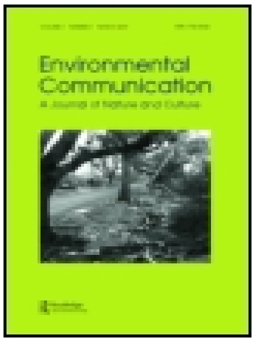

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Does Engagement in Advocacy Hurt the Credibility of Scientists? Results from a Randomized National Survey Experiment

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ABSTRACT
It is often assumed that issue advocacy will compromise the credibility of scientists. We conducted a randomized controlled experiment to test public reactions to six different advocacy statements made by a scientist—ranging from a purely informational statement to an endorsement of specific policies. We found that perceived credibility of the communicating scientist was uniformly high in five of the six message conditions, suffering only when he advocated for a specific policy—building more nuclear power plants (although credibility did not suffer when advocating for a different specific policy—carbon dioxide limits at power plants). We also found no significant differences in trust in the broader climate science community between the six message conditions. Our results suggest that climate scientists who wish to engage in certain forms of advocacy have considerable latitude to do so without risking harm to their credibility, or the credibility of the scientific community.

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Advocacy; credibility; climate change; trust in scientists; public engagement; message effects

1. Introduction and context

The question of what roles, if any, scientists should play in the dialogue about public policy is a perennial point of discussion in the scientific community (e.g. Nelkin, 1977; Pielke, 2007). It is often assumed that issue advocacy will compromise the credibility of individual scientists engaged in such behavior, and may harm the credibility of the scientific community more broadly (Nelson & Vucetich, 2009). This assumption rests upon the premise that science and advocacy are fundamentally incompatible (Nelson & Vucetich, 2009; Ruggiero, 2010). In this understanding, science is concerned with objectively observing and describing how the world works, whereas advocacy is inextricably linked to one's subjective values about how the world ought to be.

Given that many scientists are seeking guidance on how best to participate in the dialogue about public policy, there is an important need for more evidence about the potential consequences of advocacy by scientists (Runkle & Frankel, 2012). Unfortunately, much of the debate over the impact of scientific advocacy has been dominated by speculation; little empirical research has been conducted to test the impact of scientific advocacy on contentious issues. Two survey-based studies examined stakeholder attitudes about scientists' level of involvement in natural resource management decisions (Gray & Campbell, 2009; Lach, List, Steel, & Shindler, 2003), and found support among academics, government employees, NGO employees, and members of the attentive public

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for the idea that scientists should have some degree of involvement in policy-making. However, these studies have limited external validity due to uncontrolled research designs and a reliance on small convenience samples of members from these different stakeholder groups. More recently, a large, nationally representative survey in the United States found that a substantial majority of Americans (76%) say it is appropriate for scientists to "become actively involved in political debates," while small minorities say it is not appropriate (18%), or say they do not know (5%) (Pew Research Center, 2009). While these data suggest that most Americans have a positive attitude toward the abstract idea of scientists being involved in political debates, they do not answer the more important question of how the public will actually respond to specific, concrete acts of advocacy.

Another challenge is that what is called "advocacy" can have a myriad of forms. Currently, there is no clear consensus about how advocacy should be conceptualized, despite many proposed definitions (Runkle & Frankel, 2012). Among surveys of environmental scientists and natural resource professionals, there is considerable disagreement about the labeling and acceptability of a number of different behaviors that could be construed as advocacy (Crawford, Kramer, & Hinton, 2016; Reiners, Reiners, & Lockwood, 2013). For example, an exploratory study of wildlife biologists found that undergraduate students tended to see a wider range of activities as constituting advocacy compared to professionals employed in academia, government, and NGOs, who were more discrete in their perceptions of advocacy (Crawford et al., 2016).

To facilitate theorizing and research on the topic, some scholars have articulated categorical models of advocacy, where statements are either "advocacy" or not, depending on whether they contain support for a particular policy or set of policies (Lackey, 2007; Pielke, 2007). For example, Pielke (2007) defines issue advocacy as any behavior that is intended to reduce the scope of options available to a decision maker. He further differentiates overt issue advocacy from "stealth" issue advocacy, in which an expert claims to be relying solely on science as a justification for their preferred course of action without acknowledging the additional role of personal values in shaping their judgment (Pielke, 2007).

Others have argued that categorical models of advocacy are too simplistic (Donner, 2014; Scott et al., 2007). These scholars posit that all statements by scientists contain at least some degree of normative judgment, and therefore it is more useful to think of advocacy as existing on a continuum based on the relative *amount* of judgment inherent in the communication. In this model, statements can be placed on an ordinal continuum where higher "levels" of advocacy assume there is a cumulative evaluative judgment regarding the prior, lower levels of advocacy. For example, Donner (2014) suggested that simply answering the question of whether climate change is happening is a lower level of advocacy than making projections about potential risks associated with climate change because a characterization of the risks presupposes that climate change is happening. Next, weighing the pros and cons of various policy options to address climate change assumes both that climate change is happening and that the risks are sufficient to consider policies designed to address the threat of climate change. Similarly, urging action to address climate change without explicit consideration of policy solutions presupposes both that climate change is real and that the risks are serious enough to warrant action. Finally, explicit endorsement of specific policy solutions to address climate change implies that climate change is happening, poses a significant risk worthy of action, and that certain actions are more desirable than others.

Donner (2014) also predicted that progressively higher levels of advocacy would result in a greater reduction in a scientist's perceived credibility. Communication research demonstrates that there are times when a communicator's persuasive message does result in negative judgment about their credibility or character; so-called *source derogation* (Abelson & Miller, 1967; Tannenbaum & Norris, 1965). This source derogation is theorized to occur because it takes less effort to denigrate the communicator than it does to counter-argue the content of the message (Wright, 1973). In the current study, we put Donner's prediction to the test in a randomized controlled experiment in the context of climate science, focusing exclusively on public communication behaviors rather than testing more private forms of advocacy such as donating money to an environmental interest group.

We also examine whether advocacy by a single scientist would have detrimental effects on trust in the broader community of scientists and support for funding their research. Social judgment theory suggests that salient exemplars often serve as a relevant comparison when evaluating a broader standard (Bless & Schwarz, 2010; Mussweiler, 2003). When an exemplar (e.g. the communicating scientist) is seen as relevant and substantially similar to a target category (e.g. scientists as a whole), we would expect an *assimilation* effect, such that evaluations of the credibility of the scientist inform evaluations of the broader scientific community (Herr, 1986). Further, the extremity of information about an exemplar heightens the impact of an assimilation effect (Bless & Schwarz, 2010), suggesting that higher levels of advocacy will be more likely to trigger similar evaluations of the scientific community. Given the lack of previous research on the subject, our first research question asks:

> ***RQ1***: *a) Do higher levels of advocacy result in lower levels of perceived credibility of the communicating climate scientist?* And b) *Does advocacy by a single climate scientist have detrimental effects on the broader community of climate scientists in terms of reduced trust and support for funding research?*

Because climate change is a highly contested issue among political liberals and conservatives in the United States (McCright & Dunlap, 2011), we also examine the influence of political ideology on public reactions to advocacy by climate scientists. Research on motivated reasoning suggests that individuals are predisposed to selectively process and reject statements that are inconsistent with their prior beliefs or ideology (Kunda, 1990; Leeper & Slothuus, 2014; Taber & Lodge, 2006). Indeed, past research has found that both liberals and conservatives are susceptible to motivated distrust of scientific information that is incongruent with their ideology or worldview (Kahan, Jenkins-Smith, & Braman, 2011; Nisbet, Cooper, & Garrett, 2015). With regard to the issue of climate change, these studies and others find that conservatives tend to be less trusting of climate science compared to liberals (Kahan et al., 2011; McCright & Dunlap, 2011; Myers et al., 2016; Nisbet et al., 2015). However, these past studies did not test stimuli that differentiate public responses to statements from scientists that contain explicit endorsements of solutions to address climate change from statements that do not contain such endorsements. Therefore, while we can predict that conservatives will tend to view climate scientists as less credible compared to liberals, it is currently unclear whether such an opinion will be attenuated or exacerbated by observing different forms of advocacy by a climate scientist. For these reasons, we propose the following hypothesis and research question:

> ***H1***: *Compared to political liberals, conservatives will view the communicating climate scientist as less credible.*

> ***RQ2***: *Will individual reactions to different levels of advocacy from a climate scientist be conditioned by the respondent's political ideology?*

Lastly, to increase the generalizability of our findings, we decided to test whether identifying the communicating scientist as a university-based academic climate scientist versus the chief meteorologist at a local television station influenced reactions to his advocacy. Research suggests television weathercasters may be a potentially important and underappreciated source of information about climate change (Anderson et al., 2013; Bloodhart, Maibach, Myers, & Zhao, 2015; Zhao et al., 2013), however it is unclear whether individuals will respond to advocacy by television weathercasters in a similar fashion to the way they respond to advocacy by academic climate scientists. At least some weathercasters, similar to scientists, are concerned about being seen to engage in advocacy (Peters-Burton, Schweizer, Cobb, & Maibach, 2014). Thus, we wished to see whether these fears were borne out in citizens' responses to advocacy by weathercasters. Therefore, we pose the following research question:

> ***RQ3***: *Will individual reactions to different levels of advocacy from a climate scientist be conditioned by whether he is identified as a university-based academic climate scientist versus the chief meteorologist at a local television station?*

2. Method

2.1. Participants and study design

To answer these questions, we conducted a randomized online survey experiment using a quota sample ($N = 1235$)[1] of nationally representative proportions of age within sex, race (including proportion of non-white or black Hispanics), region, income, and education based on United States census figures. Participants were recruited through Survey Sampling International, a vendor that maintains a nationwide panel of people who are willing to participate in online surveys.[2]

After reading the consent form and agreeing to participate in the study, participants were first randomly assigned to read one of two biographical descriptions of Dave Wilson, Ph.D. (a fictional person created for this study) in which he was identified as either a climate scientist or the chief meteorologist at a local television station (see Appendix A in the supplementary file for the biographical stimuli). All other information in the biographical sketch was held constant.

Following presentation of the biographical information, participants were randomly assigned to read one of six Facebook posts[3] written by Dr. Wilson (see Appendix B in the supplementary file for the Facebook post stimuli). The posts were an invitation to read an interview that Dr. Wilson had (purportedly) done with the Associated Press, along with a brief description of what he said in the interview. The only part of the post that varied across conditions was the description of the interview content. Although a fake hyperlink to the interview was included in the Facebook post to create a sense of realism, participants could not click on the link to read the full interview.

The six posts were created to operationalize five points along Donner's proposed continuum, with the fifth point on the continuum represented by two different posts. From lowest to highest level of advocacy, the first four posts were: a *recent finding* (atmospheric levels of CO_2 recently surpassed 400 ppm); information about climate change risks and impacts (with regard to public health outcomes); a brief discussion of the pros and cons of two mitigation policy options (limiting CO_2 at coal power plants and building more nuclear power plants); and a statement urging non-specific action on climate change (no policies mentioned, but suggesting that urgent action is necessary). The fifth point on the continuum was operationalized by a statement urging one of two specific actions on climate change. One was a message endorsing a policy designed to be congruent for liberals (limiting CO_2 at coal power plants); the other was a message endorsing a policy designed to be congruent for conservatives (building more nuclear plants).

2.2. Measures

Participants then answered a series of five dependent measures (all on 7-point scales) designed to evaluate Dr. Wilson in terms of his perceived credibility, the perceived goals of his statement (to inform and to persuade), and the motivations behind his statement (scientific evidence and political views). We also included three dependent measures intended to assess possible effects on attitudes toward science more generally: trust in the broader community of (1) climate scientists or (2) television weathercasters, and (3) support for funding research to study climate change.[4] Question wording is described below. The experimental stimuli and additional descriptive statistics about the sample can be found in the supplementary material.

2.2.1. Perceived credibility

The perceived credibility of Dr. Dave Wilson was measured using a composite scale derived from the mean of nine different 7-point semantic differential statements adapted from McCroskey and Teven (1999).[5] (Min = 1, Max = 7; $M = 5.07$, SD = 1.13, Cronbach's $\alpha = .91$)

The order in which the statements were presented to participants was randomized to guard against possible order effects, and the positioning of descriptions for statements were counterbalanced to guard against acquiescence bias. The following statements were included in the scale: *Not at all competent/Extremely competent, Not at all expert/Extremely expert, Extremely intelligent/Not at all intelligent, Not at all trustworthy/Extremely trustworthy, Not at all honest/Extremely honest, Extremely sincere/Not at all sincere, Cares about society a great deal/Doesn't care about society at all, Is concerned about society a great deal/Isn't concerned about society at all, Not at all sensitive/Extremely sensitive.*

2.2.2. Perceived goal to persuade

Participants were asked to what extent they agree or disagree with the following statement, "The goal of the Facebook post was to persuade people to take action to address climate change." (1 = Strongly disagree, 7 = Strongly agree; $M = 5.05$, SD = 1.61).

2.2.3. Perceived goal to inform

Participants were asked to what extent they agree or disagree with the following statement, "The goal of the Facebook post was to provide impartial information about climate change." (1 = Strongly disagree, 7 = Strongly agree; $M = 4.65$, SD = 1.67).

2.2.4. Attribution to political views

Participants were asked to what extent they agree or disagree with the following statement, "Dr. Wilson's statement was shaped by his political views about climate change." (1 = Strongly disagree, 7 = Strongly agree; $M = 4.10$, SD = 1.78).

2.2.5. Attribution to scientific evidence

Participants were asked to what extent they agree or disagree with the following statement, "Dr. Wilson's statement was shaped by his evaluation of the scientific evidence about climate change." (1 = Strongly disagree, 7 = Strongly agree; $M = 5.23$, SD = 1.53).

2.2.6. Support for research to study climate change

This was measured with a single item asking participants how much they support or oppose the following policy, "Fund more research to study climate change." (1 = Strongly oppose, 7 = Strongly support; $M = 5.04$, SD = 1.68).

2.2.7. Trust in the community of climate scientists

This was measured with a single item, "To what degree do you think the broader community of all climate scientists are trustworthy?" (1 = Very untrustworthy, 7 = Very trustworthy; $M = 4.98$, SD = 1.35). Only participants who were in a condition in which Dr. Dave Wilson was identified as a climate scientist were asked this question ($n = 627$).

2.2.8. Trust in the community of television weathercasters

This was measured with a single item, "To what degree do you think the broader community of all television weathercasters are trustworthy?" (1 = Very untrustworthy, 7 = Very trustworthy; $M = 5.07$, SD = 1.24). Only participants who were in a condition in which Dr. Dave Wilson was identified as a television weathercaster were asked this question ($n = 608$).

2.2.9. Political ideology

This was measured with a single, 5-point item (Very liberal = 1, Somewhat liberal = 2, 3 = Moderate, middle of the road, Somewhat conservative = 4, Very conservative = 5; $M = 2.95$, SD = 1.07). This measure was recoded into a 3-point scale for use as an independent variable in analysis ("Very liberal" or "Somewhat liberal" = 1, Moderate, middle of the road = 2, "Very conservative" or "Somewhat conservative" = 3) because political ideology had a non-linear relationship with perceived goal to persuade (see Supplementary Figure 1).

2.3. Analysis

We conducted separate univariate ANOVAs for each dependent variable to test for main effects and interactive effects of level of advocacy, type of scientist, and political ideology (see Supplementary Tables 4–12).[6] Post-hoc comparisons were conducted for significant omnibus effects found in the univariate ANOVAs. These post-hoc comparisons used a Bonferroni adjustment to correct for family-wise error rates.

Some of these initial statistical tests showed that there were small, non-significant differences among several of the advocacy conditions. Given this lack of difference we decided to conduct equivalence tests to determine whether there was evidence that the means between conditions were equal. To explain further, non-significance in traditional null-hypothesis testing is not evidence that conditions are equal; rather, it just indicates that there is no evidence of a difference. In order to explicitly test whether there is *equality* between these conditions, we employ equivalence testing, which is designed to offer evidence that supports equality between conditions (Weber & Popova, 2012). In equivalence testing, the null hypothesis is that there is a minimally substantial difference (referred to as Δ) between conditions (e.g. for a one-tailed test, H_0: effect $\geq \Delta$, H_1: effect $< \Delta$). This minimum substantial effect should be specified based upon theory or benchmarks from prior research. If testing shows the observed effect is significantly less than Δ, the conditions are considered to be statistically equivalent. For our analysis, we specified $\Delta = .161$. This represents the average effect size r for the middle third of effects (a "medium" effect) found in the communication literature in a recent review of 112 meta-analyses[7] (Weber & Popova, 2012).

3. Results

With regard to RQ1a, we found that Dr. Wilson's credibility suffered only when he advocated for the specific policy of building more nuclear power plants to address climate change compared to a purely informational statement about a recent finding, $F(5,\ 1179) = 6.30$, $p < .001$, *partial* $\eta^2 = .026$ (see Figure 1 for means and 95% confidence intervals of each condition). Equivalence testing suggested that providing information about the risks of climate change, discussing the pros and cons of specific policies, urging action without advocating for a specific policy, and advocating for limits on CO_2 emissions from coal-fired power plants resulted in credibility levels statistically indistinguishable from informing about a recent finding (see Table 1). Although Dr. Wilson's credibility was lower when advocating for building more nuclear power plants as opposed to discussing a recent finding, he was still rated above the midpoint of the scale (4), suggesting participants found him more credible than not.

With regard to RQ1b, we did not observe any significant differences in participants' general trust in the broader community of climate scientists in response to Dr. Wilson's level of advocacy, $F(5,\ 609) = 1.51$, $p = \text{ns}$, *partial* $\eta^2 = .012$ (see Supplementary Figure 2 for means and 95% confidence intervals). Equivalence testing found that all statements by Dr. Wilson, except for one, were equivalent to informing about a recent finding (see Table 1). The one exception, when Dr. Wilson advocated for building more nuclear power plants, was not statistically equivalent to informing about a recent finding (see Table 1). For this condition, the results are statistically indeterminate (Tryon, 2001); we cannot be confident that the difference between this condition and the recent finding condition is either greater than zero, or smaller than our minimum substantial effect.

Similarly, we did not find any significant differences in general trust toward the broader community of television weathercasters in response to Dr. Wilson's level of advocacy, $F(5, 587) = 0.28$, $p = \text{ns}$, *partial* $\eta^2 = .002$ (see Supplementary Figure 3 for means and 95% confidence intervals). Equivalence testing suggested that all statements by Dr. Wilson except for two were significantly equivalent to informing about a recent finding at conventional levels of statistical significance (i.e. $p < .05$, see Table 1). When Dr. Wilson weighed the pros and cons of different policies to address climate change and when he advocated for more nuclear power to address climate change, general trust toward television weathercasters was equivalent to informing about a recent finding at a marginal level of significance (i.e. $p < .10$, see Table 1).

We also did not observe any significant differences in support for funding research to study climate change as a result of Dr. Wilson's level of advocacy, $F(5,\ 1179) = 1.57$, $p = \text{ns}$, *partial* $\eta^2 = .007$ (see Supplementary Figure 4 for means and 95% confidence intervals). Equivalence testing found

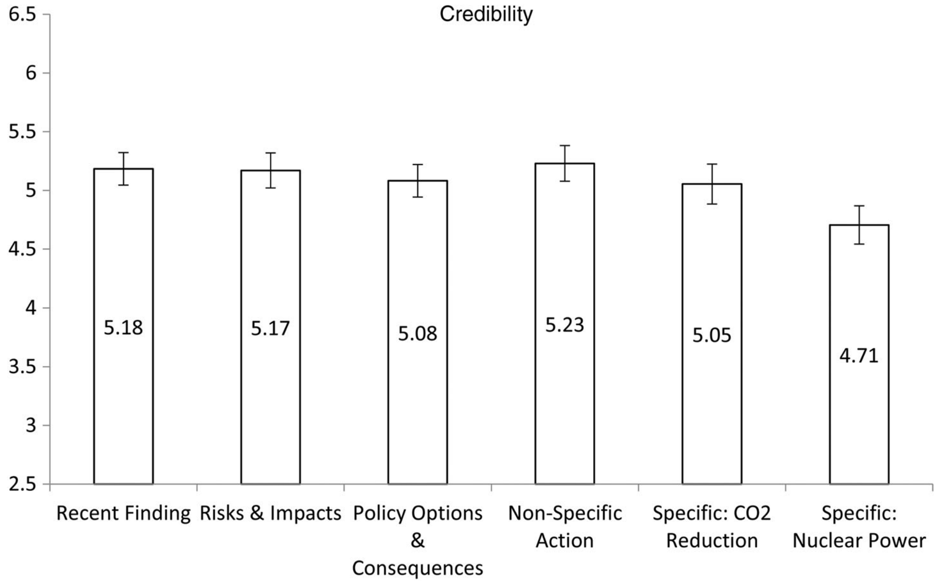

Figure 1. Participants' evaluation of Dr. Wilson's credibility by level of advocacy. Average perceived credibility of Dr. Wilson measured with a composite scale of nine semantic differential indicators (Cronbach's $\alpha = .91$; Min = 1, Max = 7); see methods section for exact item wording. Error bars represent the 95% confidence interval for the mean estimate.

that every statement by Dr. Wilson, except for one, resulted in levels of support for funding climate research that were statistically indistinguishable from the level found when he provided information about a recent finding (see Table 1). This one condition (when Dr. Wilson advocated for action without endorsing a particular policy) resulted in a higher level of support for funding climate research (see Table 1). However, because there was no evidence for the statistical significance of this difference, nor for its equivalence with the recent finding condition, we do not have evidence either for or against a significant effect.

Table 1. Results of tests for equivalence between the recent finding and other conditions, assuming an average effect (when $\Delta = 0.161$).

	Credibility			Support for funding research		
	Mean	*t*	*p*-Value	Mean	*t*	*p*-Value
Recent finding	5.183			5.01		
Risks and impacts	5.170**	$t(413) = -.13$	0.003	4.990**	$t(412) = -.11$	0.003
Policy options	5.082*	$t(391) = 1.02$	0.030	4.913*	$t(390) = .56$	0.011
Non-specific	5.230**	$t(414) = -.45$	0.007	5.304	$t(413) = -1.85$	0.108
Specific: CO_2 reduction	5.054*	$t(428) = 1.16$	0.031	4.950**	$t(427) = .37$	0.005
Specific: nuclear power	4.705	$t(415) = 4.41$	0.479	5.063**	$t(412) = -.32$	0.005

	General trust in climate scientists			General trust in TV weathercasters		
	Mean	*t*	*p*-Value	Mean	*t*	*p*-Value
Recent finding	5.009			5.08		
Risks and impacts	5.050*	$t(207) = .22$	0.025	4.981*	$t(203) = -.58$	0.050
Policy options	4.959*	$t(205) = .27$	0.028	4.965†	$t(184) = .63$	0.064
Non-specific	5.020*	$t(207) = -.06$	0.017	5.112*	$t(205) = -.19$	0.024
Specific: CO_2 reduction	5.130*	$t(215) = -.62$	0.049	5.106*	$t(211) = -.17$	0.021
Specific: nuclear power	4.750	$t(219) = 1.54$	0.174	5.177†	$t(194) = -.56$	0.053

Notes: *t*-test and *p*-values are for one-tailed equivalence tests, comparing the recent finding condition to all other conditions. A significant *p*-value indicates evidence for equivalence between the two conditions.

**$p < .01$.

*$p < .05$.

$^{\dagger}p < .10$.

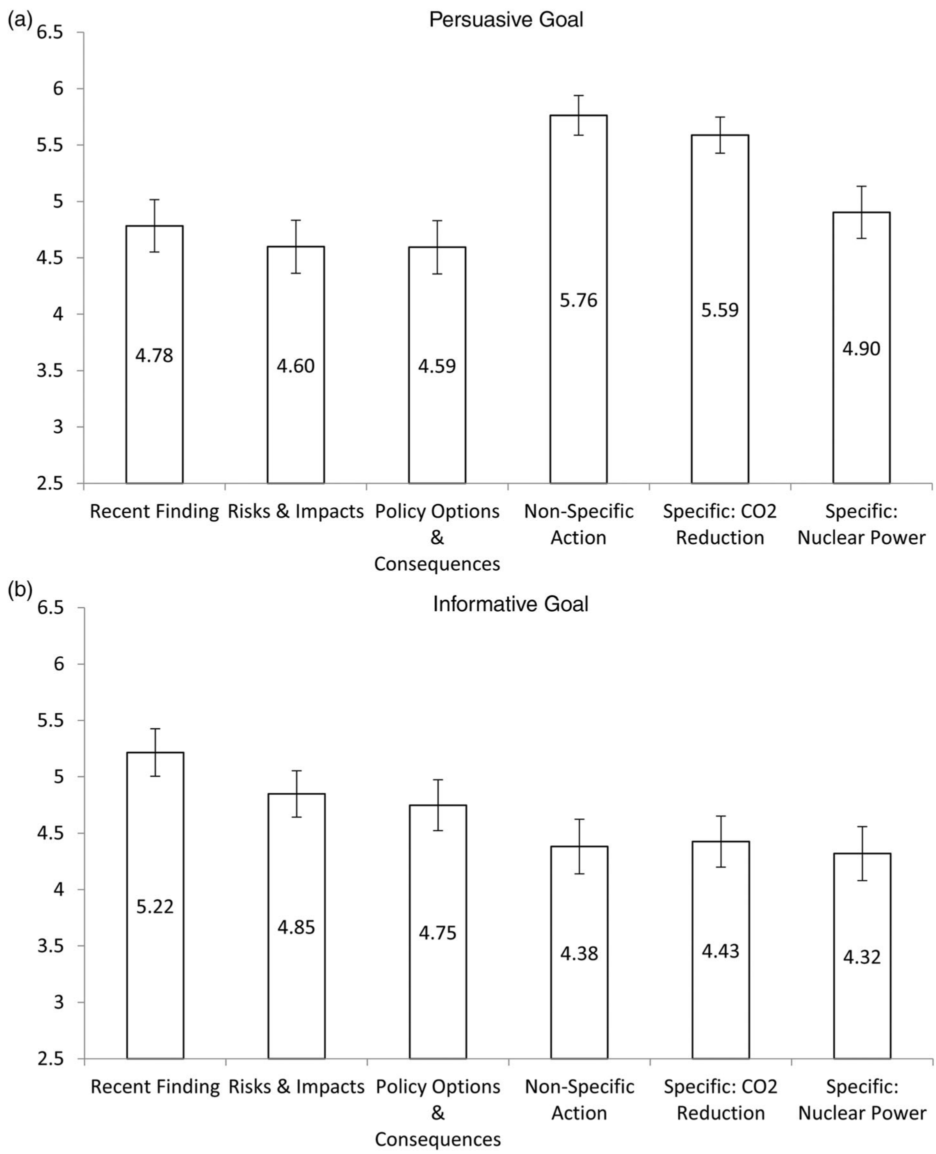

Figure 2. Participants' evaluation of Dr. Wilson's communication goals by level of advocacy (a) Average agreement or disagreement (1 = Strongly disagree, 7 = Strongly agree) with the statements that "The goal of the Facebook post was to persuade people to take action to address climate change," and (b) that "The goal of the Facebook post was to provide impartial information about climate change." Error bars represent the 95% confidence interval for the mean estimate.

These results cannot be explained by participants' failure to perceive Dr. Wilson's Facebook posts as forms of advocacy. Participants correctly understood that the non-specific action statement and the statement advocating limiting CO_2 from coal power plants were more intended to persuade compared to lower levels of advocacy, F (5, 1179) = 21.85, $p < .001$, *partial* $\eta^2 = .085$ (see Figure 2(a) for means and 95% confidence intervals). Participants did not view the statement advocating nuclear power as more intended to persuade than informing about a recent finding (see Table 2). However, all statements, even the purely informative finding about CO_2 levels, were seen as at least moderately intended to persuade (i.e. above the midpoint on the scale). Participants also viewed the non-specific and both specific action posts as less intended to provide impartial information about climate change compared to informing about a recent finding, F (5, 1179) = 9.92, $p < .001$, *partial* $\eta^2 = .040$ (see

Table 2. Results of tests for equivalence between the recent finding and other conditions, assuming an average effect (when Δ = 0.161).

	Persuasive goal			Informative goal		
	Mean	*t*	*p*-Value	Mean	*t*	*p*-Value
Recent finding	4.784			5.215		
Risks and impacts	4.598*	$t(410) = -1.11$	0.032	4.848	$t(411) = -2.46$	0.215
Policy options	4.593*	$t(388) = 1.13$	0.038	4.749	$t(388) = -1.13$	0.329
Non-specific	5.763	$t(413) = -6.63$	0.500	4.382	$t(414) = -5.13$	0.497
Specific: CO_2 reduction	5.588	$t(427) = -5.68$	0.499	4.425	$t(428) = -5.02$	0.495
Specific: nuclear power	4.903*	$t(413) = -.72$	0.014	4.319	$t(414) = -5.55$	0.499
	Political attribution			Scientific attribution		
	Mean	*t*	*p*-Value	Mean	*t*	*p*-Value
Recent finding	3.517			5.651		
Risks and impacts	3.941	$t(411) = 2.38$	0.200	5.333	$t(411) = -2.35$	0.194
Policy options	4.219	$t(390) = 3.94$	0.456	5.125	$t(391) = -3.77$	0.441
Non-specific	4.174	$t(414) = 3.71$	0.427	5.449†	$t(414) = -1.45$	0.058
Specific: CO_2 reduction	4.448	$t(426) = 5.33$	0.498	5.023	$t(428) = -4.32$	0.473
Specific: nuclear power	4.309	$t(414) = 4.57$	0.486	4.779	$t(415) = -5.89$	0.500

Notes: *t*-test and *p*-values are for one-tailed equivalence tests, comparing the recent finding condition to all other conditions. A significant *p*-value indicates evidence for equivalence between the two conditions.
*$p < .05$.
†$p < .10$.

Figure 2(b) for means and 95% confidence intervals). However, in absolute terms, both the non-specific and specific actions were still viewed as having a moderate intention to provide impartial information.

Regarding perceived scientific and political motivations underlying Dr. Wilson's statement, we found that informing about a recent finding was seen as less influenced by Dr. Wilson's political views than all other levels of advocacy, F (5, 1179) = 7.29, $p < .001$, *partial* $\eta^2 = .030$ (see Figure 3(a) for means and 95% confidence intervals). We did not observe significant differences among the other types of advocacy in attributions to political motives. Additionally, while participants saw the specific action statement advocating nuclear power as least influenced by Dr. Wilson's evaluation of the scientific evidence, it was still viewed as at least moderately attributable to scientific evidence F (5, 1179) = 9.98, $p < .001$, *partial* $\eta^2 = .041$ (see Figure 3(b) for means and 95% confidence intervals).

In support of H1, we found a main effect from ideology, such that conservatives (compared to liberals and moderates) tended to rate Dr. Wilson as less credible, less interested in providing impartial information, less motivated by scientific evidence, and more motivated by his political views (see Supplementary Tables 4–11, and Supplementary Figure 1). However, despite this more critical assessment from conservatives overall, we did not observe any differences in specific reactions to the different levels of advocacy in comparison to a recent finding, based on the political ideology of respondents (RQ2; see Supplementary Tables 4–11). Additionally, perceptions of Dr. Wilson also did not differ depending on whether he was identified as a climate scientist or a television weathercaster (RQ3; see Supplementary Tables 4–12).

4. Discussion

Our findings contribute to the conversation about the ways in which climate scientists can safely engage in public dialogue about policy matters. Our results suggest that scientists who wish to engage in certain forms of advocacy may be able to do so without directly harming their credibility, or the credibility of the scientific community. Most advocacy messages we tested had no significant effect on Dr. Wilson's credibility or general trust in climate scientists. Therefore, at a minimum, it is a mistake to assume that *all* normative statements made by scientists are detrimental to their credibility.

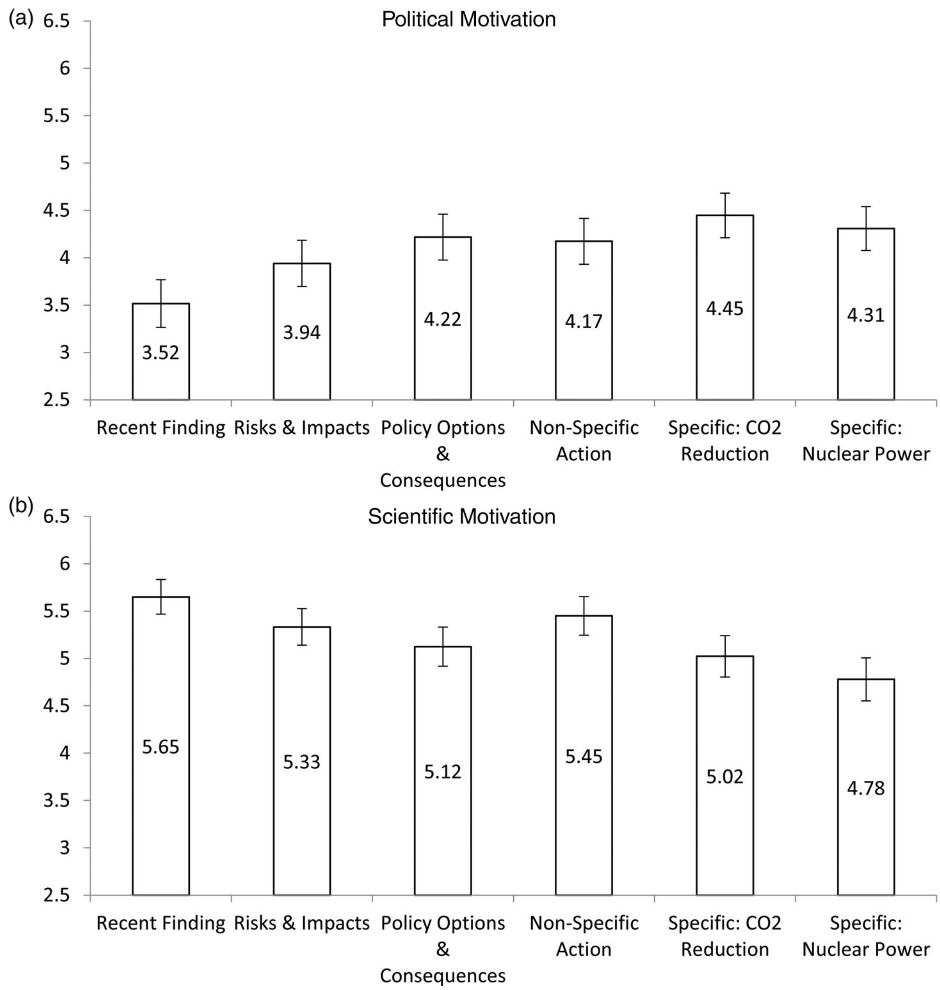

Figure 3. Participants' evaluation of Dr. Wilson's motivations by level of advocacy (a) Average agreement or disagreement (1 = Strongly disagree, 7 = Strongly agree) with the statements that "Dr. Wilson's statement was shaped by his political views about climate change," and (b) that "Dr. Wilson's statement was shaped by his evaluation of the scientific evidence about climate change." Error bars represent the 95% confidence interval for the mean estimate.

That said, negative effects may occur, depending on the specific policy endorsed. Advocating for building more nuclear power to address climate change did cause a significant drop in Dr. Wilson's credibility. Even if people do not object to scientists engaging in advocacy *per se* (as opposed to refraining from advocacy), they still may object to a specific position that is advocated. Such objections may translate into source derogation, whereby the audience develops negative perceptions of a communicator that communicates a disagreeable position (Abelson & Miller, 1967; Tannenbaum & Norris, 1965) and/or negative affect and counter-arguing (Jacks & Cameron, 2003). Therefore, it may be the case that scientists should be aware that *what* they advocate for may lead to negative credibility perceptions, rather than ruling out advocacy altogether. In this case, Dr. Wilson's credibility may have been lower in the nuclear energy condition for a couple of reasons. A nationally representative survey from 2014 suggests that about half of Americans (51%) oppose construction of more nuclear power plants, and this may simply have translated into more negative attitudes of Dr. Wilson (Pew Research Center, 2015). Other research suggests that 27% of Americans think that nuclear power is a very major or major contributor to climate change, and 29% think that it is a moderate contributor to climate change (Truelove & Greenberg, 2012). If some individuals erroneously believe that nuclear power is a major contributor to climate change, then they might reasonably conclude that a scientist advocating for more nuclear power as a solution to climate change is not credible. Although conservatives tend to be more supportive of nuclear power than liberals (Pew Research Center, 2015), it is possible that advocating for more nuclear power for the specific purpose of addressing climate change may not have been sufficient to overcome the dissonance conservatives feel toward the overall issue of climate change.

Additionally, we found that individuals perceived a greater influence of personal political views and persuasive intentions in some of the higher levels of advocacy. Interestingly, advocating for non-specific action and specifically for CO_2 limits from coal-fired power plants resulted in higher perceived intent to persuade relative to a statement about a recent finding, while advocating for more nuclear power plants did not. As mentioned above, the fact that many Americans erroneously believe that nuclear power contributes to climate change may have led some individuals to view Dr. Wilson's goal to persuade the public as insincere. Similarly, it is also possible that individuals may have been suspicious that Dr. Wilson was attempting to use climate change as a justification to expand nuclear power rather than as a good faith effort to reduce CO_2 emissions. Notably, conditions where there was a heightened perception of influence of personal views and persuasive intentions did not necessarily cause participants to reach the conclusion that the scientist was less credible as result. This finding brings into question whether the extent of normative judgment in a scientist's communication is the most salient factor that members of the public utilize when forming credibility assessments of scientists. Future research should try to find out if the extent of normative judgment is a relevant factor in other contexts and identify other dimensions of scientific advocacy that may be more important in shaping perceived credibility.

The fact that conservatives responded more negatively to Dr. Wilson regardless of the substance of his communication raises an important caution for climate scientists doing public engagement. Consistent with past research, these findings suggest that more conservative audiences are likely to view most statements by climate scientists with relatively more skepticism than liberals and moderates (Hmielowski, Feldman, Myers, Leiserowitz, & Maibach, 2014; Leiserowitz, Maibach, Roser-Renouf, Smith, & Dawson, 2013; Myers et al., 2016). However, this does not mean that it is impossible to reach common ground with conservatives, or that all conservatives are skeptical of climate science. For example, past research suggests that focusing on technological solutions to climate change such as geoengineering may preserve credibility among conservatives (Kahan, Jenkins-Smith, Tarantola, Silva, & Braman, 2015). This is because such proposals signal to conservatives that the scientist shares their faith in the ability of technological innovation and free enterprise to solve problems, and may assuage their concern that addressing climate change will necessarily lead to more government regulation.

A rather dire interpretation of our findings is that pretreatment effects (i.e. prior exposure to similar advocacy messages by scientists) made it impossible for us to find any significant negative effects of advocacy by scientists. In other words, by selecting the polarized issue of climate change, we all but guaranteed null effects, since Americans have already formed strong attitudes about climate change that are resistant to change (Druckman & Leeper, 2012; Krosnick & Petty, 1995). We believe this interpretation is incorrect for two reasons. First, while many Americans have developed strongly polarized attitudes about climate change generally (McCright & Dunlap, 2011), they are less strongly polarized in their trust in climate science researchers (Myers et al., 2016). Our primary outcome measure of interest was not respondents' belief in climate change, but the perceived credibility of climate scientists. Therefore, preexisting attitudes toward climate change generally are unlikely to have prevented effects on scientists' credibility being detected. Additionally, the idea that American attitudes about climate change have been rendered unresponsive ignores the attitude changes we did observe in the present study (i.e. the nuclear power condition, along with differences in perceptions of Dr. Wilson's motivations). Moreover, it is simply inconsistent with a sizable literature demonstrating opinion change in the context of climate change in response to a variety of messages and formats, across political orientations (e.g. Feldman & Hart, 2016; Kahan et al., 2015; Lewandowsky, Gignac, & Vaughan, 2013; Nisbet, Hart, Myers, & Ellithorpe, 2013; van der Linden, Leiserowitz, Feinberg, & Maibach, 2014).

Our study has several limitations worth highlighting. First, reactions to advocacy by scientists may differ not simply on the basis of the specific policy endorsed as noted above, but may also vary according to the wider issue domain. Some have speculated that scientific advocacy may be more widely accepted on public health issues relative to earth science issues, but to our knowledge, no research has tested this assumption (Corner & Groves, 2014). Furthermore, we operationalized our stimuli as brief Facebook posts by an individual scientist. Other forms of public communication, either by individual or by groups of scientists, may be processed differently. Additionally, the scientist depicted in our stimuli was an older white male. It is possible that individuals might react differently to a younger scientist and/or one from a minority group. For example, recent research suggests that racial identity is an important and under-examined factor in communication about climate science (Pearson & Schuldt, 2014; Schuldt & Pearson, 2016). Caution should also be exercised in generalizing our results to all communication by scientists or weathercasters given that our stimuli were fictionalized messages designed to increase the internal validity of our test of the advocacy continuum, rather than messages sampled from a population of actual climate scientists and weathercasters. It should also be noted that the climate scientist in our stimuli is employed at Massachusetts Institute of Technology, and the weathercaster is employed at a local television station in St. Louis. Varying the geographic location in this way may have led some participants to view Dr. Wilson differently not simply based on his professional occupation, but also due to stereotypical perceptions that people from Massachusetts are politically liberal and people from Missouri are relatively more conservative.

Our study helps shed light on how average Americans may respond to certain forms of advocacy, but this is not the only audience of interest to scientists. Specifically, we did not examine the reactions of journalists, policy-makers, or other climate scientists to these advocacy statements; nor did we test the effect that such elite reactions may have on Americans' perceptions of the credibility of the scientist (it may be that elite criticism of the scientist's advocacy could trigger unfavorable reactions among the public). Nevertheless, these findings underscore the importance of leveraging the science of science communication to empirically test assumptions about science communication instead of relying on intuition and conventional wisdom.

Our research addressed the specific question of whether climate scientists' advocacy harms their credibility. However, this question is less important than a broader one: What kind of communication—advocacy or otherwise, by scientists or by others—can best ensure optimal use of scientific knowledge in policy, without distorting the truth or endangering the long-term credibility and integrity of scientists? It is possible, but not yet confirmed, that certain kinds of advocacy by scientists can meet all these goals simultaneously. As climate scientist Stephen Schneider noted, many scientists engage in advocacy out of a desire to meet these goals (Schneider, 1988). Schneider himself engaged in advocacy because of his intuition—shared by others—that it was possible for scientists to be both effective and honest. Further empirical testing can help illustrate the particular circumstances in which his intuition is correct. Our research takes a first step in this direction by demonstrating that climate scientists advocating for action broadly may not harm their credibility at all.

Notes

1. This provided us with sufficient power to detect relatively small main effects ($f = 0.10$) and interactions ($f = 0.115$), when $\alpha = 0.05$, power $(1-\beta) = 0.80$, and $N = 1235$. Calculations were performed with G*Power, version 3.1.7.
2. For more information about SSI, please visit https://www.surveysampling.com/solutions/data-collection/online-surveys/

3. We chose to examine Facebook posts because scientists and communication scholars are increasingly interested in this platform for science communication (Besley, 2014; Besley, Dudo, & Storksdieck, 2015; Brossard, 2013; Dudo & Besley, 2016). Furthermore, the barriers to engagement in this form of public communication are low compared to the effort required to attract the interest of journalists, organize public presentations, or meet with elected officials.
4. General trust in the broader community of climate scientists was only assessed if Dr. Wilson was identified as a climate scientist. Similarly, general trust in TV weathercasters was only assessed if Dr. Wilson was identified as a TV weathercaster.
5. Although the original items developed by McCroskey and Teven (1999) were intended to capture three separate subdimensions of credibility (i.e. competence, trustworthiness, and goodwill), we elected to combine these into a unidimensional scale because our interest was in the effects of advocacy on overall credibility. This decision was supported by an exploratory factor analysis of our own data, which suggested these items form a unidimensional scale (analysis not shown). Differences in factor structure between our study and McCroskey and Teven (1999) may be attributable to differences in samples, study design, or measurement (because we did not use all of the original scale items).
6. We also tried running the analysis with political ideology coded as a five-point variable (rather than as a three-point variable), and with age, gender, education, and race as additional covariates but the results were not substantively different from what we report here.
7. We also examined the sensitivity of the equivalence tests by also specifying $\Delta = .053$, which represents the average effect size r for the lower third of effects (a "small" effect) and $\Delta = .394$ for the upper third of effects (a "large" effect) found in the communication literature. These additional results can found in Supplementary Table 2 for $\Delta = .053$, and Supplementary Table 3 for $\Delta = .394$.

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