

Perceptions of Science and Scientists: Bridging Ideological Divides in the US

Ashley Ross

Texas A&M University at Galveston

ashleydross@tamug.edu

Rhonda Struminger

Texas A&M University

struminger@tamu.edu

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Abstract

The American public is politically polarized, and climate change belief is one of the most visible issues dividing the electorate along ideological lines. Bridging the gap between the opposing sides relies on more than evidence as ideologies have become social identities, and motivated reasoning often causes individuals to reject new facts that run counter to their pre-existing beliefs. Studies show that interacting with science and scientists can influence individuals more than factual-based learning, and that scientific consensus acts as a “gateway” for belief in global warming. Building on these results, we contend that exposure to science through personal experience, as well as positive perceptions of scientists and science, may lessen polarized beliefs of whether or not global warming is a reality. To examine this, we use data from a 2017 original survey implemented across the United States and run a series of statistical interactions to explore how science exposure and perceptions condition the effect of ideology on climate change beliefs. The findings reveal that attitudes about global warming held by conservatives may be changed by perceptions of scientific consensus, in general, as well as by trust in climate scientists, personal experience with scientific endeavors, and how much one values science in day-to-day life. The results have implications for how we understand partisan and ideological identities, and point to the role science can play in bridging ideological divides on political issues, starting with climate change.

Keywords: climate change, science, conservative, Republican, scientific consensus, citizen science, global warming, political ideology

The American public is more divided today than at any time in recent history.¹ Republicans and conservatives, on one hand, and Democrats and liberals, on the other, are increasingly opposed to one another both in terms of issues (Pew Research Center 2017) and affect and behavior (Iyengar, et al. 2012; Mason 2015; Mason 2018a). The polarization among the U.S. polity is more social than political; instead of political behavior and beliefs being motivated by reasoned policy interests, they are compelled by emotional attachment to party and political ideology (Mason 2018b). As a result, “politics is driven not only by what we think, but also powerfully by who we think we are” (Mason 2018a: 299). At the same time, critical issues are increasingly reframed by the media and elites through ideological lenses (Carvalho 2007; Dotson, et al. 2012) and the rise of “fake news” has allowed opinions to sit alongside and, in some instances, replace facts (van der Linden, et al. 2017; Lewandowsky, et al. 2017). Lost in this political environment is an understanding of issues that are fundamentally issues of science – those grounded in the scientific method of discovery – and, as a consequence, reasoned dialogue about policy choices is stymied. While climate change is not the only example of such an issue (e.g. the safety of vaccines), it is one of the most salient.

While there has been overwhelming consensus among scientists for over two decades that global warming is occurring – 97% of scientists agree that human activities have contributed to climate change (Liu, et al. 2015; Cook, et al. 2016), it is an issue that strongly divides the American public along ideological lines. Republicans and Democrats disagree in belief of global warming² and concern for the issue, and this discord is only growing. In 2000, the gap between

¹ The survey used for this study was supported by the College of Liberal Arts, Texas A&M University, 2017 Seed Grant. The authors would like to thank Dr. Jeffrey Winking and Kersten Bergstrom for their contributions to the data collection.

² We acknowledge that climate change and global warming differ. The former refers to changes in the statistical properties of the climate system that persists for several decades or longer while the latter refers to the earth’s increasing surface temperature. While some consider global warming as one symptom of climate change, others

the two parties' expressed concern about global warming was 17%; in 2017, it had grown to 48% (Norman, 2017). This polarization was due to each party moving to the extreme: Democrats' concern increased (46% to 66%) while Republicans' concern (29% to 18%) decreased.

How do you bridge these ideological divides? It is not simply an issue of information since stances are rooted in social identities, attachments that are not swayed by logical evaluations (Mason 2015; Mason 2018b), and individuals are prone to rely on motivated reasoning to process information that reinforces pre-existing beliefs (Kunda 1990). However, bridging the divide may lie in experience with and related perceptions of the source of that information: science. Recent work has shown that how individuals interact with science and scientists, and how such experiences make individuals feel, is more influential on future behavior than factual-based learning (Dean, et al. 2018). Pivoting from this research and building upon studies that demonstrate perception of scientific consensus is a “gateway” for belief in global warming (Ding, et al. 2011; McCright, et al. 2013; van der Linden, et al. 2015), we contend that exposure to science through personal experience as well as positive perceptions of scientists and science may lessen polarization rooted in ideological identity.

This study uses data from a 2017 original survey implemented across the U.S. to assess how an individual's exposure to science, confidence in science, and value of science is related to the belief that global warming is occurring. Specifically, using a series of interactions, we explore how science exposure and perceptions condition the effect of ideology on climate change beliefs. The findings reveal that attitudes about global warming held by conservatives may be changed by perceptions of scientific consensus, in general, as well as by trust in climate scientists, personal experience with scientific endeavors, and how much one values science in

point to climate change as the side-effect of global warming (Kennedy and Lindsey 2015). The terms are used interchangeable in this study.

day-to-day life. The results have implications for how we understand partisan and ideological identities and point to a key role of science in bridging ideological divides on political issues, starting with climate change.

Exposure to Science, Confidence in Science, & Value of Science

Since the founding of the National Science Foundation in 1950, the United States government has invested billions of dollars to “promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense” (NSF). This national commitment to science is significant, but the general population may not always appreciate or understand the science, or access the scientific data scientists make available. To explore the multidimensional relationship between the public and science, this paper looks to how much individuals are exposed to science, how confident they are in scientific findings, and how much they value science in their daily life.

Exposure to Science

There are many ways the public can engage with science and scientists. First, publicly available data may be used for work purposes or to answer questions related to special interests. The National Oceanic and Atmospheric Administration’s temperature data and the U.S. Census Bureau’s extensive database of city populations are just two examples of how the public can access information through open records available online. Second, volunteering to help scientists with their research is another way for the public to learn how science works in practice, and this can take many forms from assisting scientists in laboratories to surveying an audience at a special event, to participating in a citizen science project. Citizen science activities in which

participants work closely with scientists on a research project or collect data, present opportunities for the public to experience and engage with science (Bonney, et al. 2009; Groulx, et al. 2017). We believe that such activities could help overcome the ideological divide on climate change. If people have experience with, and subsequently an understanding of, science and the scientific process, they may be more likely to trust scientific findings. Therefore, we hypothesize:

H1: Individuals who have greater exposure to science will be more likely to believe in global warming than those who have less exposure.

Confidence in Science

At the heart of science are scientists who enjoy a high level of trust from the general public. Though they have come under scrutiny for their political activism, most recently at March for Science events, scientists remain trusted sources of information (Ross, et al. 2018). In a 2016 Pew Survey, 76% of the public indicated that they trust scientists a great deal or a fair amount (Funk 2017). Researchers have looked at the mediating effects of media on the public's acceptance of anthropogenic (man-made) climate change and how scientific uncertainty impacts perception and trust of scientists (Jensen and Hurley 2010; Retzbach and Maier 2014; Hmielowski, et al. 2014), but information from climate scientists about the causes of climate change is more trusted by over 30% than information from energy industry leaders, the media, or elected officials (Funk 2017). Moreover, science media sources (i.e. magazines, web sites, television channels dedicated to science) are also shown to be more trusted than other sources of scientific reporting (Brewer and Ley 2013).

When there is trust in scientists, research shows that individuals are more supportive of solutions, such as regulations, for alleviating the pressures of climate change (Sleeth-Keppler, et al. 2017). Citizen science experiences can play a key role to build this trust as it gives the public a personal experience with scientists and the scientific process (Spellman 2015; Groulx, et al. 2017; Jordan, et al. 2012). Thus, an individual's experience with scientists can be strongly tied to an individual's level of confidence in scientists and science more generally, making scientists' level of agreement on scientific findings more meaningful for shaping opinion.

Multiple studies have tested perceived scientific consensus on global warming as a "gateway" for climate change belief and policy support (Ding, et al. 2011; McCright, et al. 2013; van der Linden, et al. 2015). This growing body of research demonstrates that perceptions of scientific agreement on global warming are a product of partisan, ideological, and environmental identities as well as socioeconomic status, namely education, income, gender, age, and race; in turn, perceived scientific consensus influences global warming beliefs that, in turn, shape support for government action on climate change. These studies robustly connect perceptions of scientific agreement on global warming to attitudes about global warming (see Kahan 2017 for dissent). Trust in scientists and perceptions of scientific consensus related to climate change, therefore, represent two ways to understand confidence in science. Accordingly, we hypothesize:

H2: Individuals who have greater confidence in scientists and recognize scientific consensus will be more likely to believe in global warming than those who have less confidence.

Value of Science

According to a recent study by Pew Research Center, most Americans think that science has done more good than harm, and 70% think scientists contribute a lot to society (Pew Research Center and the American Association for the Advancement of Science 2009). But there is a partisan divide: 74% of Democrats think this way compared with 66% of Republicans. The recent March for Science attracted those who value science as a public good that needs more public investment and support, and that was dominated by Democrats indicating a division in how “value” is understood (Ross, et al. 2018). In general, how much one recognizes the role science plays in one’s day-to-day life, and values its role, should be indicative of how willing one is to support scientific findings. We hypothesize:

H3: Individuals that more highly value science will be more likely to believe in global warming than those ascribe a lower value to science.

Data, Model, & Methods

To explore how science experience and perceptions influence climate change attitudes, we employ an original survey conducted in November 2017. The survey was launched online and included a national panel with quotas to enhance representativeness. The quotas matched 2010 U.S. Census Bureau figures for age, political ideology, and employment. Similar to previous studies and surveys (Harvard Institute of Politics 2015; Krogstad 2015), we focus on belief in the evidence of climate change. To measure this, we rely on responses to the survey question: *Do you think global warming is happening?* Response options included: “no” (coded 0), “I don’t know” (coded 0), and “yes” (coded 1).

We are interested in testing how exposure to science, confidence in science, and value of science conditions the effect of political ideology on global warming belief. To measure

exposure to science, we rely on separate measures for scientists and non-scientists. The survey asked respondents if they were a scientist by profession. For those who said “yes” (coded 1), we consider this a measure of exposure to science among professional scientists. For non-scientists, a series of questions were posed to assess experience with science, including if the respondent had ever collected data, worked with a scientist, or used publicly available data. Responses were aggregated then categorized as: no experience (coded 0), experience with 1 of these (coded 1), experience with 2 or 3 of these (coded 2).

To measure confidence in science we focus on survey responses that convey individual perceptions of scientific consensus and trust in scientist. The survey asked respondents if “hearing that scientists have reached consensus” convinces them of scientific findings; responses were delineated as “yes” (coded 1) or “no” (coded 0). In addition, respondents were asked to evaluate how much they trust climate scientists, specifically, to “give full and accurate information about global climate change.” Responses included: “not at all” (coded 1), “not too much” (coded 2), “some” (coded 3), and “a lot” (coded 4).

The measure of individual value prescribed to science was created from a set of three survey items that assessed respondent agreement with the following statements: 1) “It is important for me to know about science in my daily life;” 2) “Science and technology are making our lives healthier, easier, and more comfortable;” and 3) “Because of science and technology, there will be more opportunities for the next generation.” Responses included: “strongly disagree” (coded 1), “somewhat disagree” (coded 2), “neither agree or disagree” (coded 3), “somewhat agree” (coded 4), and “strongly agree” (coded 5). The average of responses to the three items was taken then recoded to represent perceptions of the value of science as: “negative” (average ranging from 1 to 2.67, representing disagreement), “neutral”

(average ranging from 3 to 3.67), and “positive” (average ranging from 4 to 5, representing agreement). The variable in the model, therefore, represents general sentiment regarding the value of science.

There is a robust set of literature demonstrating the role of political ideology and party affiliation in processing information on climate change (e.g. Wood and Vedlitz 2007; McCright and Dunlap 2011). In the United States, the conservatives and the Republican Party have maintained the position that holding the position that environmental protection challenges conservative values of property rights and the free market (Dunlap and McCright 2008; McCright, et al. 2014) while liberals and the Democratic Party have supported policies to protect the environment (McCright and Dunlap 2011). Recent studies have demonstrated the growing divide among conservatives and liberals, Republicans and Democrats, on the issue of climate change with the former comprising the majority of deniers (e.g. McCright and Dunlap 2011; Newport and Dugan 2015; Leiserowitz, et al. 2018). Furthermore, research has shown that the political ideology labels, specifically “liberal” and “conservative,” confer a sense of social identity that motivate political behavior and attitudes (Malka and Lelkes 2010; Ellis and Stimson 2012; Mason 2018a). In line with this, we expect conservative individuals to be less likely to believe in climate change. We measure conservative as self-reported political ideology across two categories: conservative (coded 1) and moderate or liberal (coded 0).³

Given that climate change is a psychologically distant issue, both spatially (in that it is typically perceived as a global, not local issue) and temporally (in that it is perceived to affect the

³ Mason (2018a) finds that party affiliation is significantly related to ideological labels. According to our survey data, 41.01% of respondents self-identified as conservatives (n=481). Among this group, 61.91% affiliated with the Republican Party, 19.85% with the Democratic Party, and 18.24% with another minor party or as Independent. Among the 58.99% that self-identified as liberal (n=692), 57.57% affiliated with the Democratic Party, 29.53% with another minor party or as Independent, and 12.90% with the Republican Party.

future, not present) (Spence, et al. 2012), we control for a number of factors representing the values and identities that people may rely on as heuristic devices. The first includes religious beliefs, specifically evangelical Christian affiliations. Evangelical Christians have been found to be the least likely to believe climate change is occurring and that it is caused by human activity (Funk and Alper 2015; Leiserowitz, et al. 2015). Some have attributed these trends to dominant theology among evangelicals, including “dominion over nature” (Hulme 2009); others, however, see it as the result of evangelical leaders to reframe the issue as religious, rather than environmental, and a deliberate initiative to cultivate distrust and alienation from science and liberals (Wardekker, et al. 2009). While there has been evidence of a “greening” of evangelical attitudes promoting environmental conservation and acceptance of climate science (Wilkinson 2012), we still expect evangelical beliefs to decrease the likelihood of belief in the evidence of global warming. We measure this by including a dummy variable that reports if a respondent identifies as a “born-again Christian” (coded 1) or not (coded 0).

In addition to the influence of religious beliefs on climate change attitudes, a new stream of research demonstrates that generational identity may matter as well. Recent research makes the case that the Millennial Generation, those born from about 1980 to the late 1990s, shares a persona or identity, characterized by shared values of liberalism, tolerance, and diversity that guides their political attitudes (Rouse and Ross 2018b). Polls indicate that younger adults are more supportive of the environment than older adults (Pew Research Center 2014), and recent studies demonstrate that Millennials are more likely to believe in the occurrence of global warming than older adults, and attribute its cause to human activity (Rouse and Ross 2018a; Rouse and Ross 2018b).

Similar to Millennials, ethnic minorities are progressive on environmental issues. Known as the “climate gap,” race and ethnic minority groups are disproportionately exposed to environmental and climate hazards; as a result, their health and well-being are diminished (Mohai and Bryant 1998; Yardley, et al. 2011). This disproportionate exposure has been tied to socioeconomic status – minorities are often less educated and, therefore, more likely to be socioeconomically disadvantaged, thereby putting them in risky occupations and neighborhoods that are hazardous (Hansen, et al. 2013), and they are more likely to suffer from racial discrimination and social inequities (Mechanic and Tanner 2007). The issue, therefore, can be understood through the lens of social identity or belonging (Tajfel, et al. 1971) and group consciousness or the recognition that one is part of a deprived class (Sanchez 2006). Latinos, in particular, demonstrate concern for the “climate gap.” Recent polls show that Latinos lead in climate change belief and concern, and are more likely to believe the earth is getting warmer because of human activity (Krogstad 2015). Further, recent research has shown that Latinos with greater ethnic group attachment are less likely to be skeptical of climate change (Rouse and Ross 2018a). This indicates that Latinos, in particular, exhibit awareness and concern for environmental disparities and the associated vulnerabilities members of their ethnic group experience. Therefore, we expect that Latino identity, measured in this study as self-identified membership (coded 1 for “yes” and 0 for “no”), will be associated with a higher likelihood of climate change belief.

We control for gender as females have been found to be more concerned with the environment, in general, (e.g., Bord and O'Connor 1997) and the issue of climate change, specifically (e.g., McCright and Dunlap 2011). Some scholars attribute greater environmental concern among females to norms of social responsibility (Zelezny, et al. 2000), but others have

found the ethic of care to be gender neutral (Strapko, et al. 2016). However, women across the world bear the brunt of climate change impacts when existing inequalities, such as poverty, are exacerbated by associated natural disasters (i.e. flood) (Dankelman and Jansen 2010). Therefore, we expect females (coded 1) to be more likely to believe in climate change than males (coded 0).

Finally, we control for education as it may be a proxy for knowledge of climate change. In line with past studies (e.g., Hamilton 2011), we expect that as knowledge increases about the issue, climate change belief also increases. Education is measured as highest degree obtained and categorized as: high school (coded 1); some college or associate's degree (coded 2); bachelor's degree (coded 3); and master's, doctorate, medical, or law degree (coded 4).

To test these expectations, we estimate a logistic regression model with multiple interactions to capture the how exposure to science, confidence in science, and value of science differs between conservatives and moderates/liberals as well as among these two groups. We expect that science experience and positive perceptions of scientists and science will increase acceptance of global warming, regardless of ideological identity, although the magnitude of the effect is likely to be smaller for conservatives. In addition, the following variables are included in the model: born-again Christian, Millennial, Latino, female, and education.⁴ A weight was created and applied to the regression to adjust the survey sample for population totals on political ideology, age, gender, race/ethnicity, and employment, using census data (United States Census Bureau 2015).⁵ The total number of observations analyzed is 1,170.

⁴ See Appendix A for a summary of all measures and Appendix B for descriptive statistics of all variables in the model.

⁵ The weight was calculated using a user-written command for iterative proportional fitting or raking (Bergmann 2011). While the weight does not correct for all bias in the sample, it does offer a method for addressing sample skews. The results, therefore, should be more generalizable to the national population.

Results: Science Exposure and Perceptions Associated with Ideological Differences on Climate Change Belief

The results of the logit regression are presented in Figure 1.⁶ While it is evident from this plot that being a scientist by profession, being convinced by scientific consensus, and higher levels of trust in climate scientists are significantly associated with the increased likelihood of global warming belief, some of the interactions of science experience and perceptions with conservative political ideology are statistically significant as well. Since logit coefficients are difficult to interpret directly, and because values of interactions, when examined discretely, may emerge as statistically significant, we explore the results in terms of marginal effects and pairwise comparisons of marginal effects. Specifically, we examine comparisons between conservatives, on one hand, and moderates and liberals, on the other, as well as among each ideological subgroup across a series of interactions between conservative political ideology and measures of exposure to science, confidence in science, and value of science.

[Figure 1 here]

First, we turn to exposure to science. Pairwise comparisons of non-scientists' experience with science show that conservatives with zero or only one experience are significantly less likely than moderate and liberals to believe in the occurrence of global warming.⁷ However, there are no statistically significant differences between conservatives and moderates/liberals with two or more science experiences, indicating that exposure to science negates the influence of political ideology among those with multiple science experiences. Further examination reveals that science experience works differently among each ideological subgroup. As show in Figure 2, two or more experiences significantly influence global warming beliefs among conservatives

⁶ See Appendix C for a table of the regression coefficients and standard errors.

⁷ See Appendix D for a table reporting all pairwise comparisons and their associated statistical significance levels.

while among moderates/liberals any science experience (greater than zero) exerts a significant effect on global warming attitudes. These results indicate that more science experience is needed to change conservatives' beliefs about the issue, but that science experience does shape non-scientists global warming opinions regardless of political ideology.

[Figure 2 here]

The second measure of exposure to science is being a scientist by profession. We find that there is no statistically significant difference among conservative scientists and non-scientists in their belief in global warming. Conservative non-scientists, in comparison to moderate/liberal non-scientists, are 15.21% less likely to believe in the occurrence of global warming; alarmingly, conservative scientists are 19.91% less likely than their moderate/liberal counterparts. While these findings underscore how influential political ideology is on climate change opinions, they should be interpreted cautiously. Only 88 respondents identified as scientists, and only 23 of those consider themselves as conservatives. While some studies have explored scientists' attitudes about policy (Ross et al 2018), more research on the influence of political ideology among this group is needed. Therefore, our first hypothesis regarding the positive influence of science exposure on global warming acceptance finds mixed support.

Next we examine how confidence in science influences global warming attitudes when taking into account political ideology. Pairwise comparisons between conservatives and moderates/liberals shows that being convinced of findings by scientific consensus increases the likelihood of global warming belief. Among those who are not convinced by scientific consensus, conservatives are 22.72% less likely to believe in the occurrence of global warming than moderates/liberals with the same view of scientific consensus. Among those who are convinced of scientific findings by scientific consensus, conservatives are 12.78% less likely to

believe in global warming than moderates and liberals. While political ideology is still shaping beliefs in this case, the 10% reduction in likelihood demonstrates that confidence in scientific consensus has a substantial effect on global warming beliefs. Furthermore, among conservatives, those who are convinced by scientific consensus have an 18.71% greater likelihood of global warming belief than those who are not convinced by scientific consensus. Among liberals, the difference is only 8.76%, indicating that changing perceptions of scientific consensus could be an effective way to reach conservatives on the issue.

In addition to perceptions of scientific consensus, we explore trust in climate scientists as a measure of confidence in science. There are no statistically significant distinctions between conservatives and moderate/liberals among those with no or low trust, but conservatives are 16.14% and 18.24% less likely to believe in global warming than moderates and liberals with medium and high trust of climate scientists, respectively. When we turn to examination of marginal effects among each ideological subgroup, we find there is, again, no difference between low and no trust. However, as shown in Figure 3, the likelihood of global warming belief significantly increases among those with medium and high trust of scientists compared to no and low trust; the likelihood of global warming belief even increases for the scenario of high versus medium trust. Most striking is the similarity in differences between levels of trust among conservatives and moderates/liberals. This indicates that trust in climate scientists moves conservative attitudes as much as those of moderate/liberals. Therefore, we find support for hypothesis that confidence in science positively influences global warming belief.

[Figure 3 here]

Third, we explore perceptions of the value of science, measured as the average agreement that science is important in daily life, makes our lives healthier and easier, and creates

opportunities for the next generation. Pairwise comparisons of marginal effects indicate that there is no difference among conservatives and moderates/liberals that are negative (or disagree) regarding the value of science. Among individuals who are neutral and positive about the value of science, conservatives in comparison to moderates/liberals are 19.93% and 16.74% less likely, respectively, to believe global warming is occurring. Therefore, valuing science slightly reduces the effect of ideological identity on global warming attitudes. The results also indicate that ascribing value to science influences conservative, but not moderate/liberal, global warming beliefs; however, it is not in the direction that we expect. While there are no statistically significant differences between negative, neutral, and positive values of science among moderates/liberals, a higher value of science is associated with a lower likelihood of global warming belief among conservatives. Pairwise comparisons among conservatives show those that are neutral about the value of science are 16.30% less likely than those who are negative about science's value to believe in global warming. Similarly, conservatives who hold a positive value of science are 13.36% less likely to believe in global warming than those who are negative about science's value to society. This does not support, and offers evidence that runs in direct opposition, to our hypothesis. Given that the analysis relies on an aggregated measure of scientific value, additional analyses should explore individual measures of the value ascribed to science. It may be that perceived benefit of technological advancement are driving the results, rather than general appreciation for the scientific enterprise. The former may run counter to global warming acceptance if it is undergirded by a value of corporate advancement.

Finally, two variables among the control set emerge as statistically significant. We find that evangelical beliefs, measured as self-identification as a born-again Christian, negatively influences global warming belief. Marginal effect comparisons show that Evangelicals are 6.08%

less likely to believe in the occurrence of global warming than those are not born-again Christians.⁸ This supports our expectation that evangelical beliefs hinder the acceptance of global warming. Further, we find that Latinos are more 7.67% more likely to believe in global warming than non-Latinos.⁹ Again, this is in line with our expectation and offers support that Latinos are more aware of climate change issues given the disproportionate effect of the impacts on their minority group.

Conclusion: Bridging Ideological Divides by Promoting the Science as a Public Good

Concern for global warming and beliefs about the causes of climate change is a polarizing topic among the American public as well as political and social leaders (Dunlap, et al. 2016; Kiley 2015). Political and religious conservatives are much more skeptical of climate change science and scientists than non-conservatives (Dunlap, et al. 2016). The polarization between parties on the topic of climate change has been growing since the Nixon years, and the leading cause has been an anti-regulation platform that puts industry over environmental protections (McCright, et al. 2014). Among religious conservatives, evangelical Christians consistently align themselves against environment protection policies (Wardekker, et al. 2009). Recent polls shows that only 42% of Republicans, versus 86% of Democrats, think most scientists believe global warming is occurring (Brenan and Saad 2018). Yet, the overwhelming consensus among scientists is that global warming is occurring and that human activities have contributed to it (Liu, et al. 2015, Cook, et al. 2016). The effects of global warming are evident in glacier melt, sea level rise, and cycles of drought (NASA), and climate science is increasingly connecting climate change as a driver of extreme events (National Academies of Sciences 2016),

⁸ The p-value for this marginal effect contrast is 0.013.

⁹ The p-value for this marginal effect contrast is 0.024.

including Hurricane Harvey's unprecedented levels of rainfall and the strength and frequency of the 2017 hurricane season (Risser and Wehner 2017; Sneed 2017). We are at a juncture where identifying what undergirds beliefs and concern related to climate change is critical so that we can foster better scientific communication that informs policy and programs, not only in the environmental domain but also in the areas of urban planning, emergency management, and public health.

This study has explored how experiences with and perceptions of science may increase acceptance of the occurrence of global warming, specifically among conservatives. Analyzing data from a 2017 national survey, we find that experience with scientific data collection and/or use increases the likelihood of global warming belief among conservatives and moderates/liberals, but that more experience is needed among conservatives to change their attitudes on the issue than moderates/liberals. Further, the results indicate that being convinced of scientific findings by news of scientific consensus boosts conservative likelihood of global warming belief more so than moderates/liberals. In addition, trust in climate scientists has a similar effect among conservatives and moderates/liberals by increasing the acceptance of global warming among those with greater trust.

While we did not find support that being a scientist or valuing science increases global warming belief, our results, in the aggregate, support that individual experiences with and perceptions of science matter for climate change attitudes. Most importantly, the results provide evidence that changing conservatives' opinion on the issue may be accomplished through personal experiences with science, such as citizen science, as well as initiatives that boost confidence in science. Based on the measures of scientific perceptions used in the analysis, we believe that initiatives aimed at improving the public's knowledge of scientific consensus and

trust in the accuracy of information provided by climate scientists could make the biggest strides in reducing conservative denial of climate change. Since ideological divides are driven by social identities (Mason 2018a; Mason 2018b) and messages aimed at debunking myth about global warming are not effective at changing attitudes (Ding, et al. 2011), this is fundamentally an issue of experience, not information. Specifically, experience with the scientific method seems critical to gain a better understanding of scientific processes and inherent uncertainty, thereby increasing knowledge and trust.

This study has only scratched the surface of the association of exposure to science, confidence in science, and value of science with climate change attitudes. We acknowledge that science perceptions and experiences are likely linked to one another. Experience with science may generate knowledge and trust in science that spills over to the value of science. At the same time, valuing science may drive individuals to participate in scientific endeavors and gain experiences that shape their confidence in science. How these are related was not explored in this study as such an analysis requires more in-depth information across multiple points in time. Focus groups of individuals who participate in citizen science as well as panel surveys would produce the type of information needed to trace the mechanisms by which science experience and perceptions effect acceptance of global warming and related climate change policy attitudes. The findings of this analysis simply point to the need to move beyond scientific consensus as a “gateway” for global warming belief to include science experiences and broader perceptions of science into our examination of attitudes on this issue. Identifying the mechanisms that increase individual trust in science may help to lessen polarization rooted in ideological identity, thereby bridging gaps in divisions on climate change and other critical issues facing our country.

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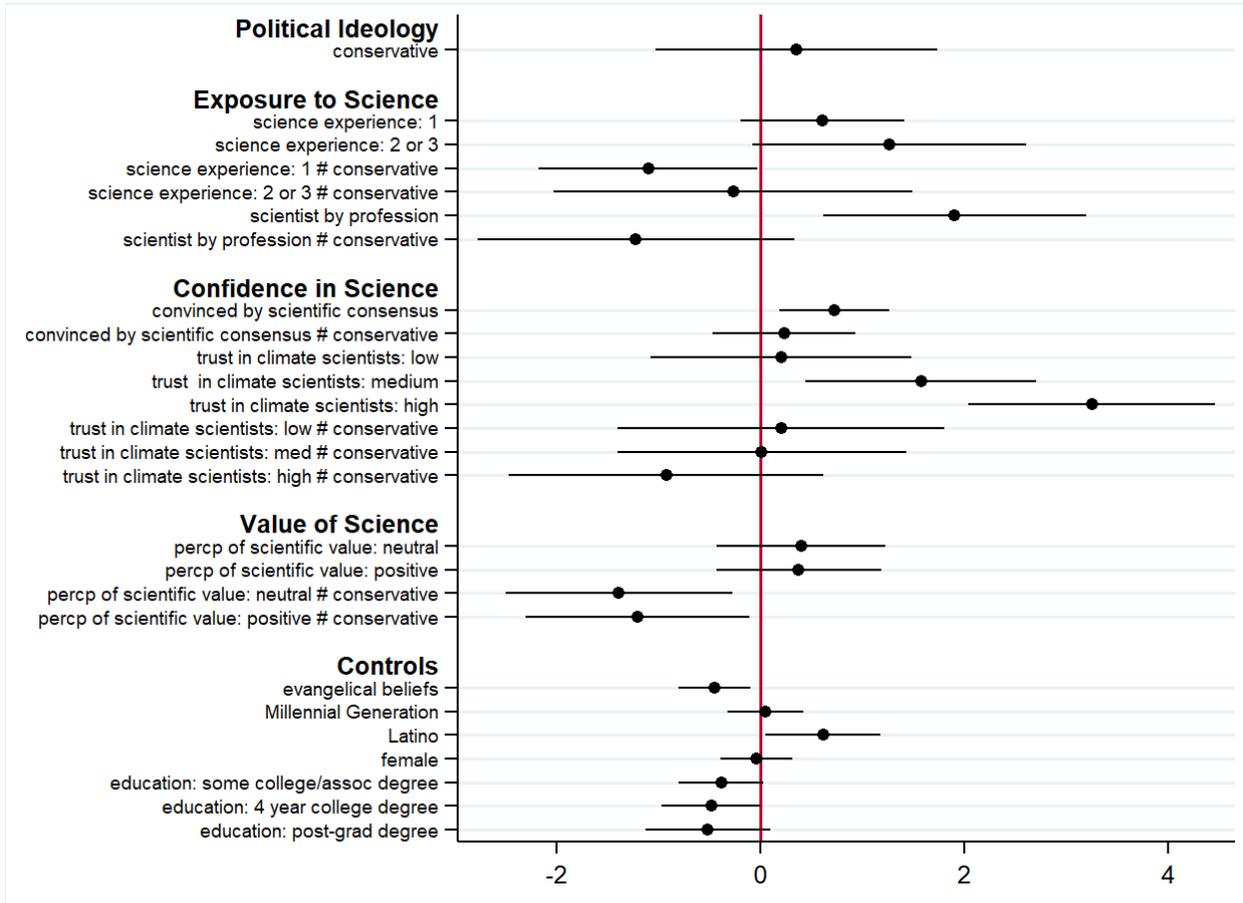
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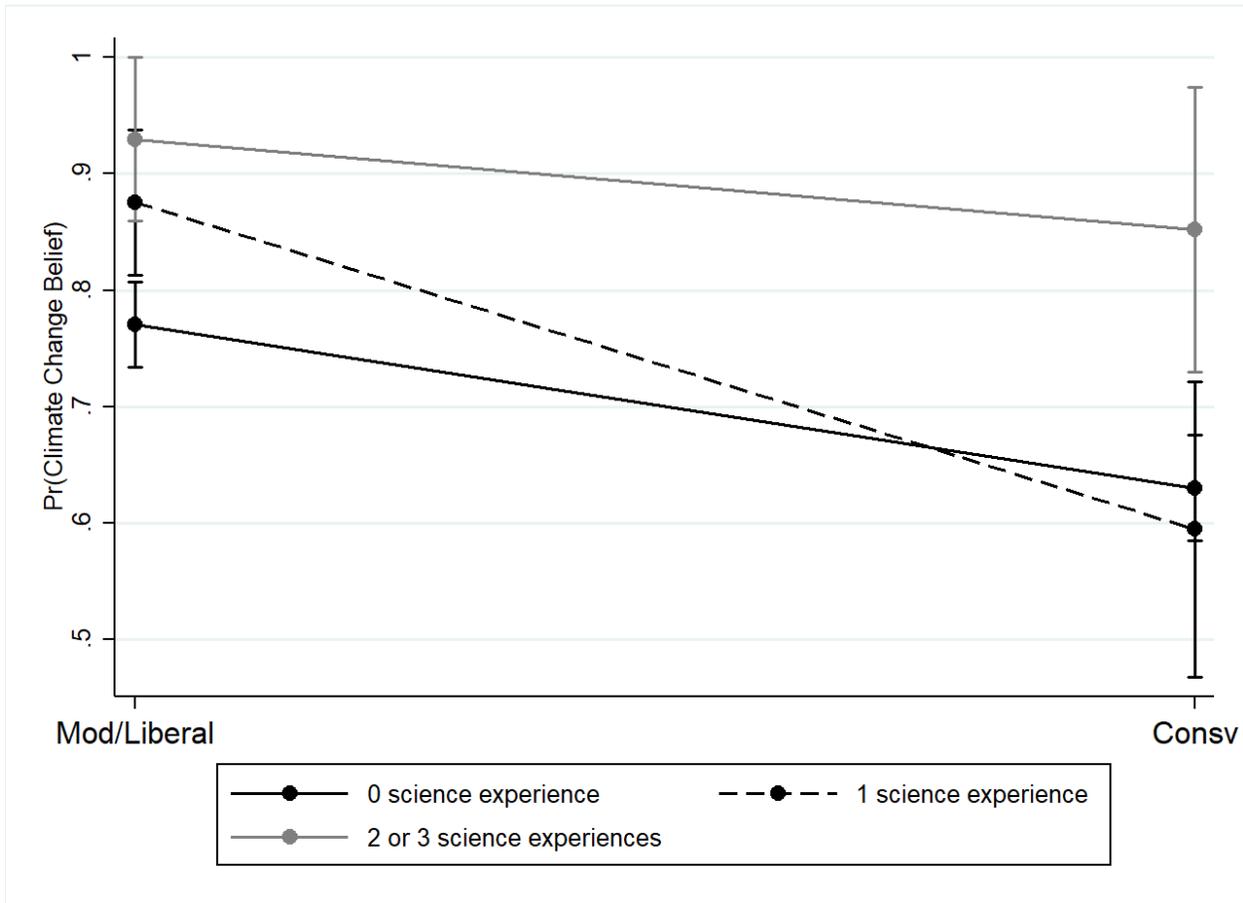
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Figure 1. Logit Regression Results



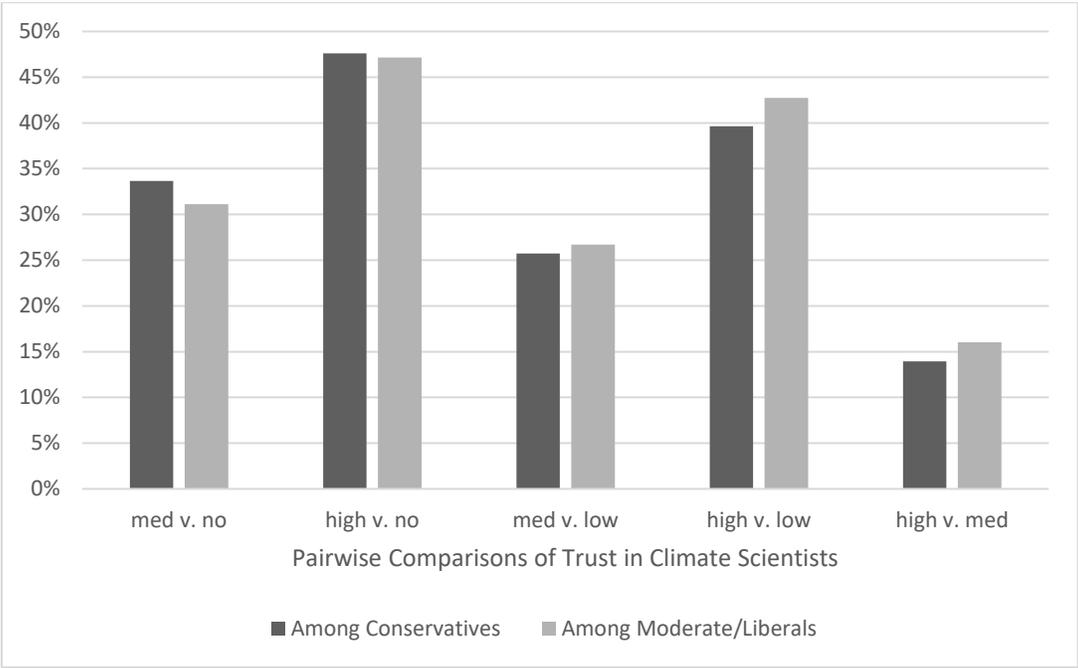
Note: Logit regression estimated. Coefficients plotted with confidence intervals shown by bars. Coefficients to the left of the zero x-line have a negative effect on the dependent variable (belief in global warming), and those to the right have a positive effect on the dependent variable. Coefficients with confidence intervals crossing the zero x-line are not statistically significant. See Appendix C for a table of the coefficients and standard errors.

Figure 2. Marginal Effects of Science Experience by Political Ideology



Note: Marginal effects shown for values of the science experience*political ideology interaction. Bars indicate 95% confidence interval.

Figure 3. Trust in Climate Scientists Boosts Global Warming Acceptance despite Political Ideology



Note: Pairwise comparisons of marginal effects plotted. Bars represent difference in likelihood of global warming belief for each pair where high = high trust in climate scientists, med=medium trust in climate scientists, low = low trust in climate scientist, and no = no trust in climate scientists. See Appendix D for a table of contrast values and associated statistical significance.

Appendix A. Variable Coding

VARIABLE	SURVEY QUESTION	CODING
<i>Global warming belief</i>	Do you think global warming is happening? [yes; no; I don't know.]	0 = no/don't know 1 = yes
<i>Science experience</i>	Asked only to non-scientists: 1) Have you ever voluntarily collected scientific data without monetary compensation? 2) Have you ever worked in an official capacity with a scientist doing research? 3) Have you used publicly available data for your own work? [yes; no]	<i>Tally of "yes" responses:</i> 0 = no experience 1 = experience with 1 2 = experience with 2 or 3
<i>Scientist by profession</i>	Do you consider yourself a scientist (currently or retired)? [yes; no]	0 = no 1 = yes
<i>Convinced by scientific consensus</i>	Does hearing that scientists have reached consensus convince you of their findings? [yes; no]	0 = no 1 = yes
<i>Trust in climate scientists</i>	How much, if at all, do you trust each of the following groups to give full and accurate information about global climate change? 1) Elected officials, 2) Climate Scientists, 3) Energy industry leaders, 4) Environmental organizers, 5) the mainstream news media [not at all; not too much; some; a lot]	1 = no ("not at all") 2 = low ("not too much") 3 = medium ("some") 4 = high ("a lot")
<i>Perception of scientific value</i>	How much do you agree with the following statements? 1) It is important for me to know about science in my daily life. 2) Science and technology are making our lives healthier, easier, and more comfortable. 3) Because of science and technology, there will be more opportunities for the next generation. [strongly disagree; somewhat disagree; neither agree or disagree; somewhat agree; strongly agree]	<i>Average of responses:</i> 1 = negative ("strongly disagree" and "somewhat disagree") 2 = neutral ("neither agree and disagree") 3 = positive ("somewhat agree" and "strongly agree")
<i>Conservative political ideology</i>	When it comes to politics do you usually think of yourself as liberal,	0 = moderate or liberal 1 = conservative

	conservative, or moderate? [liberal, conservative, moderate]	
<i>Evangelical beliefs</i>	Do you consider yourself a born-again Christian? [yes; no]	0 = no 1 = yes
<i>Millennial Generation</i>	What is your age in years?	0 = 38 years and older 1 = 18-37 years
<i>Latino</i>	Are you of Hispanic or Latino background, such as Cuban, Dominican, Mexican, Puerto Rican, Salvadoran, Central American or South American? [yes; no]	0 = no 1 = yes
<i>Gender</i>	What is your gender identity? [male; female; other]	0 = male or other 1 = female
<i>Education</i>	What is the highest level of degree you have earned? [high school; some college; associate's degree; bachelor's degree; master's degree; doctorate degree; medical degree; law degree]	1 = high school 2 = some college or associate's degree 3 = bachelor's degree 4 = master's, doctorate, medical, or law degree

Appendix B. Summary Statistics

Variable	N	Mean	Std. Dev.	Min	Max
<i>Global warming belief</i>	1,170	0.731	0.449	0	1
<i>Science experience</i>	1,170	0.243	0.527	0	2
<i>Scientist by profession</i>	1,170	0.079	0.264	0	1
<i>Convinced by scientific consensus</i>	1,170	2.518	0.675	1	3
<i>Trust in climate scientists</i>	1,170	0.609	0.491	0	1
<i>Perceptions of scientific value</i>	1,170	3.192	0.874	1	4
<i>Conservative political ideology</i>	1,170	0.400	0.492	0	1
<i>Evangelical beliefs</i>	1,170	0.373	0.481	0	1
<i>Latino</i>	1,170	0.178	0.344	0	1
<i>Millennial Generation</i>	1,170	0.377	0.485	0	1
<i>Gender</i>	1,170	0.508	0.494	0	1
<i>Education</i>	1,170	2.274	0.931	1	4

Appendix C: Logit Regression Results

Dependent variable: Global warming belief			
<i>Do you think global warming is happening? 0 = no or don't know; 1 = yes</i>			
Political Ideology			
	conservative	0.351	(0.706)
Exposure to Science			
	science experience: 1	0.609	(0.411)
	science experience: 2 or 3	1.261*	(0.685)
	science experience: 1 # conservative	-1.104**	(0.550)
	science experience: 2 or 3 # conservative	-0.271	(0.898)
	scientist by profession	1.904***	(0.658)
	scientist by profession # conservative	-1.224	(0.793)
Confidence in Science			
	convinced by scientific consensus	0.721***	(0.275)
	convinced by scientific consensus # conservative	0.231	(0.356)
	trust in climate scientists: low	0.203	(0.652)
	trust in climate scientists: medium	1.577***	(0.578)
	trust in climate scientists: high	3.252***	(0.618)
	trust in climate scientists: low # conservative	0.201	(0.816)
	trust in climate scientists: med # conservative	0.009	(0.723)
	trust in climate scientists: high # conservative	-0.927	(0.789)
Value of Science			
	percp of scientific value: neutral	0.398	(0.421)
	percp of scientific value: positive	0.376	(0.410)
	percp of scientific value: neutral # conservative	-1.391**	(0.566)
	percp of scientific value: positive # positive	-1.208**	(0.562)
Controls			
	evangelical beliefs	-0.456**	(0.179)
	Millennial Generation	0.047	(0.190)
	Latino	0.614**	(0.287)
	female	-0.0422	(0.181)
	education: some college/assoc degree	-0.384*	(0.213)
	education: 4 year college degree	-0.486*	(0.249)
	education: post-grad degree	-0.516*	(0.312)
Constant		-0.761	(0.581)
N		1,170	

Note: Logit regression estimated. Coefficients reported with standard errors in parentheses. Statistical significance denoted as: *** p<0.01, ** p<0.05, * p<0.10.

Appendix D. Pairwise Comparisons of Marginal Effects

EXPOSURE TO SCIENCE		
Science experience		
<i>consv 0 science experience vs mod/lib 0 science experience</i>	-13.75%	(0.000)
<i>consv 1 science experience vs mod/lib 1 science experience</i>	-29.70%	(0.000)
<i>consv 2 science experiences vs mod/lib 2 science experiences</i>	-10.53%	(0.235)
<i>consv 1 science experience vs consv 0 science experience</i>	-9.32%	(0.177)
<i>consv 2 science experiences vs consv 0 science experience</i>	15.34%	(0.053)
<i>consv 2 science experiences vs consv 1 science experience</i>	24.66%	(0.012)
<i>mod/lib 1 science experience vs mod/lib 0 science experience</i>	6.64%	(0.106)
<i>mod/lib 2 science experiences vs mod/lib 0 science experience</i>	12.12%	(0.018)
<i>mod/lib 2 science experiences vs mod/lib 1 science experience</i>	5.48%	(0.362)
Scientist by profession		
<i>consv non-scientist vs mod/lib non-scientist</i>	15.21%	(0.000)
<i>consv scientist vs mod/lib scientist</i>	-19.91%	(0.009)
<i>consv scientist vs consv non-scientist</i>	11.36%	(0.128)
<i>mod/lib scientist vs mod/lib non-scientist</i>	16.06%	(0.000)
CONFIDENCE IN SCIENCE		
Convinced by scientific consensus		
<i>consv not convinced vs mod/lib not convinced</i>	-22.72%	(0.000)
<i>consv convinced vs mod/lib convinced</i>	-12.78%	(0.000)
<i>consv convinced v consv not convinced</i>	18.71%	(0.000)
<i>mod/lib convinced vs mod/lib not convinced</i>	8.76%	(0.012)
Trust in climate scientists		
<i>consv no trust vs mod/lib no trust</i>	-18.69%	(0.194)
<i>consv low trust vs mod/lib low trust</i>	-15.15%	(0.141)
<i>consv medium trust vs mod/lib medium trust</i>	-16.14%	(0.000)
<i>consv high trust vs mod/lib high trust</i>	-18.24%	(0.000)
<i>consv low trust vs consv no trust</i>	7.94%	(0.388)
<i>consv medium trust vs consv no trust</i>	33.66%	(0.000)
<i>consv high trust vs consv no trust</i>	47.59%	(0.000)
<i>consv medium trust vs consv low trust</i>	25.72%	(0.000)
<i>consv high trust v consv low trust</i>	39.65%	(0.000)
<i>consv high trust vs consv medium trust</i>	13.93%	(0.008)
<i>mod/lib low trust vs mod/lib no trust</i>	4.40%	(0.756)
<i>mod/lib medium trust vs mod/lib no trust</i>	31.11%	(0.012)
<i>mod/lib high trust vs mod/lib no trust</i>	47.14%	(0.000)
<i>mod/lib medium trust vs mod/lib low trust</i>	26.71%	(0.002)
<i>mod/lib high trust v mod/lib low trust</i>	42.74%	(0.000)
<i>mod/lib high trust vs mod/lib medium trust</i>	16.03%	(0.000)

VALUE OF SCIENCE

Perceptions of scientific value

<i>consv negative value vs mod/lib negative value</i>	1.19%	(0.856)
<i>consv neutral value vs mod/lib neutral value</i>	-19.93%	(0.000)
<i>consv positive value vs mod/lib positive value</i>	-16.74%	(0.000)
<i>consv neutral value vs consv negative value</i>	-16.30%	(0.004)
<i>consv positive value vs consv negative value</i>	-13.36%	(0.015)
<i>consv positive value vs consv neutral value</i>	2.94%	(0.511)
<i>mod/lib neutral value vs mod/lib negative value</i>	4.82%	(0.364)
<i>mod/lib positive value vs mod/lib negative value</i>	4.57%	(0.384)
<i>mod/lib positive value vs mod/lib neutral value</i>	-0.25%	(0.942)

Note: The difference in marginal effects for each pair is reported, as likelihood of climate change belief. Marginal effects were calculated by holding all other variables at their mean values. Statistical significance (p-value) of the difference is reported in parentheses. Those differences with p-values \geq 0.05 are bolded.