The Impact of Source Credibility on Scientific Skepticism of Climate Change and Genetically Modified Foods: Findings from the General Social Survey

KATHLEEN P. HUNT & DARA M. WALD

Department of Agricultural Education & Studies
Iowa State University
513 Farm House Ln
Ames, IA 50011 USA
kphunt@iastate.edu
**corresponding author*

Greenlee School of Journalism and Communication
Iowa State University
214 Hamilton Hall
613 Wallace Road
Ames, IA 50011 USA
dwald@iastate.edu

ABSTRACT:
The current study explores the role of source credibility in continued public concern over climate change and GM foods, suggesting that this skepticism is more likely driven by perceptions of scientists as knowledgeable, trustworthy, and unbiased- the three primary constructs of source credibility (McCrosky & Teven, 1999; Teven 2008). We analyze data from the 2006 GSS survey to empirically measure the components of source credibility, comparing their influence and relationship to political ideology in perceptions of CC impacts and willingness to consume GM foods.

KEYWORDS: climate change, environmental communication, expertise, genetically modified foods, goodwill, source credibility, science communication, trustworthiness

1. INTRODUCTION

Climate change (CC) is a *process* of systematic shifts in the earth's biophysical conditions, discerned via disruptions in weather patterns and global temperature, among others (Dunlap & Brulle, 2015; Weber, 2010). In contrast, genetically modified foods (GM) are *products* humans (in)directly consume through agrifood production and processing (Varzakas, et al., 2007).[1] Although neither of these phenomena is immediately observable, their respective political-economic impacts are significant. For example, the estimated costs associated with greenhouse gas emissions, the leading cause of climate change, "will be equivalent to losing at least 5% of global GDP each year, now and forever" (Stern, et al., 2007, p. vi), while widespread ecosystem disturbance will disrupt livelihoods of vulnerable communities around the world (Adger, et al., 2013). Furthermore, nearly half of U.S. cropland is now dedicated to the cultivation of GM food

[1] Although genetically modified organisms (GMOs) are used in medicine and pharmaceuticals, gene therapy, and environmental management, as well as agriculture and food production, the latter is the focus of this study. Of the 12 most common GM crops, 9 are grown directly for human consumption, while other GM crops used for livestock feed and in food processing enter our food supply indirectly (see Scott et al., 2018).

crops (Fernandez-Cornejo, et al., 2014, cited in Scott et al. 2018), and the recent “megamergers” of Dow-DuPont and Monsanto-Bayer now concentrate GM production in the hands of only five transnational corporations (Fung & Dewewy, 2018).

Both CC and GM occur at the nexus of science and society, posing existential questions about humans’ relationship to- and effects on- natural systems (Dunlap & Brulle, 2015; Clancy, 2016; Weber, 2010). Researchers have pointed to scientific illiteracy and issue complexity among others, as major contributors to the continued lack of public acceptance of scientific consensus about anthropogenic climate change and safety of GM foods (Boykoff, McNatt, & Goodman, 2015; Marques, Critchley, & Walshe, 2015; Roser-Renouf et al., 2015).

However, as Wildavsky and Dake (1990) note, “[i]t is not only that ‘the facts’ cannot by themselves convince doubters, but that behind one set of facts are always other [factors]” that influence public perceptions of and decision-making about environmental science (p. 55). Individuals filter scientific information through interpretive schemata and use moral reasoning to make decisions (Passini, 2010). Pre-existing beliefs, values and identity, political affiliation, socio-economic status and other factors influence public attitudes about science and trust in scientific evidence (Kahan, Jenkins-Smith, & Brahman, 2010; Pechar, Brenauer, & Mayer, 2018; Rutjens et al., 2018). Recent work has suggested that lack of trust in science and perceptions of scientific bias have contributed to conflicting understandings and even skepticism of CC and GM (Funk & Kennedy, 2016a-b; Krosnick, Holbrook, Lowe, & Visser, 2006; McComas, Besley, & Steinhardt, 2014; Pechar et al., 2018; Vraga, Myers, Kotcher, Beall, & Maibach, 2018). Given these dynamics, it is possible that a lack of trust in science and perceptions of specific scientific sources are also likely to contribute to skepticism about these issues. We take this critical tension as our starting point.

The present study extends research on the role of source credibility in science communication (Guachat, O’Brien, & Mirosa, 2017; Hovland & Weiss, 1951-2; McCroskey & Teven, 1999; Pornpitakpan, 2004; Teven, 2008), by empirically measuring the multidimensionality of this construct. We define source credibility as an audience’s perceptions of “trustworthiness” (character, honesty) (McCroskey & Teven, 1999), “expertise” (qualifications, intelligence, authority, knowledge), and “goodwill” (caring, responsiveness, concern, empathy) (Teven, 2008). Although extant research primarily has tested a singular dimension of source credibility, defining it as a multi-item construct may capture more variation in perceptions of credibility (McCroskey & Teven, 1999; Peters, Covello, & McCallum, 1997). Additionally, given previously identified ideological differences in the perceived source credibility of scientists (Wald & Williams, 2017), we examine the degree to which each component of source credibility mediates the relationship between political ideology and public perceptions of skepticism toward CC and GM foods. Finally, as an exploratory aim we investigate whether perceived source credibility, and its influence on scientific skepticism, are contingent on the nature of the science in question.

2. SOURCE CREDIBILITY

Science alone cannot persuade because scientific knowledge is enfolded with politics, economics, and culture (Jasonoff, 2012). Individuals use interpretative schemata and moral reasoning to process scientific information and make decisions (Passini, 2010), and audiences make judgements about the speaker as well as the content of a message (Aristotle, 4th Century

BCE/1991). In communication about risk, uncertainty, or the causes and consequences of scientific phenomena source credibility functions as a heuristic, or shortcut, that influences public acceptance of scientific information (Hovland & Weiss 1951-2). The public is more likely to accept recommendations from sources that corroborate the views espoused by experts perceived to be credible (Darmofal, 2005). Compared to low-credibility sources, high-credibility sources can increase the effectiveness of strategic communication, including the likelihood of producing desired shifts in target attitudes and behavior (see Pornpitakpan, 2004 for a review).

Source credibility is a key predictor of public concern about scientific evidence (Guachat, O'Brien, & Mirosa, 2017; Hovland & Weiss, 1951-2; Pornpitakpan, 2004; Teven, 2008). Importantly, source credibility is not static or unidimensional, but includes an audience's perceptions of the source's "trustworthiness" (character, honesty, believability) (McCroskey & Teven, 1999), "expertise" (qualifications, intelligence, authority, knowledge), and "goodwill" (caring, responsiveness, concern, empathy) (Teven, 2008). Each has been shown to play a significant role in how publics use scientific information and influence public perceptions of scientists' credibility.

In recent years, scholars have demonstrated the importance of public trust in science and scientists (see Engdahl & Lidskog, 2014 for an overview). Audiences are more amenable to evidence from trusted sources and more likely to rebuff information from sourced they distrust (Berlo, Lemert, & Mertz, 1969; Chaiken, Liberman, & Eagly, 1989; Eiser, Miles, & Frewer, 2002; Frewer, Sholderer, & Bredahl, 2003; Hovland, Janis, & Kelley, 1953; Hovland & Weiss, 1951-2). Regarding policy decisions, Gibson et al. (2005) found that institutions and policy makers are more likely to engender public support and gain public "acceptance, acquiescence, and compliance" when they are perceived as trustworthy (p. 187). Trust in science and scientists is a particularly important factor affecting public attitudes in scientific and environmental domains (Brewer & Ley, 2013; Brossard & Shanahan, 2003; Myers, Kotcher, Stenhouse, Anderson, Maibach…, 2016). For example, Hamilton (2015) suggests that measurements of individuals' trust in scientists and scientific evidence about climate change or nuclear power are equivalent to measurements of individuals' general attitudes about these topics. Frewer, Scholderer, and Bredahl (2003) have also found that trust can mediate attitudes toward new scientific technologies.

Expertise refers to "competence" (McCroskey & Teven, 1999), "specialized knowledge" (Horton et al., 2016), and the degree to which a source is perceived as making correct assertions (Hansen, Holm, Frewer, Robinson, & Sandøe 2003; Hovland & Weiss, 1951-1952). Scientists are ascribed particular expertise because they communicate from what Goodnight (2012) has called the "technical sphere," or discursive context that privileges particular norms, styles of engagement, and argumentative appeals, a position that affords them legitimacy and cultural authority (Gauchat, 2011; O'Brien, 2012). Public perceptions of risk can be reduced when government agencies link messages or collaborate with expert stakeholders, such as a relevant consumer organization or committee (Dean & Shepherd, 2007). However, although the scientific community represents technical expertise, citizens and policy makers disagree on the extent to which scientists should contribute to policy decisions (Backstrand, 2003). Per Jasanoff (2003), experts "exercise a form of delegated authority...act[ing] on publics' behalf" when they participate in policy making processes; the perception that scientists' expertise is being used for political ends can contribute to public skepticism (p. 159).

Trustworthiness and expertise have each been tested for their respective impact on source credibility (Frewer, Sholderer, & Bredahl, 2003; Engdahl & Lidskog, 2014; McCroskey &

Teven, 1999; Renn & Levine, 1989). Goodwill, the third- and perhaps "lost" (McCroskey & Teven, 1999)- dimension of source credibility has received considerably less attention. Rooted in the Aristotelian concept of *ethos*, goodwill represents the degree to which a speaker is perceived as caring, demonstrated through empathy in direct interactions with others (Horton et al., 2016; Hovland et al., 1953; Teven, 2008). Thus, goodwill is "a meaningful predictor of believability and likeableness" (McCroskey & Teven, 1999). In the context of science communication, this dimension has been interpreted as publics' perception of scientists as working in the public's best interest (Horton et al., 2016; Heazle & Kane, 2015; McCroskey, 1992). Eagly, Wood, and Chaiken (1978) found that a source is "considered less manipulative and more sincere when he *[sic]* disconfirmed rather than confirmed the expectancy based on the audience's identity" (p. 431). Extending this, Frewer et al. (2003) report that perceptions that an information source has "a vested interest in promoting a particular view" can increase negative attitudes in the public (p. 1118). Finally, citizens and elected officials are reluctant to delegate decision making to experts who are not perceived as accountable to the public (Jasanoff, 2003).

In sum, source credibility and its multiple components is a key predictor of public concern about scientific evidence (Guachat, O'Brien, & Mirosa, 2017; Hovland & Weiss, 1951-2; Pornpitakpan, 2004; Teven, 2008), perceptions of scientists as technical experts (Dean & Shepherd, 2007), and the role of science in public policy and decision making (Backstrand, 2003; Jasanoff, 2003). The three dimensions of source credibility- trust, expertise, and goodwill- have been largely studied individually, yet previous research suggests that a multi-item construct that includes all three dimensions is a more accurate measure of source credibility (McCroskey & Teven, 1999; Peters, Covello, & McCallum, 1997). Furthermore, Horton et al. (2016) suggest the need for a "situationally nuanced understanding of credibility," and encourage consideration of "which dimensions of credibility are most important in each [communication] situation" (p. 31). With this in mind, the present study compares perceptions of source credibility across two environmental science communication contexts: climate change (CC) and genetically modified foods (GM).

2.1 Source Credibility and Climate Change

While not directly observable, climate change (CC) is indicated by, among other trends, biodiversity loss, sea level and global temperature rise, and shifts in weather (Weber, 2010). Scientific evidence of these impacts enters into a political economic terrain made contentious by competing objectives, varied interests, and divergent values. Despite scientific consensus, debate about the existence, cause, and extent of global climate change has divided the public sphere for more than a quarter century (McCright & Dunlap, 2000). The general public receives information about climate change from various sources including, mass media, politicians and policy-makers, newsweeklies such as *Time*, science magazines, non-profit groups, and government agencies (Brulle, et al., 2012; Dunlap & Jacques, 2013; Nisbet, 2009; Nisbet & Kotcher,2009; Weber, 2010). When scientific information or policy recommendations from these sources diverge, source credibility becomes a critical tool that the public uses to interpret scientific evidence and conflicting information about science (Zanna, Olson, & Herman, 1987), including the causes, consequences and risks associated with CC impacts.

Diverse audiences engage in CC-related issues differently, advocating various behavioral responses and policy outcomes. The "Six Americas" framework developed by Roser-Renouf et al. (2015) delineates a range of six CC positions- from alarmed to dismissive- based on the degree to which they accept or reject climate science, as well as cognitive and affective issue engagement. Theorizing the role of "climate imaginaries," or shared socio-semiotic systems of meaning and cultural values related to CC, Levy and Spicer (2013) contend that "ideologies, normative commitments, scientific understandings and material interests" shape economic and policy responses at various scales (p. 663). Extending this, Bliuc et al. (2015) suggest that CC skepticism is more than an opinion, representing instead "an aspect of self" that drives one's social and political action (p. 226). Thus, individuals' pre-existing attitudes, beliefs, and values influence perception of and responses to CC (Kahan, 2015; Kahan, et al., 2010; Weber, 2010).

Among the general public, scientists consistently rank as the most trusted sources of information about climate change (Leiserowitz et al. 2013). Trust in science is positively associated with certainty that climate change is occurring, and belief in anthropogenic climate change (Carlton & Jacobson, 2016; Hmielowski et al. 2014; Mase et al. 2015; Nisbet & Myers 2007). Trust in science and scientists can decrease climate skepticism (Malka, Krosnick & Langer, 2009; McCright 2016), and is related to support for climate change policies (Brewer & Ley, 2013; Dietz, Dan, & Shwom, 2007; O'Connor, Bord, Fisher, Staneva, Kozhouharova-Zhivkova…, 1999).

Gauchat, O'Brien, and Mirosa (2017) find that perceptions of environmental scientists' legitimacy as policy advisors are a function of their perceived credibility (p. 298). Yet scholars have also argued that climate scientists may be particularly vulnerable to perceptions of bias as their ability to obtain grants and to publish in scientific journals is, by default, predicated on the existence of harmful CC impacts (Yearly, 2014). Indeed, a recent national survey revealed that most Americans do not believe that climate scientists' research findings are influenced most of the time by concern for the best interests of the public (Funk & Kennedy, 2016a). The degree to which scientists are perceived as serving the nation's best interest is the "most important single factor…for determining public support for [environmental] scientists in policy settings" (O'brien, 2012, p. 812), making perception of the integrity of environmental scientists' policy advice a potentially critical predictor of perceptions of their legitimacy (Gauchat et al., 2017).

2.2 Source Credibility and GM

In agriculture, genetic engineering (GE)[2] constitutes the selective breeding of particular traits for crop optimization, be it for yield, rate of growth, drought resistance, herbicide complementarity, pesticide resistance, among others uses (see Varzakas, et al., 2007 for a review); genetically modified foods are the "most visible product" of this process (Clancy, 2016, p. 4). Widespread proliferation in the global marketplace (Scott, et al. 2018) and a multiplicity of stakeholders make the political economy of GM, and its communication, complex (Clancy, 2016; McComas, Besley & Steinhardt, 2014). A variety of sources- from government agencies, agricultural producers, and biotech corporations, to agroscientists and medical researchers, lobby organizations, and environmental and consumer groups- provide information and recommendations about GM, often with competing objectives (Roe & Tiesl, 2007). Because constructions of risk pervade "the *process* of manufacturing, the GM *products*, and the unknown *implications* of the technology" (emphasis original, Clancy, 2016, p. 2), source credibility can

[2] Genetic engineering refers to "the introduction or change in DNA, RNA, or proteins manipulated by humans to effect a change in an organism's genome or epigenome" (NASEM, p. 36).

impact individuals' acceptance of GM as well as consumer behavior (Scott et al., 2018; other cites). Moreover, members of the public generally lack control over the development, implementation and political process that governs GM food (Marques, Critchley & Walshe 2015), making source credibility a potentially important predictor of public attitudes toward GM food.

Much of the previous research on public support for GM has focused on the perceived trustworthiness of risk managers (see McComas, Besley & Steinhardt, 2014 for a review). This work has generally found that public acceptance of GM is strongly associated with trust in the institutions and scientists involved in GE research and development (Frewer, Sholderer, & Bredahl, 2003; Siegrist 2000), with increased trust contributing to greater support for biotechnology and reduced risk-related concerns (Brossard & Shanahan, 2003; Salvadori et al., 2004). Consumers have the least amount of trust in industry and government sources (Cook, 2006; Costa-Font & Mossialos, 2007; Dean & Shepherd, 2007; Savadori, et al. 2004). Given the range of information sources communicating about GM, a lack of consumer trust in relevant institutions can hinder public acceptance of biotechnology (Costa-Font & Mossialos, 2007). Indeed, as Frewer, et al. (2003) report, "a distrusted information source that is perceived to have a vested interest in promoting a particular view may increase public negativity toward a technology" (p. 1118).

In addition to trust, scholars have suggested the GM debate is influenced by the degree to which scientists and other technical experts are perceived as legitimate and fair (Clancy, 2016; McComas et al., 2008). In their analysis of texts addressing the sustainability implications of GM, Gauthier and Kappen (2017) identify "undue influence [of GM industries] on government" and "regulators [that] do not act in the interest of public health or public right to know" as major stakeholder concerns (p. 224). Dean and Shepherd (2007) also report that government agencies can be perceived "more positively as having fewer vested interests" if their GM messages are linked with other credible sources acting in the public's best interest (p. 460).

The National Academies of Science, Engineering, and Medicine (NASEM, 2016) and the American Association for the Advacnement of Science (AAS, 2013) report wide agreement among scientists that GM food is safe for human consumption. Yet, as Clancy (2016) notes, "scientific evidence has not been sufficient to counter [GM] skepticism in the U.S." (p. 2). To date, American consumers still perceive GM as "very risky" (NASEM, 2016). A recent study revealed that 57% of U.S. adults do not believe that scientists fully understand the health effects of GM foods (Pew Research Center, 2015). In the U.S., public concern about GM has prompted efforts to pass legislation requiring food labels that identify the use of GM ingredients in food (Pechar et al., 2018). While previous scholars have explored several of the components of source credibility within the context of GM food, none have yet fully explored this multi-item construct or how it might mediate the relationship between ideology and trust in science and scientists involved in public debate about CC and GM food.

2.3 Political Ideology

Individuals' identification with a particular political ideology functions as a lens for interpreting scientific claims, assessing scientists' legitimacy, as well as evaluating scientists' credibility (Funk & Kennedy, 2016a-b; Gauchat, 2012; Kahan, 2013; Nisbet, 2009; Nisbet, et al., 2015; Pechar, et al. 2018). When it comes to controversial social topics, cultural worldviews and identity influence individuals' interpretations of scientific information (Nisbet & Kotcher, 2009).

The shared values, moral understandings and identities that connect stakeholders together in an "in group" community can also lead "in group" members to reject contrary beliefs and perspectives (Passini, 2010). As Scott et al. (2018) note, "once a scientific issue becomes aligned with a broader social orientation, people tend to ignore the views of experts in favor of the views of their ideological in-group" (p. 12.13). Indeed, "in group" members are more likely to reject "out group" sources as less trustworthy or knowledgeable than "in group" sources (Mackie & Quellar, 2000). When science is inconsistent with people's beliefs and the beliefs of their political party, they may be less inclined to trust it and to be persuaded by it (Kahan, 2015; Nisbet, Cooper, & Garrett, 2015). Indeed, people may be more inclined to accept scientific information from those who match their political groups, especially from an opinionated or charismatic leader (Kahan, 2013; Nisbet & Kotcher, 2009). However, disagreement among political elites contributes to polarization, leading "citizens [to] rely on other indicators, such as…source credibility to make up their minds" (p. 52). An ideological gap in perceptions of science and source credibility is clear and persistent - conservatives' trust in science, for example, has declined dramatically since the 1970s (Guachat, 2012) - and evident in both CC and GM contexts.

Democrats are more likely to trust information from climate scientists than Republicans (Hamilton, 2015). Indeed, Nisbet (2009) suggests, partisan division is so entrenched that climate change "has joined a short list of issues such as gun control or taxes that define what it means to be a Republican or Democrat" (p. 14). A recent Pew Research Center study found that 15% of conservative Republicans trust climate scientists to provide them with full and accurate information on the causes of climate change, and 11% believe climate scientists understand very well the causes of climate change (Funk & Kennedy, 2016a). Additionally, the Pew study reports that 23% of moderate Democrats and 36% of liberal Democrats believe that scientists understand the best ways to address climate change. McCright and Dunlap (2011) have identified a so-called "conservative white male effect" in which conservative white males are significantly less likely to believe in, or perceive risk from, anthropogenic climate change. Brulle et al. (2012) find that "elite partisan battle"- fomented by Congressional leaders' voting records and public statements- is "the most important factor in influencing public opinion on climate change" (p. 1985).

Political ideology may also play a role in determining beliefs about the risks associated with biotechnology and the credibility of sources of scientific information about the safety of GMOs. Compared to conservative respondents, liberals are more likely to trust scientists as sources of information about GM[3] (Hamilton, 2015). Generally, conservatives express greater trust in "production" science focused on economic or technological innovation, while liberals are more likely to trust "impact" science assessing consequences on human and environmental health (McCright, et al. 2013). Yet the Pew study mentioned above found no difference in the number of Republicans and Democrats who care a great deal about the issue of GM foods (Funk & Kennedy, 2016b). Researchers point to the need for greater specificity in measuring perceptions of various science issues (Kahan, 2015; McCright & Dunlap, 2011) as political ideology may "lead individuals to trust or distrust science in different ways" (Pechar et al. 2018, p. 295).

While a recent study by Nisbet et al. (2015) confirmed conservatives' distrust of the scientific consensus on climate change, it also found that liberals reported similarly low levels of trust in science when exposed to messages promoting scientific consensus on nuclear power.

[3] This may be due, in part, to the large number of liberal respondents who selected "do not know" as their response option when asked if they trust scientists for information about GMOs (Hamilton, 2015).

These results suggest that distrust in science is not driven solely by a conservative political ideology or by distrust in science in general. Instead, scientific skepticism may stem from concerns about the perceived trustworthiness and bias of the source of the scientific information (Nisbet et al., 2015; Pechar et al., 2018; Priest, Bonfadelli, & Rusanen, 2003). The present study expands on this extant research by exploring source credibility as a mechanism through which political ideology can affect public skepticism about GM and CC science.

3. AIMS AND HYPOTHESES

The current study is motivated by several objectives: to empirically measure source credibility as a multi-item construct, to demonstrate the influence of the components of source credibility and political ideology on skepticism of CC impacts and willingness to consume GM foods, and to compare perceptions of source credibility in the contexts of CC and GM. We provide the following hypotheses:

> H1: Skepticism about the potential negative impacts associated with climate change will increase as respondents become more conservative.
>
> H2: Perceptions of climate scientists' credibility will decrease as respondents become more conservative.
>
> H3: Skepticism about the safety of GM foods will increase as respondents become more liberal.
>
> H4: Perceptions of medial researchers' credibility will increase as respondents become more conservative.
>
> H5: Source credibility will mediate the relationship between political ideology and skepticism toward CC and GM.
>
>> Corollary to H5: Respondents who perceive climate scientists as credible sources will be less skeptical about the impacts of climate change.
>>
>> Corollary to H5: Respondents who perceive medical researchers as credible sources will be less skeptical about the safety of GM foods.
>
> H6: Source credibility will be directly related to public support for scientific influence on policy.

4. METHODS

4.1 Survey Implementation

The 8 items reported here were fielded in the 2006 General Social Survey (GSS), conducted biannually by the National Opinion Research Center. The GSS is a nationally representative household survey of English-speaking persons. In 2006, along with the standard questions administered to 4,510 respondents, a subset of questions specific to climate change and genetically modified food was asked of 927 respondents.

4.2 Measurements

Sociodemographic variables previously associated with source credibility were included as control variables: Gender (1 = male, 2= female) and level of education (0 = no college, 1 =

college and beyond) are measured as dummy variables. *Age* is a continuous variable, and *income* is measured on a 9-point scale (1 = “less than $20,000” to 9 = “$150,000 and above”).

Political Ideology was measured by asking respondents to rank themselves on a scale from “extremely liberal” = 1 to “extremely conservative” = 7. Respondents who answered “other” or “do not know” were dropped from analyses.

Confidence in political and nonpolitical entities has previously been used to explore public perceptions of institutional trust and trust in elite groups (see Gauchat, 2012 for a review). In this study, confidence in scientists was used as a control variable and was operationalized by asking, “I am going to name some institutions in this country. As far as the people running these institutions are concerned, would you say you have a great deal of confidence, only some confidence, or hardly any confidence at all in them?” (1=a great deal, 2=some confidence, and 3=hardly any confidence at all). Respondents answered this question for environmental scientists and medical researchers.

Source Credibility was measured as a composite of perceived bias, expertise and agreement. Perceived bias was assessed by asking, “To what extent would the following groups support what is best for the country as a whole or what serves their own narrow interests?” (1=what is best for the country, 5=own narrow interests). Respondents answered this question for environmental scientists making policy recommendations about global warming and medical researchers making policy recommendations about genetically modified foods. Perceived expertise was measured by asking, “How well do environmental scientists understand the causes of global warming?” and “How well do medical researchers understand the risks posed by genetically modified foods” (1=very well, 5=not at all). Perceived agreement was measured by asking participants, “To what extent do environmental scientists agree among themselves about the existence and causes of global warming” and “To what extent do all medical researchers agree on the risks and benefits of genetically modified foods?” (1=near complete agreement, 5=no agreement at all).

Beliefs (*skepticism*) about global warming were assessed by asking respondents to consider several potential effects that global warming might have on the polar regions, including “Arctic seals may be threatened,” “The northern ice cap may completely melt,” “By 2020, polar bears may become extinct,” “Sea level may rise by more than 20 feet, flooding coastal areas,” and “Inuit and other native peoples may no longer be able to follow their traditional way of life.” For each item, participants were asked to indicate how much these potential consequences of global warming would bother them (1 = “a great deal”, 2 = “some”, 3= “a little,” or 4 = “not at all”). Because the scale ends with a negative item, it reflects skeptical impact beliefs. To assess beliefs about genetically modified foods, we asked participants to indicate “which statement best describes their view about eating foods that have been genetically modified” (1 = “I don’t care whether or not the food I eat has been genetically modified,” 2 = “I am unwilling to eat genetically modified foods,” or 3 = “I will not eat food that I know has been genetically modified”).

Scientific influence on policy was measured by asking “How much influence should environmental scientists have in deciding what to do about global warming?” and “How much influence should medical researchers have in deciding whether to restrict the sale of genetically modified foods?” Responses were measured on a 4-item Likert scale (1 = a great deal of influence, 4 = none at all).

We conducted reliability tests on each of the multi-item survey measures. The 5-item climate change skepticism item was reliable (Chronbach's α = .843) and the questions were aggregated into a single climate change beliefs scale (range = 5-20, *M* = 8.36, *SD* = 3.45).

To evaluate the role of source credibility as a mediator for the influence of political ideology on skepticism about CC and GM, we conducted two multiple mediation models (Figure 1). We selected this method because reliability tests on the on the proposed source credibility items revealed that the three source credibility items did not meet the threshold for reliability and this approach allowed for the simultaneous evaluation of each of the source credibility measures. For each model, the independent variable is political ideology, the mediators are perceived bias, perceived expertise and perceived agreement (source credibility) and the outcome variables are CC or GM beliefs (skepticism; Figure 1). Based on the recommendations of Preacher and Hayes (2008), we used bootstrapped confidence intervals; this method does not require a normal distribution and is recommended over the Sobel test. Using a SPSS macro script, we conducted a PROCESS 2.16 model with 5,000 bias-corrected bootstrapped samples with a 95% confidence level. A multiple regression model was used to test the fourth hypothesis that source credibility increases public support for scientific influence on policy. Sociodemographic items and confidence were used as control variables, political ideology, skepticism and source credibility were used as independent variables, and support for scientific/medical researchers' influence on policy was used as the dependent variable. For all tests, we use $p<0.05$ as our cutoff value.

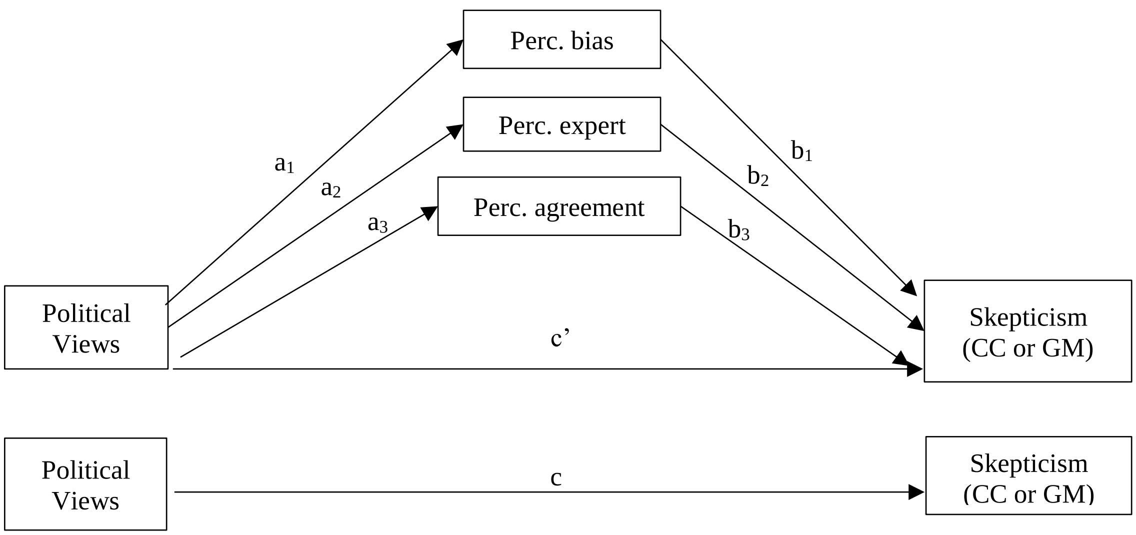

Fig. 1. Proposed multiple mediation model

RESULTS

Most of the respondents were female, white, and had a bachelor's degree or above. The average age was 47 and the median total family income ranged from $40,000 to $59,999 a year. More than a quarter of the sample identified as liberal (27% either extremely or moderate). Conservatives and political moderates were slightly more abundant (34% either extremely or moderate and 39% respectively). Approximately 43% of the sample has a great deal of confidence in environmental scientists, 50% only some and 7% hardly any (*M* = 1.65, *SD* = 0.61). Additional details about the respondents, including ideological representation, are provided in Table 1.

Table 1. Description of the respondents

	Percentage
Gender (female)	55.6
Race (white)	72.2
Education Attainment (at least bachelor's degree)	67.5
Political Ideology	
Liberal	27.2
Moderate	38.8
Conservative	34

*Sample (N=4,510)

Mediation results support hypothesis 1 for the climate change model. Conservative political ideology was associated with climate change skepticism, with greater skepticism of climate change impacts among extremely conservative respondents (path c). Political ideology was significantly related to all three of the source credibility mediators in the climate change model (Table 2, path a). Consistent with hypothesis 2, conservative ideology is associated with lower levels of perceived scientific source credibility. Respondents who identified climate scientists as credible sources were less likely to express skepticism about the impacts of climate change (path b). All three of the mediators significantly predicted CC skepticism (Table 2). Greater perceptions of scientific bias increased the likelihood of CC skepticism. Thus, our first model provided support for our first corollary to H5.

The climate change model also provided support for H5. The total indirect effect was significant, as was each of the specific indirect effects, indicating that perceived agreement, perceived bias and perceived understanding each mediated the relationship between political ideology and climate skepticism. As shown in the table, the effect of ideology on climate change skepticism was reduced from 0.290 to 0.124 by the three mediators and from a highly significant (p<0.001) to non-significant relationship, indicating full mediation.

Table 2. Results from moderated-mediation analysis climate change skepticism

Mediators (M)	Path a (IV to M)	Path b (M to DV)	Path c (IV to DV total)	Path c' (IV to DV direct)	a b (Indirect effect)
Perc. agreement climate scientists	0.079**	0.435***			0.034*
Perc. bias climate scientists	0.196***	0.357**			0.070*
Perc. expertise climate scientists	0.176***	0.353**			0.062*
			0.290***	0.124	Total indirect effect: 0.166*

*p<.05, **p≤.01, ***p≤.001
[a] IV = political ideology and DV = climate change skepticism

The results of the model exploring public skepticism about GM food also provided some support for our hypotheses (Table 3). There was no direct effect of political ideology on GM skepticism; therefore, the GM model did not support hypothesis 3. There was also no significant effect of political ideology on respondents' perceptions of medical researchers' expertise or agreement about the risks associated with GM food. Political ideology were significantly associated with medical researchers' perceived bias, but not in the expected direction (H4); perceptions of medical researchers' bias increased with conservative ideology. As expected, willingness to consume GM foods (less skeptical) increased as perceptions of medical researchers' bias decreased (path b). Skepticism about GM food was related to perceived lower levels of agreement and expertise among medical researchers and higher levels of bias among medical researchers. Thus, the GM model did provide support for hypothesis 5 and its corollary. Below, we report only the direct effects results of the mediation analysis for the GM model (Table 3).

Table 3. Results from the mediation analysis of GM skepticism

Predictor	B
Equation predicting mediator (Perc. agreement medical researchers)	
Intercept	2.838***
Polviews	0.015
Equation predicting mediator (Perc. bias medical researchers)	
Intercept	1.924***
Polviews	0.070*
Equation predicting mediator (Perc. expertise medical researchers)	
Intercept	2.017***
Polviews	0.039
Equation predicting dependent variable (GM skepticism)	
Intercept	-2.314***
Medagrgm	0.176*
Medbstgm	0.168*
Gmmed	0.225**
Polviews	0.020

*p<.05, **p≤.01, ***p≤.001

OLS regression results are presented in Table 4 and 5. In Table 4, the first model tests the effects beliefs and demographics on support for scientific influence on climate change policy. The second model tests for the effects of adding source credibility to the basic model. Model 1 results suggest significant main effects of beliefs, including political ideology (β =.126, $p \leq .05$) and GW skepticism (β =.303, $p \leq .001$), on support for scientific influence on climate change policy.

With regard to support for scientific influence on climate change policy, model 2 was a significant improvement over the first model, with an R-squared value above 27%. Model 2 results revealed main effects of GW skepticism (β =.193, $p \leq .001$) and all three of the source credibility items (bias: β =.206, $p \leq .001$; agreement: β =.177, $p \leq .01$; expertise: β =.151, $p \leq .05$) on scientific influence on climate change policy. Once the source credibility items were added to the model, the main effect of political ideology on public support for scientific influence on climate change policy disappeared. This result provides preliminary support for hypothesis 6: source credibility is related to public support for climate change policy. Moreover, it provides further evidence that source credibility is the underlying mechanism related to public skepticism about scientific evidence of climate change and public support for scientific influence on climate change policy.

In table 5, the first model tests the effects of beliefs and demographics on support for medical researchers' influence on restricting the consumption of GM food. The second model tests the effect of adding source credibility as an additional independent variable. None of the proposed items were significant predictors in the first model. Model 2 was a significant improvement over model 1 ($F\Delta_{3,297} = 19.43$, $p<.000$). Model 2 results revealed main effects for two of the source credibility items (bias: β =.310, $p \leq .001$; and expertise: β =.132, $p \leq .05$). This finding adds additional evidence to support the hypothesis that source credibility is related to public support for medical researchers influence on policies controlling GM food. This model also supported our initial multiple mediation model, suggesting that political ideology is not directly related to public opinions about GM food. While none of the demographic variables were significant predictors, education trended toward significance in both of the GM models (*p* from .051 to .097). Individuals with a college education were more supportive of medical researchers influence on policies affecting the use of GM food.

Across both of the OLS regression models, as perceived bias and concerns about scientific expertise increased (for both scientists and medical researchers), respondents' support for scientific influence on GM or CC policy decreased. As perceived agreement decreased, support for scientific influence on CC policy also decreased. Perceived agreement was not significant in the OLS model of support for scientific influence on GM policy.

Table 4. OLS regression predicting support for scientific influence on climate change policy[#]

Predictors	Model 1	Model 2
Demographics		
Gender (female)	-.047	.019
Age	.035	.008
Education (college)	.062	.070
Race (white)	.047	.042
Income	-.095	-.044
Beliefs		
Confidence in scientists (none)	-.024	-.065
Political ideology (Strong Conservative)	.126*	.025
GW skepticism	.303***	.193***
Source credibility		
Perceived Bias (extremely biased)		.206***
Perceived Agreement (none)		.177**
Perceived Expertise (none)		.151*
Total % explained R^2	14.6	27.9
	$F\Delta_{8,285} = 6.09$ p<.000	$F\Delta_{3,282} = 17.40$ p<.000

Note: Standardized beta coefficients are reported
Responses were measured on a 4-item Likert scale (1 = a great deal of influence, 4 = none at all).
*p<.05, **p<.01, ***p<.001

Table 5. OLS regression predicting support for medical influence on policies regulating genetically modified foods

Predictors	Model 1	Model 2
Demographics		
Gender (female)	-.034	-.068
Age	.057	.058
Education (college)	-.118	-.093
Race (white)	-.095	-.056
Income	.029	.020
Beliefs		
Confidence in scientists (none)	.076	.014
Political ideology (Strong Conservative)	.029	.003
Eat GM food (no)	.029	-.012
Source credibility		
Perceived Bias (extremely biased)		.310***
Perceived Agreement (none)		.092
Perceived Expertise (none)		.132*
Total % explained R^2	3.5	19.4
	$F\Delta_{8,300} = 1.38$ *p*=.205	$F\Delta_{3,297} = 19.43$ *p*<.000

Note: Standardized beta coefficients are reported
Responses were measured on a 4-item Likert scale (1 = a great deal of influence, 4 = none at all).
*p<.05, **p<.01, ***p<.001

DISCUSSION

The current study supports previous research demonstrating that source credibility is related to concern about scientific evidence and perceptions of scientists as technical experts (Gauchat, et al., 2017; Pornpitakpan, 2004; Teven, 2008), and that perceived source credibility influences scientific skepticism (Nisbet et al., 2015; Pechar et al., 2018) and attitudes toward policy (Hart & Nisbet, 2012). Our results expand these insights by comparing CC and GM as two contexts of environmental science communication, providing new evidence that attitudes towards climate scientists and medical researchers are related to attitudes toward CC and GM science and policy. In the case of CC, source credibility was a full mediator, suggesting that source credibility is one potential mechanism related to public skepticism about CC impacts. Moreover, the observed significant and direct effect of perceived medical researchers' credibility on willingness to consume GM foods provide evidence to suggest that source credibility may have a more consistent effect on scientific skepticism, across multiple scientific domains, than political ideology.

Empirical measurement of source credibility as a multi-dimensional construct was the primary aim of this study. The inclusion of the three components of source credibility – trustworthiness, expertise, and the "lost dimension" of credibility, goodwill (McCroskey & Teven, 1999, p. 91) allowed us to more accurately measure source credibility compared to previous research. All three source credibility items were significantly and directly related to CC and GM skepticism. Each of the source credibility items independently mediated the relationship between political ideology and skepticism about CC impacts. In addition, confidence in scientific expertise and perceptions of scientists as unbiased actors pursuing research in the best interests of the public was related to increased support for scientific influence on CC and GM policy. This effect remained significant when we added control variables to the OLS regression models. The importance of perceived bias in all our models highlights the continued need to include this construct more consistently in measures of source credibility (Horton et al., 2015; McCroskey & Teven, 1999; Peters, Covello, & McCalum, 1997).

Political ideology can influence beliefs and attitudes about both CC and GM (Funk & Kennedy, 2016a-b; Hamilton, 2015; Kahan, 2013; McCright et al., 2013; Nisbet, 2009). Consistent with previous research on the relationship between political ideology and climate change skepticism (e.g., McCright & Dunlap 2011; McCright 2016), the current study found that conservative participants were more likely to be skeptical about scientific evidence of CC impacts. However, after accounting for all three source credibility components, there was no significant effect of political ideology on impact skepticism, which contradicts previous empirical findings (McCright & Dunlap 2011). Compared to the credibility items, political ideology had less persistent effects across the models. This finding supports recent criticisms about the broad nature of political ideology and skepticism about its role as an antecedent of trust in science (Pechar, et al., 2018).

We found no significant relationship between ideology and concerns about the safety of GM food. Instead, our results suggest that ideology is indirectly related to skepticism about GE and biotechnology. This finding is consistent with other work pointing to latent antecedents of political ideology that impact perceptions of specific science topics (McCright, 2016; Pechar et al., 2018; Rutjens et al., 2018). Indeed, Pechar et al. (2018) recently reported that attitudes towards government and corporations (two important sources in the debate over GMOs) mediate the relationship between ideology and trust in science. Pechar et al. (2018) note that "distrust of science on particular issues may stem from an aversion to the source or the policy implications of that science" (p. 293). This study supports these previous findings and further highlights the limitations of political ideology as a lone driver of scientific skepticism in the context of GM.

In our study, general confidence in scientists and medical researchers did not have a significant effect on support for scientific influence on CC or GM policy, respectively. In line with previous findings by Marques et al. (2014), we posit that the broad nature of the confidence question, which did not directly relate to scientists involved in the evaluation of scientific evidence of climate change or medical researchers involved in the evaluation of the safety of GM food, contributed to this finding. Consistent with previous studies (Hart & Nisbet 2012), demographic items (gender, age, race, income) did not have a significant effect on support for scientific influence on policy.

A strength of the present study is that it relied on a nationally representative, nonstudent group of adult participants. However, the relevance of these results to current political debate is limited by the use of an older dataset. We acknowledge that the political landscape has changed substantially since this data was collected. To address this limitation, the authors are analyzing similar variables using data collected in 2016.

This is a single study exploring the relationship between source credibility and scientific skepticism. This study focused on CC and GM skepticism and public support for scientific influence on policies in these domains. Future research could explore additional scientific areas and outcome variables associated with public attitudes toward scientific policy. Furthermore, this study did not explore the relationship between motivated reasoning and source credibility, which might influence public responses to persuasive messaging, regardless of the characteristics of the source (Mutz, 2008). Previous work has found evidence of a relationship between political ideology and beliefs about human-induced global warming and overall support for government action on climate mitigation (Hamilton, 2015; Hart & Nisbet 2012; Kahan, et al. 2010). Our primary focus for this study was to explore the relationship between source credibility and scientific skepticism, but future research could explore how responses to climate change messages vary when presented by sources with differing levels of credibility and how perceived credibility is affected not only by partisan cues but cultural identity, values, and other interpretive schemata.

The source credibility measures used in the present study were single measures. Future research should explore whether this is the best measure or if alternative multi-item measures are more appropriate and more reliable. Following Pechar et al. (2018), there may be other latent factors, such as attitudes toward government and corporations, that mediate perceptions of trust in GM and CC science.

The results reported here have important implications in the public debate over scientific credibility, legitimacy, and the role of scientists in the policy-making process. While our first model suggested a significant relationship between political ideology and CC skepticism on public support for scientific influence on policy, the significant effect of political ideology disappeared once the source credibility items were added to the model. This adds to mounting evidence suggesting that skepticism about certain scientific issues may emerge in response to concerns about source credibility and be related to attitudes about the science-policy interface (Nisbet et al., 2015; Pechar et al., 2018).

CONCLUSION

Climate change (CC) and genetically modified foods (GM) are complicated phenomena happening at the nexus of science and society (Dunlap & Brulle, 2015; Clancy, 2016; Weber, 2010). Both also exist within complicated communicative contexts, with various stakeholders making multiple and sometimes conflicting claims about the nature and consequences of CC and GM (Clancy, 2016; Dunlap & Jacques, 2013; McCright & Dunlap, 2000; Roe & Tiesl, 2007). Interpretative schemata, such as pre-existing attitudes and identity, influence audiences' judgements of information sources, including scientists and technical experts (Kahan, et al., 2010; Passini, 2010; Pechar et al., 2018; Rutjens et al., 2018). Differences in the role of ideology on public skepticism about CC and GM warrant further investigation, particularly with more recent data that reflect increasing political polarization and greater control over exposure to scientific information and sources.

It is important for science and environmental communication research to continue to explore the dynamics at work when judgements about sources' credibility vary depending on the nature of the science in question. Following Horton et al. (2016), we encourage further development of a "situationally nuanced understanding of credibility" and the particular dimensions that "are most important in each [communication] situation" (p. 31). We also suggest further exploration of the specific antecedents that undergird audiences' resistance to scientific evidence.

When tested as a multi-item construct, as we did here, source credibility emerges as a potential shortcut associated with public evaluation of science and attitudes toward scientific influence on policy. Indeed, expertise, trustworthiness, and goodwill all contributed to perceptions of CC and GM. Yet research on source credibility largely examines a single dimension, primarily perceived trustworthiness and expertise (Frewer, et al., 2003; Engdahl & Lidskog, 2014; McCroskey & Teven, 1999; Renn & Levine, 1989). This preliminary study supports our ongoing research investigating the potential relationships between these antecedents, political ideology, and perceptions of impact versus production science in CC and GM. We entreat science and environmental communication researchers to continue exploring the multidimensionality of source credibility and its implications for public understanding of science and environmental policy.

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Appendix A

GSS Survey Questions and Coding

Variables	**Survey Items**	**Response Coding**
Global warming (GW) impact skepticism	Scientists predict that global warming may soon have big effects on the polar regions. I will describe some of these possible effects and, for each one, please say whether it would bother you a great deal, some, a little, or not at all if it actually happened. Arctic seals may be threatened. The northern ice cap may completely melt. By 2020, polar bears may become extinct. Sea level may rise by more than 20 feet, flooding coastal areas. Inuit and other native peoples may no longer be able to follow their traditional way of life.	"a great deal" = 1 "some" = 2 "a little" = 3 "not at all" = 4
GW consensus skepticism	To what extent do environmental scientists agree among themselves about the existence and causes of global warming?	"near complete agreement" = 1 to "no agreement at all" =5
Support for scientific influence on GW policy	How much influence should environmental scientists have in deciding what to do about global warming?	"a great deal of influence" = 1 to "none at all" = 4
Concern about genetically modified (gm) foods	Which statement best describes your own view about eating foods that have been genetically modified?	"I don't care whether or not the food I eat has been genetically modified" or "I am willing to eat genetically modified foods, but would prefer unmodified foods if they are available"= 0 "I will not eat food that I know has been genetically modified" = 1
Consensus skepticism about gm foods	How well medical researchers agree on the risks and benefits of genetically modified foods?	"very well" = 1 to "not at all" = 5
Support for medical researchers influence on gm policy	How much influence should medical researchers have in deciding whether to restrict the sale of genetically modified foods?	"a great deal of influence" = 1 to "none at all" = 4

Appendix B

Group Differences in Perceptions of Scientific Credibility

	Mean				
Credibility – Environmental Scientists	Liberal	Moderate	Conservative	F	*p*
To what extent would environmental scientists making policy recommendations about global warming support what is best for the country as a whole or what serves their own narrow interests?*	1.82[a]	1.96[b]	2.42[c]	19.28	<0.001
How well do environmental scientists understand the causes of global warming?	1.86[a]	1.84[b]	2.36[c]	19.46	<0.001
To what extent do environmental scientists agree among themselves about the existence and causes of global warming?	2.53[a]	2.60[a]	2.74[a]	2.57	0.077
Credibility – Medical Researchers					
When making policy recommendations about genetically modified foods, to what extent do you think the following groups would support what is best for the country as a whole or what serves their own narrow interests?	2.00[a]	2.37[b]	2.20[ab]	6.12	.002
How well do medical researchers understand the risks posed by genetically modified foods?	2.07[a]	2.25[a]	2.19[a]	1.67	.189
To what extend do all medical researchers agree on the risks and benefits of genetically modified foods?	2.82[a]	2.95[a]	2.91[a]	1.15	.318

* The letters a, b, c are used to differentiate significant mean differences between groups, at the 95% confidence level, as identified by Tukey's HSD tests. Means showing the same superscript letter are not statistically different.

** Values represent group means on a 5-point Likert scale (e.g., 1="near complete agreement," 5="no agreement at all")