THE PARTISAN BRAIN:
HOW DISSONANT SCIENCE MESSAGES LEAD TO CONSERVATIVES *AND* LIBERALS TO (DIS)TRUST SCIENCE

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Paper Submitted to *Annals of Political Science*
Last Revision: June 16, 2014

KEYWORDS: Political Polarization, Science Communication, Motivated Reasoning, Institutional Trust, Affect, Persuasion

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ABSTRACT

There has been deepening concern about political polarization in public attitudes toward the scientific community. The "intrinsic thesis" attributes this polarization to psychological deficiencies among conservatives as compared to liberals. The "contextual thesis" makes no such claims about inherent psychological differences between conservatives and liberals, but rather points to interacting institutional and psychological factors as the forces driving polarization. We evaluate the evidence for both theses in the context of developing and testing a theoretical model of audience response to dissonant science communication. Conducting a national online experiment (N=1500), we examined audience reactions to both conservative-dissonant and liberal-dissonant science messages and consequences for institutional trust in the scientific community. Our results suggest liberals and conservatives alike react negatively to dissonant science communication resulting in diminished trust of the scientific community. We discuss how our findings link to the larger debate about political polarization of science and implications for science communicators.

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Introduction

The scientific community remains one of the most trusted institutions in the United States (National Science Board, 2014), yet over the last thirty years public confidence in science has become increasingly politically polarized as liberal and conservative attitudes towards science have diverged (Gauchat 2012; Mooney, 2005 2012). Political polarization of trust threatens the scientific community's ability to provide scientific evidence as the basis for policy consensus, as well as its longstanding cultural legitimacy, but explanations for this phenomenon are highly contested (Gauchat 2012; Nelkin 1975 1992).

Two competing sets of explanations have emerged for the political polarization in attitudes about science. One set of explanations, what we term the "intrinsic thesis," argues that political polarization about science is due to fundamental psychological differences between political conservatives and liberals, asserting that conservatives are consistently more likely to reject such information and/or to be distrustful of the scientific community (Mooney 2005 2012, see also discussion by Kahan 2013). In contrast, the "contextual thesis" asserts that ideological differences in the public's scientific denialism and distrust are a consequence of which science policy issues are most salient in political and public discourse, often driven by institutional actors and political entrepreneurs (Hiltgarner & Bosk 1988; Nisbet & Huge 2006). The contextual thesis asserts that liberals are as likely as conservatives to engage in motivated reasoning and biased processing when they are exposed to ideologically dissonant[1] scientific evidence on issues such as nuclear power (Braman et al. 2012; Kahan 2013).

In order to advance the debate over science communication and political ideology, we explicate the psychological processes by which science communication about controversial topics influences trust in the scientific community. Drawing from the fields of communication and persuasion, we evaluate how conservatives and liberals react when exposed to ideologically dissonant science communication and what this means for institutional trust in the scientific community. Results show that both political

conservatives *and* liberals exhibit negative affective and cognitive reactions to ideologically dissonant evidence from the scientific community. As a consequence, although political conservatives currently exhibit a lower base-level of trust in the scientific community than do liberals (Gauchat 2012), the trust of *both* liberals and conservatives varies significantly when presented with ideologically dissonant science messages. We argue that these findings are consistent with the contextual thesis and that they provide insight into the psychological basis for the deepening divide in trust of the scientific community.

Motivated Reasoning and Political Polarization about Science

As noted, there are two competing explanations for political polarization about science with both propositions drawing upon the concept of motivated reasoning, but differing in their interpretation and application of this concept (Kunda 1990; Lodge & Taber 2000; Lord et al. 1979; Taber et al. 2009). Motivated reasoning is the desire to reach conclusions consistent with previously held beliefs and it leads to biased information processing (Kunda 1990). People do not approach evidence and arguments about controversial issues in a purely rational, even-handed manner (Lodge & Taber 2000). Instead, an individual's prior beliefs and political ideology strongly biases how he or she responds to these arguments through selective exposure, attention, comprehension, and/or recall (Kunda 1990; Lodge & Taber 2000; Lord et al. 1979; Taber & Lodge 2006; Taber et al. 2009). For example, those with greater issue involvement or with strongly held opinions are less likely to modify their beliefs when confronted with new information and so will frequently ignore and misinterpret ideologically incongruent arguments (Johnson & Eagly 1989). Others may respond to counter-attitudinal or ideologically dissonant messages with source derogation, counter-arguing, reactance, or negative affect (Byrne & Hart 2009; Jacks & Cameron 2003; Lewandowsky et al. 2012).

Therefore, equally informed citizens may employ scientific evidence in very different ways depending on their ideological orientation. This type of motivated processing is most likely to occur among those with greater cognitive sophistication (Braman et. al. 2012; Hart & Nisbet 2012; Kahan 2013; Scheufele 2006). For example, ideological orientations may bias the interpretation of information about climate change, even possibly resulting in opinion or belief outcomes that were unintended by the

message creators (a boomerang effect, see Hart & Nisbet 2012; Nyhan & Reifler, 2010). As a result, those with differing ideologies become more polarized in their beliefs upon being exposed to the same scientific evidence creating a differentiation in belief accuracy between ideological groups, or a belief gap (Hart & Nisbet 2012; Hindman 2009; Kahan 2013; Nisbet et al. in press; Taber et al. 2009).

Where the intrinsic and contextual theses differ is on *how* each applies the concept of motivated reasoning to the question of public polarization in beliefs and attitudes toward science. The intrinsic thesis argues that the polarization of institutional trust in the scientific community is due to a fundamental anti-science bias among political conservatives (Mooney 2012). The intrinsic thesis bases its arguments on two sets of scholarship. The first stems from analysis of politically charged scientific controversies over the last forty years and identifies political conservatism and institutions, as compared to political liberalism and institutions, as more often in the position of denying scientific evidence (e.g. Mooney 2012; Oreskes & Conway 2010). Supporters of the intrinsic thesis also point to Gauchat's (2012) analysis of the General Social Survey demonstrating that confidence in the scientific community has declined substantially for conservatives since the early 1990s while remaining steady for liberals.

The second set of scholarship underlying the intrinsic thesis focuses on psychological factors and argues that psychological biases among conservatives increase the likelihood of distrust in the scientific community via the use of motivated reasoning to shape value-inconsistent information so that it conforms to pre-existing beliefs. Importantly, liberals are considered substantially less likely to engage in this form of biased processing when presented with ideologically dissonant scientific claims (Oreskes & Conway 2010; Nam, et al. 2013; Mooney 2005, 2012). The intrinsic thesis relies on research asserting that political conservatives have unique psychological characteristics relative to liberals, such as dogmatism and a higher need for closure, that create stark differences in how members of these groups form attitudes and process information about science (Jost et al. 2003; Kruglanski 2004). For instance, Nam and colleagues (2013) demonstrated that conservatives are more strongly motivated to avoid dissonant messages and dissonant-arousing tasks.

In recent years, scholarship has identified some nuanced cognitive differences between liberals and conservatives (e.g. Carney et al. 2008; Dodd et al., 2012; Garrett & Stroud in press; Jost & Amodio, 2012; Shook & Fazio 2009). However, it is a mistake to overstate these subtle dissimilarities between liberals and conservatives and to use them to make broad claims about biased information processing, especially in the area of science, as the intrinsic thesis does. For example, other scholarship has demonstrated that conservatives are no more likely to reject de-biasing information or engage in motivated reasoning relative to liberals when considering counter-attitudinal political information (Gaines et al. 2007; Nyhan & Reifler 2010; Weeks & Garrett in press).

Neither is there any evidence of innate ideological differences when people consider *scientific* arguments and evidence. For instance, individuals from disparate value groups were found to make similarly biased risk assessments about ideologically incongruent science issues (Braman et al. 2012). Individuals in both groups employed motivated reasoning when forming their risk judgments about dissonant science topics, but polarization was greatest among those most likely to engage in systematic processing (i.e. those with greater cognitive sophistication; Braman et al. 2012). Consequently, ideological polarization was not a result of disproportionate reliance on heuristic processing or of scientific incomprehension by either liberals or conservatives, but rather resulted from the decision to process scientific information in a manner consistent with ideological and group affiliation.

Kahan (2013) has countered the idea of intrinsic ideological asymmetries by administering the cognitive reflection test (CRT) to liberals and conservatives and found no significant difference between the two ideological groups in their likelihood of engaging in systematic processing of information. Consistent with Braman and his colleagues' (2012) findings, individuals who scored highest on the CRT were the *most* likely to engage in ideologically motivated reasoning. These findings support the idea that ideological polarization around science issues is not a consequence of either an information deficit between groups or of an over-reliance on heuristic processing by one group compared to another (Kahan 2013). Instead, Kahan asserts that both liberals and conservatives engage in the "the reliable employment

of more effortful, conscious information processing" that magnifies "the polarizing effects of identity-protective cognition" (2013, 410).

McCright and colleagues (2013) examined ideological differences in trust of scientists engaged in policy-making. They argue that conservatives are not distrustful of all scientists, but instead react negatively to those scientists who are engaged in what they call reflexive science (i.e., science that assesses the environmental and health impacts of modern society). The researchers manipulated the type of science to which participants were exposed and evaluated how much they consequently trusted scientists to advise on policy. Some respondents were asked how much they trust scientists like climate scientists, epidemiologists, etc. (i.e., impact scientists), while others were asked about food scientists, industrial chemists, etc. (i.e., production scientists). Their results were consistent with the contextual thesis: liberals were more trusting and conservatives less trusting of impact scientists, while liberals were less trusting and conservatives more trusting of production scientists.

Political Dynamics of the Contextual Thesis

Collectively, this evidence from the fields of political psychology and risk and decision making challenge the central assertion of the intrinsic hypothesis that conservatives are fundamentally less capable of rationally processing scientific evidence. To the contrary, the evidence is consistent with the contextual thesis, which posits that distrust and denialism of scientific evidence is greatest in those science policy contexts in which individuals feel their values, identity, or interests are threatened, *regardless of their ideology* (Braman et al. 2012; Kahan 2013; McCright et al. 2013; Nisbet 2005, 2011). Liberals and conservatives are equally likely to engage in motivated reasoning and exhibit bias when scientific evidence is incongruent with their values and/or prior beliefs (e.g., nuclear power for liberals, climate change for conservatives; Braman et al. 2012; Kahan 2013).

The contextual thesis asserts that the use of science for political ends by both Democrats and Republicans has contributed to political polarization about science issues as part of a larger, ongoing competition between American political actors attempting to differentiate themselves and mobilize base constituencies within an increasingly polarized political environment (Dunlap & McCright 2008, 2011;

Leeper & Slothus 2014; Sarewitz 2009; Nisbet 2011). For instance, increased media attention to the 1997 Kyoto Treaty, organized largely by the Clinton administration, substantially increased political polarization between liberals and conservatives about the topic of climate change (Krosnick et al. 2000). Likewise, the documentary *An Inconvenient Truth*, featuring a former Democratic presidential candidate from one of the most polarizing presidential elections in recent American history, along with the corresponding media attention to the topic driven by the film, had a similarly polarizing impact on public opinion about climate change between liberals and conservatives (Nisbet 2011).

This does not exempt the well-organized and heavily funded efforts by a range of conservative and industry actors, often termed the "denialist movement," from being the primary cause of the present political polarization about climate change and climate mitigation policies in the United States (Dunlap & McCright 2008, 2011; Nisbet 2011). This institutional form of denialism has systematically attacked climate science and climate mitigation policies through extensive public communication campaigns that misrepresent science and scientific consensus, funding and targeting of political candidates, and intimidation of climate scientists. But here again, communication about the issue is polarizing due to processes of motivated reasoning: liberals tend to discount the claims made by these groups, while conservatives view them as raising legitimate questions about science.

Within this framework, the current low levels of institutional trust in the scientific community and rejection of scientific evidence (about some topics) among conservatives is an outcome of a reinforcing dynamic of institutional mobilization and psychological reactance among politically conservative segments of society. Conservative political, social, and economic actors engage in agenda-building activities to increase the salience of science-policy issues that are inconsistent with their values and interests, pushing the science topic from mostly administrative arenas into more public areas of discourse and contestation (Cobb & Elder 1983; Hiltgarner & Bosk 1988; Jasanoff 1987; Nisbet & Huge 2006).

As a consequence of these highly salient and polarized science policy debates, conservative audiences are exposed to cues from both the left and the right in media and political discourse about how

their ideology and values are largely incongruent with scientific evidence (Krosnick et al. 2000; Slothuus & De Vreese 2010). These cues provide information to conservative audiences about what they should believe and whom they should trust (Hmielowski et al. 2013; Slothuus & De Vreese 2010). Accordingly, conservative audiences engage in motivated reasoning and biased interpretations of scientific information as a means of identity maintenance and protection when such beliefs or opinions are challenged (Cohen 2003; Gaines et al. 2007; Kahan 2013).

In sum, though both the intrinsic and contextual theses explain public polarization about and distrust toward the scientific community in terms of motivated reasoning, they presume different sources of bias. The intrinsic thesis cites innate psychological differences as the basis for polarization in beliefs and attitudes toward science. In contrast, the contextual thesis focuses on how differences in the amount and nature of political mobilization around ideologically dissonant science-policy issues interact with ideological and value predispositions of the public. Thus, it is the dynamic *interplay* between institutional and psychological factors that result in different outcomes for conservatives and liberals rather than intrinsic difference between the two.

A Model of Audience Response to Dissonant Science Messages

Though motivated reasoning provides a useful psychological framework for understanding how exposure to science messages may lead to differences in beliefs and opinions about science between liberals and conservatives, we wish to further unpack the psychological processes underlying biased responses to science communication. We focus on two sets of intervening, or mediating, variables that may determine how exposure to ideologically dissonant science messages influences institutional trust in the scientific community. Since motivated reasoning and ideological dissonance have a strong affective component, and because affect is one of the key factors in message resistance, the first intervening variable that we consider is the *affective (meta-cognitive) experience* of exposure to a dissonant communication (Jacks & Cameron 2003; Schwarz 2010). Meta-cognitive refers to the individual's experience of cognition (not cognition per say), including the emotional reactions that accompany thought generation, with the valence of the emotional reactions being a key factor in determining the perceived

value of the presented information (Schwarz et al. 2007). This meta-cognitive experience provides information that audiences use to make judgments about the value of the message and/or source that may either amplify or dampen persuasiveness and trust toward the source depending on whether the net valence of the affective experience is positive or negative (Lewandowsky et al. 2012; Schwarz 2010; Schwarz et al. 2007).

The other mediating variable we consider is what we term *motivated resistance to persuasion* (Brehm & Brehm 1981; Jacks & Cameron 2003; Knowles & Linn 2004; McGuire 1964). In the context of exposure to science messages presenting evidence that is dissonant with an individual's ideology, we view audience resistance as a, "motivational state: the motivation to oppose and counter pressures to change" (Knowles & Linn 2004, 5). We consider two highly inter-correlated components of motivated resistance to persuasion – counter-arguing and reactance. Counter-arguing refers to the generation of cognitions that undermine and rebut a message's informational content, thereby reducing the persuasiveness and credibility of both message and source (Jacks & Cameron 2003; McGuire 1964; Petty & Cacioppo 1986; Slater & Rouner 2002). Psychological reactance, which includes both affective and cognitive elements, refers to an oppositional response to perceived pressure for change that occurs when a person believes that a message threatens his or her agency or freedom (Brehm & Brehm 1981; Dillard & Shen 2005; Rains 2013). This opposition can lead to message rejection and/or source derogation (Byrne & Hart 2009; Knowles & Linn 2004; Rains 2013; Smith 1977). In the case of dissonant science communication presenting factual evidence that is ideologically inconsistent, the likelihood of perceiving a threat to the freedom to believe what one wants is high, inducing reactance. Although consonant messages may induce negative affect or motivated resistance, message dissonance (in terms of ideology or belief) increases the likelihood of these outcomes (Festinger 1957; Kunda, 1990; Lewandowsky et al. 2012; Schwarz et al. 2007).

In sum, we propose a moderated-mediation model (Hayes, 2013) of audience response that explicates some of the psychological processes that underlie resistance to science communication. First, we posit that an individual's affective experience (*H1a*) and degree of motivated resistance (*H1b*) to the

message from the scientific community will mediate the relationship between exposure to the message and institutional trust in the scientific community. Second, we hypothesize that more strongly held ideological orientations (*H2a*) and belief (in)accuracy (*H2b*) will moderate (amplify) the negative affective experience and/or motivated resistance involved in an individual's response to a dissonant science message.

[INSERT FIGURE 1 ABOUT HERE]

METHODOLOGY

Experimental Design

For our study, we recruited a demographically diverse sample of 1,518 adult participants via a national paid opt-in online survey panel through Qualtrics Panels (http://www.qualtrics.com). Participants were randomly assigned to one of three conditions: 1) conservative-dissonant science (climate change or human evolution), 2) liberal-dissonant science (hydraulic fracking of natural gas or nuclear power), or 3) ideologically neutral science (astronomy or geology). We used stimulus sampling (inclusion of multiple science topics within each condition to which participants were randomly assigned) to increase the external validity of our findings without reducing the internal validity of the experimental design (Wells & Windschitl 1999).

The issues for each condition were selected based on recent national polling data indicating sharp ideological divides within each of the four "dissonant" science policy contexts of climate change, human evolution, fracking, and nuclear power (Pew Research Center 2013a, 2013b, 2013c). Furthermore, we conducted a manipulation check to examine how political ideology was associated with the accuracy of prior beliefs about each set of topics within the study. With socio-demographic controls entered as covariates, political ideology did not significantly predict accuracy of beliefs about geology and astronomy, but did so for both the ideologically dissonant science conditions (i.e. liberals were more accurate in their beliefs about climate change and human evolution whereas conservatives were more accurate about fracking and nuclear power).

Participants were asked four items assessing the accuracy of their beliefs about the science topic to which they were randomly assigned. The participants then viewed what they were told was a sample entry from an educational website for college students and adults about contemporary science topics (called *ScienceWise*). They were asked to carefully review the material and told that several questions about the material would follow. The stimulus provided information that would have allowed participants to correctly answer the all of the previously asked knowledge questions. The full text of questions and examples of the stimuli are provided in the Supplemental Appendix. After viewing the stimulus, each participant responded to survey items measuring affective response and motivated resistance (counter-arguing and reactance) to the message, as well as institutional trust in the scientific community. Participants were then debriefed.

Independent Variables

We collected socio-demographics, which were used as control variables in subsequent analyses, including age (M = 45.18, SD = 15.45), gender (51% female), race (80% white), and educational attainment (1 = *none at all*, 8 = *post-graduate training or professional schooling after college*; M = 5.78, SD = 1.37). Analyses also control for biblical literalism (M = 1.94, SD = 0.70) and whether participants considered themselves evangelical Christians (*yes* coded high; M = 0.27, SD = 0.45).

General scientific literacy was measured using a slightly modified version of the index employed biannually by the National Science Foundation (NSF 2012). Participants were asked four items on a 5-point true/false scale ranging from *definitely true* to *definitely false*, with accuracy coded high and averaged into one overall measure of biophysical scientific knowledge (M = 3.80, SD = 0.83, see Supplemental Appendix for item wording). Science and technology news attention/interest was measured by averaging three items asking respondents how much attention they paid to environmental issues, advancements in science and technology, and energy (1 = *no attention at all*, 7 = *a great deal of attention*) along with two items asking respondents how much interest they had in the topics of "nature and wildlife" and "science and technology" (1 = *no interest at all*, 7 = *a great deal of interest*; M = 5.06, SD = 1.20, α = .87). Political news attention/interest was measured by combining two items asking participants how

much interest they had in politics and how much attention they paid to political news (M = 4.37, SD = 1.76, r = .89).

Political ideology and prior belief accuracy were included as moderator variables in order to test our hypotheses regarding conditional indirect effects. Political ideology was measured by averaging two items asking participants how liberal or conservative they were on economic issues and social issues, respectively. Participants rated themselves on a 7-point scale for each item ranging from *very liberal* (0) to *very conservative* (6; M = 2.96, SD = 1.49, r = .79).

Prior belief accuracy was measured by four items about the topic to which the participant was assigned, scored on a 5-point true/false scale ranging from *definitely true* to *definitely false* (accuracy coded high). See Supplemental Appendix for full text of the belief items for each of the six topics in the study. Participant responses to the four items were averaged in an overall measure of belief accuracy for each topic on a 1-5 scale: climate change (M=3.6, SD=.71), human evolution (M=3.0, SD=1.00), hydraulic fracking (M=2.9, SD=.68), nuclear power (M=2.6, SD=.79), astronomy (M=3.5, SD=.74), or geology (M=2.6, SD=.73).

Dummy variables were coded to indicate whether the participant was assigned to the conservative-dissonant condition (33.1%), the liberal-dissonant condition (33.5%), or the ideologically neutral reference condition (33.4%). Dummy variables were coded for climate change (16.6%), fracking (16.8%), and astronomy (16.7%), to indicate which topic the participant was exposed to within each condition and were also included as controls.

Affective response to the message was measured using the following item adapted from Watson et al. (1988): "When you think about the information you just read on the *ScienceWise* website, how do you feel? Do you feel…" followed by the emotions confident, encouraged, angry, and annoyed. Each item was scored on a 1-7 scale with the two positive and two negative emotions averaged, and the positive affect score was subtracted from the negative affect score (-6 = *strong positive affective response,* 6 = *strong negative affective response; M* = -1.65, *SD* = 2.54). Resistance to persuasion was measured using a composite scale of eleven items (see Supplemental Appendix) adapted (see Moyer-Gusé & Nabi

2010; Nabi et al. 2007) to assess both counter-arguing and reactance to the science communication featured on the *ScienceWise* website (1 = *strongly disagree*, 7 = *strongly agree*; $M = 3.23$, $SD = 1.31$, *Cronbach's* $\alpha = .93$).

Dependent Variable

Institutional trust in the scientific community was measured by averaging five items (see Supplemental Appendix). Sample items included, "I am suspicious of the scientific community" (reverse coded) and "Information from the scientific community is trustworthy" (1 = *strongly disagree*, 7 = *strongly agree*; $M = 4.70$, $SD = 1.18$, *Cronbach's* $\alpha = .87$).

Data Analysis

We tested our hypothetical moderated-mediation model using Hayes (2013) SPSS PROCESS macro (hereafter PROCESS) to explore conditional indirect effects. Moderated-mediation analyses allows the simultaneous examination of the moderating effects of ideology and belief accuracy on the mediated relationships between exposure to dissonant science communication and institutional trust in the scientific community through meta-cognitive affective response and motivated resistance to persuasion. Bootstrapped 99% and 99.9% confidence intervals employing 5,000 samples were calculated to identify significant conditional indirect effects on institutional trust via the two mediators.

Results

Results from our moderated-mediation analysis and hypothesis testing employing PROCESS are provided in three different tables. Table 1 shows the results of the first step of the moderated-mediation analysis and reports the effects of exposure to liberal- and conservative-dissonant science communications, as compared to the neutral reference condition, on meta-cognitive affective experience and motivated resistance. It also shows whether prior belief accuracy and political ideology moderated these relationships. Table 2 reports the results of the equation predicting how exposure to dissonant science communications, again contrasted to the ideologically neutral reference condition, influenced institutional trust in the scientific community with mediators entered into the model. Tables S1 and S2 in

the Supplemental Appendix report the total conditional indirect effects, via the mediating variables of meta-cognitive affective response and resistance to persuasion, of exposure to each treatment condition.

[INSERT TABLE 1 ABOUT HERE]

Models 1 and 3 of Table 1 show how the two ideologically dissonant-science conditions, as compared to the neutral condition, influence meta-cognitive affective responses and motivated resistance to persuasion after accounting for the covariates described above[2]. Participants in both the conservative-dissonant (climate change/evolution) condition and liberal-dissonant (fracking/nuclear) condition experienced a more negative meta-cognitive affective response while reading the ScienceWise stimulus compared to the ideologically neutral condition (astronomy/geology) though the size of the treatment effect for the conservative-dissonant condition was four times greater than the liberal-dissonant condition. Similarly, participants in both the conservative-dissonant condition and liberal-dissonant condition reported greater motivated resistance to persuasion as compared to the referent condition, though in contrast to meta-cognitive affective response the strength of the resistance to persuasion in each condition was almost equal.

Models 2 and 4 in Table 1 test our hypotheses (H2a, H2b) that ideology and belief accuracy moderate the relationship between dissonant-science communications and the two mediators. Within each condition, the regression results show that the more accurate one's prior beliefs were about a topic, the less negative affect and resistance to persuasion you experienced in response to a corrective science message in the dissonant conditions as compared to those in the ideologically neutral condition. Greater accuracy of prior beliefs about climate change or human evolution reduced the effect size of exposure to the conservative-dissonant message on meta-cognitive affective and resistance to persuasion. Likewise, greater accuracy of prior beliefs about fracking of natural gas and nuclear power diminished the effect size of the liberal-dissonant message on meta-cognitive affective experience and resistance to persuasion. The moderating influence of ideology (with conservatism coded high) had a different relationship within each dissonant condition as compared to the referent condition. Conservatives had heightened negative affect experiences and greater resistance to persuasion in the conservative-dissonant condition as

compared to the referent condition, whereas the converse was true in the liberal-dissonant condition with liberals experiencing greater affect and resistance to persuasion than conservatives.

Using PROCESS, we graphed these patterns and calculated the marginal mean values of the meta-cognitive affective and resistance to persuasion measures for liberal (1 standard deviation below the mean ideology score), moderate (mean ideology score) and conservative (1 standard deviation above the mean ideology score) participants in each condition. The results are depicted in Figures 2 and 3. Within the ideologically neutral condition, all three ideological groups appear to have an equally positive meta-cognitive experience while reading the science message about geology or astronomy with no significant differences. In contrast, the valence of the meta-cognitive affective experience for all three groups was significantly more negative in both the conservative-dissonant and liberal-dissonant conditions, though with some variance within each condition. The emotional valence of conservatives varied between the conservative and liberal-dissonant conditions, with conservatives experiencing net negative emotions in the conservative-dissonant condition and net positive emotions in the liberal-dissonant condition. Liberals experienced the mirror image of conservatives with a net negative emotional response in the liberal-dissonant condition and a net positive emotional response in the conservative-dissonant condition, though without as much variation between conditions as conservatives.

[INSERT FIGURES 2 AND 3 ABOUT HERE]

Turning to motivated resistance to persuasion (see Figure 3), conservatives had significantly greater motivated resistance to persuasion than liberals in the conservative-dissonant condition, while liberals reported significantly greater resistance than conservatives in the liberal-dissonant condition. Interestingly, in each condition *both* conservatives and liberals resisted dissonant science messages more than their counterparts in the ideologically neutral condition regardless of their ideology. In the neutral conditions *there was no significant difference in motivated resistance* between liberals and conservatives.

The second step of our analysis was testing whether affective experience and motivated resistance predicted trust in the scientific community and thus mediated the relationship between dissonant-science message exposure and institutional trust (see Table 2). The first model in Table 2 presents the equation

predicting institutional trust without moderation or entry of the mediating variables. Beyond controls, institutional trust was lower in both the conservative-dissonant (climate change/evolution) condition, and the liberal-dissonant (fracking/nuclear power) condition as compared to the ideologically neutral condition. In other words, there is a net drop in trust of the scientific communication around politically contentious science *in both contexts* compared to the more neutral science topics. The second model presents the results with the moderating influence of ideology and accuracy of prior beliefs without the mediators in the equation. Ideology does not moderate the unmediated relationship between exposure to the conservative-dissonant condition and institutional trust but conservatism does amplify institutional trust in the liberal-dissonant condition. The treatment effect of the liberal-dissonant condition (fracking/nuclear power) as compared to the referent condition (geology/astronomy) significantly reduced trust in the scientific community among liberals and moderates, but not conservatives. In comparison, for both the conservative-dissonant and liberal-dissonant conditions, prior belief accuracy amplified trust in the scientific community as compared to the ideologically neutral condition.

The last model in Table 2 includes our measures of meta-cognitive affective experience and motivated resistance to persuasion which both significantly reduced institutional trust in the scientific community. Adding these factors also lessened the direct effect of condition on institutional trust. The effect of the liberal-dissonant condition on trust dropped below significance and the magnitude of conservative-dissonant treatment effect substantially decreased. Thus, meta-cognitive affective experience and resistance to persuasion significantly dampened institutional trust in the scientific community, seemingly absorbing most of the influence of the different ideologically charged science messages.

To further test the mediating roles of meta-cognitive affective experience and motivated resistance to persuasion we used PROCESS to estimate the conditional indirect effects of exposure to conservative and liberal dissonant science messages on trust as compared to the ideologically neutral condition at differing levels of political ideology and prior belief accuracy (not shown; see Tables S1 and S2 in the Supplemental Appendix). Indirect effects of exposure to the conservative-dissonant message on science trust through meta-cognitive experience were consistently negative, though how negative the

effects were varied significantly by ideology and belief accuracy. That is, the conservative-dissonant condition significantly reduced trust in the scientific community as compared to the neutral condition via negative affect for both conservatives and liberals but the effect was most pronounced among those with the lowest belief accuracy. In contrast, in the liberal-dissonant condition meta-cognitive experience significantly *dampened* institutional trust among liberals with low (b = -.10, $p \leq .001$) or moderate (b = -.06, $p \leq .001$) belief accuracy, while significantly *increasing* institutional trust among conservatives with moderate (b = .04, $p \leq .01$) or high (b = .08, $p \leq .001$) belief accuracy.

Examining indirect effects of dissonant science on trust in the scientific community via motivated resistance to persuasion, we find that the influence of belief accuracy is comparable to its influence through affect: individuals with less accurate initial beliefs are more likely to engage in motivated resistance, which in turn reduces trust in science. The influence of ideology, however, is reversed across the two conditions. For instance, in the conservative-dissonant condition, there were no significant indirect effects for high accuracy liberals (b = -.06, n.s.), but significant indirect effects for high accuracy conservatives (b = -.24, $p \leq .001$). A mirror image of this pattern is evident in the liberal-dissonant condition: the indirect effect of condition on trust in the scientific community among high accuracy conservatives (b = -.06, n.s.) was not significant, but was significant for high accuracy liberals (b = -.33, $p \leq .001$).

DISCUSSION

Limitations

Before we discuss the implications of our findings we wish to note some limitations to the study. One limitation is that the experiment was not fully crossed in terms of conditions—participants were not all asked the same belief questions prior to the science communication—and we employed a reference condition, not a traditional control. Employing a neutral science reference condition, and using stimulus sampling of science topics within the conditions increases the external validity of the study, though internal validity may have been only modestly reduced as participants were not all asked the same scientific belief questions in each condition. It also would have been better to have conducted a separate

pre-test in which we measured accuracy of beliefs across all topics and institutional trust prior to exposure to the stimulus with a significant time interval (e.g., a week) between exposure to the dissonant messages and the following post-test in order to assess within-subject change in addition to between-subject change, but that was not possible in this study with the resources available. We see these as future opportunities to further explicate audience reactions to dissonant science messages, as well as to better model the psychological dynamics of a salient controversial science issues by conducting a series of repeated exposures to dissonant science messages across different topics to evaluate changes in institutional trust over time.

Implications for Understanding Audience Reactions to Dissonant Science Messages

Audiences that are exposed to politically controversial science communication often experience negative emotions and cognitive resistance as they process these messages, both of which have negative consequences for institutional trust in the scientific community. These processes are politically biased, influencing conservatives and liberals alike, and they are amplified by prior beliefs and value orientations. Our experiment demonstrates that both liberals and conservatives respond more negatively to ideologically dissonant science communication, which indirectly leads to lower trust in the scientific community—findings consistent with the contextual thesis and inconsistent with the intrinsic thesis. Unpacking the intervening processes between message exposure and institutional trust makes it clear that these reactions also vary by science context.

One important open question concerns why the magnitude of the overall (negative) affective response and the motivated resistance to persuasion, and thus the conditional indirect effects, in the conservative-dissonant condition was greater than the liberal-dissonant condition. One possible explanation for these differences is the greater attitude polarization between liberals and conservatives on issues of climate change and human evolution as compared to fracking and nuclear power. For instance, posthoc analysis shows significantly higher levels of ideological differentiation in the accuracy of beliefs for the two conservative-dissonant issues (liberals more accurate and conservatives less accurate) as

compared to liberal-dissonant science issues. We suspect that these observed differences help us explain the conditional indirect effects report here.

Climate change and the debates over teaching evolution generally have had a higher profile in media and political discourse than those over fracking or nuclear power, as have associated partisan identity markers. By virtue of these topics' prominence, individuals know what (liberal and conservative) opinion leaders believe, and they know a great deal about the debate. Together, these factors leave individuals better equipped to counter-argue and more likely to react negatively to the messages, which may help explain the somewhat greater magnitude of the indirect effects on trust via motivated resistance for the conservative-dissonant condition as compared to the liberal-dissonant condition.

Just as polarized media and political discourse have contributed to greater affective polarization between liberals and conservatives (Garrett, et. al. in press; Iyengar, Sood, Lelkes 2012), the greater polarization in beliefs around issues like climate change and human evolution may also invoke a stronger emotional response in conservatives and liberals who are confronted with these topics. Additional post-hoc analysis confirms the participants were generally angrier about climate change and human evolution topics than the other four topics (i.e. fracking, nuclear power, geology, and space), and these high levels of anger translate into greater distrust of the scientific community for everyone.

These results suggest, distressingly, that political polarization around science has *the potential to depress trust for audiences across the ideological spectrum*. Within our experiment, institutional trust was significantly lower for *all* participants, including liberals, in the conservative-dissonant condition as compared to the ideologically neutral condition due to the psychological mechanisms of meta-cognitive affective response and motivated resistance to messages about polarized science.

What leads some science issues to be more ideological polarized than others? Our data do not address this question, but we suspect that this is where the institutional processes and political dynamics outlined in the contextual thesis come into play. For example, liberal-dissonant issues such as hydraulic fracking, nuclear power, or genetically-modified food currently have relatively low public salience compared to conservative-dissonant issues such as climate change and human evolution. The low salience

of liberal-dissonant science-policy issues contributes to the relative stability of institutional trust in the scientific community among liberals over the last twenty years. Liberal audiences have not been exposed to repeated liberal-dissonant messages, which we have shown would drive down institutional trust in the scientific community. Conservative audiences, in contrast, have faced a steady stream of dissonance-inducing science messages—a process augmented by the emergence of partisan news outlets that vary greatly in their treatment of issues like climate change, and lead to greater polarization about the issue among viewers (Hmielowski et al. 2013; Feldman et al. 2012).

Our findings illustrate an important step in what we suspect is a much larger cycle of science communication. In the short term, audiences' affective experience of and motivated resistance to a dissonant message may dampen trust in the scientific community. However, the possible long-term ramifications are more problematic because audiences are exposed to dissonant science messages repeatedly in political and media discourse. A cycle of science communication that includes a reinforcing spiral of source derogation toward the scientific community over time, as exampled by the issue of climate change, becomes difficult to break. The perceived trust and credibility of the messenger constrains how audiences receive and respond to *future communications,* to the point that trust in the scientific community becomes the basis on which messages are accepted or rejected, leading people to largely ignore the arguments or evidence (Brehm & Brehm 1981; Byrne & Hart 2009; Chaiken, 1987; Petty & Cacioppo 1986). As a "trust gap" develops, it significantly influences the ability of the scientific community and other associated institutions to be effective communicators and advocates for science (Gauchat 2012; Hmielowski et al. 2013; Priest et al. 2003). It also provides incentives for mobilizing strategic actors to widen the trust gap and ideological cleavages around controversial science issues to increase mobilization.

Furthermore, our findings illustrate that advocates of the intrinsic thesis (e.g., Mooney 2012) have done science communicators a disservice. By promoting the idea that there are inherent psychological differences between conservatives and liberals when forming attitudes and making judgments about science, they are effectively—and ironically—contributing to the very political polarization of science

they decry and thereby inhibiting more effective science communication. Some who adhere to this thesis rightly point out that "leading with values," not with evidence, in a science message may be an effective communication strategy when communicating dissonant science to conservative audiences (Mooney, 2011). However, by targeting conservatives specifically as somehow uniquely deficient when it comes to science, the overall framework of the intrinsic thesis lends itself to focusing on ideological counter-mobilization and/or a conversion of worldviews ("If only everyone were liberal!"), rather than to bridging ideological gaps (because the intrinsic thesis holds that they cannot be bridged). Demonizing a third of the population in a science policy debate by claiming they have an insurmountable psychological deficit does nothing to promote a solution to the challenges of effective science communication. And, as we have shown here, it is not empirically justified.

End Notes

1. A scientific claim may be considered "dissonant" when its policy implications challenge one's ideological worldview or set of cultural values – e.g. claims about the benefits of embryonic stem cell research is dissonant for social conservatives because such claims beliefs about life beginning at inception, claims about the advantages of nuclear power over fossil fuels for climate change mitigation are dissonant for liberals because claims challenge their beliefs about the environment (Kahan & Braman 2006; Kahan et al. 2012; Nisbet 2005; Nisbet & Markowitz 2014)
2. Only the variables of substantive interest are presented in Tables 1 and 2, though several control variables were entered each model as noted below each table. Specifically, we entered as covariates in each model indicators of age, sex, educational attainment, race, evangelical Christian, biblical literalism, attention to science & technology news, attention and interest to politics, general scientific literacy, and dummy codes for non-relevant experimental conditions and for the stimulus sampling.

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Table 1. Moderated-Mediation Analysis Predicting Meta-cognitive Affective Experience and Motivated Resistance to Persuasion

	Meta-cognitive Affective Experience (negative)		Motivated Resistance to Persuasion	
	Model 1	Model 2	Model 3	Model 4
Variable	*b* (*SE*)	*b* (*SE*)	*b* (*SE*)	*b* (*SE*)
Constant	-.69 (.50)	-1.69 (.54)**	3.44 (.06)***	2.94 (.28)***
Ideology (conservatism coded high)	.02 (.04)	.11 (.07)	.06 (.02)**	.08(.03)*
Prior Belief Accuracy	-.86 (.08)***	-.24 (.13)	-.62 (.04)***	-.24 (.07)***
Conservative-Dissonant Condition [a]	1.84 (.21)***	2.23 (.50)***	1.03(.11)***	1.50 (.26)***
Liberal-Dissonant Condition [a]	.45 (.21)*	3.13 (.43)***	.93(.11)***	2.13 (.23)***
Conservative Dissonant X Ideology	-	.20 (.09)*	-	.15 (.05)**
Conservative Dissonant X Belief Acc.	-	-.64 (.17)****	-	-.55 (.09)**
Liberal Dissonant X Ideology	-	-.49 (.09)***	-	-.25 (.05)***
Liberal Dissonant X Belief Accuracy	-	-.77 (.18)***	-	-.30 (.10)***
% Variance Explained (Total R^2)	*26.4*	*30.3*	*24.0*	*29.4*

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$. Unstandardized coefficients and standard error reported; Results are controlling for age, sex, educational attainment, race, evangelical Christian, biblical literalism, attention to science & tech news, attention/interest to politics general scientific literacy, dummy codes for social indicator and political cue conditions and stimulus sampling topic dummy codes (climate change, fracking, astronomy) entered as covariates. a. Reference condition is ideologically neutral condition (geography/astronomy).

Table 2. OLS Equation Predicting Institutional Trust in the Scientific Community

	Model 1	Model 2	Model 3
Variable	*b(se)*	*b* (*SE*)	*b* (*SE*)
Constant	4.00 (.25)	4.40 (.27)***	5.40 (.25)***
Ideology (conservatism coded high)	-.16 (.02)***	-.19 (.03)***	-.15 (.03)***
Prior Belief Accuracy	.32 (.04)***	.09 (.07)	-.01 (.01)
Conservative-Dissonant Condition [a]	-.49 (.10)***	-1.16 (.25)***	-.44 (.22)*
Liberal-Dissonant Condition [a]	-.22 (.10)***	-.85 (.22)***	.19 (.20)
Conservative Dissonant X Ideology	-	.01 (.02)	.08 (.04)*
Conservative Dissonant X Belief Accuracy	-	.37 (.09)***	.12 (.08)
Liberal Dissonant X Ideology	-	.12 (.05)**	-.02 (.04)
Liberal Dissonant X Belief Accuracy	-	.18 (.09)*	.02 (.08)
Meta-cognitive Affective Experience	-	-	-.07***
Motivated Resistance to Persuasion	-	-	-.38***
% Variance Explained (Total R^2)	*19.2*	*20.3*	*38.5*

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$. Unstandardized coefficients and standard error reported; Results are controlling for age, sex, educational attainment, race, evangelical Christian, biblical literalism, attention to science & tech news, attention/interest to politics general scientific literacy, dummy codes for social indicator and political cue conditions and stimulus sampling topic dummy codes (climate change, fracking, astronomy) entered as covariates. a. Reference condition is ideologically neutral condition (geography/astronomy).

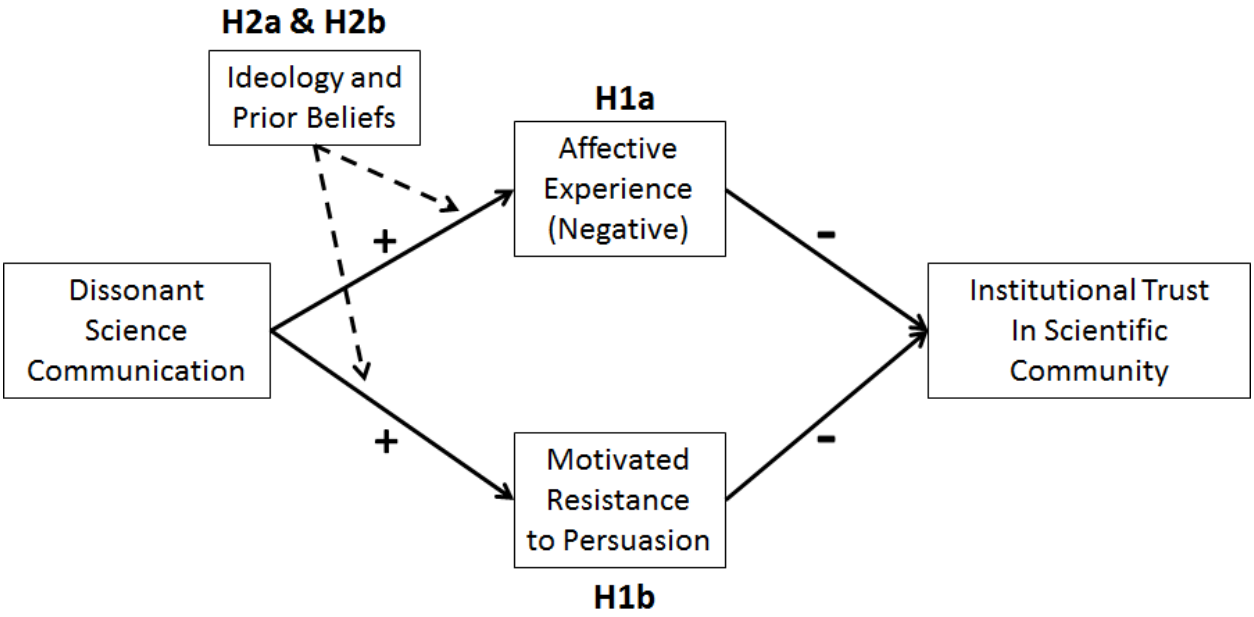

Figure 1. A Model of Audience Response to Dissonant Science Communications

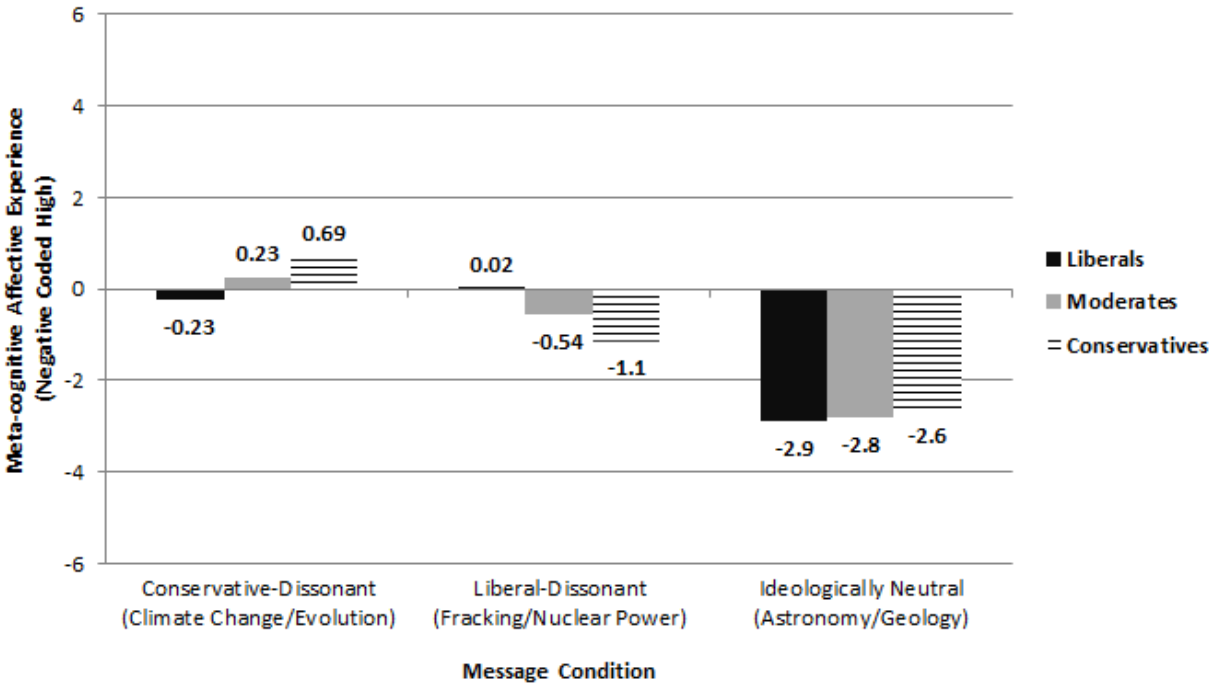

Figure 2. Meta-cognitive Affective Experience for Liberals and Conservatives by Condition

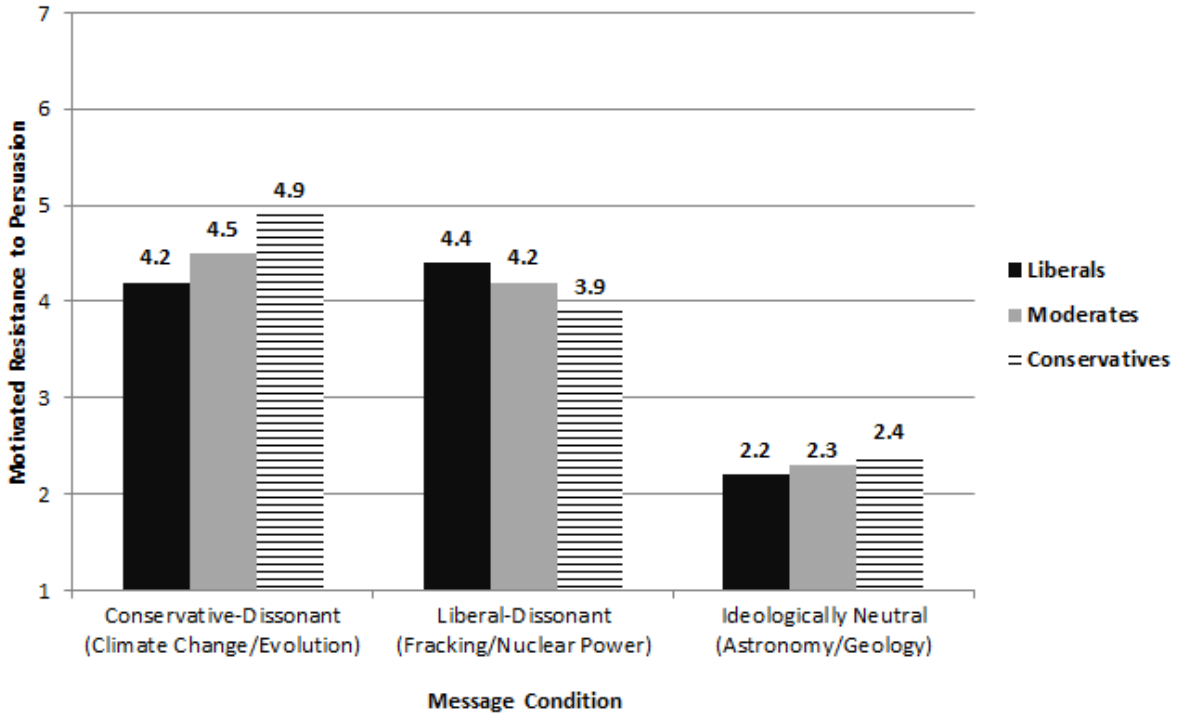

Figure 3. Motivated Resistance to Persuasion for Liberals and Conservatives by Condition