteries of dogmatism items and low inter-item reliability of the dogmatism items, deference did appear to relate to dogmatic tendencies. Here, I use larger and hopefully more reliable measures of dogmatism to assess how deference could be distinct from belief in the authority of science because of how it overlaps with more general authoritarian tendencies.

Authority of science versus epistemic beliefs. Additionally, these analyses assess how belief in the authority of science can be better understood by how they relate to general and science-specific epistemic beliefs. Conceptually, the belief in the authority of science items likely overlap with, but should be distinct from, broader views about knowledge and knowing, which are the focus of research on epistemic beliefs. Epistemic beliefs, as described briefly in the introductory chapter, capture beliefs about the nature of knowledge (e.g., whether truth is absolute or relative and complex or simple) as well as beliefs about the nature of knowing (who has access to knowledge and through what ways) (Bromme, Pieschl, & Stahl, 2010; Hofer & Pintrich, 1997; Kienhues & Bromme, 2012).

The literature on epistemic beliefs suffers from lack of reliable scales and disagreement on what dimensions constitute epistemic beliefs (DeBacker et al., 2008; Greene & Yu, 2014; Schraw, 2013). It is also another area, similar to political deference, in which studies using the term sometimes do so in a more vernacular sense, not aligned with the technical definition of the larger body of literature on the concept (see, as an example, Garrett & Weeks, 2017). There is also on-going discussion of whether epistemic beliefs must be domain- and context-specific (for example, epistemic beliefs about math versus about history) or can be captured as general beliefs that cut across learning contexts (DeBacker et al., 2008; Hofer, 2006; Kienhues & Bromme, 2012; Kienhues, Bromme, & Stahl, 2008; Schraw, 2013).

For the most part, however, studies on epistemic beliefs typically sort belief types onto a spectrum from “naïve” to “sophisticated” beliefs (Bromme et al., 2010; Greene & Yu, 2014; Hofer & Pintrich, 1997; Kienhues & Bromme, 2012; Kienhues et al., 2008; Schraw, 2013). On the naïve side are beliefs that knowledge is certain, absolute, simple, and unchanging and that it is accessible only through authorities, or comes from outside oneself (Bromme et al., 2010; Greene & Yu, 2014; Hofer & Pintrich, 1997; Schraw, 2013). As beliefs become more sophisticated, they incorporate greater understanding of knowledge as changing, complex, and context-dependent, as well beliefs that many different individuals can access different truths or be authorities on a particular type of knowledge (Bromme et al., 2010; Hofer & Pintrich, 1997; Kienhues et al., 2008; Schraw, 2013).

In many of these categorizations of epistemic beliefs, seeing knowledge as absolute is the most naïve, moving toward seeing knowledge as relative is a middle step (or series of steps), and finding a balance between the two extremes is the most sophisticated (Greene & Yu, 2014). Because classifying epistemic beliefs is not the primary focus of my research here, I will typically describe epistemic beliefs by whether they fall in a more absolute or more relative direction, rather than trying to ascribe a particular combination or balance of these beliefs to groups of individuals. For that reason, when I use the word “naïve,” it is to refer to epistemic beliefs that see knowledge as more simple and/or absolute. When I use the word “sophisticated” is to refer not to the balance of relative and absolute beliefs per se, but to seeing knowledge as more complex and/or less absolute.

Views of the authority of science likely relate to, and perhaps stem from, views about the nature of knowledge, particularly how those views apply to ideas about science and its ability to collect true information about the world. The belief in authority of science items are likely conceptually distinct from epistemic beliefs, however, in that they make a value judgment about science compared to other types of knowing about the world. In this sense, they go beyond epistemic beliefs to state that science (perhaps partly because of epistemic beliefs about the nature of knowledge and knowing) is the best way to reliably and truly know the world.

Research Questions and Hypotheses

The analyses of both the 2016 and 2018 datasets will provide answers to the broad research question of:

> RQ1: How are deference to scientific authority and belief in the authority of science distinct?

The goal of examining this question is partly to better understand the belief in the authority of science items and largely to better understand why, of all the people who see science as authoritative, only some defer to scientific authority to the point of becoming authoritarian in decision-making on science as it extends into societal applications and impacts.

In the analyses of the 2018 dataset, I will also test a more specific hypothesis and research question related to this broader research question. Based on the results of Chapters 2 and 3 and the theoretical background of the deference to scientific authority items, I expect that deference to scientific authority will again positively relate to dogmatic, general authoritarian tendencies:

> H1: Dogmatic tendencies will positively relate to higher levels deference to scientific authority.

I do not expect to see this relationship between dogmatism and belief in the authority of science.

Given the potential overlap of belief in the authority of science and epistemic beliefs, however, particularly as those beliefs relate to science, I am interested in exploring how in particular:

> RQ2: How do epistemic beliefs in general, and pertaining to science in particular, each relate to belief in the authority of science and to deference to scientific authority?

As described above, these analyses will be split into two parts. The first relies on the 2016 data to provide a first look at what predicts deference to scientific authority compared to what predicts belief in the authority of science. The second reproduces these comparisons but also expands them to examine how each set of items relates to epistemic beliefs and dogmatic tendencies. As in Chapter 3, all steps will include assessing how well the deference items and belief in the authority of science items appear to hold together to reliably capture their respective theoretical constructs.

Methods

Datasets & Measures

2016 YouGov dataset. This dataset is the first on which the *belief in the authority of science* items appeared. Descriptions of the two items as well as most of the other included items in these analyses are in the Methods section of Chapter 2. These include the same items capturing age, gender, general education, news attention, religiosity, and trust in scientists as in the models in Chapter 2. Two additional items not in the Chapter 2 analysis are the variables capturing whether respondents had a *science degree* or had taken *science courses* at the college level. Each of these is a dichotomous variable in this dataset, with 1 = “Yes” and 0 = “No” (*degree*: 13.7% yes; *courses*: 39.0% yes). For the regression analysis, to address multi-collinearity between the two, they were combined into a categorical variable: 0 = "Neither"; 1 = "Science courses but no degree"; 2 = "Science degree" (60.4%, 25.9%, 13.7% respectively).

2018 MTurk dataset. The Amazon Mechanical Turk dataset came from a survey of a convenience sample of U.S. adults (N = 1,055), captured in July 2018 through the survey platform Qualtrics and a sample pool provided by Amazon Mechanical Turk (MTurk), a service for connecting requesters to participants. Participants through MTurk tend to be younger and more educated than a representative U.S. sample (Sheehan & Pittman, 2016), and that was true of this sample, as well (52% have a bachelor's degree or higher; mean age = 37 years). The initial number of responses was 1,480 and the final number (1,055) is after filtering out responses that came from duplicate IP address or from IP addresses located outside of the U.S. and responses that fell under a minimum total response time cut-off of four minutes for the full survey. The high number of lost cases indicates the challenges of collecting and working with responses recruited through MTurk and highlights that these results are best interpreted as pilot data for future analyses to further explicate deference and views of the authority of science.

2018 measures. The survey included the deference items D1 (M = 3.3; SD = 1.00) and D2 (M = 3.6; SD = 1.02), on a 5-point scale from 1 = "Strongly disagree" to 5 = "Strongly agree." For the regression models in which deference to scientific authority was a predictor variable, D1 and D2 were averaged to create a composite deference measure (Pearson's R = 0.52). The authority of science items were the same two developed for the 2016 YouGov survey, both measured on a 5-point scale from 1 = "Strongly disagree" to 5 = "Strongly agree": 1) "Science is the best way that society has for producing reliable knowledge" (M = 4.1; SD = 0.97) and 2) "Science is the best way to understand the world" (M = 4.2; SD = 0.90). For the regression analyses in which belief in the authority of science was a predictor variable, the two items were averaged together to create a composite *authority of science* measure (Pearson's R = 0.73).

The *epistemic belief* variables were from a large battery of items asking respondents to indicate how much they agree with each statement, on a 5-point scale from 1 = "Strongly disagree" to 5 = "Strongly agree." Most came from batteries across the epistemic belief literature, and a few were adapted for this study. Each item and its source and mean and standard deviation are included in Table XIV. The dimensions are my own names for aspects of beliefs about knowledge and knowing that I expect the items to tap, adapted from the literature on epistemic beliefs, as described in the literature review. The items were left as individual items for the factor analyses. Composite variables made of these items and ones made from the dogmatism items for the regression analyses are based on the results of the factor analyses and described in the results section.

I also created two additional items that captured views of how to collect quality information in general and for decision-making in particular that did not have any mention of "science." These items I made to tap ideas that were similar to rationale for the importance of the scientific process or for democratic decision-making, and I created them partly to assess how responses might differ depending on whether explicit mention of science appeared in an item, to see if responses were partly a reaction to ideas attached to the word "science." These two items asked, on a 5-point scale from 1 = "Strongly disagree" to 5 = "Strongly agree," how much respondents agree that 1) "Testing and retesting our assumptions is the best way to find accurate information” (*M* = 4.3; *SD* = 0.78) and 2) “Collecting more information generally helps lead to better decisions” (*M* = 4.4; *SD* = 0.75).

Table XIV: Epistemic belief items wording, source, and descriptives. 2018 Amazon Mechanical Turk dataset.

Item	***Source***	***Dimension or type of belief***	***M (SD)***
Scientists can ultimately get to the truth	Schommer (1990)	Science specific	3.7 (0.92)
Truth is unchanging	Schommer (1990)	Static/dynamic	3.0 (1.24)
Today’s facts might be tomorrow’s fiction	Schommer (1990)	Static/dynamic	3.8 (1.03)
Truth is different things to different people	Adapted from Schraw et al. (2002)	Static/dynamic (Absolute/relative)	3.7 (1.17)
Absolute truth does not exist	Adapted from Schraw et al. (2002)	Static/dynamic (Absolute/relative)	2.7 (1.21)
The truth is often simple	Adapted from Schraw et al. (2002)	Simple/complex	3.4 (1.20)
Sometimes there are no right answers to life’s big problems	Schraw et al. (2002)	Simple/complex	3.8 (1.07)
The only thing that is certain is uncertainty itself	Schommer (1990)	Static/dynamic	3.7 (1.08)
If scientists try hard enough, they can find the answer to almost any question	Wood & Kardash (2002)/Schommer (1990)	Science specific	3.4 (1.08)
A sentence has little meaning unless you know the context in which it was spoken	Adapted from Wood & Kardash (2002)	Static/dynamic (Absolute/relative)	4.0 (0.89)
Most words have one clear meaning	Schommer (1990)	Simple/complex (Absolute/relative)	2.9 (1.15)
Someday scientific knowledge will present the true picture of the world	Bauer et al. (2000)	Science specific (Absolute/relative)	3.5 (1.05)

The *dogmatism* items came from Rokeach’s (1960) dogmatism scale (with one item from Altemeyer’s DOG (1996) scale), and respondents randomly were selected to receive one of two batteries of 10 of the items. Battery A included the four items present in the 2012 GfK dataset along with other items selected to capture a variety of the dimensions of dogmatism that Rokeach (1960) outlines, as described in more detail below. Battery A included an item from Altemeyer’s DOG scale (1996) that at face value seemed it could be relevant for examining deference to scientific authority as it relates to valuing (or not valuing) including a variety of voices in decision-making. Battery B included a reduced version of Rokeach's (1960) dogmatism scale that was one of the few validated reduced scales (Troldahl & Powell, 1965). The two versions of these batteries were developed to test which might be more effective for capturing dogmatism and its potential overlap with authoritarian views in science, because there is a lack of literature validating either the larger dogmatism scale or any reduced versions. All items were captured with the 5-point scale from 1 = "Strongly disagree" to 5 = "Strongly agree." The items in both batteries and their means and standard deviations are listed in Tables XV (battery A) and XVI (battery B). The dimensions and sub-dimensions are those proposed by Rokeach (1960) as composing a dogmatic, or "closed," mind.

Briefly, the three dimensions that Rokeach describes as defining a closed mind are 1) the organization of ideas within the belief and disbelief systems (the disbelief system made up of all views that are counter to one's own beliefs), 2) the content and structure of ideas from the central to the peripheral areas of each belief system, and 3) the time perspective of beliefs within the belief system (Rokeach, 1960). More closed, or dogmatic minds, will tend to have the following traits (described by sub-dimensions) within each dimension. For organization along the belief-disbelief systems, more dogmatic people should have a higher degree of differentiation within ideas in the belief system than within the disbelief system and a sufficiently high degree of isolation and narrowness within the belief system. The result of these two characteristics is that, for a highly dogmatic person, ideas outside of the belief system all seem very similar to each other and very different from one's own beliefs, and one can hold several contradictory beliefs in isolation from each other without having to synthesize them into a coherent picture of the world (Rokeach, 1960).

Table XV: Dogmatism (general authoritarianism) items wording and descriptives, for format A of the 2018 Amazon Mechanical Turk survey.

Battery A Items	**Dimension:** ***Sub-dimension:*** feature	***M (SD)***
It is only natural that a person has a better understanding of ideas he or she believes in than with ideas he or she opposes.	Belief-disbelief: *Degrees of differentiation between belief & disbelief:* relative amount of knowledge possessed	3.7 (0.97)
It is natural to fear the future	Central-peripheral: *beliefs regarding uncertainty of future:* fear of future	3.6 (1.09)
There is so much to do and so little time to do it in	Central-peripheral: *beliefs regarding uncertainty of future:* feeling of urgency	4.0 (0.96)
In a heated discussion, I generally become so caught up in what I am going to say that I forget to listen to what others are saying	Central-peripheral: *beliefs regarding uncertainty of future: compulsive repetition of ideas*	2.4 (1.13)
The main thing in life is for a person to want to do something important	Central-peripheral: *self-aggrandizement as defense: concern with power*	3.3 (1.07)
It is often desirable to reserve judgement about what's going on until one has a chance to hear the opinions of those one respects	Central-peripheral: *Interrelations among primitive, intermediate, and peripheral beliefs*	4.0 (0.89)
It is not good to only pick friends whose beliefs are the same as your own [adapted: reversed]	Central-peripheral: *Interrelations among primitive, intermediate, and peripheral beliefs*	3.5 (1.09)
The people who disagree with me may well turn out to be right [reverse code]	From Altemeyer's (1996) DOG scale	3.7 (1.00)
Most people know what's good for themselves [adapted: reverse code]	Time-perspective: *Knowing the future*	3.3 (0.89)
The principles I believe in are similar to those most other people believe in [adapted: reverse code]	Belief-disbelief: *Isolation: Accentuation of differences between belief and disbelief*	3.4 (0.98)

Organization along the central-peripheral dimension refers to the content of beliefs about the world, authority, and others' and one's own relationship to that authority. Central beliefs (those most resistant to change) are about the nature of the world and of one's self, intermediate beliefs are about the nature of authority in that world and who aligns with that authority, and peripheral beliefs (those most likely to change) refer to specific beliefs derived from that authority. The items capturing the central-peripheral dimension also refer to the content of beliefs within those central to peripheral areas rather than just to the belief structure.

Table XVI: Dogmatism (general authoritarianism) items wording and descriptives, for format B of the 2018 Amazon Mechanical Turk survey.

Battery B Items	***Dimension: feature***	***M (SD)***
The highest form of government is a democracy, and the highest form of democracy is a government run by those who are most intelligent.	Belief-disbelief: *Isolation: coexistence of contradictions in belief system*	3.1 (1.08)
In this complicated world of ours, the only way we can know what's going on is to rely on leaders or experts who can be trusted	Central-peripheral: *Interrelations among primitive, intermediate, and peripheral beliefs*	2.7 (1.15)
Humans on their own are helpless and miserable	Central-peripheral: *Primitive beliefs: aloneness & helplessness of man*	2.2 (1.11)
I'd like it if I could find someone who would tell me how to solve my personal problems	Central-peripheral: *Primitive beliefs: aloneness & helplessness of man*	3.0 (1.25)
The main thing in life is for a person to want to do something important	Central-peripheral: *self-aggrandizement as defense: concern with power*	3.3 (1.03)
My blood boils whenever a person stubbornly refuses to admit he's wrong	Central-Peripheral: *Formal content of intermediate belief region: Intolerance*	3.4 (1.17)
There are two kinds of people in this world: those who are for the truth and those who are against the truth	Central-Peripheral: *Formal content of intermediate belief region: Intolerance*	3.1 (1.21)
Most of the ideas that get printed these days aren't worth the paper they're printed on	Central-Peripheral: *Formal content of intermediate belief region: Intolerance*	2.8 (1.13)
Most people know what's good for themselves [adapted: reverse code]	Time-perspective: *Knowing the future*	3.3 (1.05)
Of all the different philosophies that exist in this world, there is probably more than one that is correct [adapted: reverse code]	Central-Peripheral: *Formal content of intermediate belief region: Authoritarianism*	3.9 (1.04)

Finally, organization along the time perspective refers whether one has a broad or narrow view of time. More dogmatic individuals, Rokeach (1960) posits, have a narrower view of time: they focus less on how the past, present, and future relate to each other and tend to fixate on one time in particular (usually the future, sometimes the past, and rarely the present). I list the dimensions, sub-dimensions, and particular feature that each item corresponds to in Tables XV and XVI, in case the items included here loaded onto different factors depending on these dimensions. The items that are most focused on authoritarian tendencies in particular are typically those that capture aspects of organization along the central-peripheral dimensions (Rokeach, 1960).

In addition to these main concepts of interest, I again included *trust in scientists*, *religiosity* and the other demographic and value-based variables, to replicate the scope of items included in the 2016 models in part one of the analyses in this chapter. *Trust in scientists* was a composite of two items measured on a 5-point scale (1 = "Do not trust at all" to 5 = "Trust very much") capturing how much respondents "trust the following sources for information on controversies about scientific issues": 1) *university scientists* (*M* = 3.9; *SD* = 0.92) and 2) *industry scientists* (*M* = 3.4; *SD* = 0.98). For the regression analyses, the two were averaged to create a composite variable *trust in scientists* (Pearson's R = 0.42). *Religiosity* was captured with a single item, measured on an 11-point scale, asking respondents how much guidance religion provides in their daily lives (0 = "No guidance at all" to 10 = "A great deal of guidance"; *M* = 3.6; *SD* = 3.76).

Education was captured on a scale from one to six, with 1 = "No high school," 2 = "Some high school," 3 = "High school degree," 4 = "Some college or associates," 5 = "Bachelor's degree," and 6 = "Graduate school" (median = 5; *SD* = 1.27). *Science degree* was a dichotomous variable, with 1 = "Has science degree" and 0 = "No science degree" (14.9% have science degree). *Science courses* was also a dichotomous variable, with 1 = "Has taken science courses in college" and 0 = "Has not taken science courses in college" (67.4% have taken college-level science courses). For the regression models, to avoid multi-collinearity, I also created composite variable for *science education* out of the responses to the *science courses* and *science degree* items: 0 = "Neither courses nor degree"; 1 = "Courses, no degree"; 2 = "Degree" (29.0%, 56.1%, & 14.9%, respectively).

News attention was a composite of two items capturing attention to "news on national government and politics" and "science and technology," both captured on a 5-point scale from 1 = "None" to 5 = "A lot" (*government & politics*: *M* = 3.7; *SD* = 0.99; *science & technology*: *M* = 3.5; *SD* = 0.90). The two were positively but not highly correlated (Pearson's R = 0.39), but because the distinctions between the two were not a focus of these analyses, they were averaged together to create a composite *news attention* variable. Finally, I included *age* and *gender* as controls. *Age* captured how old a respondent is in years (*M* = 37.6; *SD* = 12.2). *Gender* was a dichotomous variable, with "female" = 1 and "male" = 0 (48.2% female).

Analysis

Part I—2016 dataset: Deference v. authority of science. The first part of the analysis examined the belief in the authority of science variables as they related to deference to scientific authority, going beyond the examination in Chapter 2 to focus on what predicts each of the deference and belief in the authority of science items. In this sense, the analyses build on Chapter 3's focus. The goal was to not only reproduce the results from the earlier datasets, however, but to understand each item on its own along with the relationship between belief in the authority of science and deference to scientific authority more broadly.

The blocks of the models entered in roughly assumed causal order: 1) demographics; 2) science education in particular; 3) news attention; 4) religiosity; 5) views of authority of science (in the two models predicting deference) or deference (in the two models predicting views of authority of science); and 6) trust in scientists and medical professionals. Although trust in scientists is theoretically an effect of views of science and deference, it was included as a predictor in the model to capture the unique overlap between trust and the dependent variables, after controlling for related concepts. The same reasoning applied to including deference as a predictor in the authority of science models.

Part II—2018 dataset: Deference, authority of science, epistemic beliefs & dogmatism. The second part of the analysis included the same models to reproduce the first part but went beyond it by including the *dogmatism* and *epistemic belief* items in the 2018 MTurk data to address the more specific hypothesis and research question. For these analyses, I also used hierarchical OLS regression, and I ran four models: one for each of the deference items and one for each of the belief in the authority of science items. Based on the results, these analyses provided information to assess 1) how well each of the items appeared to be capturing a similar concept to their partner item, based on their relationships to the theoretically related independent variables in the models; and 2) what differences appeared between the concepts that can help us understand why deference is distinct from belief in the authority of science.

Before running the regression analyses, I first assessed the reliability of the dogmatism and epistemic belief items by examining the inter-item correlations and running exploratory factor analyses (EFA) to see whether the items loaded onto a single factor or onto related dimensions. I used EFA instead of confirmatory factor analysis because of the item reliability issues described in both the dogmatism (Altemeyer, 1996; Rokeach, 1960; Troldahl & Powell, 1965) and the epistemic belief literatures (DeBacker et al., 2008; Schraw, 2013) and, in the case of the dogmatism items, because I was using only 10 items from a larger battery of 60 items that span the three dimensions, and several dozen sub-dimensions listed above in the description of the measures (Rokeach, 1960). The EFA used maximum likelihood (ML) models and the oblique Promax rotation.

As previously mentioned, based on the results of the factor analyses, I reduced the number of dogmatism and epistemic beliefs items included and combined the items into indices based on their conceptual and empirical overlap. I then used these indices in the regression analyses predicting each of the deference items and belief in the authority of science items. These analyses followed the structure of the analyses of the 2016 data but with the edition of the epistemic belief and dogmatism measures. As in the previous chapters, all analyses use IBM's statistical software SPPS, Version 25.

Results

Part I: Deference & Authority to Science, 2016 Dataset Results

The results of the regression analyses predicting the deference to scientific authority items and the belief in the authority of science items in the 2016 dataset revealed considerable distinctions between the two concepts based on how the independent variables related to each of the items across the two. Table XVII provides the final betas for each analysis, and full models for each dependent variable, with all upon-entry coefficients listed, are in Appendix B (Tables BI-BIV). The deference items and the authority of science items shared considerable overlap, as seen in how large the coefficients and shared variance were when each was introduced into the models of each other. The belief in the authority of science items together explained close to 30 percent of the variance of each of the deference to scientific authority items, and the deference items in turn together explained 24-26 percent of the authority of science items. All these items also had similarly large relationships to trust in scientists, although trust overlapped with a larger portion of the variance in the deference items than in the authority of science items.

Those, however, were the only congruent findings across the items for the two concepts. The results otherwise indicated clear differences in how the deference to scientific authority items related to predictors such as education and science education, news attention, and religiosity compared to how the belief in the authority of science items related to those same antecedents and related concepts. Starting with education, as seen in Table VXII, science education had opposite relationships to the deference items as it did to the belief in the authority of science items. Greater science education indicated significantly higher belief in the authority of science but significantly lower levels of deference to scientific authority.

General education levels were not significant in the full models for any of the dependent variables. In almost all the models—with the exception of the model predicting D2—education started out significantly related to the dependent variables until science education entered the model (Tables BI-BIV). For D1, this significant relationship, however, was also negative (Table B1), while for the two authority of science items it was positive Tables BIII & BIV). These findings are in contrast to the research on just the deference items that found that education positively related to deference (Brossard & Nisbet, 2007). In both of the deference item models, science education did not become significant, however, until the belief in the authority of science composite measure entered the model (Tables BI & BII). Similarly, news attention became significant and negatively related to item D1 after the belief in the authority of science items entered the model. News attention, however, started out significant and positively related to D2, before controlling for the authority of science items.

Table XVII: OLS regression results predicting deference to scientific authority items and authority of science items. 2016 YouGov dataset.

	Standardized betas			
	Scientists know best (D1)	*Scientists should do (D2)*	*Science best way to understand*	*Science most reliable way*
Age	-0.14**	-0.09***	0.10***	0.04*
Gender (female)	-0.01	-0.09***	0.02	0.03
Education	-0.04	0.03	-0.02	0.00
Adjusted R^2 (%)	*3.7****	*3.4****	*1.6****	*2.4****
Science education	-0.10***	-0.10***	0.10***	0.09***
Adjusted R^2 (%)	*0.0*	*0.0*	*0.8****	*0.8****
News attention	-0.11***	-0.03	0.08***	0.14***
Adjusted R^2 (%)	*0.1*	*1.2****	*2.3****	*4.2****
Religiosity	0.09***	0.01	-0.29***	-0.24***
Adjusted R^2 (%)	*2.3****	*5.8****	*16.9****	*13.0****
Authority of science	0.49***	0.51***	------------	------------
Adjusted R^2 (%)	*28.7****	*29.0****		
Deference	------------	------------	0.47***	0.43***
Adjusted R^2 (%)			*26.1****	*24.6****
Trust in scientists	0.26***	0.22***	0.13***	0.18***
Adjusted R^2 (%)	*5.1****	*3.4****	*1.2****	*2.2****
Total adjusted R^2 (%)	**39.9**	**42.8**	**48.9**	**47.2**
Sample size (N)	1546	1553	1553	1550

*p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001.

Religiosity also changed its relationship to the deference items when the belief in the authority of science measure entered the models. It started out negatively related to both the deference items and then turned positively related to D1 and not significantly related to D2. Looking at the authority of science models, it appears that this could be because of how strongly religiosity negatively related to believing that science is the best form of knowledge. Religiosity explained 13 to almost 17 percent of the variance in responses to the authority of science items, compared to only 2 to 6 percent of the variance in the deference to scientific authority items.

Part II: Deference & Authority to Science, 2018 Dataset Results

Before moving to the regression analyses of the 2018 dataset and how they compared to the results of the 2016 dataset as described above, I first describe the results of reducing the dogmatism and epistemic belief items to create composite variables that I then included in the regression analyses.

Reducing the dogmatism and epistemic belief items. The factor analyses of the dogmatism batteries and the epistemic belief items provided information on how to reduce the batteries into composite variables for inclusion in regression analyses, and revealed several problems with the dogmatism items and interesting aspects of the epistemic belief items.

Dogmatism—Battery A. As seen in the correlation table and table of factor analysis results listed in Appendix B (Tables BV and BVI, respectively), the dogmatism items in battery A had poor inter-item reliability. The ML EFA provided four factors, two of which were factors with only a single item loading: "The principles I believe in are similar to those most other people believe in" (Factor 1) and "The main thing in life is to want to do something important" (Factor 2). Three other items either did not even moderately load (at a coefficient of above 0.3) on any of the factors. The five items that did at least moderately load on factors were split across two factors—Factors 3 and 4 in Appendix Table BVI—with the positively worded items (positive indicating more dogmatic) mostly on Factor 3 and the negatively worded items (less dogmatic) mostly on Factor 4.

Those two factors, Factors 3 and 4, were not especially highly correlated, however, at a correlation of 0.19, which suggests they likely would not reliable join together to make a composite dogmatism item. Calculating the Cronbach's alpha for these five items confirmed that conclusion, with a very poor alpha of 0.19 when testing the five items: 1) "It is only natural that a person has a better understanding of ideas he or she believes in than with ideas he or she opposes," 2) "It is natural to fear the future," 3) "It is often desirable to reserve judgement about what's going on until one has a chance to hear the opinions of those one respects," 4) "It is not good to only pick friends whose beliefs are the same as your own" [reverse-coded], and 5) "The people who disagree with me may well turn out to be right" [reverse-coded]. After removing the two reverse coded items, the Cronbach's improved only to 0.42 with the three remaining items. Because the battery B items had much higher reliability, as described next, I did not combine the battery A dogmatism items or use them in any further analyses in this study.

Dogmatism—Battery B. Fortunately, the battery B items did have higher inter-item correlations and loaded more cleanly onto a few factors, as seen in Appendix Tables BVII and BVIII. The ML EFA produced three factors, with the third occurring because two items cross-loaded on both it and Factor 1 (Table BVIII). Only one item— "Most people know what's good for themselves"—failed to load on any of the factors. That particular item was also in battery A, where it also failed to load on any of the factors. This could be due to the original idea it captures being a poor representative of dogmatic thinking or because my change of the original wording to negative wording (i.e., so that responses in the affirmative indicate being less dogmatic) affected the interpretability. One item— "My blood boils whenever someone refuses to admit he's wrong"—loaded at only 0.32, and one of the negatively worded items loaded moderately across all three factors ("Of all the different philosophies that exist, there is probably more than one that is correct"). The two factors that most items loaded on, Factor 1 and Factor 2, were highly correlated at 0.52. Model fit, based on an RMSEA calculated from the chi-square fit information, was acceptable but not good, at 0.06 (below the 0.08 cut-off for acceptable and above the 0.05 cut-off for good) (Fabrigar & Wegener, 2012).

Based on this information, I calculated the Cronbach's alpha for all the items except for the one that did not load on any factors and the one that loaded moderately on all three, as described above. The Cronbach's alpha for these 8 items was acceptable at 0.62. The results indicated that the alpha would increase if the item, "Most of the ideas that get printed these days aren't worth the paper they're printed on" was removed, empirically probably because it was the only item that loaded positively on one of the main factors (Factor 2) but negatively on the other (Factor 1) (Table BVIII). At face value it also looks like a dated item.

After removing that item, the seven remaining dogmatism items had a slightly increased Cronbach's alpha of 0.63. I averaged these seven items to create a dogmatism index: 1) "The highest form of government is a democracy, and the highest form of democracy is a government run by those who are most intelligent," 2) "In this complicated world of ours, the only way we can know what's going on is to rely on leaders or experts who can be trusted," 3) "Humans on their own are helpless and miserable," 4) "I'd like it if I could find someone who would tell me how to solve my personal problems," 5) "The main thing in life is for a person to want to do something important," 6) "My blood boils whenever a person stubbornly refuses to admit he's wrong," and 7) "There are two kinds of people in this world: those who are for the truth and those who are against the truth."

Epistemic beliefs—Science-specific v. general. Factor analysis of the epistemic belief items along with the two additional items that I created to have a sense of views of informed decision-making processes without including mention of "science"— "Testing and retesting our assumptions is the best way to find accurate information" and "Collecting more information generally helps lead to better decisions"—resulted in four mostly clean factors with good model fit (RMSEA = 0.00). As seen in Table XVIII, these factors appear to relate mostly to how general versus specific the epistemic belief is, with the three items that include mention of "science" loading on one factor (Factor 1), and to whether the belief refers to seeing truth as absolute and simple (the naïve view in the epistemic belief literature; Factor 4) or relative and complex (what I broadly call the more sophisticated view; Factor 2). The two items that I created to capture the rationale for the scientific process in decision-making without mention of "science" load together on their own factor (Factor 3) and that factor was moderately correlated with the factor onto which the science-specific items loaded (Factor 1; correlation = 0.42). One item— "A sentence has little meaning unless you know the context is which it was spoken"—loaded only moderately (0.30) on one factor, and I cut it from further analyses.

Based on these results and how they appeared to overlap with conceptual distinctions underlying the items, I created three composite variables. One was the average of the epistemic belief items that referred explicitly to science: 1) "If scientists try hard enough, they can find the answer to almost any question," 2) "Scientists can ultimately get to the truth," and 3) "Someday scientific knowledge will present the true picture of the world" (Cronbach's alpha = 0.81). The two new items focused on whether testing and retesting and collecting more information leads to better knowledge and decision-making I averaged to create an item capturing views of the

Table XVIII: Maximum likelihood exploratory factor analysis exploring epistemic belief items. Promax (oblique) rotation. 2018 Amazon Mechanical Turk dataset.

Pattern matrix[a] (Structure matrix loadings in parentheses) *Item*	**Factor Loadings**			
	Factor 1	***Factor 2***	***Factor 3***	***Factor 4***
Someday scientific knowledge will present the true picture of the world	**0.816** (*0.802*)	0.045 (*0.147*)	-0.048 (*0.302*)	-0.002 (*0.023*)
If scientists try hard enough, they can find the answer to almost any question	**0.734** (*0.749*)	-0.003 (0.060)	0.025 (*0.332*)	0.096 (*0.138*)
Scientists can ultimately get to the truth	**0.722** (*0.762*)	-0.084 (*0.035*)	0.121 (*0.406*)	0.004 (*0.082*)
The only thing that is certain is uncertainty itself	0.008 (*0.133*)	**0.689** (*0.627*)	0.054 (*0.192*)	0.170 (*-0.123*)
Sometimes there are no right answers to life's big problems	-0.096 (*0.037*)	**0.529** (*0.537*)	0.145 (*0.206*)	0.015 (*-0.213*)
Truth is different things to different people	0.086 (*0.137*)	**0.484** (*0.546*)	-0.020 (*0.106*)	-0.126 (*-0.329*)
Absolute truth does not exist	0.022 (*0.006*)	**0.479** (*0.506*)	-0.175 (*-0.077*)	-0.136 (*0.342*)
Today's facts might be tomorrow's fiction	-0.042 (*0.059*)	**0.479** (*0.451*)	0.074 (*0.149*)	0.085 (*-0.121*)
Testing and retesting our assumptions is the best way to find accurate information	0.109 (*0.421*)	0.034 (*0.209*)	**0.742** (*0.793*)	-0.046 (*-0.040*)
Collecting more information generally helps lead to better decisions	0.040 (*0.297*)	-0.026 (*0.129*)	**0.633** (*0.643*)	0.258 (*-0.043*)
A sentence has little meaning unless you know the context in which it was spoken	-0.077 (*0.077*)	0.196 (*0.244*)	**0.304** (*0.309*)	0.001 (*-0.081*)
Truth is unchanging	-0.107 (*-0.062*)	-0.100 (*-0.402*)	0.048 (*-0.001*)	**0.695** (*0.733*)
The truth is often simple	0.059 (*0.076*)	0.111 (*-0.071*)	-0.051 (*0.003*)	**0.423** (*0.378*)
Most words have one clear meaning	0.225 (*0.181*)	0.044 (*-0.129*)	-0.171 (*-0.061*)	**0.398** (*0.389*)
Eigenvalue (initial values in parentheses)	(*2.95*) 2.42	(*2.30*) 1.73	(*1.31*) 0.72	(*1.23*) 0.62
Cumulative % of variance	15.3	24.5	28.6	28.6

[a]Rotation converged in 6 iterations.

Factor correlation matrix	***Factor 1***	***Factor 2***	***Factor 3***	***Factor 4***
Factor 1	**---**	0.135	0.417	0.055
Factor 2	---	---	0.190	-0.427
Factor 3	---	---	---	0.020

Goodness-of-fit: Chi-square = 82.79; df = 41; sig = 0.000; RMSEA = 0.00. N = 1029 process for knowing, separate from mention of science (Pearson's R = 0.53). I refer to this composite variable as beliefs about *informed decision-making*.

Of the remaining general epistemic belief items, the naïve beliefs factor (Factor 4) and the sophisticated beliefs factor (Factor 2) were negatively correlated (-0.43), which makes conceptual sense. I reverse-coded the three naïve belief items: 1) "Truth is unchanging," 2) "The truth is often simple," and 3) "Most words have one clear meaning." Those three combined with the five sophisticated belief items had a Cronbach's alpha of 0.64 and the results suggested that the Cronbach's would increase if only the "Truth is unchanging" item of the naïve belief items were included with the sophisticated belief items. Without the other two naïve belief items, the Cronbach's of the remaining 6 items increased to 0.67. While the increase is not so large that I would not be able to justify combining all eight of the general items into one index, based on these results and that those two naïve belief items both had the lowest factor loadings and inter-item correlations of the remaining items, I cut them for these analyses to have a cleaner—even if not necessarily as broad—measure of general epistemic beliefs. The three naïve items did not appear to have high inter-item reliability even if they had been combined into their own index, as the Cronbach's alpha for the three was 0.48.

Regression analyses results. After entering these composite items (dogmatism, general epistemic beliefs, science-specific epistemic beliefs, and views of informed decision-making) into the regression analyses of the deference to scientific authority items and the belief in the authority of science items, the distinctions that started to emerge between the concepts in the analysis of the 2016 data became more clear, as did the distinctions that emerged in Chapter 3 analyses between the two deference items. A condensed table with final betas for each model is below (Table XIX) and full models are presented in Appendix B, Tables BI through BIV.

As seen in Table XIX, the results supported Hypothesis 1, that dogmatism positively predicted higher levels of deference to scientific authority, and provide information for Research Question 2, as epistemic beliefs positively predicted belief in the authority of science and related to levels of deference to scientific authority, although in distinct ways.   General epistemic beliefs started out significantly related to the deference to scientific authority items until the belief in the authority of science composite variable entered the models. Only the science-specific beliefs remained positively related and only to item D1 of the deference items (Tables BI & BII). Item D2 was also less related to dogmatism than is D2.

Both the general epistemic beliefs and science-specific epistemic beliefs strongly related to belief in the authority of science. The items on informed decision-making—views on the value of testing assumptions and collecting more information for decisions—also positively related to belief in the authority of science but not to deference to scientific authority. Altogether, both the science-specific and the general items (the general epistemic beliefs and the test-retest/better decision items) predicted one-fifth to more than one-fourth of the variance in the belief in the authority of science items and only 1 to 3.5 percent of the variance in the deference to scientific authority items.

Distinct from the 2016 dataset models, in none of the models here did education or science education significantly relate to the dependent variables, even when they first entered the model (see Tables BI through BIV). After examining before-entry coefficients for these variables, it appeared that this was not just due to the education items entering the models in the

Table XIX: OLS regression results predicting deference to scientific authority items and authority of science items with dogmatism items (battery B) and epistemic beliefs items. 2018 Amazon Mechanical Turk dataset.

	Standardized betas			
	Scientists know best (D1)	*Scientists should do (D2)*	*Science best way to understand*	*Science most reliable way*
Age	-0.12**	0.07	0.03	0.01
Gender (female)	0.02	-0.06	-0.01	-0.05
Education	0.05	0.05	-0.05	-0.06
Science education	0.04	0.01	0.03	0.05
News attention	0.05	-0.01	0.05	0.04
Adjusted R^2 (%)	*9.9****	*2.6***	*5.3****	*6.4****
Religious guidance	-0.03	-0.14***	-0.18***	-0.10**
Adjusted R^2 (%)	*1.8****	*7.6****	*12.3****	*7.4****
Epistemic beliefs (general)	0.00	0.00	0.12***	0.11**
Adjusted R^2 (%)	*0.9**	*0.9**	*3.5****	*3.1****
Epistemic beliefs (science)	0.16***	0.07	0.23***	0.26***
Adjusted R^2 (%)	*14.0****	*10.3****	*18.1****	*20.0****
Views of informed decision-making	-0.07	0.06	0.14***	0.19***
Adjusted R^2 (%)	*0.0*	*1.0***	*2.0****	*3.3****
Dogmatism	0.17***	0.11*	0.01	0.01
Adjusted R^2 (%)	*2.9****	*1.3***	*0.3*	*0.1*
Authority of science	0.30***	0.33***	------------	------------
Adjusted R^2 (%)	*7.0****	*8.1****		
Deference	------------	------------	0.32***	0.24***
Adjusted R^2 (%)			*8.3****	*5.7****
Trust in scientists	0.22***	0.19***	0.10*	0.16***
Adjusted R^2 (%)	*3.4****	*2.7****	*0.5**	*1.6****
Total adjusted R^2 (%)	**39.9**	**34.5**	**50.3**	**47.6**
Sample size (N)	506	505	504	506

*p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001.

same blocks as each other and as the news attention item in these analyses, compared to the 2016 analyses where they entered one at a time in separate blocks. Instead, it could be an artifact of the particular sample, as the MTurk respondents were much more educated than a representative sample of the U.S. population. This could have reduced the variance in responses and therefore the ability to detect differences between respondents on this variable.

The results also indicated that religiosity had a stronger relationship to belief in the authority of science than to deference to scientific authority. Religiosity maintained a strong relationship to item D2 in these analysis, even after controlling for belief in the authority of science. For item D1, however, religiosity lost significance once the science-specific epistemic beliefs entered the model (Table BI).

Finally, as in the 2016 dataset models, the results again indicated that trust in scientists overlapped with the deference items to a greater degree than it did with the authority of science items, although it strongly and positively related to all the dependent variables.

Altogether, the models explained a substantial portion more of the belief in the authority of science items (47 to 50 percent) than they did of the deference to scientific authority items (35 to 40 percent).

Discussion

The results of analyses of both the 2016 and the 2018 datasets indicate that the existing deference to scientific authority items and belief in the authority of science items are capturing distinct concepts in ways theoretically consistent with the conceptual definitions of deference to scientific authority and of the cultural authority of science. As predicted, deference to scientific authority is significantly related to higher levels of dogmatism, while belief in the authority of science is not. Belief in the authority of science, in contrast, highly related to both general epistemic beliefs and science-specific epistemic beliefs, as well as to ideas concerned with the role of systematic knowledge collection—such as those commonly used to describe the scientific process—for increasing accuracy and quality of decision-making. Of these items concerning the nature of knowledge and knowledge production, however, only science-specific epistemic beliefs relate to the deference to scientific authority items. Within and beyond these key relationships of focus, some telling differences across the items for each concept and between the items capturing deference to scientific authority indicate ways we can better understand deference and some problems that could be arising from how we currently measure it.

Deference to Scientific Authority & Education

Consistent through the foundational literature on deference to scientific authority is that authoritarian views of decision-making in science (as captured by the deference items and/or the participatory views items) tend to relate to higher levels of education (Brossard, 2002; Brossard & Nisbet, 2007; Brossard & Shanahan, 2003). As the results of the 2016 data indicate, however, this relationship did not appear in these analyses, even before belief in the authority of science entered the models. Education had no significant relationship to views of what scientists should do (item D2) and actually started out with a significant negative relationship to views of whether scientists know best (item D1) (Tables BI & BII). Science education at the college level did have a significant relationship to both deference items, but it was a negative one that became markedly stronger after controlling for belief in the authority of science (Table XVII and Appendix Tables BI & BII). In the 2018 dataset, neither education nor science education had significant relationships to any of the deference or authority of science items (Table XVII and Appendix Tables BIII & BIV).

As described in the results, that lack of relationship in the analyses of the 2018 dataset could be at least partly an artifact of the MTurk respondents, who had substantially higher levels of general education and science-specific education than does a representative sample of the U.S. public, which the other datasets examining deference were based on. As we saw in the analyses in Chapter 3, however, the relationship between the deference items and general education and science education was inconsistent even in the nationally representative U.S. samples. In the 2010 data, education related to both deference items, as did science education. In the 2012 data, however, general education related to neither of the items while science education related positively to only item D2, and in the 2014 data, general education related negatively to both deference items while science education related positively to both.

One take-away of this inconsistent relationship between education and the deference items could be that the deference items have low test-retest reliability, which we see other evidence for in patterns that emerged in the results described in this chapter combined with the results in Chapter 3. I describe some of this evidence in greater detail below in the discussion of the results from the analyses in part two of the 2018 MTurk dataset. Briefly, however, some of this evidence could include the variability in how well the items correlate across surveys—ranging from 0.5 in the 2010 data to 0.7 in the 2014 data. These correlations, along with how different variables related to each of the deference items across the analyses in this dissertation, could also indicate that the two deference items are not cleanly capturing the same concept. Overall, however, based on these results, it does not appear that education in general or science education in particular is necessarily a predictor of deferent views, or at least not in a straight-forward enough manner to be consistently captured with the very broad education items examined here.

The regression results from the 2016 dataset did indicate, however, that education was more strongly related to belief in the authority of science than to deference to scientific authority. Science education at the college level in particular predicted greater belief that science is the best or most reliable way to collect knowledge about the world (Table XVII and Appendix Tables BIII, & BIV). This makes theoretical sense—particularly if the cultural authority of science is passed down through education (Brossard & Shanahan, 2003). Because this pattern did not reemerge in the 2018 data, however, it remains to be seen if this relationship holds across other samples. For now, however, we see evidence that those who are more educated—even if they hold stronger beliefs in the authority of science as a way of knowing the world—might not necessarily be more authoritarian in their beliefs about the role of scientists and citizens in decision-making on the societal applications and impacts of science.

Deference & Dogmatism

Capturing dogmatism. As seen in the low reliability of the dogmatism items in Chapter 3 and in battery A of the items in the 2018 dataset as described in this chapter, the dogmatism items do not appear to capture the same concept well, at least when taken in samples of ten or less from Rokeach's (1960) larger battery of items (Appendix Table BVI). Given the range of dimensions and sub-dimensions that Rokeach (1960) posited for capturing dogmatism, it is perhaps not surprising that taking items from a variety of sub-dimensions does not work well from a reliability standpoint. Part of the challenge could also stem from weaknesses in the original items themselves, as Altemeyer (1996) argued. Rewording items so that not all of the items were valenced in the same, positive, direction (to reduce bias from people tending to skew toward agreement when answering survey questions) likely further reduced the cohesion of the items I used here. Even with a small sample of items, however, most of the battery B items (originally reduced and tested by Troldahl & Powell, 1965) held together well enough to create a composite dogmatism item (Appendix Table BVII). It would be useful in further development of the deference to scientific authority items, though, to pull from more of Altemeyer's (1996) DOG scale, perhaps alongside some of Rokeach's (1960) dogmatism items, to better capture general authoritarian tendencies. These items could provide models for creating new deference items that capture the more authoritarian side of deferring to scientists in decision-making on the societal implications of science.

Deference's distinct relationship to dogmatism. Using the dogmatism index created from the battery B items on the 2018 survey, the results indicate that both deference items overlapped with dogmatic tendencies, in support of the theoretical conception of deference to scientific authority as capturing a form of authoritarianism. This relationship also suggests that the deference items—even if capturing other concepts or having measurement issues—are capturing aspects of "defer" in the sense of letting another decide in one's place. We saw this in Chapter 2 as well, where the deference items predicted less democratic views of the role of citizens in decision-making on science applications in society. The results here more directly indicate that deference overlaps with dogmatic tendencies, and we see this relationship even with the potentially weak reliability of the dogmatism items and the potential conceptual fuzziness of the deference to scientific authority items. That dogmatism did not relate to belief in the authority of science suggests that what makes some people deferential is not necessarily just that they view science as authoritative but that, for some reason, they are also generally more authoritarian even outside of the context of science-related issues and seem to place fewer boundaries around the reach of scientific authority. As the relationships between the deference items and the science-specific epistemic beliefs indicate, this authoritarianism might partly stem from particular views of how closely scientific knowledge represents truth and how absolute that truth is.

Before moving to those results concerning such epistemic beliefs, however, the relationship between the deference items and the dogmatism battery also provides more evidence of distinctions between the two deference items. Item D1 had twice the overlap with the dogmatism items that D2 had. This is consistent with the results in Chapter 3 and could be evidence of D1 being a more extreme—in the sense of more authoritarian—deference item. This makes sense when examining the wording of each item as well. Thinking that scientists know best what is good for the public seems more authoritarian at face value than does thinking that scientists should do what they think is best. The distinctions between how these two items relate to dogmatism, however, could also, and simultaneously, be more evidence of item D2 capturing, at least partly, views of what scientists as individuals should be able to do, compared to scientists as authorities or representatives of science. The evidence from the relationship between the epistemic belief items and each of the deference items, as I describe below, offers more evidence that the two deference items could at least be partly capturing distinct concepts.

Authority of Science & the Nature of Knowledge

Capturing epistemic beliefs. Before moving into those results, however, the composite measures of the epistemic beliefs that I examined in the regression analyses were based on the factor analyses of the batteries of the epistemic belief and views of knowledge items, as described earlier. These analyses indicated four factors that I interpreted as three conceptions of views of knowledge and knowing (Table XVIII). One was the general epistemic beliefs, which loaded on two negatively related factors: one capturing more “naïve” epistemic beliefs, such as that truth is simple, unchanging, and absolute, and one capturing more “sophisticated” beliefs, such as that truth in contingent, relative, and changing. A second factor was captured by the items related to the nature of science as a way of approximating reaching the truth. These items all mentioned “scientists” and/or “science.” Broadly, they could capture not only science-specific epistemic beliefs but also potentially a view that skews more toward naïve, as they capture whether scientists can ultimately reach the truth and whether what scientists reach will be “the true picture” of the world—suggesting a universal, potentially unchanging, and accessible truth.

The last factor and resulting construct was made up of the two new items that captured views of what processes of knowledge collection were best for achieving reliability and quality decisions—or for what I called informed decision-making. These items I created to capture views that are commonly associated with the scientific methods for knowledge collection and decision-making without having the items explicitly refer to “science” or “scientists.” This was partly to test how responses to these items differed from the epistemic belief items that referred to science and how they related to the belief in the authority of science items. Namely, the goal was to see whether belief in the authority of science overlaps with these more general views about the quality a particular process for information collection and decision-making rather than just with items that explicitly refer to “science.”

That these two new items on views of what constitutes informed decision-making loaded on their own is not surprising. But that finding, combined with the fact that the items concerning "science" loaded on their own, suggests that responses to items with "science" are distinct from more general views about the nature of knowledge and can be distinct from views of a particular process of knowledge collection, per se. As I describe next, these items on informed decision-making and how they appeared to be distinct from items that explicitly mentioned "science" ended up providing insight into how deference to scientific authority differs from just believing in the authority of science in how each concept differentially related to these items.

Views of the authority of science grounded in epistemic beliefs. That the belief in the authority of science items had such strong relationships to all of the epistemic belief items—both with and without explicit mention of science—suggests that views of the authority of science could stem from a bigger picture view of the nature of knowledge and knowing and views of how science fits within that epistemic worldview. Interestingly, the general epistemic beliefs were coded such that higher levels indicated more sophisticated beliefs, while the science-specific epistemic beliefs could arguably be more representative of more naïve beliefs concerning the potential for science to present the true picture of the world, accessible through the work of scientists.

That belief in the authority of science positively relates to both of these views could mean several things that are relevant for understanding where this authority stems from. It could be that people who generally hold more sophisticated epistemic beliefs about the world also hold science to a distinct standing within that more general view. Essentially, such a combination of views could mean that one overall sees truth as complex and relative in general but sees science as offering a way to, or at least closer to, the absolute and universal, eventually. That the belief in the authority of science also related to the two items that I label as views of informed decision-making suggests that people who see science as authoritative knowledge also tend to value a particular type of information gathering and decision-making process that overlaps with features of scientific method, even when that methodology is not explicitly labeled as “science.”

The deference to scientific authority items, however, only related to the science-specific epistemic belief items, and only item D1 did so after controlling for belief in the authority of science. This suggests that deference could be stemming from, or at least consistent with, more naïve views about the ability of science to provide an absolute truth, and that these views could be more ignorant of or less connected to ideas of what the appropriate or quality methods are for collecting information and making decisions. In this sense, the appearance of the word “science” could be more important for those who are more deferent, perhaps due to particular images or conceptualizations attached to the word. Essentially, a particular idealized image of “science” could be at play in determining how deference to scientific authority emerges in people’s opinions about the role of scientists in decision-making.

This interpretation could also align with the 2016 dataset results that indicated that science education was related to belief in the authority of science but not to deference to scientific authority. Even if early education initially spreads this idealized image of science, science education at the college level and experience with science as a particular method, rather than as a cultural institution or form of pure truth, might muddy, disperse, or otherwise make less top-of-mind such a view of science when considering the value of science and the potential bounds of its authority in society and decision-making.

We also see from these analyses, however, that item D2 was again distinct from item D1 in its relationship to these key independent variables. In this case, D2 did not remain significantly related to epistemic beliefs about science. This distinction could be more evidence that the item is not as cleanly capturing deference to scientific authority. That we have evidence that it not only related less to dogmatism than did D1 but also related less to beliefs about science and more strongly related to views of the importance of free speech (as seen in Chapter 3) suggests that it would be worthwhile to test item D2 through additional and qualitative analyses to see how much people respond to it with a view of scientists as individuals versus scientists as authorities representing scientific knowledge.

Science & Religion

One final notable distinction between the deference items and the belief in the authority of science items is how they each related to levels of religiosity. As expected, religiosity related to less belief that science is the authoritative way of understanding or reliably knowing the world. Therefore, religiosity also related to being less deferential to scientists. These results are consistent with the deference to scientific authority literature that posited that religiosity and deference would likely be negatively correlated in the U.S. (Brossard & Nisbet, 2007) and that found that the two had opposite effects in predicting views of issues such as embryonic stem cell research (Ho et al., 2008). The findings are also consistent with the larger body of literature in science communication that consistently finds that those who are more religious are less supportive of emerging science and technologies (Cacciatore et al., 2014; Deane-Drummond, Grove-White, & Szerzynski, 2001; Dragojlovic & Einsiedel, 2013; Evans, 2011; Scheufele, Corley, Shih, Dalrymple, & Ho, 2009; Scheufele et al., 2017).

What is new in these analyses is the findings that this relationship between religiosity and views related to science appeared to be stronger between religiosity and belief in the authority of science than between religiosity and deference to scientific authority, and this relationship holds beyond the just the effect of distinct epistemic beliefs about science. That religiosity more strongly related to belief in the authority of science than to deference to scientific authority conceptually fits with the idea that deference to scientific authority stems from these greater beliefs in the authority of science. If religiosity makes it less likely that one would hold science as a sole or primary authority for knowledge about the world, then that would likely partly be where the lower levels of deference to scientific authority among more religious individuals would stem from.

More interesting or novel, however, is that these relationships between religiosity and belief in the authority of science and between religiosity and deference held even after controlling for epistemic beliefs in general and about science in particular. The relationships did shrink, suggesting that religiosity relates to these epistemic beliefs—particularly to the science-specific epistemic belief items (Appendix Tables BX through BXIII). That they remained large and significant, however, also suggests that it is not just distinctions in views of knowledge and the nature of knowing—even concerning views of scientific knowledge—that drive the division between religiosity and belief in the authority of science. The division, then, could emerge from the fact that the belief in the authority of science items place science as above all other ways of knowing. If that is the case, it is not necessarily that a more religious individual would think that science is less likely to reach the truth (although that appears to be partly the case as well) but that he or she would be less likely to grant science, and therefore scientists, the sole claim to authoritative knowledge. This nuance could be valuable for better understanding the relationship between religious beliefs and perceptions of science in general and of particular science and technology issues—and decision-making on those issues—in society.

Conclusion

Overall, deference to scientific authority does appear to be capturing dogmatic or general authoritarian tendencies, even if that level of overlap differs across the two deference items. This relationship between deference and dogmatism, along with how deference distinctly relates to only science-specific epistemic beliefs, helps explain why deference diverges from broader belief in the authority of science. Belief in of the authority of science also could relate more to science education in particular than does deference to scientific authority, but it also is more strongly related to sophisticated epistemic beliefs about the nature of knowledge and truth in general alongside more naïve—in the sense of more absolute—epistemic beliefs about the potential for science to access the truth of the world. Similarly, belief in the authority of science also relates to views of informed decision-making: what particular processes are appropriate for collecting reliable knowledge and decision-making. The processes that these items refer to—testing and re-testing assumptions and collecting more information in general—capture tenets of the value of the scientific method. But, unlike the deference to scientific authority items, belief in the authority of science relates to these views on informed decision-making even when they are not explicitly categorized as "science."

Deference to scientific authority, on the other hand, strongly relates to belief in the authority of science but is distinct in how it relates to more dogmatic tendencies in general and in how it appears to relate only to science-specific epistemic beliefs, rather than more sophisticated general beliefs about the nature of knowledge and practical beliefs about what types of knowledge-generating processes facilitate informed decision-making. Deference also does not appear to have a strong and consistent relationship to education in general or to higher-level science education specifically. Altogether, these results suggest that out of all the people who believe that science is authoritative knowledge, those who become deferent to that knowledge are more dogmatic in general and could hold an idealized image of science, removed from a bigger picture of knowledge or of the value of particular processes of knowledge collection. As a result, more deferent individuals could have a belief in science's value that is more reliant on naïve perceptions of science's authority and tied to a tendency to over-claim on where that authority reaches. The result of this combination could be a misunderstanding of the processes and conclusions of science that manifests in anti-democratic views concerning who should have a say in deliberation and decision-making on the normative questions concerning how we use science and technology in society.

Chapter 5. Conclusions on Deference, Deliberation, and Democracy

This dissertation examined three broad questions addressing theoretical and empirical gaps in how we conceptualize and operationalize deference to scientific authority:

1) Does deference to scientific authority matter for views of decision-making even for those "science matters. . . with ethical and social implications"?
2) How is deference best understood: as a form of respect for scientific expertise or as a form of authoritarianism regarding views of who should participate in decision-making on science?
3) How does deference to scientific authority relate to belief in the authority of science as a way of knowing the world?

Each of the chapters focused on one of these questions in particular but also supplemented the other chapters' focuses to provide a more complete picture of deference and its origins and implications overall.

Recap of the Results & What Picture They Provide for Understanding Deference

The results of Chapter 2 gave the first evidence that deference to scientific authority does predict more authoritarian views of who should be involved in decision-making concerning science and technology's societal impacts. More deferent individuals were more likely to not only support using human gene editing technology but to believe that scientists developing the applications should not consult with the public and that citizens should not be involved in regulations concerning research or applications of the technology. Deference was distinct from other views of science and scientists—belief in the authority of science and trust in scientists—in this relationship to anti-democratic views on decision-making around the societal impacts of science.

Chapter 3 found further evidence that deference to scientific authority is not only deference as an expression of respect toward scientists' expertise but moves into deference as a form of authoritarianism, as the deference items positively related to general dogmatic, or general authoritarian, tendencies. Chapter 4 then provided stronger evidence of deference's relationship to general authoritarianism, while also adding greater detail to the findings that from Chapter 2 on how deference to scientific authority is distinct from just believing that science is authoritative knowledge. Chapters 2 and 4 were the first examinations of items capturing belief in the authority of science. Although those items likely need further development, as I describe below, including them in analysis alongside the deference items revealed insights that are key to understanding the origin and extent of deference.

Deference: Misguided Extensions of the Authority of Science?

Although deference does strongly relate to beliefs in the authority of science for understanding the world, it appears to be a narrower and more dogmatic view of knowledge and ways of knowing about the world than are views that predict simply seeing science as authoritative knowledge. People who are deferent to scientific authority, as captured by the existing deference items, appear to be so partly because they also hold more general authoritarian or dogmatic tendencies about non-science issues, too. But these authoritarian beliefs also combine with epistemic beliefs about science that see science as providing a true picture of the world that scientists have access to. Such beliefs about the nature of scientific knowledge also predict seeing science as an authoritative form of knowledge. The difference for deference, however, is that deference to scientific authority does not overlap with views about the nature of knowledge or processes of knowledge collection in general. Deference only related to the epistemic beliefs that specifically referred to "science." Views of the authority of science, however, related to more general and sophisticated epistemic beliefs as well, along with beliefs that collecting more information is best for checking assumptions and making decisions. The latter beliefs connect, at least at face value, with common justifications for the value of the scientific process in knowledge-generation and decision-making, but did not explicitly refer to "science."

That being deferent to scientific authority does not relate to these beliefs suggests that deference could be stemming from a narrow, idealized, and misguided view of what science is, how it operates, and what it can tell us. It could also be due to those who are more deferent reacting to the word "science" when answering the survey items, which would likely relate as well to holding particular idealized views of science that are not connected to broader views about the nature of knowledge and knowing. Given the inconsistent relationships between the deference items and the general and science-specific education items, it does not seem that education is the largest or sole cause of such views, at least as captured by these broader education measures. That deference does co-occur with these broader worldviews about science and authoritarianism, however, suggests that it is at least somewhat due to cultural views of the authority of science that possibly interact with individual authoritarian tendencies.

Implications of Deference for Deliberation on Societal Conflicts

Deference as Authoritarianism

Although the analyses revealed limitations to the existing deference items and have limitations of their own, as I touched on in the previous chapters and will describe in greater detail below, even with a rough measure of deference to scientific authority, we have seen through these analyses the ways that deference matters for deliberative democratic decision-making on issues concerning the role of science and technology in society. Those who are deferent are also authoritarian in their views of such decision-making. This matters because democratic deliberation only works if we have broad buy-in in its importance and willingness to view disagreements and the rationale behind disagreements in good faith and as valid viewpoints relevant for the topic at hand. Based on the evidence here, those who are deferent will likely not only extend science's authority to normative decisions but, because of this, see such public deliberation on those decisions as unnecessary and not believe that non-scientists who dissent against a particular impact of science have standing or authority in the issue.

As the introductory chapter outlined, such views matter for decision-making on societal issues because science and technology are at the core of many of the most pressing and wide-spread societal issues today—as causes, solutions, information sources, structural components, or all of the above (Funtowicz & Ravetz, 2003; Leshner, 2003, 2013; Lubchenco, 1998). Although science provides descriptive information about these issues and can provide information on, or even change, the bounds and structures shaping these issues, it cannot provide the answer to what we want to do with that scientific information and those technologies. Instead, those are normative questions that—especially for controversial issues—are tied to moral and social considerations and conflicts. These moral conflicts are exactly what public deliberation is meant to address (Bohman, 1996; Gutmann & Thompson, 1996; Young, 1997).

Such conflicts are also ones that specialized institutions and discourses—such as in science or the judicial system or even the marketplace—cannot truly or legitimately address (Bohman, 1996; *Deliberative democracy: Essays on reason and politics*, 1997; Elster, 1997;

Gutmann & Thompson, 1996). Specialized discourses, such as science and law, are not appropriate models for public discourse on moral conflicts not only because they are less democratic, but also because they can be too narrow for achieving the best, as in most legitimate and epistemically valuable, outcomes. In part, this is because specialized and formalized discourses such as those used in science can set too narrow a scope to what counts as acceptable reasoning and types of knowledge (Bohman, 1996; Gutmann & Thompson, 1996; Young, 1997). Although Rawls arguably saw scientific information as a model for reason and as more likely to be knowledge that is held in common and therefore more desirable for deliberation (Hurlbut, 2017), many political theorists since Rawls and Habermas have highlighted how viewing certain institutional discourses as models for public deliberation on moral disagreements is counter to the goals of such deliberation (Bohman, 1996; Gutmann & Thompson, 1996; Hurlbut, 2017; Young, 1997). As Bohman (1996) describes, specialized institutional models such as those used in scientific or judicial decision-making fail to achieve the inclusiveness and publicness needed for true democratic deliberation and filter out potentially reasonable ideas and other types of knowledge.

The goal of truly public deliberation is achieve a kind of objectivity by combining multiple viewpoints for a more complete picture (Young, 1997). When it comes to achieving this goal, the true or perceived objectivity of specialized fields' ways of producing knowledge, such as that of scientific or academic fields, will often not be successful because, "Impartiality is not identical with publicity" (Bohman, 1996, p. 45). Publicity is key to public deliberation. Objectivity in a public deliberation and decision-making depends on all perspectives being expressed (Young, 1997). Doing so successfully depends on sharing rationale not only in public settings but also in ways that are "public reasons" in the sense that they can be shared or accepted as legitimate viewpoints across different perspectives (Bohman, 1996; Gutmann & Thompson, 1996; Rawls, 1997).

Relying too heavily on a particular existing authority for justifying what views counts, therefore, harms these goals. It does so, first, because it relies on a non-public reason: belief in a particular authority without having to justify or elucidate how depending on that authority connects to broader, shared goals and views (Bohman, 1996; Gutmann & Thompson, 1996). Second, it sets a priori what will count as allowed rationale—bypassing a key purpose of deliberative process itself (Gutmann & Thompson, 1996; Young, 1997).

As public deliberation is particularly important in issues in which normal political decision-making and structures are not working—issues in which there are moral divides on issues that concern the rights and opportunities of citizens—such standardized discourse is typically not appropriate and/or has already failed to satisfactorily address the issues. It will not be likely on its own to help us better understand or truly address such conflict in a public way, especially in a way that will be seen as legitimate, even if participants disagree with the ultimate decision outcome (Bohman, 1996; Gutmann & Thompson, 1996). The authority in such cases lies with citizens and, if the political system is legitimate and functioning, with their elected representatives.

Deference to scientific authority matters as a concept because it reveals one way in which people might inappropriately ascribe authority to science in deciding on moral conflicts. We care about such views in part because they can serve as a barrier to actually accomplishing public deliberation. Although approaches for effectively implementing deliberation are still lacking (Bohman, 1996) or hindered by methodological and logistical issues (see the discussion between

Fishkin, 1991; Merkel, 1996, for an example), political theorists also acknowledge that the success of deliberation depends on the worldviews, ideologies, and general moral psychology of citizens (Bohman, 1996; Elster, 1997; Rawls, 1997). Researchers are typically well aware of the more logistical, organizational constraints to effective deliberation—namely, the plurality, complexity, and size of the modern populace and factors connected to societal issues (Bohman, 1996; *Civic engagement in American democracy*, 1999; *Deliberative democracy: Essays on reason and politics*, 1997). We are gaining a greater understanding but still have a ways to go, however, to understand the potential cultural, psychological, and behavioral barriers to deliberation (for examples across the social sciences, see Abramowitz, 2010; Altemeyer, 1996; Crawford & Pilanski, 2014; Haidt, 2012; Hibbing & Theiss-Morse, 2004; Kahneman & Tversky, 1982; Koleva, Graham, Iyer, Ditto, & Haidt, 2012; Lord, Ross, & Lepper, 1979). This dissertation and work on deference to scientific authority fits into the growing body of social science research that focuses on that latter category of obstacles to deliberation.

Deference & Beyond: The Danger of Conflating Normative & Scientific Conflicts

Based on the results of the studies in this dissertation, deference to scientific authority can be an obstacle to deliberation not only because it is a type of authoritarianism but because that authoritarianism appears to stem from over-claims of what science is capable of answering. Such over-claims can be harmful not only because they might pose a barrier that limits who gets to have a say in deliberation but also because they can perpetuate an image of science that is more likely to generate counter-productive pushback that further derails opportunities for deliberation. Many of the controversies we see around science and technology issues today and in the past few decades arguably to some degree involve conflated normative and descriptive questions. Discussion around climate change, for example, could have been a normative, policy-focused discussion over what, given the information available through science and other descriptive considerations about the world, we want to do to act or not act on that information. Of course, key actors helped create and encourage discussion focused more on how much uncertainty (real or created) was present in the scientific information on climate change and its impacts that devolution (Westervelt, 2019). But such doubt-creation could have been so successful in part because of how people tend to view the authority of science and to step quickly from its descriptive claims to prescribing certain societal actions as if those actions were a "given" based on the scientific evidence.

Misunderstanding "science" and science issues. Blending of science's descriptive claims with societal and political normative claims likely made it easier for conversation to be derailed into discussion of what the science says—as if that on its own prescribed a given policy answer—rather than on making explicit the rationale for different policy options. Although agreeing on scientific facts is an important part of such discussions, there are many avenues for finding overlapping goals and rationale beyond those facts. We see this, for example, in polls that highlight widespread agreement on advancing renewable energy research, even across groups that disagree on the cause or even existence of climate change (Funk, Kennedy, Hefferon, & Strauss, 2018; Popovich & Albeck-Ripka, 2017)

Missing opportunities for deliberation. Scientific information on its own does not provide any particular action as a given without the help of a particular moral belief or personal or societal goal attaching itself to the information. Seeing that global temperatures are rising and that man-made activities are causing that rise does not have to mean one cannot also argue for the value of continuing development of carbon-based fuels, per se—for short-term stability and economic gain, for example—or against a particular balance of regulation relative to using market place tools. The role of deliberation, then would be to see how well an interpretation of the scientific results in combination with other information aligns with broad societal and personal goals and moral rationale and how much we want to rely on particular considerations for shaping our decisions. When we conflate scientific evidence with normative claims, however, we bypass those discussions that need if we want any say in shaping our society. We end up without the deliberation needed to elucidate the different rationale given for particular viewpoints and courses of action and decide which are publically acceptable.

This can happen because of how we tend to misunderstand the bounds of science or because interested parties weaponize such misunderstandings of the scope of science to derail democratic deliberation. Such parties could be interested in derailing deliberation in these ways because when we do not have this deliberation and decision-making in public arenas such decision-making ends up confined to existing powerful institutions such as private actors in the market place or courts, where outcomes could also be more likely to benefit the status quo (Jasanoff, 2005). In these cases, broader groups of citizens, rather acting deliberately together as private individuals to determine the appropriate paths, end up consumers of or subjects to choices set by others without consent.

Missing key causes of conflict in science issues. Similarly, a related corollary of oversubscribing authority to scientific information is that reactions to “science” can be reactions to what people, sometimes rightly in certain cases, perceive as an illegitimate authority in such decision-making. For example, many groups who might be viewed as “anti-science” based on where they stand on views about the proper course of action given scientific information, often use scientific information to counter claims about what is the scope of certainty in existing scientific work. At least anecdotally, many such groups—such as the anti-vaccine, anti-GMO, and even the flat-earth movements—use and try to conduct their own scientific research to support their claims (Clark, 2018; GMOScience, 2019; London School of Economics, 2019), even if they cherry-pick or misunderstand the overall processes of science and what a single study can offer. Similarly, people who have concerns about one area of scientific research and its applications can be supportive of other types and uses of scientific research. Therefore, views about "science" within the context of a particular issue might be better understood as against a particular idea of science as an institutional authority and/or a particular application of science rather than against science as a way of collecting information to make descriptive claims about the world or against the whole body of scientific research and applications.

Returning to the bigger point of this section, in that sense, these reactions to "science" might be better understood as people at least implicitly recognizing that the term "science" and the ideas connected to it are often used to make claims about how people ought to live in society. For some of these people, then, although the way their views manifest can unhealthy both for individuals and society—as seen perhaps most clearly in the number of measles and other infectious disease outbreaks that are due to individuals going against scientific consensus that vaccination safely prevents against these diseases—the original source of their views is not necessarily unreasonable. Science is tied to epistemic, institutional, financial, and political power. If we fail to recognize the limits of its ability to make claims about how we ought to live, we risk letting those powers decide how we live. If we go too far in trying to counter those powers, however, without decoupling science's worth as a descriptive instrument from normative claims about how we use science and technology, we run the risk of floating in relativism—or, if we believe everyone who disagrees with us is wrong, locked in absolutism—without shared ground in sight. Framing such debates as “pro” versus “anti” science, therefore, could be more counterproductive to actually resolving conflicts and seems to be tied to misunderstanding of what the bounds of scientific authority are—on both the pro- and anti- sides of particular issues, such as vaccination and climate change.

Not getting to the heart of such debates and instead framing them as answerable only by having the “right” view of science can limit our ability to use scientific information in the ways in which it can really inform and add value to decisions. Deliberation could be one way to pull out those reasonable justifications and explicate them in a way that helps us see what shared ground there could be, even if disagreement still exists on those grounds. Science, within that process, can play an important role in providing information that helps us navigate less morally fraught, daily decisions as well as decide on multiple options and potential outcomes in large morally bound conflicts and assessing what implications particular decisions could have. We lose that ability to effectively use science if we keep fighting conflicts about what to do in society as if they are primarily answerable by agreeing on particular scientific information.

For this dissertation, the point is that while we in academic circles often focus on those who do not agree with scientific consensus or support particular science and technology research or applications, those who unquestionably defer to science can also have harmful impacts on democratic deliberation and society. To support and defer to science in areas in which it in cannot have legitimate authority is damaging to both science’s ability to provide useful information about the world and the democratic process for deciding on science and societal issues. The point of deliberation is not to reduce this disagreement, per se, but to make it productive and self-reflective—to make explicit what it is we are really talking about and why (Bohman, 1996; *Deliberative democracy: Essays on reason and politics*, 1997; Gutmann & Thompson, 1996; Young, 1997). Without this, we are just talking over each other in political discourse, likely about different things, while making assumptions about what the other person means without checking our own assumptions. The important decisions that should be through public deliberation get pushed to institutions that are more efficient in decision-making but less equipped to anticipate or answer these moral conflicts, which in the U.S. is particularly the court systems and market decisions (Jasanoff, 2005).

Deference prevalent, potential source of division in the U.S. Important to note for interpreting these potential implications of deference to scientific authority is that it does not appear to be a fringe view. In the 2016 U.S.-representative data set examined in Chapters 2 and 4, for example, approximately one-fifth of respondents agreed (indicated a 5 to 7 (somewhat to strongly agree) on the 7-point scale) with the deference items. Men are more likely to be more deferent to scientific authority, with 26 percent of men indicating that they are at least somewhat deferent compared to 17 percent of women. Deference to scientific authority also seems to align with value-based characteristics that typically relate to some of the divisions we see in public opinion and discourse in the U.S., such as religious guidance and political ideology. As the regression analyses throughout this dissertation illustrated, individuals who are more deferent are less likely to rely on religious guidance in their daily lives, are more politically liberal, and more likely to be. Based on the 2016 dataset, of those in the U.S. who indicate that they rely on religion for a great deal of daily guidance (the highest value on an 11-point scale), only a little less than 18 percent are at least somewhat (agree or strongly agree with the deference items) deferent to scientific authority, compared to 40 percent of those who say they receive no guidance from religion. Similarly, only 11 percent of political conservatives currently respond to the existing deference items in a manner indicating that they are at least somewhat deferent, compared to 38 percent of political liberals and 20 percent of moderates.

The amount of people who qualify as "deferent to scientific authority" will likely change as future research further refines how we conceptualize and capture deference, as I will describe below. The results, however, still illustrate the potential for such views to pose a significant barrier to deliberative decision-making on issues in science and society.

Moving Forward with Deference: Next Steps for Understanding the Concept

Challenges with the existing items

What do we mean by "defer?" As these analyses also highlighted, there is much work left to do to better understand and measure deference to scientific authority and its relationships and implications. We saw in Chapters 3 and 4 in particular that the existing deference items are difficult to interpret, do not appear to cleanly attach to a common sense or clearly explicated definition of what it means to "defer," and seem to be capturing slightly different ideas, even if also capturing deference. The existing data sets largely have only two deference items. As these chapters illustrated, those two can behave in very different ways. Capturing a complete picture of a complex and abstract concept such as deference to scientific authority is unlikely to happen with only two items. But with the two existing most common items in particular, it appears that item D2— "Scientists should do what they think is best, even if they have to persuade others that it is right"—is also capturing views of the rights of individuals to freely speak and act. This could be deference in the sense of respecting individuals' rights, but it is likely not only capturing deference in the sense of deferring to scientists as representative authorities due to their scientific expertise. Future development of items should include tests to see how much responses reflect seeing scientists as representative authorities of science, rather than as individuals, in decision-making on scientific issues.

The contexts of deference. What it means to defer depends on the decision-making context and in what ways one grants another a role in that decision-making. Additional weaknesses of the existing items are that they do not refer to decision-making in a particular context but research often uses them to claim that they capture authoritarian views toward decision-making on the societal implications of science. We saw in Chapters 2 and 3 that these items do relate to such views, but the items themselves do not explicitly refer to those views, despite what common definitions of deference to scientific authority suggest. It makes sense for capturing a complete picture of deference and why it matters to have items that capture deference in a particular context and to different degrees. For example, based on the deference literature in sociology, political science, and legal studies, items should encapsulate deference from a range of showing respect for authority to letting that authority decide in one’s place (Chan, 2017; Daly, 2012; Erickson, 1977; Goffman, 1997), including the degree to which the latter type of deference becomes a version of authoritarianism (Zhai, 2017).

Capturing this range of deference will require making explicit the context of interest for examining deference. If it is on decision-making on the societal and moral implications of science and technology, rather than decision-making on more purely scientific questions, the items should clarify that. As I will describe below when I propose particular ways of capturing deference, in many contexts deference will likely not be authoritarianism. Decisions that scientists make in basic research, for example, and beliefs that scientists have a place in helping inform decision-making on normative and societal implications, alongside citizens, seem less likely to be manifestations of authoritarianism than examples of respect for expertise and for more bounded roles in decision-making. The usefulness of deference to scientific authority for capturing a complete picture of the concept and its implications will depend on such elucidation of the features of the concept and its manifestation and implications in different decision-making contexts on science and technology.

We also saw in Chapters 2 and 3 that in all the models predicting participatory views of how much citizens should be involved in decision-making on science, the models explain only very little of the variance in responses to those items (from as little as 0.6 percent to only as much as 9.9 percent across the five different participatory views items in those two chapters). Those results could be an indicator that such views are more strongly related to concepts that were not captured here. It could also be due to flaws in those particular items that make it difficult for respondents to accurately respond to what the items are supposed to capture, or it could be due to respondents not having strong feelings regarding the concepts that the items intend to capture. Part of the work of further developing deference to scientific authority, especially as it encompasses authoritarian tendencies, should include improving our ability to understand what drives responses to these participatory views items and views of the roles of citizens in particular.

Deference v. belief in the authority of science & epistemic beliefs. These were also the first analyses to systematically assess the new authority of science items. The items hold well together and appear to capture slightly different degrees of believing that science is the best form of knowledge. Future work, however, could help assess the extent to which views of the authority of science are distinct but related to epistemic beliefs about knowledge in general and scientific knowledge in particular. I have argued here that the belief in the authority of science items are distinct from epistemic beliefs in that, rather than making a claim about what we are able to know and how, as epistemic beliefs capture (DeBacker et al., 2008; Grimm, 2008; Kienhues, 2013; Schraw et al., 2002), they state that a particular type of knowledge is best or most authoritative for a particular context. These views could still partly stem from epistemic beliefs, and indeed, as this analysis found, they are related to epistemic beliefs. They are distinct, however, in that they capture claims that science is the most authoritative type of knowledge compared to other types of knowledge when it comes to make valid and reliable claims about the world.

Additionally, as the analyses of the batteries of the epistemic belief items in Chapter 4 and the dogmatism and authoritarianism items in Chapters 3 and 4 revealed, the literature and operationalization of those concepts suffers from reliability and potentially from validity issues. Given the apparent importance of these concepts for understanding how views of science and authoritarianism in decision-making on science can stem from or relate to such dogmatic tendencies, pursuing more explication work on those areas will be a valuable contribution to understanding deference in particular and advancing social science on views of science issues and governance in those issues in particular.

Future Areas of Research

The origins of deference to scientific authority. As these limitations suggest, we have only skimmed the surface of deference to scientific authority. That view, however, has offered enough to suggest interesting and important areas to explore that are lurking beneath the surface of this concept. In addition to developing and testing more complete and clear batteries of items capturing deference to scientific authority, next steps can address some of the important remaining questions raised by this research. One of the main ones will be better understanding where deference to scientific authority comes from. We saw here that deference is highly related to views of the authority of science but also importantly distinct in how it positively relates to general dogmatism, to less democratic views on decision-making on science issues in particular, and in relating only to more narrow (and naïve/absolutist) epistemic views about the nature of scientific knowledge. As seen in the inconsistent relationship between the deference items and the general and science-specific education items, however, it would be worth examining in greater detail what role experiences with science in formal or informal education play in shaping views of science as authoritative and tendencies to defer to that authority.

Understanding deference through views of "science." We also saw some evidence that respondents could be reacting to the word "science" in particular. Part of this could be evidence of differences in domain-general versus domain-specific epistemic beliefs (Hofer, 2006), with people holding distinct views of science compared to views of knowledge in general. The pattern of responses, with people who were more deferent agreeing more primarily with only items that explicitly mentioned "science" could also reflect subconscious or implicit associations connected to the word "science" that could include idealized images of what science and its authority is. It would be interesting to test what the impact of including the word "science" is in expressed responses to a particular survey item or idea. If people appear to be reacting as much, or more, to the inclusion of that word rather than any particular idea expressed beyond inclusion of that word, that could have implications for how we conduct and interpret responses in research on science issues. Such analyses could also provide useful insights for understanding cultural and group-specific views of science and how they translate into expressed opinions on specific science issues or ideas.

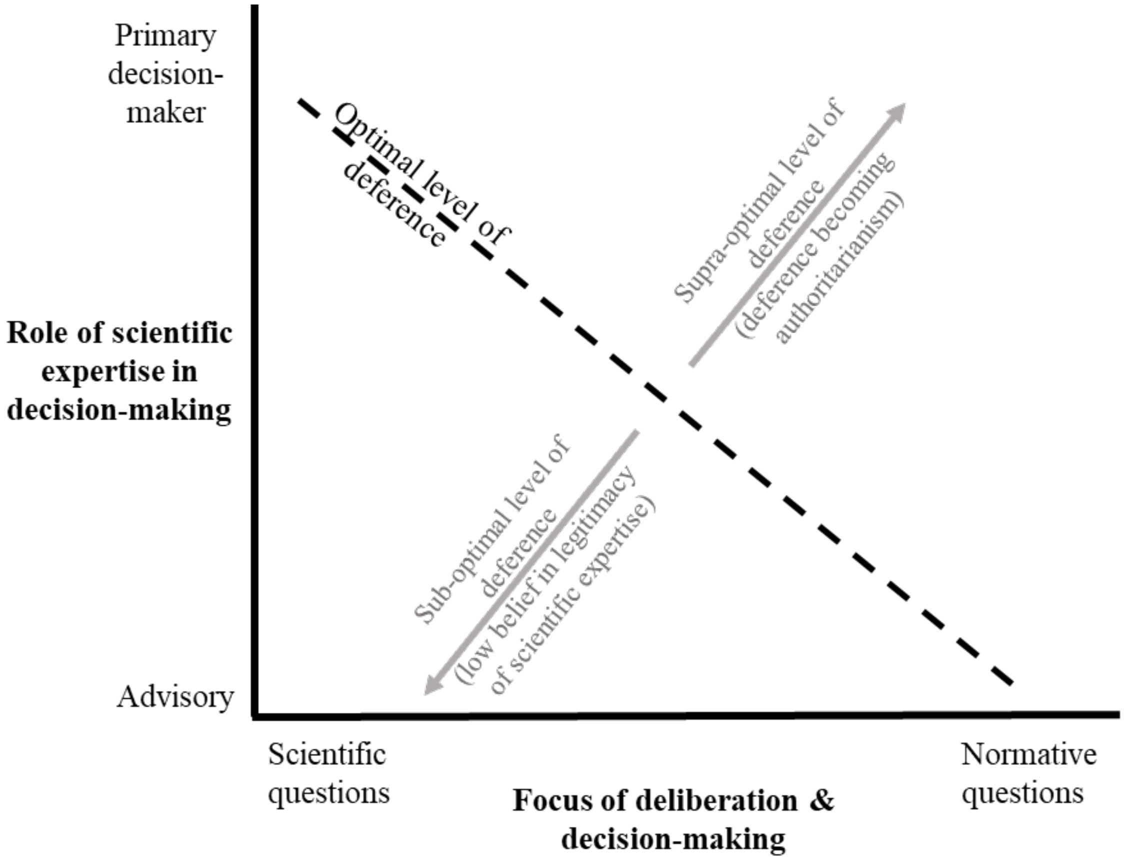
As a potential example of what such an examination could help us understand, particularly for survey research, research on trends in how much people in the U.S. trust scientists finds that trust in scientists has gone down among those who identify as Republicans but stayed relatively stable or gone up among those who identify as Independents or Democrats (Krause et al., forthcoming). Part of this trend could reflect real changes in opinions toward all scientists, which may or may not connect to changes in perceptions of science more broadly as an institution or an endeavor or to epistemic beliefs connected to science. Occurring simultaneously and possibly tied to these changes, however, could also be changes in what specific topics or issues related to “science” or “scientists” are top-of-mind when people see those words. For example, top-of-mind views of science in the 1970s and 1980s, when Republicans were more trusting on average of scientists than were Democrats (Krause et al., forthcoming), could have been more tied to science in industry and national defense and therefore science and technology with environmental impacts (Nixon, 1970; Whitaker, 1996) or connections to the military and war (NPR Staff, 2011; Williams, 1992). These are associations that could have a greater impact on Democrats’ perceptions than on Republicans’ (Boudet et al., 2014; Pierce, Boudet, Zanocco, & Hillyard, 2018) and potential reduce expressed trust in scientists among Democrats. Conversely, science today could be more commonly associated with policy decisions such as environmental regulation to counter potential negative impacts of technology, such as climate change—factors that could make Republicans more likely to see scientists as less trustworthy (Brewer, 2012; Campbell & Kay, 2014).

Responses to surveys and to particular words mask many assumptions, associations, and worldviews that would be useful to unearth for understanding what people mean when they talk about "science" and, therefore, the way we interpret potential implications of those views. We also see from the results in this dissertation, particularly in Chapter 2, that these general views of science—views of its authority and deference to that authority—have a huge relationship to expressed views of particular science and technology issues, such as human gene editing. If these general views are providing a starting point or stand-in for views about a particular technology, it is even more useful for conducting research and for understanding views of science and technology that we determine where these general views of science come from and what people think of when they think of science. This work could include a greater dive into some of the factors that this dissertation touched on but did not go into in great depth, including the relationships between views of the authority of science and deference to that authority with predispositions such as political ideology and religiosity. Such analyses will help us better understand the factors that shape views of science and how those views translate into opinions concerning science issues and decision-making on those issues.

Understanding deference as a cultural phenomenon—beyond the U.S. context. These more detailed analyses should also include examinations of cultures beyond the U.S. As described in the introduction, almost all of the work on deference to scientific authority, including this dissertation, has been within U.S. contexts (Anderson et al., 2012; Binder et al., 2016; Brossard, 2002; Brossard & Nisbet, 2007; Brossard & Shanahan, 2003; Ho et al., 2008; Ho et al., 2011; Kim et al., 2014; Lee & Scheufele, 2006). The exceptions are two studies that compared deference in its implications for support for nanotechnology in samples from the U.S. and from Singapore (Ho et al., 2010; Liang et al., 2015). Research on the cultural authority of science in general also tends to focus on western, and mainly U.S., contexts, although that is changing somewhat (*The cultural authority of science: Comparing across Europe, Asia, Africa and the Americas*, 2018). Based on that research and research studying political decision-making in different countries (*The cultural authority of science: Comparing across Europe, Asia, Africa and the Americas*, 2018; Hurlbut, 2017; Isakhan & Stockwell, 2015; Jasanoff, 2005), we know that the U.S. is culturally and politically unique in ways that will matter for how deference manifests and its implications. As we move forward in studying deference and views of the authority of science as they relate to views of emerging and controversial issues in science and society, we need more work examining other cultures to better understand deference to scientific authority and its implications overall.

A proposed model for capturing deference and its manifestations. Based on the findings and discussion above, it will be useful to be able to capture deference to scientific authority in a fuller range, from respect for others to deferring to others in decision-making, with extremity of deference in decision-making indicating a form of authoritarianism. This classification of what counts as respect versus bounded deference versus authoritarianism, however, also depends on the decision-making context: what the issue or questions of focus are in decision-making. Going forward, as we develop new items that allow us to capture this more complete and more nuanced picture of deference to scientific authority and its range of implications in decision-making on science issues, I propose the model illustrated in Figure IV as one way of thinking about the different scopes of deference as it concerns issues in science and society.

Figure IV: Model for categorizing levels of deference to scientific authority, depending on degree of deference and decision-making context in which it occurs.



In the model, the dotted line indicating the "optimal level of deference" captures the point across different decision-making contexts in which deference allows for a more effective and legitimate combination of scientific input and larger public considerations in deliberation and/or decision-making on a particular issue in science and society. Above that line indicates giving too much weight to scientific expertise in issues that do not have solely, or even primarily, scientific answers. Below that line indicates not seeing value in including scientific information or expertise in decision-making, even when such expertise could provide a more complete picture of an issue and of potential paths forward. The optimal level in practice in each context is up for debate, but in the model and in general, optimal deference represents a balance between these over-claims and under-claims of science's legitimate authority on particular questions and issues of debate. It is important to note, in this sense, that "supraoptimal," therefore, does not indicate "better than optimal" conditions. In this model, supraoptimal is the opposite of suboptimal in terms of its characteristics but is similarly undesirable in terms of its implications.

This model is, of course, a simplified version of the bounds of scientific authority in different contexts and the implications of those views concerning that authority in reality. Different people will likely have reasonable rationale for making the cut-off on where optimal deference lies. This will also be the case for deciding at what point deference deviates from granting scientists a bounded role in decision-making to granting unbounded roles in decisions that go beyond answering scientific questions, or what I have focused on here and called a version of authoritarianism. At the less extreme manifestations of deference, however, (and at the boundaries where one manifestation or decision-making contexts meets the next) there is also considerable room for discussion on what exactly deference looks like there and what its implications are. As a starting point, however, the model in Figure IV can help us add some nuance and provide terms and ways of thinking about deference to scientific authority that will help clarify and advance our ability to test and capture the concept.

The policy and communication implications of deference. Finally, as we improve our ability to capture and study deference to scientific authority, the overall goal will continue to be understanding what its implications are in policy and communication settings concerning scientific issues in society. In particular, this will include understanding the negative effects of straying from either side of that optimal line of deference to scientific authority and testing how to avoid or alleviate those negative effects. As one example of an open-question and area that such research could examine, if, as theorized, levels of deference to scientific authority represent a predisposition that is relatively stable, is it even possible to address its worst effects, such as overly deferent people not seeing the value in deliberation on normative questions?

Theoretically, I believe it should be possible to address these effects—even if not by changing people's level of deference overall—by changing the conversations and perceptions of what science offers and what is up for debate in conflict concerning a particular scientific issue in society. Summarizing what I have argued throughout this chapter, people who are overly deferent to scientific authority in the sense of believing that science is the authority to questions of how we want to use scientific information and applications in society misunderstand both science and the nature of these issues in science and society. Those two areas of misunderstanding are also two potential avenues for communication and engagement to help complicate and move beyond those misconceptions in ways that allow for more productive discourse.

For example, greater focus in science communication and education on the scientific process and what it offers could be one way to do this—as many in different social science fields and advisory boards have already recommended (see, for example, National Academies of Sciences, 2019). Similarly, as I touched on in the earlier sections of this chapter, in discourse on particular science and societal issues—such as climate change or human gene editing—communicators can be more explicit about what in particular is the root of disagreement and what it is that we need to decide on. This could allow people who are more deferent, and people in general, to see these issues as more than just science issues answerable by agreement on a particular scientific fact. Recognizing these issues as societal and moral issues tied to but going beyond particular scientific facts could help us move toward greater deliberation and perhaps common ground on what we want to do, in what ways, and why.

Conclusion

If we believe democracy is the best approach—normatively, practically, and epistemically—to governance and that science information and processes for gathering information have an important place in how we make decisions, we need to be able to make explicit the benefits and bounds of what science can tell us and have legitimate processes for deciding how to use science and technology in society. Public deliberation can help us do this. But overly narrow and misguided views of what science is and who should and should not be involved in decision-making on societal issues involving science will likely hinder the effectiveness and quality of any such deliberation. Deference to scientific authority, as a version of authoritarianism when it comes to who should be involved in decision-making on the normative questions concerning how we use science in society, is one such barrier to creating opportunities for, and carrying out, effective deliberation.

Based on the conceptual and empirical work conducted for this dissertation, it appears that deference to scientific authority can stem from misperceptions of the bounds of science's authority to provide prescriptive information on what we, as individuals and as a society, ought to do. These views stem from belief in science as authoritative knowledge, likely transmitted through cultural views in the U.S. of the authority of science. They go beyond simply seeing science as authoritative and providing a true picture of the world, accessible through expertise, to seeing science as being a sole and legitimate authority on in decisions on what the appropriate societal implications of science and technology should be. Such normative claims, however, belong in the realm of the public sphere and to decision-making that is accessible to citizens and to their legitimate democratic representatives. The scientific process cannot provide legitimate answers to resolve the moral conflicts tied to such claims and questions about societal issues. Scientists cannot serve as representatives for citizens or as authorities for such claims except in their roles as individual citizens or if democratically elected as political representatives.

There are two overlapping problems with treating science as though it does have the answer to the moral conflicts that arise when we have to decide how to use and shape science and technology information and applications in society. One is that it can result in bypassing the deliberation we should have in these issues by not creating space for public involvement. The other is that this authoritarianism can also produce the pushback we see when people recognize that groups in public discourse often use or refer to science as if it had authority in such normative claims. In such cases, people who dissent with a particular normative claim might want to counter this admittedly illegitimate power and use of science but often do so without separating the illegitimate authority of science in normative claims from the usefulness or potential epistemic authority of science in descriptive claims. The result can be that debates that should involve deliberation about what to do, based on explicitly and publicly shared rationale, turn into largely unresolvable debates about what is true and who is right. Deference to scientific authority, then, matters because of its authoritarian tendencies to bypass important deliberation and in the extreme counter-reactions that this misguided deference can trigger.

What we need, then, is to disentangle the descriptive information that science can offer from the normative questions that usually have no clear right answer beyond what we deliberatively and democratically decide is appropriate. Such a separation of what we mean by the value of including scientific information in decision-making can help us move conversations to more productive and democratic places by helping us parse out what we can say based on scientific information, why we care about or know particular facts, what to do with that information or lack of information, and where future research can inform further deliberation. This is, of course, a simplified, idealized version of how deliberative discussion on controversial issues concerning science and technology would likely look, and we have much work to do to logistically and socially create space for such deliberation. Having a chance to parse out the complexity of these issues on how we use scientific applications and information in society, however, with a clear picture of what we are disagreeing about and why, could go a long way to helping us understand where we as individual citizens and as a society stand and how we want to move forward.

Appendix A—Results from Chapter 3

Results from Analyses of 2010 Data: Deference & Participatory Views

Table AI: Correlations between deference, participatory views, and education. 2010 Knowledge Networks dataset.

Pearson's correlation (unless otherwise noted)	*D1*	*D2*	*P3*	*P4*
Scientists know best what is good for the public (*D1*)				
Scientists should do what they think is best, even if they have to convince others that it is right (*D2*)	0.50***			
Public opinion is more important than scientists' opinion when making decisions about scientific research (*P3*)	-0.02	-0.15***		
Scientists should pay attention to the wishes of the public, even if they think they are mistaken (*P4*)	0.00	-0.08***	0.48***	
Education	0.07***	0.20***	-0.15***	-0.06***
Science degree†	0.13***	0.18***	-0.09***	-0.02***

†Spearman's rho reported because variable is dichotomous. *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$

Table AII: OLS regression analysis predicting belief that scientists know best what is good for the public (deference item 1). 2010 Knowledge Networks dataset.

	Standardized betas			
	Model 1	*Model 2*	*Model 3*	*Model 4*
Age	-0.10***	-0.09**	-0.11***	-0.11***
Gender (female)	-0.03	-0.02	0.00	0.00
Education	0.07**	0.02	-0.01	-0.01
Adjusted R^2 (%)	*1.4****			
Science education		0.11***	0.10***	0.10***
Adjusted R^2 (%)		*1.0****		
News attention			0.12***	0.12***
Adjusted R^2 (%)			*1.2****	
†Public opinion more important (*P3*)				-0.01
†Scientists should pay attention to public (*P4*)				0.00
Adjusted R^2 (%)				*0.0*
Total adjusted R^2 (%)				**3.7**

†Before-entry coefficients. N = 2288; *p≤0.05; **p≤0.01; ***p≤0.001.

Table AIII: OLS regression analysis predicting belief that scientists should do what they think is best, even if they have to persuade others that it is right (deference item 2). 2010 Knowledge Networks dataset.

	Standardized betas			
	Model 1	*Model 2*	*Model 3*	*Model 4*
Age	-0.03	-0.02	-0.05**	-0.06**
Gender (female)	-0.10***	-0.10***	-0.07***	-0.07***
Education	0.19***	0.14***	0.09***	0.08***
Adjusted R^2 (%)	*4.8****			
Science education		0.11***	0.09***	0.09***
Adjusted R^2 (%)		*1.0****		
News attention			0.20***	0.19***
Adjusted R^2 (%)			*3.2****	
†Public opinion more important (*P3*)				-0.11***
†Scientists should pay attention to public (*P4*)				-0.08***
Adjusted R^2 (%)				*1.3****
Total adjusted R^2 (%)				**10.3**

†Before-entry coefficients. N = 2286; *p≤0.05; **p≤0.01; ***p≤0.001.

Table AIV: OLS regression analysis predicting belief that public opinion is more important than scientists' opinion when making decisions about scientific research (participatory views item 3). 2010 Knowledge Networks dataset.

	Standardized betas			
	Model 1	*Model 2*	*Model 3*	*Model 4*
Age	-0.05*	-0.05	-0.05*	-0.05**
Gender (female)	0.01	0.01	0.00	0.00
Education	-0.10***	-0.14***	-0.13***	-0.12***
Adjusted R^2 (%)	*2.4****			
Science education		-0.03	-0.03	-0.02
Adjusted R^2 (%)		*0.0*		
News attention			-0.05*	-0.03
Adjusted R^2 (%)			*0.1**	
Deference				-0.08***
Adjusted R^2 (%)				*0.6****
Total adjusted R^2 (%)				**3.1**

N = 2301; *p≤0.05; **p≤0.01; ***p≤0.001.

Table AV: OLS regression analysis predicting belief that scientists should pay attention to the wishes of the public, even if they think citizens are mistaken or do not understand their work (participatory views item 4). 2010 Knowledge Networks dataset.

	Standardized betas			
	Model 1	*Model 2*	*Model 3*	*Model 4*
Age	0.03	0.03	0.02	0.02
Gender (female)	0.02	0.02	0.02	0.02
Education	-0.06**	-0.06**	-0.07**	-0.07**
Adjusted R^2 (%)	*0.4**			
Science education		0.00	0.00	0.00
Adjusted R^2 (%)		*0.0*		
News attention			0.04	0.05*
Adjusted R^2 (%)			*0.0*	
Deference				-0.05*
Adjusted R^2 (%)				*0.2**
Total adjusted R^2 (%)				**0.6**

N = 2304; *p≤0.05; **p≤0.01; ***p≤0.001.

Results from Analyses of 2012 Data: Deference & Dogmatism

Table AVI: Correlations between deference, participatory views, dogmatism, trust, and education. 2012 GfK dataset.

Pearson's correlation (unless otherwise noted)	*D1*	*D2*	*Wt. sci.*	*Wt. citizens*	*Dogma 1*	*Dogma 2*	*Dogma 3*	*Dogma 4*	*Trust uni. sci.*	*Trust indus. sci.*
Scientists know best what is good for the public (*D1*)		.56***	.27***	-.09**	.15***	.21***	.30***	.22***	.29***	.26***
Scientists should do what they think is best. . . (*D2*)			.31***	-.05	.18***	.23***	.33***	.19***	.31***	.25***
Weight scientists should have (*Wt. sci*)				.25***	.05	.17***	.16***	.02	.57***	.39***
Weight citizens should have (*Wt. citizens*)					.14***	.16***	.02	.04	.19***	.14***
The principles I believe in different from those others believe (*Dogma 1*)						.18***	.32***	.24***	.05	.04
Often reserve judgment until hear opinions of someone respected (*Dogma 2*)							.26***	.17***	.26***	.18***
Most people don't know what's good for them (*Dogma 3*)								.24***	.22***	.15***
Best to pick friends whose beliefs same as own (*Dogma 4*)									.02	.08*
Trust in university scientists (*Trust uni. sci.*)										.61***
Education	.06*	.07**	.20***	.05	-.06*	.00	-.03	.01	.16***	.09*
Number of science courses	.08**	.20***	.23***	.00	-.03	.04	.01	.01	.17***	.10**
Degree in science field†	.08**	.15***	.12***	.00	-.03	.03	.02	.04	.12***	.04

†Spearman's rho reported because variable is dichotomous. *p≤0.05; **p≤0.01; ***p≤0.001

Table AVII: Maximum likelihood exploratory factor analysis exploring deference items, views of role of citizens and scientists in decision-making, and dogmatism items. Promax (oblique) rotation. Random sample of 50 percent of 2012 GfK dataset responses.

Pattern matrix[a] **(**Structure matrix loadings in parentheses) *Item*	**Factor Loadings**		
	Factor 1	***Factor 2***	***Factor 3***
Scientists know best what is good for the public (D1)	**0.814** (*0.757*)	-0.111 (*0.262*)	-0.031 (*0.112*)
Scientists should do what they think is best, even if they have to convince others that it is right (D2)	**0.700** (*0.672*)	-0.095 (*0.239*)	0.078 (*0.201*)
Weight scientists should have when society is faced with decisions about scientific issues (Wt. scientist)	0.155 (*0.563*)	**0.928** (*0.987*)	0.108 (*0.029*)
Weight citizens should have issues when society is faced with decisions about scientific issues (Wt. citizens)	-0.279 (*-0.027*)	**0.494** (*0.379*)	0.123 (0.127)
The principles I believe in are quite different from those believed in by others (Dogma 1)	-0.048 (*0.146*)	0.094 (*0.163*)	**0.791** (*0.792*)
I often reserve my judgment until I have had the chance to hear the opinions of someone I respect (Dogma 2)	0.131 (*0.259*)	0.190 (*0.275*)	0.209 (*0.256*)
Most people just don't know what's good for them (Dogma 3)	**0.363** (*0.457*)	0.085 (*0.286*)	0.280 (*0.360*)
In the long run it is best to pick friends whose beliefs are the same as your own (Dogma 4)	0.206 (*0.221*)	-0.097 (*0.035*)	**0.314** (*0.342*)
Eigenvalue (initial in parentheses)	(*2.41*) 1.49	(*1.30*) 1.27	(*1.15*) 0.71
Cumulative % of variance	18.7	34.5	43.4
[a]Rotation converged in 5 iterations.			
Factor correlation matrix	***Factor 1***	***Factor 2***	***Factor 3***
Factor 1	---	0.463	0.191
Factor 2	---	---	0.116

Goodness-of-fit: Chi-square = 20.77; df = 7; sig = 0.004; RMSEA = 0.07. N = 352.

Table AVIII: OLS regression analysis predicting belief that scientists know best what is good for the public (deference item 1). 2012 GfK dataset.

	Standardized betas					
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
Age	-0.04	-0.03	-0.03	-0.02	-0.02	-0.02
Gender (female)	-0.01	-0.01	0.02	0.00	-0.01	-0.02
Education	0.04	0.03	0.02	0.02	0.00	0.01
Adjusted R^2 (%)	*0.0*					
Science education		0.03	0.01	0.02	0.00	-0.01
Adjusted R^2 (%)		*0.0*				
News attention			0.06	0.03	-0.03	-0.03
Adjusted R^2 (%)			*0.0*			
Dogmatism (*sum*)				0.31***	0.26***	0.27***
Adjusted R^2 (%)				*9.2****		
Trust in scientists					0.25***	0.28***
Adjusted R^2 (%)					*5.6****	
Wt. citizens						-0.18***
Adjusted R^2 (%)						*3.1****
Total adjusted R^2 (%)						**17.9**

N = 772; *p≤0.05; **p≤0.01; ***p≤0.001

Table AIX: OLS regression analysis predicting belief that scientists should do what they think is best, even if they have to persuade others that it is right (deference item 2). 2012 GfK dataset.

	Standardized betas					
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
Age	-0.10**	-0.06	-0.06	-0.06	-0.06	-0.05
Gender (female)	-0.02	-0.01	0.00	-0.02	-0.03	-0.03
Education	0.08*	-0.01	-0.02	-0.02	-0.04	-0.03
Adjusted R^2 (%)	*1.2***					
Science education		0.21***	0.19***	0.19***	0.18***	0.17***
Adjusted R^2 (%)		*3.1****				
News attention			0.07	0.04	-0.01	-0.01
Adjusted R^2 (%)			*0.3*			
Dogmatism (*sum*)				0.31***	0.26***	0.27***
Adjusted R^2 (%)				*9.3****		
Trust in scientists					0.23***	0.25***
Adjusted R^2 (%)					*4.6****	
Wt. citizens						-0.13***
Adjusted R^2 (%)						*2.5****
Total adjusted R^2 (%)						**20.0**

N = 772; *p≤0.05; **p≤0.01; ***p≤0.001

Table AX: OLS regression analysis predicting weight that citizens should have when society faced with decisions about scientific issues. 2012 GfK dataset.

	Standardized betas					
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
Age	0.02	0.01	0.01	0.02	0.01	0.01
Gender (female)	-0.01	-0.01	0.00	-0.01	-0.01	-0.02
Education	0.05	0.05	0.05	0.05	0.05	0.03
Adjusted R^2 (%)	*0.0*					
Science education		-0.02	-0.03	-0.03	-0.01	-0.01
Adjusted R^2 (%)		*0.0*				
News attention			0.06	0.05	0.05	0.01
Adjusted R^2 (%)			*0.0*			
Dogmatism (*sum*)				0.13***	0.18***	0.16***
Adjusted R^2 (%)				*1.5****		
Deference					-0.15***	-0.21***
Adjusted R^2 (%)					*1.8****	
Trust in scientists						0.21***
Adjusted R^2 (%)						*3.6****
Total adjusted R^2 (%)						**6.9**

N = 776; *p≤0.05; **p≤0.01; ***p≤0.001

Results from Analyses of 2014 Data: Deference, Dogmatism, & Free Speech

Table AXI: Correlations between deference, support for free speech, dogmatism, trust, and education. 2014 GfK dataset

Pearson's correlation (unless otherwise noted)	*D1*	*D2*	*Free speech 1*	*Free speech 1*	*Dogma 5*	*Dogma 6*	*Dogma 7*	*Dogma 8*	*Trust uni. sci.*	*Trust industry scientists*
Scientists know best what is good for the public (*D1*)		.69***	.09***	.09***	.19***	.04*	.16***	.10***	.47***	.41***
Scientists should do what they think is best. . . (*D2*)			.16***	.14***	.14***	.00	.08***	.06***	.49***	.42***
Should be able to express controversial idea publicly (*Free speech 1*)				.53***	-.07***	.14***	-.01	.10***	.22***	.14***
Everyone should be free to propagandize for what they believe (*Free speech 2*)					.02	.21***	.10***	.21***	.14***	.12***
Need to restrict freedom of certain groups (*Dogma 5*)						.27***	.28***	.29***	.13***	.14***
Dangerous to compromise, betrays own (*Dogma 6*)							.37***	.41***	-.03	.09***
Changing mind a weakness (*Dogma 7*)								.41***	-.02	.07***
Classify people as for or against me (*Dogma 8*)									.02	.06**
Trust in university scientists (*Trust uni sci.*)										.57***
Education	.06***	.18***	.10***	-.01	-.04	-.13***	-.13***	-.12***	.20***	.12***
Number of science courses	.11***	.19***	.08***	-.01	-.04*	-.08***	-.09***	-.07***	.18***	.13***
Degree in science field†	.09***	.16***	.06***	.03	-.05**	-.04*	-.02	-.03	.11***	.08***

†Spearman's rho reported because variable is dichotomous. *p≤0.05; **p≤0.01; ***p≤0.001

Table AXII: Maximum likelihood exploratory factor analysis exploring deference items, support for free speech, and general authoritarianism. Promax (oblique) rotation. Random sample of 50 percent of 2014 GfK dataset responses.

Pattern matrix[a] **(**Structure matrix loadings in parentheses) *Item*	**Factor Loadings**		
	Factor 1	***Factor 2***	***Factor 3***
Scientists know best what is good for the public (D1)	0.071 (*0.226*)	**0.833** (*0.844*)	-0.021 (*0.090*)
Scientists should do what they think is best, even if they have to convince others that it is right (D2)	-0.061 (*0.108*)	**0.809** (*0.807*)	0.082 (*0.166*)
No matter how controversial an idea is, an individual should be able to express it publicly (Free speech 1)	-0.071 (*0.084*)	0.026 (*0.109*)	**0.824** (*0.814*)
Everybody should have complete freedom to propagandize for what they believe to be true (Free speech 2)	0.080 (*0.200*)	0.041 (*0.129*)	**0.615** (*0.635*)
Even though freedom of speech for all is a worthwhile goal, unfortunately necessary to restrict freedom of certain groups (Dogma 5)	**0.472** (*0.469*)	0.142 (*0.212*)	-0.169 (-*0.067*)
It is dangerous to compromise with our political opponents because it usually leads to betrayal of our own side (Dogma 6)	**0.603** (*0.603*)	-0.135 (-*0.003*)	0.137 (*0.231*)
Changing one's mind is a sign of weakness (Dogma 7)	**0.638** (*0.632*)	0.031 (*0.145*)	-0.069 (*0.051*)
I tend to classify people as either for me or against me (Dogma 8)	**0.660** (*0.676*)	-0.006 (*0.131*)	0.095 (*0.215*)
Eigenvalue (initial values in parentheses)	(*2.35*) 1.71	(*1.57*) 1.14	(*1.45*) 1.14
Cumulative % of variance	21.4	35.6	49.8
[a]Rotation converged in 5 iterations.			
Factor correlation matrix	***Factor 1***	***Factor 2***	***Factor 3***
Factor 1	---	0.191	0.182
Factor 2	---	---	0.117

Goodness-of-fit: Chi-square = 12.87; df = 7; sig = 0.075; RMSEA = 0.02; N = 1523.

Table AXIII: OLS regression analysis predicting belief that scientists know best what is good for the public (deference item 1). 2014 GfK dataset.

	Standardized betas					
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
Age	-0.11***	-0.10***	-0.13***	-0.12***	-0.12***	-0.08***
Gender (female)	-0.03	-0.02	0.00	0.01	0.01	-0.01
Education	0.06***	-0.04	-0.07*	-0.04	-0.05	-0.07**
Adjusted R^2 (%)	*1.6****					
Science education		0.13***	0.11***	0.11***	0.11***	0.08***
Adjusted R^2 (%)		*0.6****				
News attention			0.15***	0.13***	0.12***	0.03
Adjusted R^2 (%)			*1.9****			
Dogmatism				0.16***	0.15***	0.11***
Adjusted R^2 (%)				*2.4****		
Free speech					0.06***	0.00
Adjusted R^2 (%)					*0.3****	
Trust in scientists						0.45***
Adjusted R^2 (%)						*17.9****
Total adjusted R^2 (%)						**24.7**

N = 3095; *p≤0.05; **p≤0.01; ***p≤0.001

Table AXIV: OLS regression analysis predicting belief that scientists should do what they think is best, even if they have to persuade others that it is right (deference item 2). 2014 GfK dataset.

	Standardized betas					
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
Age	-0.03	-0.02	-0.05**	-0.04*	-0.05**	-0.01
Gender (female)	-0.08***	-0.07***	-0.05**	-0.04*	-0.04*	-0.06***
Education	0.18***	0.06*	0.03	0.05	0.05	0.02
Adjusted R^2 (%)	*3.7****					
Science education		0.14***	0.12***	0.12***	0.13***	0.09***
Adjusted R^2 (%)		*0.8****				
News attention			0.16***	0.15***	0.12***	0.03
Adjusted R^2 (%)			*2.1****			
Dogmatism				0.11***	0.09***	0.05***
Adjusted R^2 (%)				*1.1****		
Free speech					0.12***	0.06***
Adjusted R^2 (%)					*1.3****	
Trust in scientists						0.45***
Adjusted R^2 (%)						*17.7****
Total adjusted R^2 (%)						**26.7**

N = 3088; *p≤0.05; **p≤0.01; ***p≤0.001

Appendix B—Results from Chapter 4

Results from Part I: Analysis of 2016 YouGov Dataset

Table BI: OLS regression analysis predicting belief that scientists know best what is good for the public (deference item 1). 2016 YouGov dataset.

	Standardized betas					
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
Age	-0.19***	-0.19***	-0.20***	-0.18***	-0.16***	-0.14**
Gender (female)	-0.03	-0.03	-0.02	0.00	-0.01	-0.01
Education	-0.06*	-0.04	-0.04	-0.04	-0.04	-0.04
Adjusted R^2 (%)	*3.7****					
Science education		-0.03	-0.04	-0.05	-0.10***	-0.10***
Adjusted R^2 (%)		*0.0*				
News attention			0.04	0.04	-0.08***	-0.11***
Adjusted R^2 (%)			*0.1*			
Religiosity				-0.16***	0.10***	0.09***
Adjusted R^2 (%)				*2.3****		
Authority of science					0.61***	0.49***
Adjusted R^2 (%)					*28.7****	
Trust in scientists						0.26***
Adjusted R^2 (%)						*5.1****
Total adjusted R^2 (%)						**39.9**

N = 1546; *p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001.

Table BII: OLS regression analysis predicting belief that scientists should do what they think is best, even if they have to persuade others that it is right (deference item 2). 2016 YouGov dataset.

	Standardized betas					
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
Age	-0.13***	-0.13***	-0.16***	-0.12***	-0.11***	-0.09***
Gender (female)	-0.13***	-0.13***	-0.11***	-0.08**	-0.08***	-0.09***
Education	0.04	0.05	0.03	0.03	0.04	0.03
Adjusted R^2 (%)	*3.4****					
Science education		-0.02	-0.04	-0.05	-0.10***	-0.10***
Adjusted R^2 (%)		*0.0*				
News attention			0.13***	0.12***	0.00	-0.03
Adjusted R^2 (%)			*1.2****			
Religiosity				-0.25***	0.02	0.01
Adjusted R^2 (%)				*5.8****		
Authority of science					0.62***	0.51***
Adjusted R^2 (%)					*29.0****	
Trust in scientists						0.22***
Adjusted R^2 (%)						*3.4****
Total adjusted R^2 (%)						**42.8**

N = 1553; *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$.

Table BIII: OLS regression analysis predicting belief that science is the best way to understand the world (authority of science item 1). 2016 YouGov dataset.

	Standardized betas					
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
Age	-0.03	-0.02	-0.05*	0.01	0.09***	0.10***
Gender (female)	-0.09***	-0.08***	-0.05*	0.01	0.03	0.02
Education	0.10***	0.01	-0.02	-0.01	-0.01	-0.02
Adjusted R^2 (%)	*1.6****					
Science education		0.13***	0.10**	0.08***	0.11***	0.10***
Adjusted R^2 (%)		*0.8****				
News attention			0.17***	0.16***	0.11***	0.08***
Adjusted R^2 (%)			*2.3****			
Religiosity				-0.42***	-0.30***	-0.29***
Adjusted R^2 (%)				*16.9****		
Deference					0.54***	0.47***
Adjusted R^2 (%)					*26.1****	
Trust in scientists						0.13***
Adjusted R^2 (%)						*1.2****
Total adjusted R^2 (%)						**48.9**

N = 1553; *p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001.

Table BIV: OLS regression analysis predicting belief that science is the best way we have for producing reliable knowledge (authority of science item 2). 2016 YouGov dataset.

	Standardized betas					
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
Age	-0.08**	-0.06*	-0.10***	-0.05*	0.04	0.04*
Gender (female)	-0.08**	-0.08**	-0.04	0.01	0.04	0.03
Education	0.12***	0.03	0.00	0.00	0.00	0.00
Adjusted R^2 (%)	*2.4****					
Science education		0.13***	0.09**	0.08*	0.10***	0.09***
Adjusted R^2 (%)		*0.8****				
News attention			0.22***	0.22***	0.17***	0.14***
Adjusted R^2 (%)			*4.2****			
Religiosity				-0.37***	-0.25***	-0.24***
Adjusted R^2 (%)				*13.0****		
Deference					0.52***	0.43***
Adjusted R^2 (%)					*24.6****	
Trust in scientists						0.18***
Adjusted R^2 (%)						*2.2****
Total adjusted R^2 (%)						**47.2**

N = 1550; *p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001.

Results from Part II: Analysis of 2018 Amazon Mechanical Turk Dataset

Table BV: Correlations between dogmatism items, battery A. 2018 Amazon Mechanical Turk dataset.

Pearson's correlation	*Dog A1*	*Dog A2*	*Dog A3*	*Dog A4*	*Dog A5*	*Dog A6*	*Dog A7*	*Dog A8*	*Dog A9*
Better understanding of ideas I believe than ones I oppose (Dog A1)									
It is natural to fear the future (Dog A2)	0.27***								
There is so much to do and so little time to do it in (Dog A3)	0.08	0.16***							
In heated discussion, become so caught up that I forget to listen (Dog A4)	0.12**	0.07	-0.02						
The main thing in life is to want to do something important (Dog A5)	0.10*	0.24***	0.10*	0.10*					
Reserve judgement until hear opinions of those one respects (Dog A6)	0.17***	0.14***	0.21***	-0.10*	0.07				
Not good to only pick friends with same beliefs as own (Dog A7)	-0.06	-0.01	0.07	-0.07	0.10*	0.14***			
People who disagree with me may well turn out to be right (Dog A8)	0.04	0.08	0.07	-0.12**	-0.07	0.22***	0.29***		
Most people know what's good for themselves (Dog A9)	0.10*	0.07	-0.01	-0.04	0.11*	0.10*	0.05	0.07	
Principles I believe in similar what most others believe in (Dog A10)	0.15***	0.14***	0.11**	0.13**	0.17***	0.13**	0.11**	0.16***	0.28***

*p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001.

Table BVI: Correlations between dogmatism items, battery B. 2018 Amazon Mechanical Turk dataset

Pearson's correlation	*Dog B1*	*Dog B2*	*Dog B3*	*Dog B4*	*Dog B5*	*Dog B6*	*Dog B7*	*Dog B8*	*Dog B9*
Highest form of democracy run by most intelligent (Dog B1)									
Only way to know what's going on is to rely on trusted experts (Dog B2)	0.36***								
Humans on their own are helpless and miserable (Dog B3)	0.06	0.25***							
I'd like someone to tell me how to solve my problems (Dog B4)	0.12**	0.23***	0.27***						
The main thing in life is to want to do something important (Dog B5)	0.25***	0.21***	0.06	0.13**					
My blood boils whenever someone refuses to admit he's wrong (Dog B6)	0.18***	0.13**	0.18***	0.17***	0.23***				
Two kinds of people: those for and those against truth (Dog B7)	0.18***	0.16***	0.34***	0.17***	0.28***	0.20***			
Most of the ideas printed these days aren't worth the paper (Dog B8)	-0.05	0.02	0.20***	0.00	0.06	0.07	0.24***		
Most people know what's good for themselves (Dog B9)	0.01	0.04	-0.12**	0.00	0.12**	-0.10*	0.02	0.02	
Of all philosophies, probably more than one correct (Dog B10)	0.12**	0.07	-0.19***	0.15***	0.19***	0.11*	-0.09*	-0.15***	0.09

*p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001.

Table BVII: Maximum likelihood exploratory factor analysis exploring dogmatism items, battery A. Promax (oblique) rotation. 2018 Amazon Mechanical Turk dataset.

Pattern matrix[a] (Structure matrix loadings in parentheses) *Item*	**Factor Loadings**			
	Factor 1	***Factor 2***	***Factor 3***	***Factor 4***
It is only natural that a person has a better understanding of ideas he or she believes in than with ideas he or she opposes (Dog A1)	0.022 (*0.156*)	-0.065 (*0.077*)	**0.577** (*0.538*)	-0.159 (-*0.043*)
It is natural to fear the future (Dog A2)	0.002 (*0.157*)	0.114 (*0.227*)	**0.475** (*0.495*)	-0.041 (*0.048*)
There is so much to do and so little time to do it in (Dog A3)	0.027 (*0.125*)	0.033 (*0.089*)	0.228 (*0.268*)	0.125 (*0.173*)
In a heated discussion, I generally become so caught up that I forget to listen to what others are saying (Dog A4)	0.145 (*0.125*)	0.052 (*0.100*)	0.082 (*0.083*)	-0.287 (-*0.245*)
The main thing in life is for a person to want to do something important (Dog A5)	0.014 (*0.185*)	**0.990** (*0.999*)	0.030 (*0.266*)	-0.003 (-*0.014*)
It is often desirable to reserve judgement about what's going on until one has a chance to hear the opinions of those one respects (Dog A6)	-0.012 (*0.150*)	-0.007 (*0.063*)	**0.334** (*0.391*)	**0.329** (*0.390*)
It is not good to only pick friends whose beliefs are the same as your own (Dog A7)	0.048 (*0.124*)	0.122 (*0.092*)	-0.122 (*0.016*)	**0.493** (*0.476*)
The people who disagree with me may well turn out to be right (Dog A8)	0.070 (*0.178*)	-0.105 (-*0.083*)	0.085 (*0.182*)	**0.527** (*0.558*)
Most people know what's good for themselves (Dog A9)	0.248 (*0.282*)	0.045 (*0.099*)	0.060 (*0.155*)	0.045 (*0.103*)
The principles I believe in are similar to those most other people believe in (Dog A10)	**1.01** (*0.999*)	-0.015 (*0.147*)	-0.018 (*0.281*)	-0.020 (*0.167*)
Eigenvalue (initial values in parentheses)	(*1.96*) 1.40	(*1.44*) 0.90	(*1.13*) 0.81	(*1.01*) 0.58
Cumulative % of variance	14.0	23.0	31.1	36.9
[a]Rotation converged in 5 iterations.				
Factor correlation matrix	***Factor 1***	***Factor 2***	***Factor 3***	***Factor 4***
Factor 1	**---**	0.165	0.303	0.188
Factor 2	---	---	0.235	-0.019
Factor 3	---	---	---	0.191

Goodness-of-fit: Chi-square = 23.27; df = 11; sig = 0.016; RMSEA = 0.05. N = 535.

Table BVIII: Maximum likelihood exploratory factor analysis exploring dogmatism items, battery B. Promax (oblique) rotation. 2018 Amazon Mechanical Turk dataset.

Pattern matrix[a] (Structure matrix loadings in parentheses) *Item*	**Factor Loadings** *Factor 1*	*Factor 2*	*Factor 3*
Highest form of democracy run by most intelligent (Dog B1)	**0.529** (*0.474*)	-0.099 (*0.114*)	0.185 (*0.205*)
Only way to know what's going on is to rely on trusted experts (Dog B2)	**0.623** (*0.542*)	-0.160 (*0.184*)	-0.064 (-*0.025*)
Humans on their own are helpless and miserable (Dog B3)	**0.353** (*0.482*)	0.224 (*0.596*)	**-0.568** (-*0.651*)
I'd like someone to tell me how to solve my problems (Dog B4)	**0.473** (*0.422*)	-0.105 (*0.189*)	-0.147 (-*0.124*)
The main thing in life is to want to do something important (Dog B5)	**0.343** (*0.464*)	0.251 (*0.293*)	**0.407** (*0.315*)
My blood boils whenever someone refuses to admit he's wrong (Dog B6)	**0.316** (*0.374*)	0.115 (*0.255*)	0.072 (*0.026*)
Two kinds of people: those for and those against truth (Dog B7)	0.125 (*0.443*)	**0.620** (*0.640*)	0.134 (-*0.075*)
Most of the ideas printed these days aren't worth the paper they're printed on (Dog B8)	-0.193 (*0.072*)	**0.513** (*0.408*)	0.012 (-*0.154*)
Most people know what's good for themselves (Dog B9)	-0.016 (*0.014*)	0.069 (-*0.017*)	0.234 (*0.211*)
Of all philosophies, probably more than one correct (Dog B10)	**0.336** (*0.173*)	**-0.302** (-*0.213*)	0.258 (*0.350*)
Eigenvalue (initial values in parentheses)	(*2.24*) 1.53	(*1.51*) 0.92	(*1.12*) 0.42
Cumulative % of variance	15.3	24.5	28.6
[a]Rotation converged in 5 iterations.			
Factor correlation matrix	*Factor 1*	*Factor 2*	*Factor 3*
Factor 1	**---**	0.519	-0.024
Factor 2	---	---	-0.333

Goodness-of-fit: Chi-square = 49.91; df = 18; sig = 0.000; RMSEA = 0.06. N = 514

Table BIX: OLS regression analysis predicting belief that scientists know best what is good for the public (deference item 1). 2018 Amazon Mechanical Turk dataset.

	Standardized betas							
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*	*Model 8*
Age	-0.26***	-0.24***	-0.25***	-0.21***	-0.21***	-0.16***	-0.15***	-0.12**
Gender (female)	0.03	0.06	0.04	0.01	0.01	0.03	0.04	0.02
Education	0.05	0.05	0.06	0.10*	0.09*	0.08	0.08	0.05
Science education	0.01	0.01	0.01	0.03	0.03	0.05	0.03	0.04
News attention	0.22***	0.22***	0.22**	0.10*	0.11**	0.10*	0.07	0.05
Adjusted R^2 (%)	*9.9****							
Religiosity		-0.14***	-0.12**	-0.06	-0.06	-0.10*	-0.02	-0.03
Adjusted R^2 (%)		*1.8****						
Epistemic beliefs (general)			0.11*	0.09*	0.09*	0.07	0.01	0.00
Adjusted R^2 (%)			*0.9**					
Epistemic beliefs (science)				0.40***	0.41***	0.34***	0.20***	0.16***
Adjusted R^2 (%)				*14.0****				
Views of informed decision-making					-0.02	0.00	-0.08	-0.07
Adjusted R^2 (%)					*0.0*			
Dogmatism						0.20***	0.17***	0.17***
Adjusted R^2 (%)						*2.9****		
Authority of science							0.37***	0.30***
Adjusted R^2 (%)							*7.0****	
Trust in scientists								0.22***
Adjusted R^2 (%)								*3.4****
Total adjusted R^2 (%)								**39.9**

N = 506; *p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001.

Table BX: OLS regression analysis predicting belief that scientists should do what they think is best, even if they have to persuade others that it is right (deference item 2). 2018 Amazon Mechanical Turk dataset.

	Standardized betas							
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*	*Model 8*
Age	-0.05	-0.01	-0.02	0.02	0.00	0.04	0.05	0.07
Gender (female)	-0.08	-0.03	-0.05	-0.08	-0.07	-0.06	-0.05	-0.06
Education	0.03	0.04	0.05	0.08	0.09*	0.08	0.08*	0.05
Science education	0.00	0.01	0.00	0.02	0.02	0.03	0.01	0.01
News attention	0.15***	0.16***	0.15***	0.05	0.04	0.04	0.00	-0.01
Adjusted R^2 (%)	*2.6***							
Religiosity		-0.28***	-0.26***	-0.21***	-0.19***	-0.22***	-0.14***	-0.14***
Adjusted R^2 (%)		*7.6****						
Epistemic beliefs (general)			0.11*	0.09*	0.08*	0.07	0.00	0.00
Adjusted R^2 (%)			*0.9*.*					
Epistemic beliefs (science)				0.34***	0.30***	0.26***	0.10	0.07
Adjusted R^2 (%)				*10.3****				
Views of informed decision-making					0.12**	0.14**	0.05	0.06
Adjusted R^2 (%)					*1.0***			
Dogmatism						0.13**	0.11*	0.11**
Adjusted R^2 (%)						*1.3***		
Authority of science							0.40***	0.33***
Adjusted R^2 (%)							*8.1****	
Trust in scientists								0.19***
Adjusted R^2 (%)								*2.7****
Total adjusted R^2 (%)								**34.5**

N = 505; *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$.

Table BXI: OLS regression analysis predicting belief that science is the best way to understand the world (authority of science item 1). 2018 Amazon Mechanical Turk dataset.

	Standardized betas							
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*	*Model 8*
Age	-0.08	-0.03	-0.05	0.00	-0.02	0.00	0.02	0.03
Gender (female)	-0.02	0.05	0.02	-0.02	-0.02	-0.01	0.00	-0.01
Education	-0.09	-0.08	-0.06	-0.02	0.00	-0.01	-0.04	-0.05
Science education	0.03	0.03	0.02	0.05	0.04	0.05	0.03	0.03
News attention	0.23***	0.24***	0.23***	0.10**	0.08*	0.08*	0.05	0.05
Adjusted R^2 (%)	*5.3****							
Religiosity		-0.36***	-0.32***	-0.25***	-0.23***	-0.25***	-0.18***	-0.18***
Adjusted R^2 (%)		*12.3****						
Epistemic beliefs (general)			0.20***	0.18***	0.16***	0.15***	0.13***	0.12***
Adjusted R^2 (%)			*3.5****					
Epistemic beliefs (science)				0.45***	0.39***	0.37***	0.25***	0.23***
Adjusted R^2 (%)				*18.1****				
Views of informed decision-making					0.17***	0.17***	0.14***	0.14***
Adjusted R^2 (%)					*2.0****			
Dogmatism						0.07	0.00	0.01
Adjusted R^2 (%)						*0.3*		
Deference							0.35***	0.32***
Adjusted R^2 (%)							*8.3****	
Trust in scientists								0.10*
Adjusted R^2 (%)								*0.5**
Total adjusted R^2 (%)								**50.3**

N = 504; *p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001.

Table BXII: OLS regression analysis predicting belief that science is the best way we have for producing reliable knowledge (authority of science item 2). 2018 Amazon Mechanical Turk dataset.

	Standardized betas							
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*	*Model 8*
Age	-0.11*	-0.07	-0.09*	-0.04	-0.06	-0.05	-0.03	-0.01
Gender (female)	-0.04	0.02	-0.02	-0.06	-0.05	-0.05	-0.04	-0.05
Education	-0.09	-0.09	-0.07	-0.03	-0.01	-0.01	-0.04	-0.06
Science education	0.04	0.05	0.03	0.06	0.05	0.06	0.05	0.05
News attention	0.24***	0.24***	0.23***	0.10*	0.08*	0.08*	0.05	0.04
Adjusted R^2 (%)	*6.4****							
Religiosity		-0.28	-0.24***	-0.17***	-0.14***	-0.15***	-0.10**	-0.10**
Adjusted R^2 (%)		*7.4****						
Epistemic beliefs (general)			0.19***	0.17***	0.15***	0.14***	0.12***	0.11**
Adjusted R^2 (%)			*3.1****					
Epistemic beliefs (science)				0.48***	0.40***	0.38***	0.28***	0.26***
Adjusted R^2 (%)				*20.0****				
Views of informed decision-making					0.21***	0.21***	0.19***	0.19***
Adjusted R^2 (%)					*3.3****			
Dogmatism						0.06	0.00	0.01
Adjusted R^2 (%)						*0.1*		
Deference							0.29***	0.24***
Adjusted R^2 (%)							*5.7****	
Trust in scientists								0.16***
Adjusted R^2 (%)								*1.6****
Total adjusted R^2 (%)								**47.6**

N = 506; *p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001.

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