THE POLITICAL DETERMINANTS OF ATTITUDES TOWARDS SCIENCE

A Dissertation

by

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ABSTRACT

In the contemporary United States, politics often seems to dominate the conversation surrounding scientific topics and related technologies. At a time rich in scientific discoveries, the public is more interested than ever in what science holds for the future and the impact of constantly evolving technology. Yet we also live in times of high political polarization, leading to an almost inevitable stream of political debate over scientific discoveries, their applications, and subsequent policy change. Science, in working to establish “facts" and known truths about the world, inherently intersects and often collides with individuals’ values by enabling and limiting different ideas of what is possible. When this happens, those with strong convictions have an incentive to try to affect the path of scientific research or have biased reactions to scientific findings. When scientific evidence is rejected based on political values, political polarization on science and scientific beliefs results. This in turn threatens the application of these scientific findings, since the public is able to punish politicians who fail to follow the path they prefer at the ballot box. Given these dynamics, there is much to be learned about the politicization of science, individuals’ policy views, and the public’s relationship with the communication and interpretation of scientific findings. Work on this topic has thus far focused on two major areas: first, citizens’ beliefs and attitudes about science and science-related public policy, and second, the communication of scientific findings and how those findings are interpreted. This dissertation seeks to build on both of these bodies of work by examining attitudes among members of the mass public towards science over time, comparing political mechanisms for changes in these attitudes, and experimentally testing the role of politics in the formation of science attitudes and information interpretation.

DEDICATION

To Todd and Ginny Haglin, the best research team I know.

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No one accomplishes anything alone and this doctoral journey is no exception. First and foremost, I have to thank my parents, Todd and Ginny Haglin, for their never-ending love and support over the last five years. They have done so much to help me achieve my dreams and make sure I had the right tools to make it happen. I cannot thank them enough for listening to all my long-winded complaints, worries, and fears over the last five years. And they always reminded me to never panic, even if I did anyway.

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1. INTRODUCTION AND LITERATURE REVIEW

In the contemporary United States, politics often seems to dominate the conversation surrounding scientific topics and related technologies. At a time rich in scientific discoveries, the public is more interested than ever in what science holds for the future and the impact of constantly evolving technology. Yet we also live in times of high political polarization, leading to an almost inevitable stream of political debate over scientific discoveries, their applications, and subsequent policy change. Given these dynamics, there is much to be learned about the politicization of science, individuals' policy views, and the public's relationship with the communication and interpretation of scientific findings.

It has been argued that science, and the public's understanding of science, was a "rational" process that advanced over time with little interference from prejudice (Popper 2001)[53]. However, scholars increasingly understand that the scientific process does not play out free of bias or in a vacuum. Individual values, including political ones, influence the process of scientific discovery, as well as the communication and reception of those findings (Douglas 2009[14]; Nisbet 2009[46]). Scholars in fields such as science and technology studies, history, and philosophy have chronicled the effect of political and religious values on the scientific process dating from Copernicus to current debates over a wide variety of topics. This emphasis on values is not surprising. Values represent beliefs individuals hold about the way the world ought to be and guide how we assess world events and the behavior of others (Rokeach 1973[56]; Schwartz 1992[57]). Science, in working to establish "facts" and known truths about the world, inherently intersects and often collides with individuals' values by enabling and limiting different ideas of what is possible. When this happens, those with strong convictions have an incentive to try to affect the path of scientific research or have biased reactions to scientific findings.

When individuals and their interests can interact with the scientific process happens at a few

points. Some individuals may try to influence the problems scientists spend time and resources trying to solve. While academics agree that taking public opinion about what should be a priority on the scientific agenda is desirable (Brown 2009[5]; Douglas 2009), using value-based assessments to influence the scientific agenda is clearly problematic for the scientific method. When the desire for a particular outcome biases the researcher's methodology, the process becomes corrupt.

Individual values can also intersect with science when it comes to interpreting scientific findings. When values become a part of the evidence evaluation process, seemingly "objective" facts can become wildly skewed (Lodge and Taber 2013)[39]. Lodge and Taber (2013) tell us that these values often play a major role in information interpretation and that interpretation depends on if the information conforms to the individual's previously held beliefs and attitudes. Climate change is but one example of these sorts of biased assessments: conservatives who do not believe in climate change often downplay evidence of human-caused climate change, while liberals holding different prior beliefs find the same evidence compelling. Thus, when scientific evidence is rejected based on political values, political polarization on science and scientific beliefs results (Lodge and Taber 2013; Druckman, Peterson, and Slothuus 2013[16]). This in turn threatens the application of these scientific findings, since the public is able to punish politicians that fail to follow the path they prefer at the ballot box.

There are of course times when values play a necessary and important role in considering the results of scientific discovery. Some applications of technologies developed by scientists raise significant moral and ethical questions. The most classic example is human cloning, a procedure we have the technology and knowledge to implement, but choose not to out of moral and ethical concerns. So while values have a place in evaluating scientific findings and their applications, certain value differences between experts and the public can cause tensions over policy, such as those surrounding vaccines and climate change (Fowler and Gollust 2015[19]).

The combination of increasing scientific and technological discovery and intense political polarization leaves us much to study on the intersection of politics and science. Work on this topic

has thus far focused on two major areas: first, citizens' beliefs and attitudes about science and science-related public policy, and second, the communication of scientific findings and how those findings are interpreted. This dissertation seeks to build on both of these literatures by examining attitudes among members of the mass public towards science over time, comparing political mechanisms for changes in these attitudes, and experimentally testing the role of politics in the formation of science attitudes and information interpretation.

Research on public opinion of science and scientists exists in several disciplines and approaches the subject from diverse angles. In political science, fews studies directly examine attitudes towards science generally. Existing studies typically focus on a particular subject matter, with climate change as the primary scientific topic, in order to test hypotheses about attitudes towards science. While it is well established that the left-right spectrum colors how individuals perceive political phenomena, including policy debates like those around climate change (Feldman 1988[18], Jacoby 1995[30]), other studies have examined how the information environment affects attitudes towards science. Kellstedt, Zahran, and Vedlitz (2008)[36] examine attitudes towards global warming and find that more informed individuals and those with more confidence in science are less concerned about global warming and feel less personally responsible. This suggests that the knowledge-deficit model, which proposes that a lack of information and understanding contributes to a lack of belief or support, may not be the primary explanantion for climate change skepticism. Additionally, Krosnick et al. (2006)[37] find that existence beliefs, certainty, and attitudes drive how nationally serious one thinks global warming is.

From here, public opinion about science and scientists has been explored in sociology, history, and science and technology studies (STS). Complementary to work in political science, STS has established that science and politics are indivisible (Cozzens and Woodhouse 1995[12]; Frickel and Moore 2005[21]) and that science has always been politicized. Other work has then attempted to piece together the relationship between scientific knowledge and attitudes and political orientations. Reminiscent of Hofstadter (1970)[29], Mooney (2005)[44] argues that the political neutrality

of science began to change in the 1970's with the emergence of the "new right", which preferred limited government, traditional values, and was skeptical of organized science and intellectualism. Following from this, Mooney argues that the elections of Reagan and Bush began the "war on science".

Several works examine the sorts of claims made by Mooney (2005) and seek to assess them empirically. Most notably, Gauchet (2012)[22] tests Mooney's (2005) claim that conservatives have become more distrustful of science over time using the General Social Survey "confidence in scientific community" question. He finds that group differences in trust are stable, with the exception of conservative respondents, who end the analyzed period with the lowest levels of trust in science. Other work also offers support for Mooney's (2005) arguments. McCright and Dunlap (2000)[43] demonstrate the prevalence of conservative counter-claims to climate science in the 1990's and discuss the impact such a countermovement can have on the overall information environment. Overall, these lines of research show that public opinion of science is complex, inseparable from politics, and in need of further investigation.

These cross sectional studies are complemented by a body of experimental work examining how individuals process scientific information and how changes to the source and type of information presented affects attitudes towards science. Dan Kahan and his colleagues have published numerous experimental papers describing the "cultural cognition hypothesis", which suggests that individuals' factual beliefs are formed based on risk assessments that align with their cultural evaluations of a subject (Wildavsky and Dake 1990[66]). Kahan and colleagues have the used this theory to address how reasoning about science is often politically motivated and related to curiosity towards science and open-mindedness (Kahan et al. 2017a[32]; Kahan 2017b; Kahan 2015[34]; Kahan, Jenkins Smith and Braman 2011[33]). Outside of this group's work, select studies in political science have experimentally addressed the role of misperceptions and corrective information in attitudes towards vaccines (Nyhan and Reifler 2015[48]) and health care reform (Nyhan et al. 2013[49]); however, these studies do not address attitudes towards science more generally.

While these diverse works all shed light on the relationship between public opinion of science and politics, key questions remain un-addressed. First, with the exception of Gauchet (2012), none of these studies examine public opinion of science over time. As such, we have little theory and analysis to explain variation in attitudes towards science. While Gauchet (2012) makes an attempt to do this using a repeated cross-sectional sample, his analysis focuses on individual level factors, rather than broader aggregate movers of public opinion. Given the scope of science in society and the impact aggregate public opinion can have on general discussions of science and science policy, the first chapter of my dissertation addresses this issue by building a longitudinal measure of attitudes towards science and develops a theory to explain the waxing and waning in aggregate support for science.

Further, there is limited experimental work addressing the political identity factors that play a role in attitudes towards science and the impact politics has on individuals' views of the scientific community. While Dan Kahan and colleagues have done a number of experimental studies testing the cultural cognition hypothesis (see Kahan et al. 2015; Kahan 2012[31]), these studies (and those like them) typically focus on particular topics, such as climate change or vaccines, and information sources. Similarly, work by political scientists typically also focuses on a particular scientific topic and then tests different methods of correcting misperceptions, rather than examining the role of politics. To date, no study has directly manipulated politics as an experimental treatment in a study of attitudes towards science. Doing so would allow us to better understand the specific role politics plays in communications about science and scientists by varying the politicized nature of the information environment. The second chapter of my dissertation addresses this issue with experiments that manipulate the identity context in the study and elucidating the mechanisms that form individual attitudes towards science.

Finally, the majority of studies done on attitudes towards science tend to be cross sectional analyses using survey data. While these studies are important and use data that directly addresses science attitudes, previous work has not considered the changes in these cross sectional relation-

ships over time. Given changes to the political climate and information environment over time, examining changes in survey responses between cross sections can provide valuable insights into shifts in attitudes towards science. To address this question, my third chapter looks at survey data from three time periods and analyzes changes in attitudes towards science between these cross sections.

As evident from the preceding paragraphs, this dissertation takes a multi-method approach to studying the politics of attitudes towards science. By engaging with experimental, cross-sectional, and time series methods, I create a more complete picture of how the public's relationship to science and politics has developed and changed over time. This approach will also allow me to look at both macro-level attitudes as well as individual level factors and mechanisms that affect attitudes towards science. Being able to create a dialog between these two levels of opinion with multiple methods will be essential to creating a more complete picture of how politics affects science attitudes.

2. THE DYNAMICS OF PUBLIC SUPPORT FOR SCIENCE

The relationship between science and politics has been well established, with the politicization of science becoming increasingly apparent in recent years (Cozzens and Woodhouse 1995; Frickel and Moore 2005). One does not need to look further than recent news headlines to see evidence of this politicization. As President Trump signs executive orders to undo Obama administration policies meant to curb global warming[1] and implements budget cuts to various research programs at places like the National Institutes of Health and the Department of Energy[2], it is clear that the politicization of science has extended into nearly every scientific field, including biology, physics, medicine, and the social sciences.

While the public often seems to acknowledge that scientists and other experts have a knowledge and understanding of phenomena in the world, there remains high levels of resentments and animus towards intellectual pursuits (Hofstadter 1970). These attitudes in the mass public are often lamented and seen as increasingly prevalent in the United States today. However, few studies have examined attitudes towards science over time or developed a theory to explain why we might observe variation in pro-science sentiment. In this paper, I propose a theory to explain this variation and develop a longitudinal measure of pro-science sentiment from 1973-2014. I conclude by outlining future plans for analysis and implications of developing an index of science attitudes over time.

2.1 Public Opinion about Science and the Scientific Community

Research on public opinion of science and scientists exists in several disciplines and approaches the subject from diverse angles. In political science, fews studies directly examine attitudes towards science generally. Existing studies typically focus on a particular subject matter, with climate

[1]Davenport, Coral. "Trump Signs Executive Order Unwinding Obama Climate Policies." New York Times, 28 Mar. 2017.

[2]Fountain, Henry, and John Schwartz. "Scientists Bristle at Trump Budget's Cuts to Research." New York Times, 16 Mar. 2017, New York Times, https://www.nytimes.com/2017/03/16/climate/trump-budget-science-research.html.

change as the primary scientific topic, in order to test hypotheses about attitudes towards science. While it is well establighed that the left-right spectrum colors how individuals perceive political phenomena, including policy debates like those around climate change (Feldman 1988, Jacoby 1995), other studies have examined how the information environment affects attitudes towards science. Kellstedt, Zahran, and Vedlitz (2008) examine attitudes towards global warming and find that more informed individuals and those with more confidence in science are less concerned about global warming and feel less personally responsible. This suggests that the knowledge-deficit model, which proposes that a lack of information and understanding contributes to a lack of belief or support, may not be the primary explanantion for climate change skepticism. Additionally, Krosnick et al. (2006) find that existence beliefs, certainty, and attitudes drive how nationally serious one thinks global warming is.

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2.2 A Theory of the Political Dynamics of Public Trust in Science

While it is clear that science has become politicized, the philosophical notion that science ought to be objective in practice remains a core value of the scientific community and those that consume scientific information. In attempting to discover truths about the world, scientists endeavor to eliminate personal biases, outside commitments, and emotional attachments. In doing so, researchers establish credibility in their work and are able to test and verify claims that produce findings that can be communicated to the public at large.

Despite these goals, science and scientists are often discussed using subjective, and often partisan, language. One need not look further than recent news headlines to see discussions of "Republican climate resolutions" and "keeping science in our politics" to see evidence that science is often talked about in ways that do not appear nonpartisan or objective. This type of language sends

signals to readers that perhaps this community that is thought to conduct research and report their findings without bias might not be as impartial as the public thinks they should be.

Seminal work in political science tells us that this language can be important in shaping the considerations the public thinks about when forming and articulating their attitudes towards science. Zaller (1992)[68] argues that exposure to elite discourse has a strong influence on public opinion, with attention to this discourse varying by level of interest and how much said discourse aligns with prior beliefs. Zaller then asserts that individual's expressed opinions are described by the "Receive-Accept-Sample" (RAS) model, where those opinions are a function of the messages a person received, accepted (contingent on accordance with prior beliefs), and sampled from at that moment.

Most information about science and the scientific community comes from elites, often through various mass media platforms. Conditional on the level of awareness among individuals, those invested in the interpretation of scientific findings can use media platforms to send signals to their audience about various aspects of the science, including credibility, importance, and relevance of the evidence. This process forms the information environment a person receives from. If the language and information fits with prior beliefs, it is more likely to be accepted into ones set of considerations and later sampled from when a person is asked for their opinion on the subject.

Zaller's model provides a framework for understanding how changes in the information environment over time affect science attitudes. The framing provided by political and scientific elites is often the primary source for understanding science in the mass public. As elites feed different reports and interpretations of scientific information to the public, they subsequently shape the considerations the public holds and samples from when they are asked about science more generally. Thus, as elite portrayals of science in the media change over time, so too will public opinion about science.

Research in science communication demonstrates how media reports can affect public opinion about science and scientific findings. While scientists themselves often feel positively towards

their personal interactions with the media, they do not feel as positively towards media coverage of science in general (Peters et al. 2008)[52]. The media often portrays scientific controversy in ways that overstate the degree of disagreement amongst scientists. Reports cover multiple sides when a consensus supports only one view (Boykoff and Boykoff 2004[2]; Stocking 1999[61]), creating a controversy where one does not really exist. This altering of the information environment by the media elite has consequences for public opinion. Exposure to this kind of balanced coverage can alter how certain the public feels about issues like the autism-vaccine link (Dixon and Clarke 2012)[13] and change risk perceptions. This shaping of considerations available to the public and the subsequent sampling of those considerations varies with the information environment and thus alters the level of pro-science sentiment in the mass public.

Given these observations, I theorize that changes to the information environment over time have affected the level of pro-science sentiment and attitudes towards the scientific community over time. It is no secret that the information environment has become more expansive over time; with the creation and proliferation of the Internet, there is more information available to the general public than ever before. Of course, not all this information is created equal. Reputable news outlets, aspiring journalists, bloggers, and everyone in between all contribute to what has now become a diverse and often overwhelming amount of news and other stories available online. Different groups bring different messages to the this environment, leaving readers to sort through and accept the considerations available.

As previously noted, partisan language is often involved in stories related to science in the information space. This language is not used exclusively by less credible sources; many leading news outlets contribute to this language use as well. My theory suggests that the use of this sort of rhetoric has changed and varied over time and thus contributed to changes in science attitudes. The use of partisan language is not a binary outcome; one could think of this language use as a continuum, with objective language at one end and partisan or ideological language at the other. When the public is exposed to partisan language in discussions of scientific research and the sci-

entific community, this signals that science and politics are intertwined in a way that goes beyond regulatory and funding agencies. Instead, this rhetoric indicates that science is partisan in an identity sense by connecting parties and party identifications to the findings and activities of science. As the use of this type of language has varied, attitudes about science have changed to match these tides of partisan rhetoric.

Similarly, strategies used to compete with scientific research have changed the information environment and contributed to variation in pro-science sentiment. When the information environment is populated by rhetoric intended to cause false conflict and doubt in the public, the public is inclined to think there is no consensus amongst experts, even if this is not the case. Scientific research and findings are of course never “final"; while a scientific consensus reflects the collective judgment and opinion of the scientists in a particular field, sciences progresses and changes over time as new data become available and new findings tell us more about the world. However, that does not mean that there is no general agreement on a particular topic amongst the scientists working in the that field. Strategies used by groups such as the tobacco industry to cloud this agreement change both the information environment and individuals' understanding of what scientific consensus means. This false notion of disagreement compounds the effects of the partisan rhetoric by further establishing a divide between two groups. Given the use of partisan rhetoric around science, this often results in the perception that this split is along party lines.

Furthermmore, changes in the information environment around other political institutions contribute to the politicization of science and changes in pro-science sentiment. In addition to science, another institution thought to be objective and nonpartisan is the judiciary in the United States. In theory, judges should interpret the laws free of bias and political pressures. However, the rhetoric around the judiciary, and particularly the Supreme Court, does not reflect this philosophy. While it was not always the case, Justices on the Supreme Court are often referred to as either “liberal" or “conservative" or discussed in the context of the president that appointed them. I theorize that variations in this rhetoric contributes to variation in science attitudes over time by changing how

individuals think about institutions that are intended to be unbiased and nonpartisan. When partisan rhetoric is used to undermine the objectivity of an institution like the judiciary, I hypothesize that this framing spills over to other groups, like the scientific community, that are meant to be objective as well. Thus, while there are changes to the information environment specific to science that affect attitudes, changes to the information environment around related institutions can affect those attitudes as well.

Finally, Zaller's (1992) model suggests changes to the information environment will have mostly short run effects. The RAS model states that issues that hold priority in a particular moment are the considerations that are most likely to be sampled when an individual's opinion is sought. As a result, language use and information change should have immediate effects that dissipate relatively quickly, rather than lingering for years after a person is exposed to the information. Thus, I hypothesize that changes to the information environment will have immediate effects on pro-science sentiment.

In sum, my theory of the political dynamics of pro-science sentiment suggests that variation in the information environment over time have affected the level of pro-science sentiment over time. In the short run, the use of partisan language and a false sense of conflict in discussions of science and the scientific community contribute to this variation, while similar rhetoric around related institutions plays a role as well. In order to test this theory, I create a longitudinal measure of public pro-science sentiment over time.

2.3 Developing a Longitudinal Measure of Pro-Science Sentiment in the Mass Public

Though longitudinal public opinion research usually requires repeated measures of identical questions over time, in the case of attitudes towards science, the survey record is a bit patchy. There are a number of reasons for this. First, survey administration has shifted between survey houses and those houses have varied in the time between administrations. For example, the General Social Survey sometimes administered surveys several years in a row with identical items in the

1970's and 1980's but later shifted to administering surveys every two years. Additionally, it is not uncommon for there to be gaps of four or more years between administration of a particular item. Finally, questions measuring attitudes towards science often change based on current political debates and scientific discoveries. For example, during the Bush presidency, stem cell research became a prominent topic of discussion amongst scientists, politicians, and the public generally. As a result, survey houses began including items specifically asking about stem cell research. These items were no longer administered after the issue left the public eye.

To address these problems with measuring aggregate attitudes towards science over time, I adopt the methodology developed by Stimson (1991)[60]. Stimson demonstrates that individual survey items can be used as indicators to measure a broader concept, which in his case is policy mood. For the question at hand, if the general concept of "pro-science sentiment" is meaningful, Stimson suggests that numerous indicators of that sentiment ought all move together through time. If the concept isn't meaningful, then the various series should be independent of one another.

For this analysis, I have compiled a group of twenty-one time series items on trust in the scientific community. These question were taken from two different sources. First, I use questions asked on the General Social Survey, administered annually from 1973-1977 and every two years beginning in 1978 through 2014. Second, I use questions asked on the National Science Foundation (NSF) Surveys of Public Attitudes Toward and Understanding of Science and Technology, 1979-2001. The content of each item varies, but I include questions about federal support for science, the effect science has on our lives, and the benefits of science, among other things.

It should be noted that some indicators were excluded from the analysis. After first creating a time series using all questions pulled from the two surveys noted above, I found a large number of puzzling negative factor loadings. This first set of loadings can be found in the appendix. All of the negatively loading indicators came from the NSF surveys and the question wordings did not clearly suggest that the items were measuring a different concept. After checking all coding procedures, I examined the survey instruments themselves and found that between 1995 and 2001,

Table 2.1: Correlations of Indicators of Trust in Science with Overall Index

Item	Correlation with Index
GSS/Confidence in Science Community	.763
NSF/Daily Life	.864
GSS/Science Spending	.843
NSF/Life Easier	.953
GSS/Federal Government Support	.994
NSF/New Inventions	.955
GSS/Environmental Solvency	.932
GSS/Life Change Too Fast	.676
GSS/Medical Discoveries	.776
GSS/Next Generation	.565
NSF/Change Life Too Fast	.430
GSS/Science and Faith	.500
NSF/Standard of Living	1.00
GSS/Trust Science	1.00
NSF/Improve Life	.459
GSS/Science Benefits	.305
NSF/Federal Government Support	.258
NSF/Life Better	.291
GSS/Proud of Science	.163
GSS/Scientific Discoveries	.063
GSS/Science Harm	-.081

Note: See the appendix for precise question wording.

the NSF surveys had a potentially troublesome preamble, which had not been used in previous years. The 1995-2001 survey preamble includes a section where the potential participant is told that the NSF is "part of the federal government and is responsible for supporting scientific and engineering research."[3] This language has strong primes, both for attitudes towards the government and attitudes toward government spending in general. It is reasonable to think that this introduction would then alter now participants might answer the subsequent questions about science and its relationship to the government. Given these concerns, I dropped all items from the NSF surveys between 1995 and 2001.

[3]The full text of this preamble can be found in the appendix.

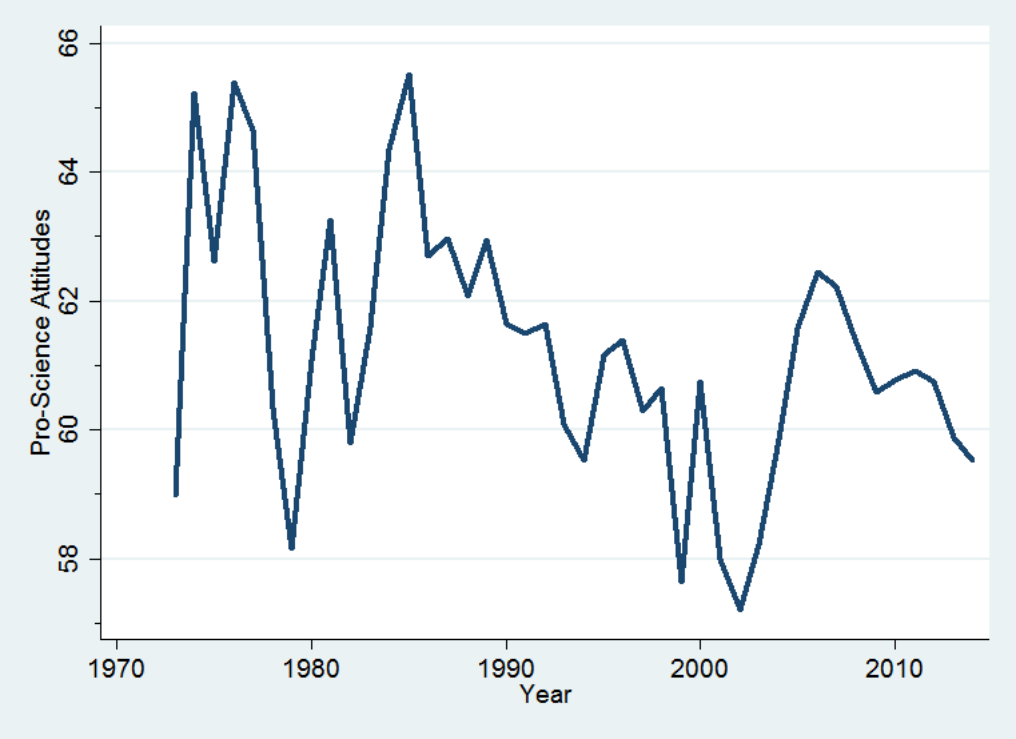

Figure 2.1: Pro-Science Attitudes from 1973-2014

After these drops, the correlations between each specific indicator and the overall index can be found in Table 1. Many of the items load strongly onto the index, with eight of the indicators having correlations above 0.70. Indicators from a range of topics related to attitudes towards science correlate highly with the index, including items about how science affects your daily life, federal government support for science, and enthusiasm for new inventions.

I combined the various series into a single annual time series using Stimson's algorithm, measured from 1973-2014. The results can be seen in Figure 1, where higher values represent more pro-science sentiment. The scientific community in the United States has experienced varied levels of pro-science sentiment over the past 40 years. Figure 1 shows these attitudes beginning in 1973, the earliest date for which survey data exists, and ending in 2014. Support for science was at one of its highest levels for this time period in the early 1970's with a sharp decline in the mid-1970's, reaching a low of 58 in 1980. From there, attitudes rebounded back to previous levels of support,

Table 2.2: Correlations between Pro-Science Sentiment and Macro-level Public Opinion Measures

	Pro-Science	Mood	ICS	Macropartisanship
Pro-Science	1.00			
Mood	-0.0058	1.00		
ICS	-0.0296	0.0165	1.00	
Macropartisanship	0.1195	-0.5258	-0.4964	1.00

reaching up to approximately 66 by the mid-1980's. Over the next 15 years, pro-science attitudes steadily declined to a low of 56, a 10 change, by the early 2000's. After seeing a brief resurgence into the mid-2000's, pro-science attitudes have been falling ever since to below 60 in 2014.

The movement in Figure 1 represents sizable shifts in aggregate sentiment. While many of the items in the index do not cover long time spans[4], those that do have ranges of ten to fifteen percentage points in pro-science attitudes. At one extreme, a NSF question about whether science makes our way of life change too fast sees a nearly twenty point range between 1979 and 2001.

From this analysis, a picture of aggregate movement in pro-science sentiment has emerged: there appears to be sizable and systematic movement in attitudes towards science over time. Using a single longitudinal measure to capture aggregate movement in these attitudes across a longer period of time gives a better sense of how the public's science sentiments have evolved and provides a jumping off point to test the effects of the information environment and how changes to that environment over time affect the public's pro-science sentiment.

Finally, I examine the correlations between pro-science sentiment and several other macro-level indicators of public opinion to determine if pro-science sentiment, as conceptualized here, is simply another measure of partisanship, desire for spending, or economic confidence. These correlations can be found in Table 2.2.

It appears that my measure of pro-science sentiment is measuring something different from some from the typical measures of macro-level political attitudes. Trust in science does not corre-

[4]Many of the items were asked six or less times over various year ranges.

late above 0.2 with either Stimson's mood index, the Index of Consumer Sentiment, or traditional measures of macropartisanship. While this does not tell us what underlies pro-science sentiment, we can be confident that the dependent variable is not merely a reconstruction of already existing macro-level attitude measures.

2.4 Explaining Public Trust in Science: Developing Independent Variable Measures

In order to test the theory that partisan language shapes attitudes towards and pro-science sentiment and the scientific community over time, variables that measure the volume of media attention to science and the use of partisan language usage over time are necessary. I create these measures using headlines from the New York Times between 1980 and 2014. While pro-science can be measured back to 1973, the New York Times has only digitized articles in their printed papers starting in 1980. Thus, for the purpose of the following analysis, all data will begin in the year 1980.

To identify relevant headlines, I submitted search queries to Lexis-Nexis for a set of topical key words: *science, sciences, scientist, scientists, technology, research, researchers,* and *scientific.* I also narrowed my search to section A of the New York Times in order to focus on stories that would most likely be seen by the majority of readers.[5] This strategy produced a set of headlines for each year between 1980 and 2014 that included at least one of the search terms. There were 4,828 headlines collected in total.

To get a sense of the volume of overall media attention to science, I aggregate all headlines by year into an annual count of attention to science. Figure 2.2 depicts this attention to science. The level of attention to science in media reports has varied meaningfully between 1980 and 2014. The number of headlines per year ranges from 48 to 281, with an average of 137 headlines per year across the 34 year time period. After an increase in attention in the late 1980's, attention dropped in the mid-1990's, only to rebound and see a large increase in headlines from the late 1990's and peaking in the mid-2000's. From here, attention quickly declined, but remained higher than in the

[5]The New York Times does have produce a separate weekly science section of the newspaper; however, this coverage is not daily and the section is less likely to be read by a broad spectrum of readers.

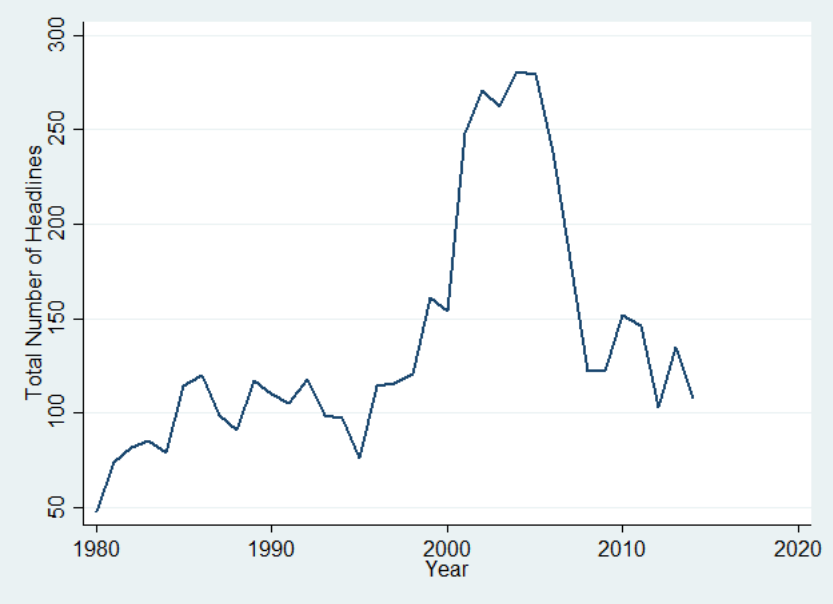

Figure 2.2: Total Number of Science-Related Headlines, New York Times, 1980-2014

1980's.

There may be search-related reasons for these drastic swings in attention, particularly during the 2000's. The New York Times may have adopted particular conventions for naming headlines that used the relevant search terms more frequently. A brief look at the headlines during this time period confirm this was the case. From 2001-2007, the New York Times published "National Briefings" that focused on science and technology, often beginning with the phrase "National Briefing Science And Health" or "National Briefing Science And Technology". As a result, these headlines were included in the Lexis search results. This is not necessarily problematic for the analysis; the subsequent portion of the headlines often included other relevent search terms and nearly always dealt with developments in research, science, and health. Some examples of such headlines include: "National Briefing Science And Health: Following The Research Money"; "National Briefing Science And Health: Martian Rock Surprises Scientists"; and "National Briefing Science And Health: Researchers Link Famine And Schizophrenia". Thus, many of these headlines would have already been included the search, even without the fixed header to the headline's unique con-

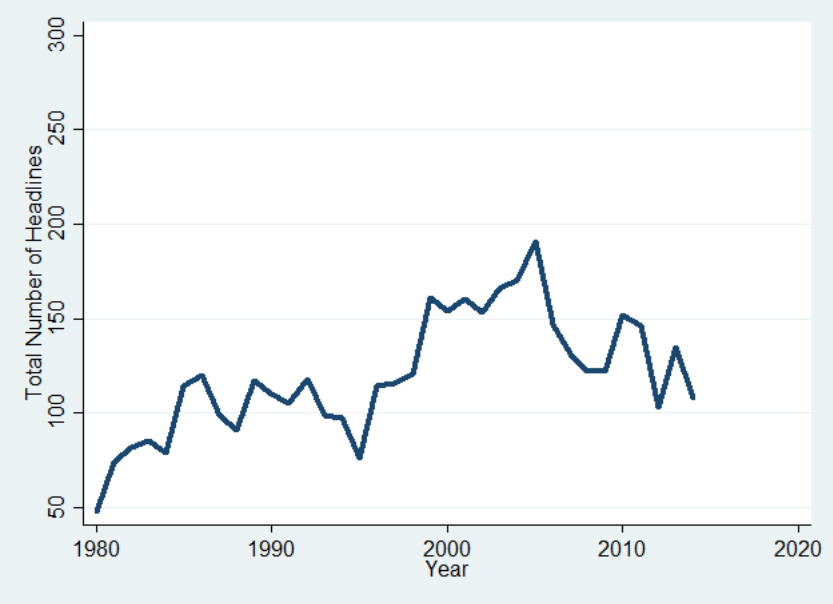

Figure 2.3: Total Number of Science-Related Headlines After Data Cleaning, 1980-2014

tent. Furthermore, the fixed header was able to pull in headlines that did not include the specific search terms, but still related to science and reporting on research and development around the world. If anything, the header likely gives a better sense of the amount of attention being given to science, as it draws more attention to the connection between the article content and the scientific elements behind it.

However, even though the headlines captured with the fixed header belong in the analysis, their inclusion creates bias in the data. It is likely that the number of headlines in the other years is being under-reported; without the language used in the fixed header, there are not as many relevant headlines being included in the search. To see the effect the fixed header has on the total number of headlines, I removed all the variations of the header text from the data set.[6] After doing so, I then re-ran the search on the remaining portion of the headlines using the search terms used in the initial Lexis Nexis search (*science, sciences, scientist, scientists, technology, research, researchers,*

[6]A list of phrases and variations on the header text that were removed from the data set can be found in the appendix.

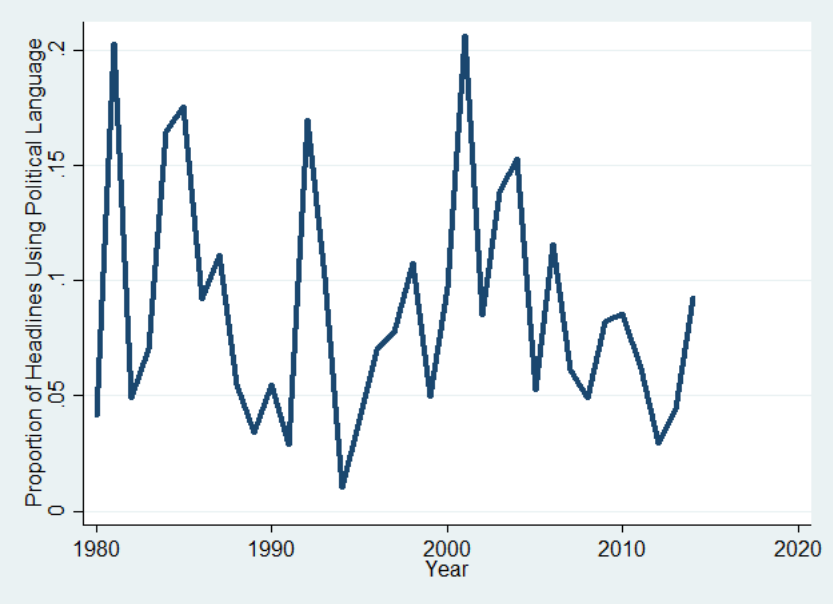

Figure 2.4: Proportion of Headlines Using Political Language by Year, New York Times, 1980-2014

and *scientific*), retaining only those headlines that contained those terms. This ensures that the headlines in the data set are included based on text outside of the fixed header, thus removing the header as a cause for a headline being included in the data.

Figure 2.3 shows the revised total number of headlines per year after performing these data cleaning procedures. The variation in media attention continues to be meaningful, though not as extreme as in Figure 2.2. The number of headlines per year now ranges from 48 to 191, with an average of 119 headlines per year and a total of 4,340 headlines. The increase in attention in the late 1980's persists, along with the attention drop in the mid-1990's. Attention rebounds and sees a large increase in headlines from the late 1990's and peaking in the mid-2000's, as before, with a steady decline in the following ten years.

Noting this variation in media attention to science over time and after removing a potential source of bias in the data, to directly test my theory that partisan language changes in the information environment over time affect pro-science sentiment, I use the headlines data to create a

measure of partisan language use. To do this, I searched all headlines for word stems that occured more than 20 times during the 34 year time period and identified the word stems connected to words with political connotations. The stems identified included the following: *polit, hous, budget, bush, court, govern, law, polici, presid, reagan*, and *vote*.[7]

After then examining the headlines that included these word stems to confirm the search was not collecting headlines outside the scope of the search, I added together, by year, the number of headlines that contained these word stems. Between 1980 and 2014, there were an average of 10 headlines per year that contained an instance of political language use. The minimum number of headlines in a given year was 1, with a maximum of 33 headlines. Finally, in keeping with the nature of the other variables used in the models, I divide the total number of headlines containing political language each year by the total number of headlines collect in that year to get the proportion of headlines using political language each year, referred to as *Proportion Political Language*.

The proportion of headlines using political language over time is depicted in Figure 2.4. The proportion ranges from 1% to 20% during the 34 year time period, with an average of 8%. There is a meaningful amount of variance during this time period, with a slight negative trend from 1980 until the mid-1990's, followed by an increase in political language use leading into the 2000's. This increase peaks in roughly 2003 and then declines through the remaining time period. Within this movement, we see considerable shifts, often up to a 10% change in the number of headlines using political language from year to year. This suggests that this measure of change in the information environment and the degree to which coverage of science contains political language and references may be important in explaining pro-science sentiment over time.

There are other potential explanations for the variance in pro-science sentiment that I control for in this analysis. First, spending on science at the federal level may contribute to the presence of science in the public eye. When the government spends more on research and development of

[7]Expanding the search to include word stems used 15 times did not add a meaningful number of additional stems to this list.

new technologies and scientific endeavors, the public is more likely to be aware of such projects. Thus, spending on federal research and development could contribute to how the public thinks about science overall. To measure spending, I use data from the American Association for the Advancement of Science trends tables to compute *R&D Spending*, which indicates spending on federal research and development, including defense, as a percent of total outlays.

I also create a variable to account for popular culture representations of science. A small literature suggests that television viewers are heavily exposed to science, technology, and medicine through prime-time dramatic programs (Gerbner, 1987: 110), rather than documentaries such as NOVA. Similarly, movies provide similar frames of reference for science and technology, with studies showing a range of effects on the general public. Gerbner (1987)[24] suggests that "exposure to science and technology through television entertainment appears to cultivate a generally less favorable orientation toward science". Relatedly, Weingart and Muhl (2003)[65] find that depictions of science in fiction films often focus on results over methods and portray science as done in secretive settings, often by some sort of "genius" or "mad scientist" character. These portrayals both reflect and reinforce societal perceptions of science and scientists and thus may exert some influence over macro-level pro-science sentiment.

To measure the degree to which portrayals of science on the big screen might affect public attitudes towards science, using the Internet Movie Database (IMDB), I calculate *SciFi Film Revenue*, the proportion of domestic revenues from the top ten films of a given year that was earned by science fiction films, as defined by IMDB and including Star Wars films.[8] The variable ranges from zero, where no science fiction or Star Wars films were in the top ten films that year, to .432, indicating that 43% of the domestic revenues from the top ten films of that year came from science fiction or Star Wars films. The average across the 35 years is .173.

[8]The Star Wars films are classified as action/adventure/fantasy films by IMDB. However, few would question the role Star Wars has played in influencing popular culture and representations of technology, space, and the potential for exploring the galaxies. As such, I have included them in the analysis here.

Table 2.3: The Determinants of Pro-Science Sentiment: 1980-2014

	(1)	(2)	(3)
Trust in Science$_{t-1}$	0.67**	0.54**	0.59**
	(0.13)	(0.15)	(0.17)
Proportion Political Language	8.14	4.82	6.92
	(4.59)	(5.37)	(6.15)
Proportion Political Language$_{t-1}$	-10.13**	-11.44**	-11.19^{+}
	(4.61)	(5.29)	(5.46)
R&D Spending		132.7	81.99
		(135.5)	(169.4)
R&D Spending$_{t-1}$		2.53	29.58
		(131.1)	(148.9)
SciFi Film Revenue		-1.08	-1.63
		(2.22)	(2.46)
SciFi Film Revenue$_{t-1}$		1.20	-0.25
		(2.07)	(2.33)
Index of Consumer Sentiment			0.05
			(0.04)
Index of Consumer Sentiment$_{t-1}$			-0.05
			(0.03)
Mood			0.10
			(0.15)
Mood$_{t-1}$			-0.07
			(0.14)
Constant	19.88**	22.38**	18.60
	(8.160)	(8.369)	(12.25)
Observations	34	34	34
R-squared	0.492	0.588	0.632

Standard errors in parentheses
** p<0.05, + p=.053

2.5 Results

I model changes in pro-science sentiment as a function of current and long-term levels of political language use, spending on research and development, and prevalence of cultural representations of science in film. To test both my theory and the robustness of my findings, I test three model

specifications as shown in Table 2.3.

Model 1 shows the results of a simple bivariate model with political language use and pro-science sentiment. Contrary to the expectations drawn from Zaller (1992), I find that the long-term effect of political language use is a significant determinant of pro-science sentiment, while the contemporaneous effect of political language is not. When the proportion of headlines using political language is larger, in the long-term, pro-science sentiment declines by ten points over the course of one year. While the artificial metric of the algorithm obscures the size of the effect to some extent, given that the individual items in the index often have ten to fifteen point ranges in pro-science sentiment, this represents a meaningful decline in sentiment. However, there does not appear to be a significant effect of political language use in the immediate time period.

To control for other potential explanations of changes to pro-science sentiment, Model 2 adds the research and development spending and film revenue variables to the model. Neither of these variables has a significant contemporaneous or long-term effect on pro-science sentiment. However, the results for political language use remain robust and increase in size, with the coefficient moving from -10.13 in the bivariate model to -11.44 after controlling for spending and film revenue. While not a large increase in the overall effect, the effect remains meaningful with respect to change in pro-science sentiment in the long run.

Finally, Model 3 adds two standard macro-level public opinion indicators to the model to further verify the effect of political language use and see if pro-science sentiment is driven by shifts in aggregate opinion on policy and/or the economy. I find that neither Stimson's conception of public mood, nor the Index of Consumer Sentiment have a significant effect on pro-science sentiment over time. Adding these variables does produce a change in the results for political language use, shifting the p-value to slightly above conventional levels of statistical significance at p=0.053. The coefficient remains approximately the same at -11.19.

2.6 Discussion

Exposure to headlines that connect science and politics have the potential to connect partisan attitudes to the findings and activities of the scientific community. Making these connections changes what the public expects from science and how the public thinks about science as a means of discovery. This study provides initial support for the theory that these changes in the information environment, and specifically changes in political language use over time, contribute to changes in pro-science sentiment over time. I find that there is meaningful variation in the use of political language in science-related headlines over time and that this variation contributes to declining levels of pro-science sentiment. These findings hold when controlling for federal science spending, cultural portrayals of science, and broader macro-level public opinion measures.

These results have significant implications for our understanding of how public opinion about science is shaped and the role the media plays in that process. Knowing that the few words reporters choose to headline an article about science has an effect on trust in the scientific community underscores the important role the media plays in shaping opinion. Even if the full article is not read, headlines communicate important general impressions that have consequences for public understanding of science and science's associations in the world. As news becomes increasingly available and headlines more sensational, understanding the impacts of word choice and language use in reporting is important not only for science, but public opinion more broadly.

As a result, this study suggests many avenues for future research. I only use headlines from a single national newspaper in the work presented here. This work could be extended to include a wider range of newspapers to determine if there are differences in the level of political language used between news outlets or if different newspapers differ in their volume of reporting on science. Additionally, being able to collect and analyze the full text of the articles, rather than just the headlines, may paint a richer picture of how politics and science are intertwined in reporting by the media. While this extension poses a data collection challenge, it would open many new doors to

a deeper understanding of how the media portrays science, technology, and the connections made between politics and science.

3. COMMUNITY IMMUNITY: SOCIAL PRESSURE AND VACCINE CHOICES

Research in public opinion suggests that individuals often hold beliefs that are not consistent with the current state of scientific research. For example, many people are not concerned about climate change and/or do not feel responsible for it despite being well-read on the subject (Kellstedt et al. 2008). Many parents do not give their children common vaccinations because they consider them unsafe (Nyhan et al. 2014[51]), and millions of Americans do not get an annual flu vaccine because of their unfounded fear of actually getting the flu.[1] These misperceptions persist despite the prevailing scientific consensus and frequent attempts to communicate that consensus to the public.

These misperceptions have significant normative and public health implications. As noted by Nyhan and Reifler (2015), seasonal influenza leads to thousands of deaths and high costs in medical care and lost earnings, yet immunization rates continue to fall well below targeted numbers. Similarly, childhood diseases like measles which rarely occur in the contemporary United States have experienced several major outbreaks as parents forgo the advice of doctors in vaccinating their children. These diseases can cause serious complications and death in young children and other vulnerable populations. These individual consequences underscore the importance of correcting vaccination misperceptions.

Additionally, individuals' skewed risk perceptions have consequences for public policy. Mandatory vaccination policies for children remain controversial despite the scientific consensus on vaccine safety, and parents disagree on the extent to which state governments can regulate the choices they make about their children's health. Findings demonstrating resistance, rejection, and backfire effects from corrective information (Kuklinkski et al. 2000[38]; Nyhan and Reifler 2010[47]; Nyhan and Reifler 2015[48]) have substantial implications for discourse between the scientific

[1] Centers for Disease Control and Prevention. Flu vaccination coverage, United States, 2014-15 Influenza Season; 2013. https://www.cdc.gov/flu/fluvaxview/coverage-1415estimates.htm.

community and the public. It appears that a knowledge deficit is not the primary explanation for misperceptions about scientific issues and that education is ineffective or counter-productive for correcting them.

This chapter reports the results of a study investigating the extent to which social appeals in public health campaigns are effective communications in changing vaccination attitudes and intentions. The findings suggest that information that debunks myths about the flu vaccine can have different effects on beliefs about vaccines than on intentions to vaccinate. Additionally, messages that emphasize pro-social appeals to identity have differential effects across demographic groups of interest.

3.1 Misperceptions and Their Correction

In recent years, information available to the public about the importance and safety of vaccines has become increasingly salient and more widely available. Yet misperceptions continue to persist; many parents are concerned about the connection between autism and childhood vaccinations, and still others believe the flu shot will give you the flu. Given the scientific consensus that neither of these concerns pose a serious risk, scholars have explored how we might correct these misperceptions and re-weight individuals' cost/benefit calculations such that they arrive conclusions that are in line with the current scientific consensus, with some success (e.g. van der Linden, Clarke, and Maibach 2015[64]). If individuals' policy preferences are based on false or unsubstantiated information, correcting these misconceptions is of great normative importance.

However, studies of misperception correction often find that it is difficult to realign individuals' beliefs. Individuals resist information and arguments that contradict their opinions (e.g. Lord, Ross and Lepper 1979[41]; Redlawsk 2002[54]; Taber and Lodge 2006[62]). Attempts to correct misperceptions can also result in "backfire effects" as people defend their prior beliefs (Nyhan and Reifler 2010; Nyhan and Reifler 2015)[2]. In some cases, those that are the most informed about a

[2]The 'backfire effect' has not always been found in subsequent studies (Haglin 2017[28]; Wood and Porter 2016)[67].

topic are the ones least likely to be persuaded by the evidence, indicating that more information may not solve the misconception problem (Kellstedt et al. 2008). Overall, misperceptions are rarely altered, and even when we are able to change minds, individuals' intentions and behavior typically remain the same (e.g. Nyhan and Reifler 2014). These contradictory findings suggest that simply trying to reorder individuals' considerations may not be the most effective approach to correcting misperceptions.

To summarize, scholarship to this point gives us reason to suspect that individuals' intentions about vaccines do not always operate in a purely rational framework. Yet misperception studies often do not go beyond attempts to provide factual information that we anticipate will cause a broad audience of individuals to change their minds. This suggests that there is room to explore other possible avenues for effecting attitude change. Drawing on research in social psychology, this chapter posits that psychological appeals to identity, specifically one's social identity and community, have the potential to move attitudes and behavioral intentions.

3.2 Context and Misperception Correction

Previous work has often studied misperception correction in specific topical contexts, such as vaccines, climate change, and the like. These studies typically investigate corrective treatments that are intended to fit a general audience, rather than examining tailored approaches to correcting misperceptions. As a result, misperception studies provide corrective information without any situational references or connections to the context of the individual. Because of this, studies addressing general solutions to misperception correction may underestimate the potential effectiveness of corrections. Examining general approaches does not tell us if the effects of corrective treatments are conditional or if they are weakened due to a lack of contextual framing.

This chapter addresses this issue by positing that appeals to identity and applications of social pressure have the potential to move attitudes and behavioral intentions by providing contextual and situational references to corrective appeals. While there may be many types of appeals that may be

effective at correcting misperceptions, the importance of individual affinity and circumstances has implications for how people respond to corrective information. Citizens often use mental shortcuts to make political decisions (Downs 1957[15]) and there has been a long recognition of the importance of group identification and social identity as a basis for such shortcuts (Converse 1964[11]; Sniderman, Brody, and Tetlock 1991[59]). Furthermore, Brewer (1991, 1996)[3][4] suggests that social identity is a dynamic element of a person's life and that priming more social contexts and self-concepts leads to changes in judgment. This broader work suggests that references to these concepts play a meaningful role in information processing and thus may serve as a catalyst for changing attitudes and perceptions in a variety of situations.

An array of research has shown that social pressure and social norms can also influence behavior. People are aware of the behavior of others around them and conform to the norms of the community. Knowing one's behavior will be made public is also a compelling factor in complying with social norms (Cialdini and Goldstein 2004[10]; Kallgren, Reno, and Cialdini 2000[35]). For example, Gerber and Green (2008)[23] demonstrate this effect in a voter turnout context, finding that social pressure influences voter turnout, especially when shaming tactics are used to incentivize compliance. They further conclude that social pressure is additive: more pressure leads to more voting regardless of predispositions to vote. While there are typical caveats like ceiling effects, on balance, people typically comply with social norms when they know they are being watched in order to avoid being socially excluded when their behavior is made public.

The importance of social setting and norms has been demonstrated in the vaccine context. Nyhan, Reifler, and Richey (2012)[50] find that health discussion networks play a key role in shaping vaccination attitudes. Those who believe their network supports vaccination feel more positively towards vaccines and express stronger intent to vaccinate themselves. Similarly, Betsch et al. (2017)[1] find that cultures that focus on collective benefits have higher rates of compliance with vaccines and communicating the concept of herd immunity improves an individual's willingness to get vaccinated. While this is not entirely surprising, it does underscore the importance of the cli-

mate in which individuals form attitudes. Being in a particular context can evoke feelings of pride or shame or change an individual's disposition system. Working to understand the individual, the context they find themselves in, and the relationship between the two could provide significant leverage into understanding attitudes that are not consistent with the current scientific consensus. If information is not perceived as relevant to the recipient, it is unlikely they will incorporate it into their decision making calculus.

Consistent with previous findings and subsequent discussion, I derive two primary hypotheses. First, social appeals to community norms should increase the effectiveness of appeals to get vaccinated. By priming a social identity and connecting it to a pro-social vaccine appeal, I attempt to exploit the relationship between the individual and the context in order to change perceptions and intentions. In this study, the identity I prime and connect to CDC data on vaccinations rates is one's identity as a Texan. Texans have high levels of state pride and care deeply about their identity as Texans. Hence, in order to test the effect of pro-social identity appeals, I use data from the CDC reporting the final vaccination rate in the state of Texas at the end of the 2014-2015 flu season. From this discussion, I therefore hypothesize:

Pro-social Hypothesis: Exposure to a pro-social identity appeal will increase intentions to vaccinate more than corrective treatments will.

Furthermore, previous findings suggest that simple textual appeals are not compelling enough to change intentions and misperceptions (Nyhan et al. 2014; Nyhan and Reifler 2015). Outside of the misperceptions literature, Gibson, Lodge, and Woodson (2014)[25] have found evidence that visual symbols can reinforce institutional legitimacy. Building upon this work, I go beyond text-only appeals and activate the identity of interest (being a Texan) using symbolic images. Texas is well known for its many icons, including flags, bluebonnets, and the Texas star, among others. In this study, we chose the Texas state flag as the background imagery for our pro-social appeal. The state flag is well-known, very prevalent in public places, and a symbol of Texas pride. The design elements of the flag also made it an ideal image to use with text in a public health-style appeal.

Hence:

Pro-social Image Hypothesis: Adding visual symbols of a community's identity to a pro-social appeal will lead to more positive attitudes toward vaccines than the appeals without images.

In addition to these two primary hypotheses, I also expect that the effect of these pro-social treatments will be stronger for certain individuals. As noted by Nyhan and Reifler (2015), high concern individuals may be more susceptible to the backfire effect and are more likely to believe vaccine misperceptions. Thus, level of concern about vaccine side effects may strengthen individuals' resistance to pro-social appeals and reduce their effectiveness. As a result, I hypothesize that:

Concern Hypothesis: Higher levels of concern about vaccine side effects will reduce the effectiveness of pro-social treatments.

Next, I expect that political ideology will have differential effects across the outcome variable measures. Party identification and ideology are well established as a strong source of identity for many individuals (Campbell et al. 1960[6]; Greene 1999[26]; Greene 2004[27]) and in the context of vaccines, might affect responses to pro-social appeals and corrective information. Data from the 2014 Cooperative Congressional Election Study suggests that conservatives are more likely to believe there is a link between vaccines and autism, regardless of party identification.[3] As such, I hypothesize that:

Ideology Hypothesis: Conservatives exposed to the pro-social images will be more likely to get vaccinated, while conservatives exposed to the correction treatment will be less likely to get vaccinated and more likely to believe the misperception that the flu vaccine gives you the flu.

Finally, gender may play a role in responses to pro-social appeals to vaccinate. Differences in trust placed on sources of information about vaccines varies by gender, as Freed et al. (2011)[20] find that women are more likely to trust vaccine safety information from celebrities, television

[3]Lupton, Robert, and Christopher Hare."Conservatives Are More Likely to Believe That Vaccines Cause Autism." The Washington Post, 1 March 2015, https://www.washingtonpost.com/news/monkey-cage/wp/2015/03/01/conservatives-are-more-likely-to-believe-that-vaccines-cause-autism/?utmterm=.d8b077827c8a

shows, and parents who claim their child was injured by a vaccine. Additionally, women make the majority of health care decisions for their children; the Kaiser Family Foundation (2014)[4] found that three-quarters of mothers choose their child's doctor and implement recommended care. While this study uses the flu vaccine as its context, this attitudinal and responsibility differences between genders suggests that women may be more receptive to pro-social appeals. Thus, I also hypothesize:

Gender Role Hypothesis: Women exposed to the pro-social identity appeals will be more likely to get vaccinated and have more positive attitudes towards vaccines than men.

3.3 Method

3.3.1 Data Collection

This study replicates and extends the work done by Nyhan and Reifler (2015) and thus closely follows their methods and procedures.[5] The data for this study were collected using Amazon's Mechanical Turk platform, using a worker pool limited to those with IP addresses located in Texas. The study was fielded from March 2016 to May 2016. Respondents were adults located in Texas who were told they would be answering questions meant to elicit their opinions on important political issues of today. Data was collected from 525 respondents. After dropping respondents whose geographic coordinates suggested they were not inside Texas, 474 respondents remained.[6]

3.3.2 Design and Procedure

Respondents were randomly assigned to one of seven different conditions in the experiment. In each condition respondents were asked about the flu vaccine and whether or not they intended to get vaccinated in a future flu season. The seven conditions were as follows[7]:

[4]"Balancing on Shaky Ground: Women, Work, and Family Health", October 2014.

[5]The results of the direct replication of Nyhan and Reifler (2015) are reported in Haglin (2017) and thus not covered in detail here.

[6]Qualtrics collects the latitude and longitude of the respondents location. Because IP addresses may not correspond with the current residence of the respondent, respondents outside the bounds of the state of Texas were dropped from the analysis.

[7]Complete treatment wording and images can be found in the appendix.

1. Control- The respondents received no additional information about the flu or flu vaccines prior to answering the outcome questions.

2. Correction- Respondents received information debunking the myth that people can get the flu from the flu vaccine. The text used in this treatment was the same as in Nyhan and Reifler's (2015) study.

3. State Percentage Text- Respondents read a two line statement about flu vaccination in Texas that included an appeal to the respondent's identity as Texans. This condition used the percent of Texans who got vaccinated last year.

4. Raw Number Text- This condition is identical to condition three, but instead used the raw number of Texans who got vaccinated last year.

5. Flag Image with No Data- As seen in Figure 3.1, respondents were shown an image of the Texas flag with a pro-social slogan printed over the image.[8]

6. Flag Image with Percentage- As seen in Figure 3.2, respondents were shown an image of the Texas flag with the same slogan printed over the image. Additionally, the image also included the appeal to "join the 50% of Texans who got the flu vaccine last year."

7. Flag Image with Raw Number- The final condition showed respondents the same image as in the fifth condition, expect that the percentage (50%) was changed to the raw number of Texans who got a flu vaccine last year (13 million).

The "raw number" and "percentage" treatment figures are taken from data collected by the Centers for Disease Control on flu vaccination rates in each state. The numbers used here are based on the 2015 flu cycle, the most recently completed cycle at the time of experimentation. While it would have been possible to vary these numbers to examine the effect of different degrees

[8]Images of the Texans flag are courtesy of Patriot Wood, LLC and are being used with permission from the company owners.

Figure 3.1: Flag Image with No CDC Data

of social compliance on vaccine attitudes, to present an accurate and realistic representation of a potential public health campaign, this manipulation was avoided.

Additionally, as noted by Nyhan and Reifler (2015), responses to vaccine information might vary based on one's pre-existing attitudes towards vaccines. Since it was not possible to accurately measure prior vaccine receipt as part of the study, I measured each respondent's general concerns about vaccine safety and side effects. Specifically, in replicating Nyhan and Reifler (2015), I asked, "In general, how concerned are you about serious side effects from vaccines?" prior to the interventions. This was measured on a five point scale ranging from "not at all concerned" to "extremely concerned."

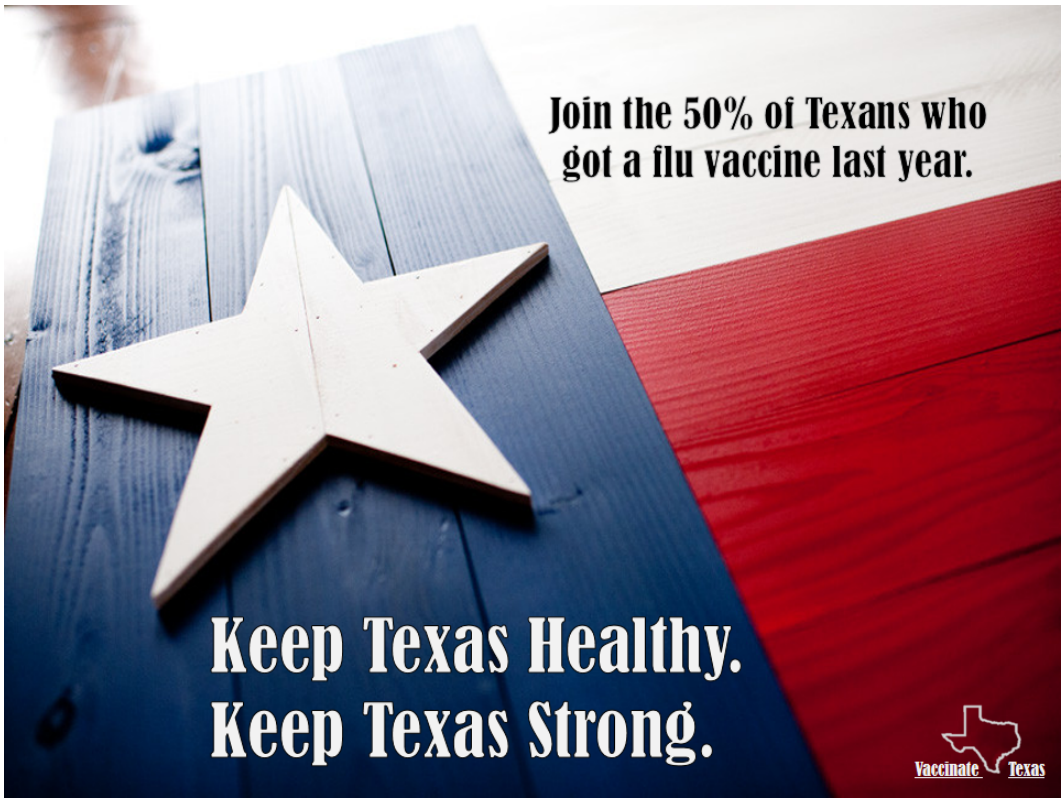

Figure 3.2: Flag Image with Percent Vaccinated in Previous Flu Season

3.3.3 Outcome Measures

After the experimental intervention, I measured respondents' (mis)perceptions about the flu vaccine ("You can get the flu from the seasonal flu vaccine"), feelings about vaccine safety ("Just based on what you know, how safe do you believe the seasonal flu vaccine, meaning the flu vaccine available every year, is generally for most people to take?"), intent to get vaccinated in the future ("How likely is it that you will get a flu vaccine for the seasonal flu during future flu seasons?"), and attitudes about school vaccination policies ("Just based on what you know, how much do you agree with the following statement: If a child has not been vaccinated (even though they are healthy enough to receive vaccines), that child should be allowed to attend public school."). With the exception of the policy question, these measures were taken from Nyhan and Reifler (2015),

and the full text and scale of each measure can be found in the Appendix.

These measures were used not only for replication purposes, but because they measure the complex relationship between attitudes and behavior regarding vaccinations. By asking about both beliefs and intentions, I can assess the effect of debunking misperceptions on two different dimensions. As shown below and in line with previous findings, I demonstrate that the interventions have different effects on people's beliefs as compared to their intentions. If the study had not included these questions, I would not be able to see this differential effect.

The results of the study were analyzed using difference of means tests and ordered logit models. I estimate the effects of assignment to the correction, flag, percent, and raw number conditions on misperceptions about the flu vaccine and intentions to vaccinate in the future. I also test to see if the non-replication treatments result in significantly different outcomes from the correction and control conditions.

3.4 Results

Table 3.1 summarizes the characteristics of the respondents in the Mechanical Turk sample. As is to be expected when working with convenience samples like those from MTurk, the sample is not fully representative of the demographics of the national, or even Texas, adult population. This sample is younger, more educated, and disproportionately white than the adult population of Texas.[9] However, the sample appears to be balanced across conditions, indicating that the randomization process was successful.

It is also notable that a large portion of the sample (58%) reports themselves as being either not at all concerned or not too concerned about the side effects of vaccines. Approximately 20% of the sample falls into the high concern category, which I define as saying you are either "very" or "extremely" concerned about vaccine side effects. This distribution approximates that found in Nyhan and Reifler's (2015) sample and thus gives us confidence that we can make inferences about

[9] Additional information about the distribution of party identification and ideology in the MTurk sample can be found in the appendix.

high and low concern individuals.

Table 3.1: Characteristics of Respondents in Study Sample by (%)

	Control	Correction	% Text	Raw # Text	Image No Data	% Image	Raw # Image	Total
Age								
18-29	36.2	39.4	46.4	34.8	45.3	38.6	38.8	39.9
30-44	47.8	39.4	37.7	47.8	42.2	35.7	43.3	42.0
45-59	13.0	18.2	14.5	15.9	9.4	22.9	10.4	15.0
60+	2.9	3.0	1.4	1.4	3.1	2.9	7.5	3.2
Gender								
Male	44.9	45.5	50.7	50.7	46.9	50.0	53.7	48.9
Female	55.1	54.5	46.4	49.3	53.1	48.6	46.3	50.4
Education								
High School	7.2	6.1	7.2	10.1	6.3	11.4	7.5	8.0
Some College	27.5	24.2	33.3	33.3	26.6	21.4	25.4	27.4
Trade School	2.9	3.0	2.9	2.9	3.1	7.1	9.0	4.4
Associates Degree	13.0	13.6	8.7	7.2	4.7	10.0	6.0	9.1
Bachelors Degree	30.4	34.8	33.3	29.0	56.3	37.1	29.9	35.7
Masters/Doctoral Degree	18.8	18.2	14.5	14.5	3.1	12.9	22.4	15.0
Other Professional Degree	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.4
Race/ethnicity								
White	66.7	77.3	65.2	69.6	78.1	72.9	64.2	70.5
Black	10.1	9.1	8.7	10.1	9.4	4.3	10.4	8.9
Hispanic/Latino	13.0	10.6	15.9	18.8	6.3	14.3	16.4	13.7
Asian	4.3	3.0	10.1	0.0	3.1	4.3	4.5	4.2
Pacific Islander	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.2
Other	5.8	0.0	0.0	1.4	3.1	2.9	4.5	2.5
Concern About Side Effects								
Not at all concerned	23.2	22.7	31.9	20.3	21.9	31.4	25.4	25.3
Not too concerned	33.3	33.3	26.1	43.5	39.1	24.3	32.8	33.1
Somewhat concerned	24.6	19.7	27.5	15.9	15.6	30.0	16.4	21.5
Very concerned	7.2	21.2	7.2	11.6	12.5	7.1	13.4	11.4
Extremely concerned	11.6	3.0	7.2	8.7	10.9	7.1	11.9	8.6
Number of observations	69	66	69	69	64	70	67	474

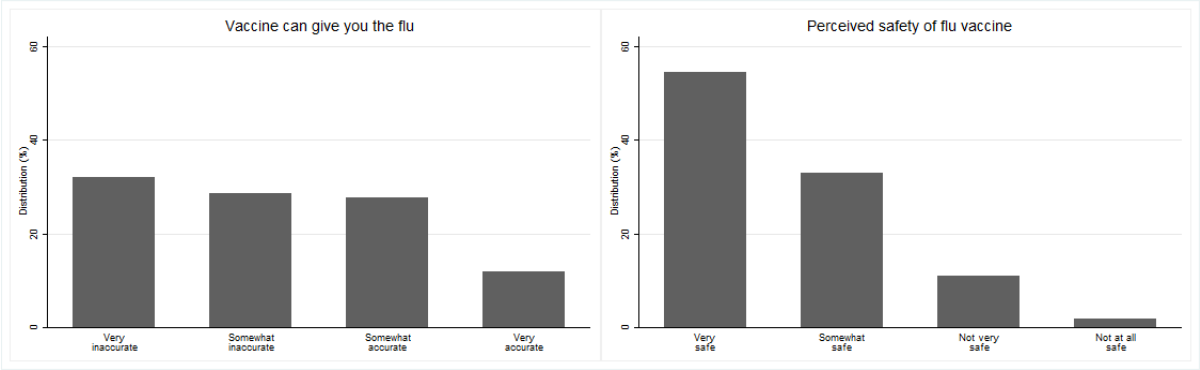

Figure 3.3: Distribution of Vaccine Misperception and Safety Measures

Figures 3.3 and 3.4 summarize the distribution of responses to the four outcome variables of interest across all seven conditions in the study: this mis-perception that the flu vaccine can give you the flu, perceptions of the vaccine's safety, self-reported intent to vaccinate in the next flu season, and attitudes about school vaccination policies.

Roughly 40% of the respondents believe the myth that the flu vaccine can give you the flu is "somewhat accurate" (28%) or "very accurate" (12%). Far fewer believe the flu vaccine is unsafe. Only a total of 15% say they consider the vaccine "not very safe" or "not at all safe." Figure 5 shows that the distribution of self-reported intentions to vaccinate is bimodal. 31% of respondents say it is very unlikely they will get a flu vaccine in the next flu season, while 30% say it is very likely they will get a vaccine. The remaining 39% of the respondents were not as certain and approximately evenly distributed about the remaining response options, with a slightly larger number in the "somewhat likely" category. Finally, approximately 43% of the respondents thought a child who has not been vaccinated should not be allowed to attend public school by indicating either "disagree" or "strongly disagree", with roughly 25% saying that an un-vaccinated child should be allowed to attend public school.

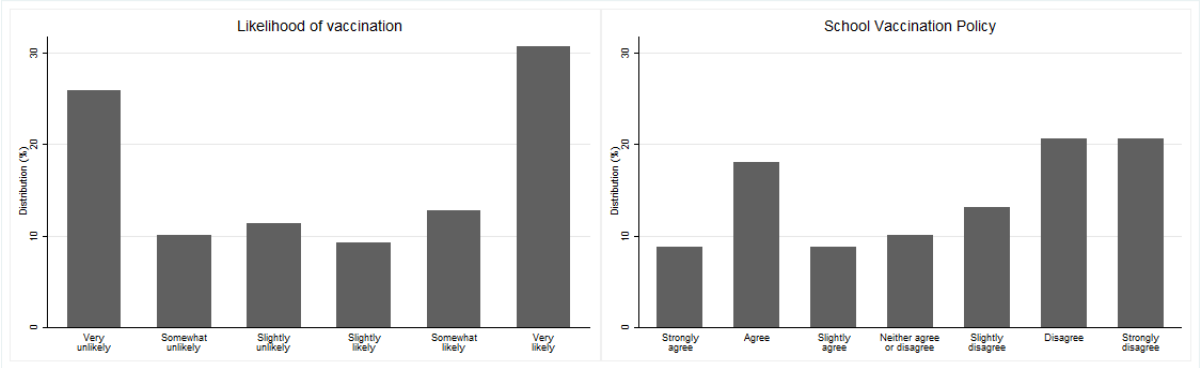

Figure 3.4: Distribution of Vaccine Intention and School Policy Measures

3.4.1 Experimental Results: Difference of Means Tests

Figures 3.5-3.8 report the differences of means tests for each of the four outcome variables. To examine the effect of the Texas-based treatments compared to the control and correction treatments, the added treatment conditions were compared to the control and correction conditions using two-sample t-tests. In Figures 3.5-3.8, a diamond over the bar indicates that the effect is statistically significantly different from the control condition at conventional levels, while a triangle over the bar means that the effect is statistically significantly different from the correction condition.[10]

Figure 3.5 shows the difference of means tests for perceptions of safety, where higher bars mean the respondents think the vaccine is more unsafe. The means all fall between 1 (“Very safe") and 2 (“Somewhat safe")[11], with means at nearly identical levels across all conditions. None of the difference of means tests was statistically significant. However, this result does shed some light on the role corrections play in shaping individuals’ understanding of vaccine safety; the correction treatment is not moving attitudes any differently than any other condition, indicating that corrections may not have particular appeal beyond the benefits of social identity appeals.

Figure 3.6 shows the difference of means tests for vaccine misperceptions, where higher bars mean the respondents believe the statement “You can get the flu from the seasonal flu vaccine" is

[10] A complete table of the dependent variable means by condition can be found in the appendix.
[11] The question scale ranges from 1 to 4, with 4 corresponding to “Not at all safe".

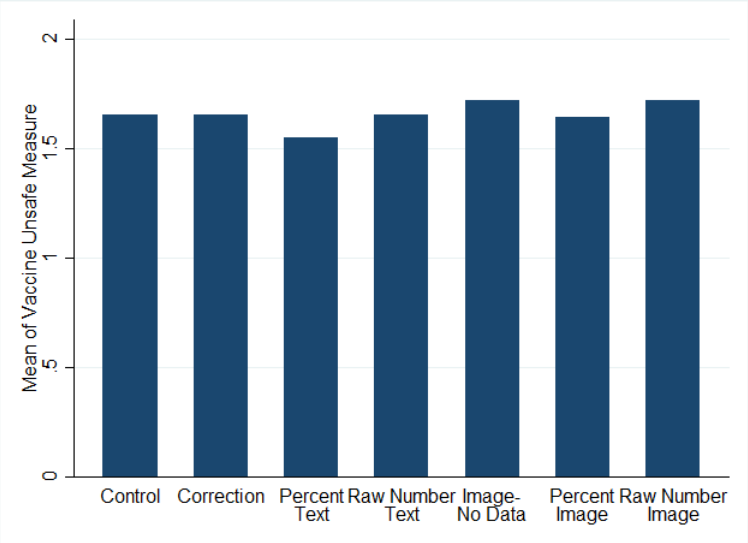

Figure 3.5: Difference of Means Tests for Perceptions of Safety

more accurate. The question scale ranged from 1 (“Very inaccurate") to 4 (“Very accurate"). The diamond above the correction bar indicates that the correction condition is significantly different from the control group, with about .75 point difference, indicating that the correction treatment is effective in correcting the misperception that the flu vaccine can give you the flu. The triangles above the other six bars further evidence this effect, as the control group is significantly different from the correction for all other conditions. The correction treatment reduces misperceptions by approximately .5 to .75 points on the question scale compared to both image and text conditions. While the the image and text treatments were not corrective in the sense that they did not contain information meant to debunk the myth that the flu vaccine gives you the flu, these treatments were found to be ineffective across all outcome measures relative to the control condition.

Figure 3.7 shows the difference of means tests for vaccine intentions, where higher bars mean the respondents are self-reporting a greater likelihood to vaccinate in the next flu season. The question scale ran from 1 (“Very unlikely") to 6 (“Very likely").[12] The figure indicates that none

[12]Here, “very likely" means that the respondent self-reported that they were very likely to get a flu vaccine during future flu seasons.

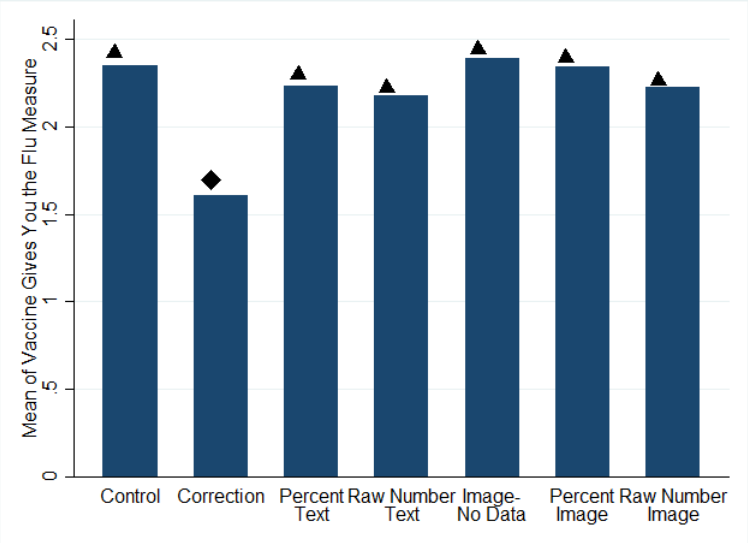

Figure 3.6: Difference of Means Tests for Vaccine Misperceptions

of the treatments was significantly different from the control or correction groups.

When examined in concert with Figure 3.6, key conclusions can be drawn from Figure 3.7. First, it appears that corrective interventions can be used to correct misperceptions, but few interventions are effective in changing intentions. In this case, identity appeals that use text to describe the previous year's vaccination rates produce the most absoluate change in intentions to vaccinate, but are not statistically significantly different in effectiveness from receiving no treatment at all. Interestingly, the identity-priming images were all equally ineffective, indicating that the image does not significantly increase vaccination intentions.

Furthermore, Figures 3.6 and 3.7 show that we can change perceptions using corrective information while failing to change intentions using any kind of appeal. Insofar as I find little evidence for the backfire effect thus far, these findings suggest that perceptions and intentions might be changed through separate processes. Even if the backfire effect is not a significant force in the difference of means tests, there is still evidence to support further investigation of the role pro-social identity appeals can play in affecting the attitudes of different individuals.

Finally, Figure 3.8 shows the difference of means tests for the school policy attitudes question,

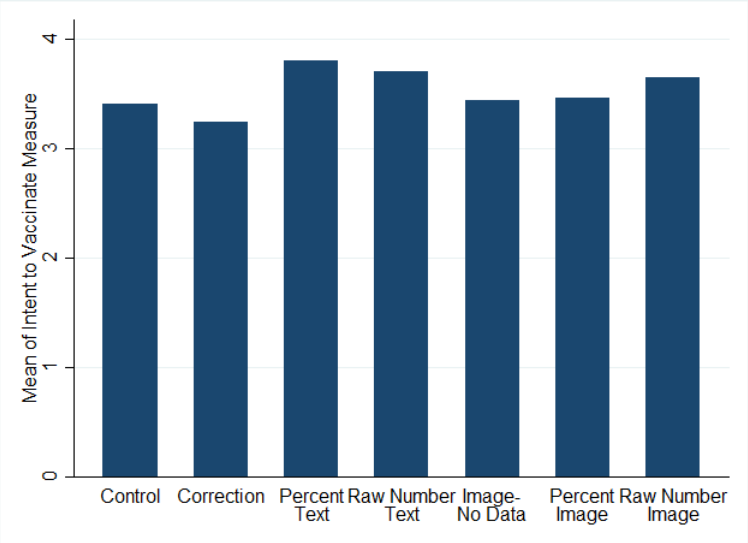

Figure 3.7: Difference of Means Tests for Intent to Vaccinate

where higher bars mean the respondents disagree more with the statement “If a child has not be vaccinated (even though they are healthy enough to receive vaccines), that child should be allowed to attend public school." While most of the bars all fall between 4 (“Neither agree nor disagree") and 5 (“Slightly disagree"),[13] the raw number with flag image condition was significantly different from both the control and correction conditions. This finding indicates that this condition made individuals more accepting of un-vaccinated students attending public schools. This might suggest that those who saw the raw number of vaccinated individuals thought that the number was high and thus un-vaccinated children do not pose a significant threat to the other students, given the established effects of herd immunity.[14]

3.4.2 Interactive Effects: Ordered Logit Models

Thus far, the data show no evidence of the backfire effect as identified by Nyhan and Reifler (2010; 2015). However, the data suggest that misperceptions can be changed without altering

[13]The question scale ranged from 1 (“Strongly Agree) to 7 (“Strongly Disagree").

[14]Herd immunity refers to “the resistance to the spread of a contagious disease within a population that results if a sufficiently high proportion of individuals are immune to the disease, especially through vaccination" (Oxford Dictionaries).

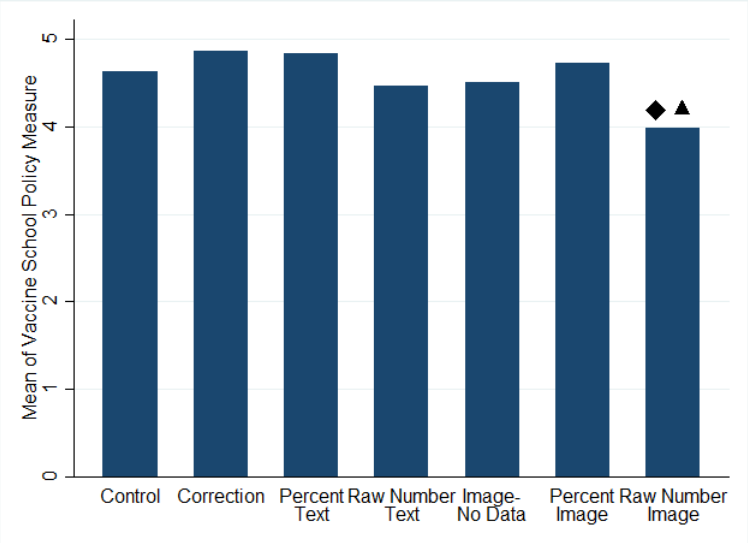

Figure 3.8: Difference of Means Tests for School Vaccine Policy Attitudes

intentions to vaccinate (Nyhan and Reifler 2014). Additionally, there is little support for the pro-social and pro-social image hypotheses, as the text and flag-based appeals appear to have little effect on increasing intentions to vaccinate and creating more positive attitudes towards the flu vaccine. To elucidate the effect of pro-social appeals across different groups of individuals and test the conditional hypotheses, I estimate a model examining the main effects of the treatment variables and the observational variables, followed by models that interact the experimental treatments with observational data collected from participants using separate ordered logit models. These models estimate the interactive effects of the self-reported level of concern about side effects, ideology. and gender with assignment to the various experimental treatments of interest. Because of the directional nature of the hypotheses, statistical significance is determined using one-tailed tests.[15]

[15]Models using two-tailed tests can be found in the appendix.

3.4.3 Main Effects

Table 3.2 reports the results for the main effects analysis by examining the effects of the treatment variables and the observational variables of interest. Participants' pre-existing concern about vaccines' side effects are significantly associated with all four outcomes measures: intent to vaccinate, perceptions of vaccine safety, belief that vaccines cause the flu, and school vaccine policy preferences. Higher levels of concern are associated with decreased intentions to vaccinate, greater belief vaccines are unsafe, greater belief that the flu vaccine can give you the flu, and more permissive attitudes towards un-vaccinated children in public schools. These results are not particularly surprising and are consistent with a wide range of previous work; those with the highest levels of concern about vaccines tend to express the greatest skepticism about their safety and getting vaccinations. However, it is interesting to note that those more concerned about side effects are also less concerned about children being exposed to un-vaccinated children. This indicates that those individuals may not only hold misperceptions about the vaccines themselves, but that they also misperceive the potential consequences of not being vaccinated and its impact on others.

Furthermore, the models show the effects of the correction treatment on each of the outcome variables. The first model in Table 3.2 shows that the correction treatment has a backfire effect for intentions to vaccinate, in line with those find by Nyhan and Reifler (2010, 2015). The data also show that the correction treatment significantly reduces respondents beliefs that the flu vaccine can give you the flu. This is evident in the third model, which reports a negative and significant coefficient for the correction treatment. Those receiving the correction treatment have a 69% probability of thinking the misperception is "very inaccurate", compared to 37% among those who did not see the correction treatment.[16]

Turning to the treatments unique to this study, I find that the flag treatment condition and the pro-social text-only treatment did not have a significant effect on any of the dependent variables.

[16] All reported predicted values were calculated using spost for Stata 14 as developed by Long and Freese (2014)[40] . In these calculations, all unspecified variables were held at their medians.

Table 3.2: Ordered Logit Models for Main Effects

	(1) Intentions To Vaccinate	(2) Believe Vaccine Unsafe	(3) Vaccine Gives the Flu	(4) Prohibit Unvax Child in School
Main Effects				
Side Effects Concern	-0.31**	1.14**	0.48**	-0.57**
	(0.07)	(0.09)	(0.07)	(0.07)
Correction	-0.53**	0.10	-1.33**	0.20
	(0.32)	(0.38)	(0.34)	(0.32)
Flag Treatment	-0.02	0.20	0.16	-0.19
	(0.20)	(0.23)	(0.20)	(0.19)
Text Treatment	0.38	-0.16	0.02	0.08
	(0.27)	(0.33)	(0.27)	(0.26)
Conservative	-0.18**	0.24**	-0.02	-0.17**
	(0.07)	(0.08)	(0.07)	(0.06)
Female	-0.35**	-0.06	-0.27	0.59**
	(0.17)	(0.20)	(0.17)	(0.16)
Republican	0.61**	-0.53**	0.32	0.34
	(0.25)	(0.28)	(0.25)	(0.24)
Education	0.11**	-0.10**	-0.10**	0.06
	(0.05)	(0.06)	(0.05)	(0.05)
Age	0.18	-0.23**	-0.38**	0.23**
	(0.11)	(0.13)	(0.11)	(0.10)
Observations	459	459	459	459
Pseudo R-squared	0.03	0.22	0.07	0.06

Standard errors in parentheses; ** $p<0.05$ with one-tailed tests

As a result, these findings provide little support for the pro-social hypothesis and the pro-social image hypotheses. Rather than increase intentions to vaccinate, the flag-based appeal and the text-based appeal did not significantly affect intentions to vaccinate, lending no support for the pro-social hypothesis. Additionally, contrary to the pro-social image hypothesis, adding the flag to the pro-social appeal did not lead to more positive attitudes towards vaccines overall and did not yield a significant improvement in attitudes beyond the text-only appeals. The findings to this point therefore suggest that pro-social identity appeals are not an effective means of changing vaccination attitudes.

There is some evidence of gender differences in vaccines attitudes in the main effects. Women have lower intentions to vaccinate, though the effect is small, with women and men both having approximately a 25% probability of being “very likely" to get a vaccine. Women also have less permissive attitudes towards un-vaccinated children in schools. While this may seem contradictory, this may be a reflection of women often being primary health care providers for their children. While perhaps not concerned about their own need for a vaccine, women may understand the importance of having children immunized to avoid disease outbreaks in schools and thus are not as accepting of un-vaccinated children in classrooms.

I also included three standard control variables (party identification, education, and age) in each model. Being a Republican and more educated has a positive relationship with intentions to vaccinate. Similarly, Republicans, the more educated and older individuals are more likely to think the vaccine is safe. Older individuals are also less likely to think that the flu vaccine can give you the flu and less permissive of un-vaccinated children in public schools. Since older respondents are more likely to recall outbreaks of diseases, such as measles, amongst their peers when they were children, these results are not especially surprising.

Finally, the coefficients for ideology and Republican are oppositely signed across all four models in Table 3.2. In the case of all four models, where significant, the Republican variable is associated with the more “desirable" outcome (greater intent to vaccinate, vaccine perceived as more safe, etc.), while the ideology variable has more “less desirable" outcomes (lower intent to vaccinate, vaccine perceived as unsafe, etc.) This is noteworthy, as the Republican party is often an identity associated with anti-science attitudes and skepticism about vaccines.[17] However, these findings suggest that it may not be party identification that leads to troubling attitudes towards vaccines. Rather, ideology, and specifically degree of conservatism, acts as the key political demographic factor in predicting vaccination attitudes and intentions.

[17] See Mooney (2005) for examples.

3.4.4 Testing Conditional Hypotheses

I next turn to tests the three conditional hypotheses dealing with side effects concern, ideology, and gender. First, in Table 3.3 I test the concern hypothesis in the interactions between levels of side effect concern and the three treatments of interest. I hypothesized that higher levels of concern would reduce the effectiveness of pro-social appeals, and the models suggest this is not the case. The third model in Table 3.3 shows that those who are more concerned and exposed to the correction treatment are more likely to think the flu vaccine will give you the flu. This suggests that the correction treatment backfires among the most concerned individuals, a finding that comports with previous research and indicates that corrective interventions may not be able to override the concerns that individuals have about vaccine side effects.

However, as concern increases among those in the flag and text treatment conditions, I find no significant effects in the hypothesized direction. Two coefficients are of note here. First, for intentions to vaccinate, those who are more concerned in the flag treatment condition were more likely to get vaccinated in the future. This coefficient is statistically significant, but not in the hypothesized direction. Contrary to the predictions of the concern hypothesis, concern did not reduce the effectiveness of the pro-social treatment. The same case emerges in the school policy model: the more highly concerned in the correction treatment are more concerned about children being exposed to un-vaccinated children. This coefficient is also statistically significant in opposition to the hypothesis. While one must be cautious in interpreting such results, there are normative implications for these two findings. If the most concerned individuals are positively affected by pro-social images and have differential reactions to corrections across measures, this could have important implications for future public health research. While only suggestive given the parameters of this study, these findings offer some evidence that should be explored in future research.

Next, I test the ideology hypothesis by interacting ideology with the pro-social treatment variables, as seen in Table 3.4. Looking first at the main effects, the conservative variable indicates

Table 3.3: Ordered Logit Models for Conditional Effects of Concern: Concern Hypothesis

	(1) Intentions To Vaccinate	(2) Believe Vaccine Unsafe	(3) Vaccine Gives the Flu	(4) Prohibit Unvax Child in School
Side Effects Concern	-0.56**	1.03**	0.45**	-0.55**
	(0.14)	(0.15)	(0.13)	(0.13)
Correction	-0.80	-0.47	-3.00**	-1.14
	(0.74)	(1.01)	(0.86)	(0.77)
Flag Treatment	-0.90**	-0.28	-0.16	-0.14
	(0.47)	(0.58)	(0.46)	(0.45)
Text Treatment	-0.26	-0.23	0.91	0.87
	(0.62)	(0.81)	(0.62)	(0.62)
Conservative	-0.18**	0.25**	-0.03	-0.16**
	(0.07)	(0.08)	(0.07)	(0.06)
Female	-0.35**	-0.05	-0.25	0.61**
	(0.17)	(0.20)	(0.17)	(0.16)
Republican	0.61**	-0.54**	0.29	0.30
	(0.26)	(0.28)	(0.25)	(0.24)
Education	0.12**	-0.09	-0.09**	0.07
	(0.05)	(0.06)	(0.05)	(0.05)
Age	0.18	-0.23**	-0.37**	0.24**
	(0.11)	(0.13)	(0.11)	(0.10)
Concern X Correction	0.11	0.21	0.68**	0.56*
	(0.28)	(0.34)	(0.30)	(0.29)
Concern X Flag	0.36*	0.17	0.13	-0.01
	(0.17)	(0.19)	(0.16)	(0.16)
Concern X Text	0.25	0.01	-0.39	-0.35
	(0.24)	(0.28)	(0.23)	(0.24)
Observations	459	459	459	459
Pseudo R-squared	0.04	0.22	0.07	0.06

Standard errors in parentheses; ** $p<0.05$ with one-tailed tests
*$p<0.05$ in opposition of the hypothesis

results consistent with the finding that conservatives are more distrustful of vaccines. Across the four models, conservative respondents are less likely to get vaccinated, more likely to find the flu vaccine unsafe, and more permissive of un-vaccinated children in public schools. However none of the interactions between ideology and the flag and correction treatments are statistically significant,

Table 3.4: Ordered Logit Models for Conditional Effects of Ideology: Ideology Hypothesis

	(1) Intentions To Vaccinate	(2) Believe Vaccine Unsafe	(3) Vaccine Gives the Flu	(4) Prohibit Unvaxx Child in School
Side Effects Concern	-0.31**	1.14**	0.48**	-0.57**
	(0.07)	(0.09)	(0.07)	(0.07)
Correction	-0.89**	0.58	-1.54**	-0.40
	(0.52)	(0.63)	(0.57)	(0.51)
Flag Treatment	-0.38	0.048	-0.03	-0.17
	(0.35)	(0.44)	(0.35)	(0.34)
Text Treatment	0.34	-0.17	0.01	0.07
	(0.27)	(0.33)	(0.27)	(0.26)
Conservative	-0.26**	0.25**	-0.06	-0.20**
	(0.09)	(0.10)	(0.08)	(0.08)
Female	-0.34**	-0.04	-0.26	0.59**
	(0.17)	(0.20)	(0.17)	(0.16)
Republican	0.62**	-0.54**	0.32	0.36
	(0.26)	(0.28)	(0.25)	(0.24)
Education	0.12**	-0.10**	-0.10**	0.07
	(0.05)	(0.06)	(0.05)	(0.05)
Age	0.17	-0.24**	-0.39**	0.23**
	(0.11)	(0.13)	(0.11)	(0.10)
Conserv. X Flag	0.13	0.05	0.06	-0.01
	(0.10)	(0.12)	(0.10)	(0.09)
Conserv. X Correction	0.12	-0.16	0.07	0.22
	(0.14)	(0.17)	(0.15)	(0.14)
Observations	459	459	459	459
Pseudo R-squared	0.04	0.22	0.07	0.06

Standard errors in parentheses; ** $p<0.05$ with one-tailed tests

providing no support for the ideology hypothesis.

Finally, I test the gender role hypothesis by interacting the female variable with the pro-social treatment variables, as seen in Table 3.5. Here we find mixed evidence for the gender role hypothesis. While the relationship between being male and intent to vaccinate is negative, women who are exposed to the flag treatment have higher intentions to vaccinate. This indicates that the flag treatment has a positive effect on behavioral intentions for women, but no significant effects

Table 3.5: Ordered Logit Models for Conditional Effects of Gender: Gender Hypothesis

	(1) Intentions To Vaccinate	(2) Believe Vaccine Unsafe	(3) Vaccine Gives the Flu	(4) Prohibit Unvaxx Child in School
Side Effects Concern	-0.31**	1.15**	0.49**	-0.58**
	(0.07)	(0.09)	(0.07)	(0.07)
Correction	-0.53**	0.10	-1.33**	0.24
	(0.32)	(0.38)	(0.34)	(0.32)
Flag Treatment	-0.40	0.60**	0.35	-0.02
	(0.29)	(0.34)	(0.30)	(0.28)
Text Treatment	0.36	0.01	0.18	0.63**
	(0.35)	(0.44)	(0.36)	(0.34)
Conservative	-0.19**	0.24**	-0.03	-0.17**
	(0.07)	(0.08)	(0.07)	(0.06)
Female	-0.67**	0.37	-0.02	1.07**
	(0.32)	(0.37)	(0.32)	(0.31)
Republican	0.64**	-0.53**	0.32	0.34
	(0.26)	(0.28)	(0.25)	(0.24)
Education	0.11**	-0.10**	-0.10**	0.06
	(0.05)	(0.06)	(0.05)	(0.05)
Age	0.19**	-0.24**	-0.39**	0.24**
	(0.11)	(0.13)	(0.11)	(0.10)
Female X Flag	0.77**	-0.77	-0.37	-0.32
	(0.41)	(0.48)	(0.41)	(0.39)
Female X Text	-0.05	-0.34	-0.29	-1.18**
	(0.45)	(0.53)	(0.46)	(0.44)
Observations	459	459	459	459
Pseudo R-squared	0.04	0.22	0.07	0.06

Standard errors in parentheses; ** $p<0.05$ with one-tailed tests

on attitudes. In contrast, women exposed to the text-only pro-social appeal are more permissive towards un-vaccinated children in public schools. This backfire effect suggests that women might find the text persuasive in the sense that they consider the number of vaccinated Texans sufficient to allay their concerns about un-vaccinated children in schools, even if those concerns are valid.

3.5 Discussion and Conclusions

The results of this study indicate that information seeking to debunk myths about the flu vaccine can have different effects on beliefs than on intentions to vaccinate. I replicate the findings from Nyhan and Reifler (2014, 2015) showing that a corrective intervention reduces misperceptions, but does not change beliefs about safety or intentions to vaccinate. Furthermore, I identify a backfire effect of corrective treatments for intentions to vaccinate. These findings are consistent with previous research on factual corrections, while providing additional evidence for the backfire effect.

Most notably, I find that pro-social identity appeals are not particularly effective mechanisms for changing attitudes towards vaccines. The pro-social treatments have null results in the main effects, suggesting that a general appeal to pro-social identity is not particularly effective at changing attitudes or intentions towards flu vaccination. While additional studies are needed to fully examine the role of pro-social appeals, these results are cause for caution in dedicating scarce public health education resources to pro-social appeals aimed at the public at large. However, vaccines are only one area of science subject to misperceptions and misguided behavioral intentions. Pro-social identity appeals may still be effective in addressing other topics of interest, including climate change, nuclear power, and the like.

I also find that various demographic groups are differentially affected by pro-social identity appeals. Women and those most highly concerned about vaccines in particular respond differently to two kinds of pro-social identity appeals, with images producing more desirable outcomes for intentions to vaccinate and text and corrective appeals resulting in attitude changes on school policy. This may be because both groups of individuals find the symbolism of the Texas flag persuasive or because they find the text-based treatments sufficient to convince them that un-vaccinated children are a serious concern. The preliminary findings underscore the need for additional studies to further understand how identity, information, and community expectations interact when people

encounter different types of public health appeals and how gender and concern level operates in identity-based appeals.

This study is of course not without limitations. I was not able to measure directly whether the respondents had actually received a flu vaccine for both logistical and privacy reasons. As such, I was not able to fully explore the impact of social pressure by exposing individuals' behavior to their contemporaries, as Gerber and Green (2008) do in their seminal social pressure study. Additionally, I face some challenges when working with a convenience sample from Mechanical Turk, particularly when limiting the workers to a specific state. However, the findings in this chapter show that the primary results might be context-dependent and indicates the need for additional research to identify conditions why the backfire effect occurs, when it does not, and which individuals are most strongly affected. Additionally, further exploration of when pro-social appeals can compliment corrective information to change intentions to vaccinate would also be relevant moving forward. Future research might extend this work to a larger, national sample in different pro-social contexts and examine the role of group behavior as a pro-social force in correcting misperceptions.

Despite these limitations, these results suggest that there is much more work to be done to experimentally evaluate the effects of different types of appeals in science communication. Continuing to explore the role of psychological appeals in this sort of messaging by testing corrective and identity appeals together, as well as separately in contexts other than vaccines, are promising avenues for future studies. Additionally, exploring how political context effects these types of appeals by attaching partisan content to the appeal will further our understanding of how political forces shape the effects of social pressure and the correction of misperceptions in science communication.

This chapter also has implications for public policy. If a variety of demographic groups react differently to language and images used in public health appeals, this poses a challenge for health agencies working to create those appeals. Funding for public health appeals is typically directed

at projects meant address a broad audience across the country or in a specific state. These results suggest that such efforts may not be the best use of public funds. Instead, directing resources towards creating more targeted appeals may be more effective in changing behavior. Accounting for identity in how health agencies address different groups in the public may be key in shifting vaccination behavior and attitudes towards public health more broadly.

4. PARTISANSHIP, KNOWLEDGE, AND THE ASSESSMENT OF SCIENCE POLICY AGENCIES

In the contemporary United States, politics often seems to dominate the conversation surrounding scientific topics and related technologies. At a time rich in scientific discoveries, the public is more interested than ever in what science holds for the future and the impact of constantly evolving technology. Yet we also live in times of high political polarization, leading to an almost inevitable stream of political debate over scientific discoveries, their applications, and subsequent policy change. Given these dynamics, there is much to be learned about the politicization of science, individuals' policy views, and the public's relationship with the communication and interpretation of scientific findings.

Science policy plays out in various arenas and in particular in the many federal government agencies. Agencies, such as the Environmental Protection Agency (EPA) and the Department of Energy (DOE), are often responsible for deciphering and implementing legislation related to all areas of scientific inquiry. Ranging from regulatory laws to research funding, agencies have influence and power over the course of all fields of scientific research and serve important functions throughout the process of scientific discovery. Yet little work thus far has investigated what shapes attitudes towards agencies and connect the public's general science attitudes to their attitudes about agencies.

This chapter uses data from three large national surveys to investigate the relationships between partisanship, science attitudes, and attitudes towards science policy agencies. I theorize that scientific agencies provide source cues for the public, which can lead to partisan evaluations. Additionally, I expect to find a relationship between how individuals view scientists and their work and how they view the agencies that carry out relevant science policy. I test this theory in three topic areas (climate change, energy, and the energy-water-food nexus) and find that individuals'

party affiliations and science attitudes shape assessments of scientific agencies, while education and income do not. These findings have important implications for our understanding of general science attitudes.

4.1 Science Attitudes: A Diverse Literature

Research on public opinion of science and scientists exists in several disciplines and approaches the subject from diverse angles. In political science, existing studies typically focus on a particular subject matter, with climate change as the primary scientific topic, in order to test hypotheses about attitudes towards science. While it is well established that the left-right spectrum colors how individuals perceive political phenomena, including policy debates like those around climate change (Feldman 1988, Jacoby 1995), other studies have examined how the information environment affects attitudes towards science. Kellstedt, Zahran, and Vedlitz (2008) examine attitudes towards global warming and find that individuals who self-report as being more informed and those with more confidence in science are less concerned about global warming and feel less personally responsible. Similarly, Malka, Krosnick, and Langer (2009)[42] find differences among partisans, with more self-reported knowledge yielding more concern among Democrats and Independents, but not among Republicans. This suggests that the knowledge-deficit model, which proposes that a lack of information and understanding contributes to a lack of belief or support, may not be the primary explanation for climate change skepticism.

From here, public opinion about science and scientists has been explored in sociology, history, and science and technology studies (STS). Complementary to work in political science, STS has established that science and politics are indivisible (Cozzens and Woodhouse 1995; Frickel and Moore 2005) and that science has always been politicized. Other work has then attempted to piece together the relationship between scientific knowledge and attitudes and political orientations. Reminiscent of Hofstadter (1970), Mooney (2005) argues that the political neutrality of science began to change in the 1970's with the emergence of the "new right", which preferred

limited government, traditional values, and was skeptical of organized science and intellectualism. Following from this, Mooney argues that the elections of Reagan and Bush began the “war on science".

Several works examine the sorts of claims made by Mooney (2005) and seek to assess them empirically. Most notably, Gauchet (2012) tests Mooney’s (2005) claim that conservatives have become more distrustful of science over time using the General Social Survey “confidence in scientific community" question. He finds that group differences in trust are stable, with the exception of conservative respondents, who end the analyzed period with the lowest levels of trust in science. Other work also offers support for Mooney’s (2005) arguments. McCright and Dunlap (2000) demonstrate the prevalence of conservative counter-claims to climate science in the 1990’s and discuss the impact such a counter movement can have on the overall information environment. Overall, these lines of research show that public opinion of science is complex, inseparable from politics, and in need of further investigation.

These cross sectional studies are complemented by a body of experimental work examining how individuals process scientific information and how changes to the source and type of information presented affects attitudes towards science. Dan Kahan and his colleagues have published numerous experimental papers describing the “cultural cognition hypothesis", which suggests that an individual’s factual beliefs are formed based on risk assessments that align with their cultural evaluations of a subject (Wildavsky and Dake 1990). Kahan and colleagues have the used this theory to address how reasoning about science is often politically motivated and related to curiosity towards science and open-mindedness (Kahan, Jenkins Smith and Braman 2011; Kahan et al. 2015; Kahan 2017a).

Across these diverse fields and studies, two key observations emerge. First, partisanship and ideology play a prominent role in shaping science attitudes. While not exactly surprising, the idea that these political identities and forces directly affect how individuals think about the scientific process conflicts with the notion that science is objective and research oriented. When politics

collide with this process, attitudes towards “objective" facts and related institutions can become wildly skewed. Second, these studies suggest that knowledge does not always lead to more concern about climate change or any other scientific topic. Overall, the relationship between concern, self-reported knowledge, and partisanship is complex and changes how scientific information is processed.

4.2 Agency Credibility

Thus far, studies of attitudes towards science have often overlooked scientific agencies in their assessments of the public’s support or opposition to particular science policies. This is not entirely surprising; compared to Congress, the president, and the federal government, studies of trust in and support for agencies are sparse. Yet agencies often play central roles in the administration and direction of science policy. Agencies are primarily responsible for deciphering legislation, a difficult task given the typical vagueness of legislation and the length and complexity of bills, and are often tasked with drafting rules and regulations. Given the nature of the legislative process, this requires great flexibility and this flexibility requires agencies to be viewed as legitimate and trustworthy.

Trust in agencies often fluctuates widely. This is because agencies often engage the public with large portions of the population predisposed to distrust them over ideological or policy differences. These disagreements often directly conflict with the goals and missions of an agency or the directives they have been given by Congress. The most clear example of this is the Environmental Protection Agency. The EPA’s mission is simple: “The mission of the EPA is to protect human health and the environment" (Environmental Protection Agency, 2014). Yet we also know that Democrats and liberals are more likely to be environmentalists than Republicans and conservatives (Dunlap, Xiao, and McCright, 2001[17]). As a result, Republicans are more likely to disagree with the goals of the EPA and thus less likely to trust the agency overall.

If a large portion of the population is predisposed to distrust an agency, how do agencies foster

public trust? Though not entirely clear, scholars have identified a few potential mechanisms for this creation of trust. First, Robinson et al. (2013)[55] and others argue that agency competence is a good indicator of agency trust. Competence is established when the agency consistently does a good job in completing its work. Though it may take some time, consistent quality work ought to generate goodwill towards the agency in question (Thomas 1998)[63]. Another mechanism to establish competence focuses on the shared values and goals between individuals and the agency (Needham and Vaske 2008[45]; Smith et al. 2013[58]). This argument assumes that party identification and ideology form the basis of a relationship to an agency via shared goals and values. Thus, when an agency demonstrates that it shares these underlying standards with someone, that individual is more likely to trust the agency.

A third way to frame how agencies foster trust focuses on the agency's reputation. Carpenter's (2001[8], 2014[7]) extensive research on this subject suggests that skillful leadership at the agency itself can preserve the autonomy of the agency and create areas in which the agency hold unique expertise. Doing so protects the agency from congressional and executive control, which are the typical focus of agency trust studies. Thus, rather than focusing on the outcomes and goals of the agency, trust might be fostered through agency leadership and reputational integrity.

While there is no consensus on the mechanisms used by agencies to build trust with the public, a few "stylized facts" do emerge. First, agencies are complex bodies comprised of many individuals (Carpenter and Krause, 2012)[9]. From high level leadership to office management to technical and scientific experts, agencies are large and diverse, making them hard to define in the minds of the public. Second, the public thinks agencies are often more unified than they are in reality (Carpenter and Krause, 2012). Since agencies are such large, diverse groups, often there is dissent within the agency and not the coherence the public often thinks of. Yet the reputation of and trust in the agency reflects on all its members; subsequently, it is often assumed the members all reflect the goals and reputation of the agency. This is particularly important for studies of public opinion about agencies, as public opinion assumes some level of coherence about agencies. Finally,

agencies have multiple audiences (Carpenter and Krause, 2012). They must speak to the public, Congress, scientists, government officials, and so on. This is also important for the study at hand; given that agencies must speak to so many groups, understanding attitudes from those audiences is critical to understanding how agency information is processed. This is important for all agency information and especially important for the study of science communication.

4.3 Agencies and Science Attitudes

As previously noted, agencies are able to stake out reputations for unique expertise in order to facilitate trust in the public and government officials. It follows then that agencies can then act as source cues for the public. This kind of heuristic information processing allows individuals to draw inferences about the aims of the agency and the goals of the policies and regulations they implement. Given that agencies are often subject to a predisposition towards distrust over ideological or policy differences among some individuals, it is reasonable to think that those predispositions are then connected to information given by the agency and thus to more general attitudes about science.

Furthermore, there is evidence that agencies are subject to partisan evaluations. Survey research conducted by the Pew Research Center finds that while most federal agencies are viewed favorably, there are partisan differences in how people view some agencies. For example, Pew finds wide partisan gaps in favorability for the EPA, Health and Human Services, and the Internal Revenue Service, with 29-34 point differences in ratings between Democrats and Republicans. This indicates that the understanding of these agencies reputations is not purely objective and as a result, information coming from these agencies may not be processed in a non-partisan or objective way.

Understanding how partisanship, science attitudes, and agency attitudes are connected is essential to advancing our understanding of science communication. As other studies have shown, simply providing information from authoritative sources does not always change misperceptions

about science (Kellstedt, Zahran, and Vedlitz 2008; Nyhan and Reifler 2015). If individuals are connecting their partisanship to how they view agencies and their reputations, this can in turn affect the degree to which they update their beliefs about related science policy and research. Agencies often serve as a link between the public, politicians, and scientists, making attitudes towards these mediating bodies critical elements in our attempt to improve and understand the nature of science communication.

In the analysis that follows, I explore the nature of the partisanship, science attitudes, and agency attitudes relationship. I expect to find significant relationships between party identification and ideology across all levels of government and types of agency, given the existing evidence in the literature. I also expect to find a relationship between individuals attitudes towards science and scientists, with more positive feelings towards science expected to result in more trust for agencies, especially those with specialized goals like the EPA. Finally, I examine the relationship between education, religion, and income on trust in agencies.

4.4 Data and Methods

My data come from three large national surveys conducted by the Institute for Science, Technology, and Public policy at the Bush School of Government and Public Service at Texas A&M University. GfK Custom Research, LLC administered all three national public opinion surveys of adults 18 years and older. In order to address a wider range of agencies and scientific topics, each of the three surveys chosen focused on different subject matter. The surveys addressed 1) energy, especially fracking, 2) climate change and 3) the energy-water-food nexus. The energy survey was in the field from May 11, 2012 through May 26, 2012. The climate change survey was in the field from November 13, 2013 through November 26, 2013. The nexus survey was in the field from August 12, 2015 through August 29, 2015. The samples were drawn from GfK's web-enabed KnowlegePanel, a probability-based panel designed to be representative of the U.S. population. The survey was offered in English and targeted to adults over the age of 18. For the energy survey,

the median survey completion time was about 29 minutes. The response rate of 62 percent yielded 1,525 completed energy surveys. For the climate change survey, the median survey completion time was about 24 minutes and the response rate of 55.9 percent yielded 1,321 completed surveys. Finally, the median survey completion time for the nexus was 24 minutes and the response rate of 61.0 percent yielded 1,463 completed surveys.[1]

Linear models with robust standard errors are used to test the predictions outlined above. The dependent variables of interest across all three surveys focus on trust in the federal government, the agencies asked about on each survey, and state and local governments/agencies. The dependent variables are measured on 0-10 scales, where higher values indicate higher levels of trust, with two exceptions: trust in the federal government on the energy and climate change surveys are measured on five point scales. These exceptions are noted on the relevant tables.

It is worth noting that between the three surveys, question wording on the dependent variables varied slightly. For example, on the 2012 energy survey, respondents were asked to "place the following information sources on a scale from 0 to 10 in terms of the trustworthiness of information provided on energy", followed by a list of sources, including the EPA, DOE, state government agencies, elected officials, and the like. In contrast, on the 2013 climate change survey, respondents were asked "How trustworthy are the following organizations?", followed by a shorter, but similar, list of groups to the energy survey question. While there is no reason to believe that respondents would answer these questions in completely different ways, the questions do frame the scales differently and it is thus worth keeping in mind while considering the results.[2]

To test the predictions related to education, income, religion and partisanship, all three sets of

[1]The following material is based upon research conducted by the Institute for Science, Technology and Public Policy in The Bush School of Government and Public Service, Texas A&M University. The energy survey was done in cooperation with the Texas A&M Energy Institute and was supported by Texas A&M University's Crisman Institute for Petroleum Research in the Harold Vance Department of Petroleum Engineering, the Institute for Science, Technology and Public Policy, and the Texas A&M University Office of the Vice President for Research. Support for the energy-water-food nexus survey was provided by the Institute for Science, Technology and Public Policy and Area 41, part of the Texas A&M University System. The statements, findings, conclusions, and recommendations are solely those of the authors.

[2]Complete question wording can be found in the appendix.

models include the same set of independent variables. *Household income* is a 19-category variable, where higher values indicate a higher range of household income. *Education* is a categorical variable where a higher value indicates that the respondent has received a higher degree and therefore more years of formal education. *Church Attendance* is a categorical variable where a higher value indicates that the respondent attends church more often. *Democrat* is a dummy variable indicating whether the respondent considered themselves to be a "leaning Democrat", "not strong Democrat", or "strong Democrat".[3] Finally, *Conservative* uses the traditional seven point ideology scale, where higher values indicate the respondent is more conservative. Independent variables that are specific to the particular survey and used to test the science attitudes predictions will be discussed in detail in the results section.

4.5 Results

The results for each of the three surveys can be found in Tables 4.1-4.3. Beginning with the earliest survey administered, the energy survey, I find support for the notion that partisanship and ideology have an effect on agency attitudes. Democrat has a positive relationship with trust in agencies across all five agencies asked about on the survey (the federal government, EPA, DOE, state agencies, and local agencies). Higher levels of conservatism had a consistent negative relationship with agency trust, but was only statistically significant at conventional levels for the federal government and the EPA. This may reflect the politicized nature of these two entities, as state and local government and agencies typically get less attention than those at the national level. Beyond these political variables, I find a significant negative relationship between church attendance and trust in the federal government and state and local agencies. While the effect is small, it is notable that this relationship does not exist for specific federal agencies (in this case, the EPA and DOE). This indicates that while more religious individuals may have broader distrust in the government overall, they do not distrust agencies that focus on particular policies. However, I find no effect

[3] In the case of the energy survey, party identification was only asked as a three category question. Thus, the variable indicates those who marked themselves as a Democrat.

of education on trust in any of the agencies and income only had a statistically significant effect on trust in the federal government overall. Combined, these results paint a picture where agency trust is not a function of general socio-economic status, but instead is driven by more politically relevant identities.

To test my theoretical expectations about the relationship between science attitudes and agency trust, I rely on two different measures from the energy survey. First, *Fracking Concern* asks respondents "How concerned are you about the use of [hydraulic fracturing/fracking] to access hidden pockets of natural gas?" The variable ranges from 0 to 10, where "0" indicates "not at all concerned" and "10" indicates "extremely concerned." Second, *Confidence in Scientists* is comprised of individual confidence measures for oil and gas scientists, university scientists, and environmental scientists.[4] Each of the individual scientist confidence measures uses a 5-point Likert scale, where 1=Not At All Confident and 5=Extremely Confident. The *Confidence in Scientists* variable is an additive scale that sums the values of each of the three individual scientist confidence measures into a single composite scale ranging from 3 (Least Confident) to 15 (Most Confident).

Returning to Table 4.1, I find that confidence in scientists and concern for fracking both have a significant positive relationship with agency trust across all agencies. In other words, the more trust you have in scientists and the more concerned you are about fracking, the more trust one has in different agencies. These findings demonstrate a connection between more general attitudes towards science and scientist's work and how individuals feel about the agencies that carry out policy. Additionally, the fracking variable shows that individuals use topic-specific attitudes in evaluating agencies, even when controlling for political variables.

Next, Table 4.2 shows the results from the October 2013 climate change survey. Agencies asked about include the EPA, the Federal Emergency Management Agency (FEMA), the Department of Defense (DOD), and state and local governments. I again find no effect of education on trust in any of the agencies and income only had a statistically significant effect on trust in FEMA

[4]See the Appendix for specific question wording.

Table 4.1: Linear Models of Agency Trust, Energy Survey, April 2012

VARIABLES	(1) Fed. Gov't	(2) EPA	(3) DOE	(4) State Agency	(5) Local Agency
Church Attendance	-0.02**	-0.01	-0.07	-0.08**	-0.11**
	(0.01)	(0.03)	(0.03)	(0.03)	(0.03)
Household Income	0.01**	0.004	0.01	0.02	0.01
	(0.004)	(0.01)	(0.01)	(0.01)	(0.01)
Education (Highest Degree Received)	-0.01	0.02	-0.01	-0.005	-0.001
	(0.01)	(0.03)	(0.03)	(0.03)	(0.03)
Democrat	0.33**	0.71**	0.77**	0.74**	0.57**
	(0.04)	(0.15)	(0.15)	(0.15)	(0.15)
Conservative	-0.07**	-0.18**	-0.07	-0.12**	-0.11**
	(0.01)	(0.05)	(0.05)	(0.05)	(0.05)
Confidence in Scientists	0.05**	0.46**	0.44**	0.40**	0.39**
	(0.007)	(0.02)	(0.02)	(0.02)	(0.02)
Fracking Concern	0.01	0.20**	0.11**	0.10**	0.09**
	(0.006)	(0.02)	(0.02)	(0.02)	(0.02)
Constant	1.73**	-0.13	0.56	0.34	0.71
	(0.17)	(0.51)	(0.53)	(0.52)	(0.52)
Observations	1,439	1,431	1,427	1,430	1,434
R-squared	0.177	0.339	0.262	0.253	0.225

Robust standard errors in parentheses
** p<0.05

and local government. Democratic party affiliation has a significant positive relationship with trust in the federal government, the EPA, and FEMA, but not state or local government. The same is true for ideology; higher levels of conservatism have a significant negative relationship with trust in the federal government, the EPA, and FEMA, but not the other levels of government. In contrast, being more conservative was positively related to trust in the DOD; this is not entirely surprising, as conservatives typically strongly support the military and defense efforts generally, even if they do not consider climate change a defense issue.

A key difference between the energy and climate change models comes in the results for church attendance. While attendance had a negative effect on trust in the energy survey, I find a significant and positive relationship between agency trust and church attendance across all agencies and levels of government in the climate change survey. While the effects are small in these models as well,

there are several reasons why the direction of the relationship is different. First, the surveys deal with different subject matter and it is possible that energy-related topics stir up more distrustful feelings among religious individuals than climate change questions do. Second, religious individuals may trust certain agencies more on climate change than they do on energy policy. For example, finding no significant effects of religion on EPA trust in the energy survey and then finding a positive relationship on climate change may indicate that more religious persons trust the EPA to address climate change, but not energy policy. Finally, the year and a half between the two surveys included a presidential election; it is possible that changes to the political climate surrounding and after the election may have produced a shift in religious individual's attitudes towards agencies and particular scientific topics. Unfortunately, the questions asked on these two surveys make it nearly impossible to test such a hypothesis.

The climate change survey included questions asking respondents to report their own level of knowledge about climate change, as well as assess the degree to which scientists understand climate change. Two variables in the model address how knowledge level and attitudes towards climate science affect trust in agencies. First, *Self Reported Information Level* asks respondents "how informed do you consider yourself to be about global warming and climate change?". The scale runs from 0 to 10, where higher values indicate higher levels of information. Second, *Perceptions of Scientist Understanding* is comprised of six different measures of how much the respondent believes scientists understand certain threats steming from global warming and climate change. The threats asked about included sea level rise, flooding, drought, rising temperatures, wildfires, and strong storms.[5] Each threat's understanding level was asked on a 0 to 10 scale, where higher values indicate that the respondent thinks the scientists understand the threat's consequences more. *Perceptions of Scientist Understanding* combines the six scales into one variable that ranges from 0 to 60.

Table 4.2 shows that self reported information level has no effect on trust in federal agencies,

[5]See the Appendix for specific question wording.

Table 4.2: Linear Models of Agency Trust, Climate Change Survey, October 2013

VARIABLES	(1) Fed. Gov't	(2) EPA	(3) FEMA	(4) DOD	(5) State Gov't	(6) Local Gov't
Church Attendance	0.06**	0.12**	0.12**	0.13**	0.20**	0.19**
	(0.01)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Household Income	0.004	0.02	0.04**	0.03	0.005	0.04**
	(0.005)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Education (Highest Degree Received)	-0.002	0.004	0.03	-0.01	0.01	0.07
	(0.01)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Democrat	0.28**	1.15**	0.72**	0.17	0.28	0.12
	(0.05)	(0.18)	(0.17)	(0.18)	(0.18)	(0.18)
Conservative	-0.07**	-0.38**	-0.22**	0.08	-0.03	-0.03
	(0.01)	(0.06)	(0.06)	(0.07)	(0.06)	(0.06)
Self Reported Information Level	0.003	0.03	0.01	0.06	0.10**	0.14**
	(0.009)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Perceptions of Scientist Understanding	0.005**	0.04**	0.04**	0.02**	0.02**	0.02**
	(0.001)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Constant	1.50**	2.59**	2.01**	2.78**	1.77**	0.94
	(0.18)	(0.59)	(0.60)	(0.64)	(0.62)	(0.62)
Observations	1,174	1,174	1,174	1,174	1,174	1,174
R-squared	0.110	0.247	0.141	0.030	0.059	0.076

Robust standard errors in parentheses
** p<0.05

but does have a significant positive relationship with state and local government trust. Given that state and local government is often viewed in a more positive light than the federal government and its entities, this may reflect more confidence in state and local government resources when it comes to dealing with climate change among those who percieve themselves as knowing more about global warming and climate change. Finally, perception of scientist understanding has a statistically significant and positive relationship across all agencies and levels of government. These findings demonstrate another type of connection between more general attitudes towards scientist's work and how individuals feel about the agencies that carry out policy, even when controlling for political ideology and party.

Finally, Table 4.3 shows the results for the analysis of the energy-water-food nexus survey, conducted in August 2015. The agencies included on this survey included the EPA, the DOE,

Table 4.3: Linear Models of Agency Trust, Energy-Water-Food Nexus Survey, August 2015

VARIABLES	(1) Fed. Gov't	(2) EPA	(3) DOE	(4) USDA	(5) State Gov't	(6) Local Gov't
Church Attendance	0.20**	0.18**	0.17**	0.16**	0.22**	0.25**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Household Income	0.02	0.02	0.02	0.02	0.02	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Education (Highest Degree Received)	0.03	0.003	0.01	0.02	0.01	0.03
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Democrat	1.31**	1.27**	0.87**	0.71**	0.59**	0.47**
	(0.15)	(0.14)	(0.13)	(0.13)	(0.14)	(0.14)
Conservative	-0.33**	-0.44**	-0.31**	-0.19**	-0.07	-0.06
	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
Constant	3.32**	5.09**	4.74**	4.55**	3.184**	3.27**
	(0.44)	(0.42)	(0.41)	(0.41)	(0.41)	(0.41)
Observations	1,836	1,836	1,836	1,836	1,836	1,836
R-squared	0.145	0.169	0.101	0.059	0.044	0.043

Robust standard errors in parentheses
** p<0.05

and the United States Department of Agriculture, along with federal, state, and local government. Once again, I find no effect of education and household income on trust in any of the agencies or levels of government. Similarly, I find that being a Democrat has a positive relationship with trust in agencies across all five agencies and levels of government. Higher levels of conservatism had a consistent negative relationship with agency trust, but was only statistically significant at conventional levels for entities at the federal level. And like the climate change survey results, I find a significant positive relationship between church attendance and trust in agencies at all levels of government. This particular survey did not include any questions related to science, scientists, or knowledge of the topic at hand. This does limit the extent to which conclusions can be drawn from the data, but the results provide additional confirmatory evidence for the findings about partisanship, ideology, religion and education found in the first two surveys.

4.6 Discussion

Understanding how partisanship, science attitudes, and agency attitudes are connected is essential to advancing our understanding of science communication because agencies often serve as a connection between the public, politicians, and scientists. This connection makes attitudes towards these mediating bodies critical elements in our attempt to understand how people respond to communications about science and research conducted at the federal level. This chapter attempts to take a first step in exploring the nature of the partisanship, science attitudes, and agency attitudes relationship and provide a foundation for future research in this area.

I find significant relationships between party identification and ideology across all levels of government and types of agency across all three topics covered in the ISTPP surveys. I also find a relationship between individuals' attitudes towards science and scientists, with more positive feelings towards science resulting in more trust for agencies, especially those with specialized goals like the EPA. Conflicting results for church attendance between the energy survey and the climate change and nexus surveys indicate that religion may play an important and shifting role in atttitudes towards agencies, with the effects perhaps altered by the political climate and the scientific subject at hand. Finally, I find no general relationship between education and income on trust in agencies.

The results presented here suggest that additional work is worthwhile and necessary to understand how individuals use their partisanship and science attitudes in forming opinions about science policy agencies. Establishing a connection between these general science sentiments and agencies, even when controlling for party and ideology, sheds light on the complex connections individuals make in their assessment of science, the federal government, and the agencies responsible for implementing policy. These findings also underscore the need to further address how information from those agencies is processed and used in forming attitudes towards policy and other institutional factors that shape the direction of scientific research at the federal level.

Future research following up on this initial study has several possible directions. The climate change and energy surveys both include additional questions asking about the competence of agencies and the federal government and whether or not the respondent feels the agency shares their values. I plan to incorporate these questions into an extend analysis to see if there are different effects across dependent variables that address additional dimensions of attitudes towards agencies. Additionally, I plan to analyze the relationship between agency attitudes and other institution attitudes and behaviors, particularly religious institutions. Finally, work that examines the effect of agencies as sources of information for the public and how individuals incorporate that information into their risk assessments, attitudes, and behavior more generally would provide a practical extension of these initial findings.

5. SUMMARY AND CONCLUSIONS

The preceding sections have laid out a number of individual and macro-level theories about the nature of attitudes towards science and the role politics play in shaping public opinion about science. The literature, as it exists currently, spans a diverse set of fields in the social sciences and takes a wide range of methodological approachs. The chapters presented here elaborate on previous work by connecting studies of aggregate and individual level opinion across a variety of different subject areas, including public health, the bureaucracy, public opinion, and public policy.

Each chapter provides different insights into the nature of public opinion about and the politics of science. Chapter 2 presented evidence that trust in science can be measured at the macro level and that this concept is distinct from other measures of political attitudes in the mass public. This aggregate measure of trust in science is not easily explained.

Turning to individual level opinion, Chapter 3 presents an equally complex picture. While no single treatment works across the relevant population, I find differential effects of pro-social treatments across demographic groups, suggesting that careful consideration of the audience in public health messaging is crucial to formulating effective campaigns. By examining science communications at the intersection of psychology, political science, and public health, Chapter 3 suggests a context-dependent theoretical approach to addressing misperceptions about scientific findings. Incorporating identities, community norms, and information sources into experimental studies provides a more comprehensive picture of that context and suggests richer avenues for future experimental work. While Chapter 3 is merely one small step in examining the intersection of these complicated elements, it sets the stage for a considerable body of future work.

Finally, Chapter 4 compliments the previous two chapters by demonstrating how the general public incorporates their political views into views about the administration of science policy. This chapter also presents new findings suggesting that attitudes towards science and scientists trans-

late into individuals' assessments of federal science policy agencies, making connections between those who conduct scientific research and those responsible for carrying out policy. Partisanship also plays a role in assessing these agencies, a finding crucial to understanding how the public responds to communications about science. Establishing a connection between these attitudes and identities confirms the complex relationship between assessments of science, agencies, and the federal government in general and suggests a need for further investigation.

The theories and tests reported in the preceding chapters have many merits. First, by taking a multi-method approach across the empirical chapters, I am able to leverage a more diverse set of perspectives in addressing the politics of science. Additionally, the emperical results reported in these chapters reflect unique tests of their respective theories. The longtitudinal measure of trust in science presented in Chapter 2 is a new conceptualization of attitudes towards science using a novel measure of trust in the mass public. The experimental design in Chapter 3 not only contributes a new set of treatment variables using real public health data, but also supports increasingly important replication efforts in the field. Finally, Chapter 4 uses a unique dataset to address attitudes towards science policy agencies, a previously unexplored set of attitudes.

The theory and evidence presented here can of course be improved. One of the primary concerns here is the use of headlines in Chapter 2. While the data and text analysis garnered from headlines is valuable, the complete article text has the potential to provide a much richer picture of how science is portrayed in media reports and the extent to which politics and changes to the information environment over time influence trust in science. Future work can continue to extend the analysis presented here to address this shortcoming and continue to improve our understanding of the role of partisan language in science reporting.

A second concern is with the experimental design in Chapter 3. A measure of the strength of the participants' relevant identities was not included as a part of the question battery. This leaves me unable to directly test how the strength of one's identity as a Texan affects vaccines attitudes and how that identity interacts with participants' responses to the unique treatments. This is certainly

a limiting factor and hinders the extent to which the experimental results can inform us about the role identity plays in public health campaigns, even if we do see that the results may be context dependent. This study could easily be amended and extended into other identities outside of the Texas context, allowing for the potential for additional future runs of the same basic experiment. This would not only allow for me to account for this gap in the previous measures, but also use what was learned from this first experiment to create a more streamlined study with more specific treatments.

In closing, my work here is only the first step in addressing a myriad of questions about the relationship between science and politics. While politics and science are forever intertwined, we currently face a number of unique and pressing challenges to the role of science in society and the minds of the American public.

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APPENDIX A

A.1 Preamble Example for NSF Surveys, 1995-2001

2001 Survey of Public Attitudes Toward and Understanding of Science and Technology

Question: Intro1

OMB Clearance 3145-0033, expires 2/2002

Hello, my name is X. I'm calling long distance for the National Science Foundation. We are not calling to sell you anything. We are conducting an important national study of people's opinions about some current issues in the news, and your telephone number has been selected at random. Have you ever been interviewed for a national opinion survey before? WAIT FOR RESPONSE.

Question: Intro1 used after 3/2/2001

Hello, my name is X. I'm calling long distance for the National Science Foundation. We are conducting an important national study of people's opinions about some current issues in the news. Your telephone number has been selected at random and we are not calling to sell you anything.

Question: Intro2

As you may know, the National Science Foundation is part of the federal government and is responsible for supporting scientific and engineering research. They have conducted a study for about 30 years to track public opinions about some important topics regarding science and technology. This study is anonymous and confidential.

We are interested in learning more about the attitudes of people on several important issues and we would like to talk to one person in the household.

A.2 First Set of Loadings for a Longitudinal Measure of Trust in Science

Loadings and descriptive variable information

Vn	Variable	Cases	Dim 1 Loading	Dim 2 Loading	Mean	Std Deviation
18	gss_consci	28	.781	.000	42.908	2.630
17	gss_natsci	7	.846	.000	40.486	1.931
21	gss_advfront	5	.994	.000	86.888	2.109
28	gss_scigrn	4	.986	.000	22.084	1.857
10	nsf_nuinvent	8	.478	.000	43.499	4.037
20	gss_toofast	5	.679	.000	52.209	3.385
26	gss_scifaith	4	.769	.000	22.755	4.737
24	gss_intmed	4	.767	.000	59.485	.793
5	nsf_notimpt	7	.424	.000	85.575	1.057
29	gss_proudsci	3	.985	.000	94.900	.898
19	gss_nextgen	5	.566	.000	90.802	1.436
13	nsf_standliv	2	1.000	.000	85.000	.300
25	gss_trustsci	2	1.000	.000	42.458	.999
11	nsf_destroy	3	.599	.000	69.667	1.926
22	gss_scibnfts	5	.311	.000	74.060	2.383
14	nsf_fedsupsc	8	.171	.000	82.594	1.907
27	gss_harmgood	6	.079	.000	60.810	3.868
23	gss_intsci	4	.064	.000	40.025	.642
8	nsf_lifebetr	8	-.093	.000	82.889	3.863
2	nsf_makebetr	4	-.428	.000	83.574	4.797
1	nsf_goodhum	2	-1.000	.000	86.436	2.953
12	nsf_danger	2	-1.000	.000	51.950	8.650
16	nsf_riskben	10	-.432	.000	72.591	2.255
7	nsf_toofast	10	-.520	.000	57.548	5.277
9	nsf_moreopp	6	-.893	.000	84.078	1.993
6	nsf_easier	10	-.571	.000	87.516	2.159
3	nsf_workmore	6	-.971	.000	75.500	.513
15	nsf_fundsci	8	-.852	.000	35.016	2.784
4	nsf_onfaith	9	-.811	.000	46.532	2.654

Figure A.1: First Set of Loadings for a Longitudinal Measure of Trust in Science

A.3 Variations of Fixed Header Text Used by the New York Times between 2001 and 2007 That Were Removed from Chapter 2 Data

“National Briefing Science And Health:", “National Briefing Science and Health", “NATIONAL BRIEFING SCIENCE", “National Briefing: Science and Health:", “NATIONAL BRIEFING: SCIENCE AND TECHNOLOGY:", “NATIONAL BRIEFING SCIENCE AND HEALTH;", “NATIONAL BRIEFING SCIENCE AND HEALTH", “National Briefing Science and Technology:", “National Briefing: Science:", “National Briefing Science", “National Briefing Health And Science:", “National Briefing/SCIENCE AND HEALTH:", “National Briefings Health And Science:", “National Briefing Health and Science:", “National Briefing Health and Science:", “National Briefing Education And Science:", “National Briefing: Science And Health", “National Briefings Science And Health:", “National Briefing: Science And Health",

APPENDIX B

B.1 Survey for "Community Immunity: Social Pressure and Vaccine Choices"

[Vaccine concern - pre-intervention]
In general, how concerned are you about serious side effects from vaccines?

- Extremely concerned [5]
- Very concerned [4]
- Somewhat concerned [3]
- Not too concerned [2]
- Not at all concerned [1]

[Delay questions]

[Randomization after delay; control group receives no message]

Please examine the following information about seasonal influenza (âĂIJthe fluâĂİ) carefully.

[Correction intervention]

Can the flu shot give me the flu?

No, a flu shot cannot cause flu illness. The viruses contained in flu shots are inactivated (killed), which means they cannot cause infection. Flu vaccine manufacturers kill the viruses used in the flu shot during the process of making vaccine, and batches of flu vaccine are tested to make sure they are safe. In randomized, blinded studies, where some people got flu shots and others got saltwater shots, the only differences in symptoms was increased soreness in the arm and redness at the injection site among people who got the flu shot. There were no differences in terms of body aches, fever, cough, runny nose or sore throat.

More information about these studies is available at:

Carolyn Bridges et al. (2000). Effectiveness and cost-benefit of influenza vaccination of healthy working adults: A randomized controlled trial. JAMA. 284(13):1655-1663.

Kristin Nichol et al. (1995). The effectiveness of vaccination against influenza in healthy working adults. New England Journal of Medicine. 333(14): 889- 893.

Can the nasal spray flu vaccine give you the flu?

Unlike the flu shot, the nasal spray flu vaccine does contain live viruses. However, the viruses are attenuated (weakened) and cannot cause flu illness. Some children and young adults 2-17 years of age have reported experiencing mild reactions after receiving nasal spray flu vaccine, including runny nose, nasal congestion or cough, chills, tiredness/weakness, sore throat and headache. Some adults 18-49 years of age have reported runny nose or nasal congestion, cough, chills, tiredness/weakness, sore throat and headache. These side effects are mild and short lasting, especially when compared to symptoms of influenza infection.

[Texas Text Only- Percentage intervention]

Join the 50% of Texans who got a flu vaccine last year.

Keep Texas Healthy. Keep Texas Strong.

[Texas Text Only- Raw Number intervention]

Join the 13 million Texans who got a flu vaccine last year.

Keep Texas Healthy. Keep Texas Strong.

[Texas Image (No data) intervention]

Figure B.1: Flag Image with No CDC Data

[Texas raw number intervention]

Figure B.2: Flag Image with Number of Texans Vaccinated in Previous Flu Season

[Texas percentage intervention]

[Dependent variables]
We would like to ask you some questions about the seasonal flu vaccine (a flu shot or nasal flu spray).

How likely is it that you will get a flu vaccine for the seasonal flu during future flu seasons?

- Very likely [6]
- Somewhat likely [5]
- Slightly likely [4]
- Slightly unlikely [3]
- Somewhat unlikely [2]
- Very unlikely [1]

Just based on what you know, how safe do you believe the seasonal flu vaccine, meaning the flu vaccine available every year, is generally for most people to take?

- Very safe [1]

Figure B.3: Flag Image with Percent Vaccinated in Previous Flu Season

- Somewhat safe [2]
- Not very safe [3]
- Not at all safe [4]

Just based on what you know, is the following statement accurate or inaccurate?

You can get the flu from the seasonal flu vaccine.

- Very accurate [4]
- Somewhat accurate [3]
- Somewhat inaccurate [2]
- Very inaccurate[1]

Just based on what you know, how much do you agree with the following statement?
If a child has not been vaccinated (even though they are healthy enough to receive vaccines), that child should be allowed to attend public school.

- Strongly Agree
- Agree
- Slightly Agree
- Neither Agree Nor Disagree

- Slightly Disagree
- Disagree
- Strongly Disagree

[Manipulation Checks âĂŞ not given to control group]
[If in correction group]

The nasal spray flu vaccine contains live viruses.

- True
- False

[If in Texas raw number group OR Texas text only raw number group]

How many million Texans got a seasonal flu vaccine last year?

- 5 million
- 13.5 million
- 20 million
- 10 million

[If in Texas percentage group OR Texas text only percentage group]

What percent of Texans got a seasonal flu vaccine last year?

- 10%
- 50%
- 20%
- 40%

[if in the Texas image (no data) condition]

Which of the following was used as the background image in the graphic you viewed earlier?

- The Texas state flag
- The Texas State Capitol Building
- The Alamo
- The American flag

[Demographics]

Now we would like to ask you some questions about yourself.

Please indicate your age range:

- 18-29
- 30-44
- 45-59
- 60+

Please indicate your gender:

- Male
- Female
- Prefer Not To Answer

What is the highest degree or level of schooling you have completed?

- High school diploma or less
- Some college credit, no degree
- Trade, technical, or vocational training
- Associates degree
- BachelorâĂŹs degree
- Masters/Doctoral degree
- Other professional degree

Please indicate your race:

- White
- Black
- Hispanic/Latino
- Native American
- Asian

- Pacific Islander
- Other (please write in)

Generally speaking, do you usually think of yourself as a Republican, a Democrat, an Independent, or what?

- Strong Democract
- Weak Democrat
- Independent Leaning Democrat
- Independent
- Independent Leaning Republican
- Weak Republican
- Strong Republican

We hear a lot of talk these days about liberals and conservatives. Here is a seven-point scale on which the political views people might hold are arranged from extremely liberal to extremely conservative. Where would you place yourself on this scale, or havenâĂŹt you thought much about this?

- Very Liberal
- Liberal
- Slightly Liberal
- Moderate, Middle of the Road
- Slightly Conservative
- Conservative
- Very Conservative
- Do Not Know/Have Not Thought About It

B.2 Party Identification and Ideology in the Sample for "Community Immunity: Social Pressure and Vaccine Choices"

Data for the Nyhan and Reifler (2015) study were collected as part of the 2012 Cooperative Congressional Election Survey. Because this paper follows the methods and procedures implemented by Nyhan and Reifler (2015) and they do not report the distribution of party identification and ideology in their panel, I have included the distribution of party identification and ideology from the larger survey as a means of comparison between the Mechanical Turk sample and a national sample taken used for Nyhan and Reifler (2015).

Table B.1: Distribution of Party Identification in Community Immunity Sample and 2012 CCES by (%)

	Comm. Immunity	2012 CCES
Strong Democrat	16.5	25.6
Weak Democrat	9.9	11.5
Independent Leaning Democrat	18.5	10.1
Independent	20.7	11.6
Independent Leaning Republican	14.1	11.8
Weak Republican	10.8	8.6
Strong Republican	9.5	18
N	474	53,522

Due to rounding, percentgaes may not add to 100%

Table B.2: Distribution of Ideology in Community Immunity Sample and 2012 CCES by (%)

	Comm. Immunity	2012 CCES
Very Liberal	12.2	7.8
Liberal	17.1	12.7
Slightly Liberal	15.4	10.7
Moderate, Middle of the Road	17.5	21.9
Slightly Conservative	12.7	11.1
Conservative	16	18.4
Very Conservative	5.9	12.5
Do Not Know/Haven't Thought About It	3.1	4.7
N	474	54,181

Due to rounding, percentgaes may not add to 100%

B.3 Means of Dependent Variables by Condition for "Community Immunity: Social Pressure and Vaccine Choices"

Table B.3: Mean of Dependent Variables by Condition

	Vax Gives Flu	School Policy	Safety	Intentions	N
Control	2.32	4.61	1.65	3.34	67
Correction	1.61	4.84	1.61	3.26	63
Percent Text	2.21	4.78	1.53	3.92	66
Raw Number Text	2.16	4.48	1.63	3.69	68
Image No Data	2.37	4.5	1.69	3.41	62
Percent Image	2.35	4.76	1.65	3.47	67
Raw Number Image	2.21	4.01	1.71	3.6	66

B.4 Ordered Logit Models Using Two-Tailed Tests for "Community Immunity: Social Pressure and Vaccine Choices"

Table B.4: Ordered Logit Models for Main Effects Using Two Tailed Tests

	(1) Intentions To Vaccinate	(2) Believe Vaccine Unsafe	(3) Vaccine Gives the Flu	(4) Prohibit Unvax Child in School
Main Effects				
Side Effects Concern	-0.31**	1.14**	0.48**	-0.57**
	(0.07)	(0.09)	(0.07)	(0.07)
Correction	-0.53*	0.10	-1.33**	0.20
	(0.32)	(0.38)	(0.34)	(0.32)
Flag Treatment	-0.02	0.20	0.16	-0.19
	(0.20)	(0.23)	(0.20)	(0.19)
Text Treatment	0.38	-0.16	0.02	0.08
	(0.27)	(0.33)	(0.27)	(0.26)
Conservative	-0.18**	0.24**	-0.02	-0.17**
	(0.07)	(0.08)	(0.07)	(0.06)
Female	-0.35**	-0.06	-0.27	0.59**
	(0.17)	(0.20)	(0.17)	(0.16)
Republican	0.61**	-0.53*	0.32	0.34
	(0.25)	(0.28)	(0.25)	(0.24)
Education	0.11**	-0.10*	-0.10**	0.06
	(0.05)	(0.06)	(0.05)	(0.05)
Age	0.18	-0.23*	-0.38**	0.23**
	(0.11)	(0.13)	(0.11)	(0.10)
Observations	459	459	459	459
Pseudo R-squared	0.03	0.22	0.07	0.06

Standard errors in parentheses; ** $p<0.05$; * $p<0.10$ with two-tailed tests

Table B.5: Ordered Logit Models for Conditional Effects of Concern Using Two Tailed Tests: Concern Hypothesis

	(1) Intentions To Vaccinate	(2) Believe Vaccine Unsafe	(3) Vaccine Gives the Flu	(4) Prohibit Unvax Child in School
Side Effects Concern	-0.56**	1.03**	0.45**	-0.55**
	(0.14)	(0.15)	(0.13)	(0.13)
Correction	-0.80	-0.47	-3.00**	-1.14
	(0.74)	(1.01)	(0.86)	(0.77)
Flag Treatment	-0.90**	-0.28	-0.16	-0.14
	(0.47)	(0.58)	(0.46)	(0.45)
Text Treatment	-0.26	-0.23	0.91	0.87
	(0.62)	(0.81)	(0.62)	(0.62)
Conservative	-0.18**	0.25**	-0.03	-0.16**
	(0.07)	(0.08)	(0.07)	(0.06)
Female	-0.35**	-0.05	-0.25	0.61**
	(0.17)	(0.20)	(0.17)	(0.16)
Republican	0.61**	-0.54**	0.29	0.30
	(0.26)	(0.28)	(0.25)	(0.24)
Education	0.12**	-0.09	-0.09*	0.07
	(0.05)	(0.06)	(0.05)	(0.05)
Age	0.18	-0.23*	-0.37**	0.24**
	(0.11)	(0.13)	(0.11)	(0.10)
Concern X Correction	0.11	0.21	0.68**	0.56
	(0.28)	(0.34)	(0.30)	(0.29)
Concern X Flag	0.36**	0.17	0.13	-0.01
	(0.17)	(0.19)	(0.16)	(0.16)
Concern X Text	0.25	0.01	-0.39	-0.35
	(0.24)	(0.28)	(0.23)	(0.24)
Observations	459	459	459	459
Pseudo R-squared	0.04	0.22	0.07	0.06

Standard errors in parentheses; ** $p<0.05$; * $p<0.10$ with two-tailed tests

Table B.6: Ordered Logit Models for Conditional Effects of Ideology Using Two Tailed Tests: Ideology Hypothesis

	(1) Intentions To Vaccinate	(2) Believe Vaccine Unsafe	(3) Vaccine Gives the Flu	(4) Prohibit Unvaxx Child in School
Side Effects Concern	-0.31**	1.14**	0.48**	-0.57**
	(0.07)	(0.09)	(0.07)	(0.07)
Correction	-0.89**	0.58	-1.54**	-0.40
	(0.52)	(0.63)	(0.57)	(0.51)
Flag Treatment	-0.38	0.048	-0.03	-0.17
	(0.35)	(0.44)	(0.35)	(0.34)
Text Treatment	0.34	-0.17	0.01	0.07
	(0.27)	(0.33)	(0.27)	(0.26)
Conservative	-0.26**	0.25**	-0.06	-0.20**
	(0.09)	(0.10)	(0.08)	(0.08)
Female	-0.34**	-0.04	-0.26	0.59**
	(0.17)	(0.20)	(0.17)	(0.16)
Republican	0.62**	-0.54**	0.32	0.36
	(0.26)	(0.28)	(0.25)	(0.24)
Education	0.12**	-0.10*	-0.10**	0.07
	(0.05)	(0.06)	(0.05)	(0.05)
Age	0.17	-0.24*	-0.39**	0.23**
	(0.11)	(0.13)	(0.11)	(0.10)
Conservative X Flag	0.13	0.05	0.06	-0.01
	(0.10)	(0.12)	(0.10)	(0.09)
Conservative X Correction	0.12	-0.16	0.07	0.22
	(0.14)	(0.17)	(0.15)	(0.14)
Observations	459	459	459	459
Pseudo R-squared	0.04	0.22	0.07	0.06

Standard errors in parentheses; ** p<0.05; * p<0.10 with two-tailed tests

Table B.7: Ordered Logit Models for Conditional Effects of Gender Using Two Tailed Tests: Gender Hypothesis

	(1) Intentions To Vaccinate	(2) Believe Vaccine Unsafe	(3) Vaccine Gives the Flu	(4) Prohibit Unvaxx Child in School
Side Effects Concern	-0.31**	1.15**	0.49**	-0.58**
	(0.07)	(0.09)	(0.07)	(0.07)
Correction	-0.53*	0.10	-1.33**	0.24
	(0.32)	(0.38)	(0.34)	(0.32)
Flag Treatment	-0.40	0.60*	0.35	-0.02
	(0.29)	(0.34)	(0.30)	(0.28)
Text Treatment	0.36	0.01	0.18	0.63*
	(0.35)	(0.44)	(0.36)	(0.34)
Conservative	-0.19**	0.24**	-0.03	-0.17**
	(0.07)	(0.08)	(0.07)	(0.06)
Female	-0.67**	0.37	-0.02	1.07**
	(0.32)	(0.37)	(0.32)	(0.31)
Republican	0.64**	-0.53*	0.32	0.34
	(0.26)	(0.28)	(0.25)	(0.24)
Education	0.11**	-0.10*	-0.10**	0.06
	(0.05)	(0.06)	(0.05)	(0.05)
Age	0.19*	-0.24*	-0.39**	0.24**
	(0.11)	(0.13)	(0.11)	(0.10)
Female X Flag	0.77*	-0.77	-0.37	-0.32
	(0.41)	(0.48)	(0.41)	(0.39)
Female X Text	-0.05	-0.34	-0.29	-1.18**
	(0.45)	(0.53)	(0.46)	(0.44)
Observations	459	459	459	459
Pseudo R-squared	0.04	0.22	0.07	0.06

Standard errors in parentheses; ** $p<0.05$; * $p<0.10$ with two-tailed tests