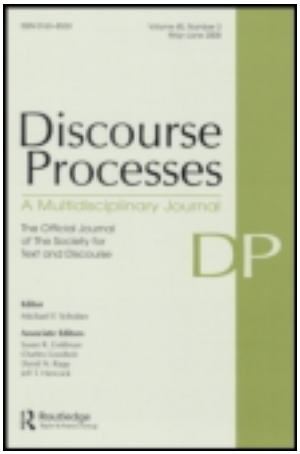

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Source Effects and Plausibility Judgments When Reading About Climate Change

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Source Effects and Plausibility Judgments When Reading About Climate Change

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Gaps between what scientists and laypeople find plausible may act as a barrier to learning complex and/or controversial socioscientific concepts. For example, individuals may consider scientific explanations that human activities are causing current climate change as implausible. This plausibility judgment may be due—in part—to individuals' perceptions about the information source and the certainty associated with the message claim. In this study, we examined the relationship among source credibility (trustworthiness and expertise), perceptions of certainty in message claims, and plausibility perceptions about climate change. Our analysis revealed that trustworthiness and message certainty perceptions were significant predictors of plausibility perceptions, above and beyond knowledge about human-induced climate change. These findings suggest that perceptions about information sources may have an important influence on plausibility judgments and, consequently, on learning about controversial and/or abstract concepts.

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INTRODUCTION

Individuals may consider scientific explanations about complex and controversial topics (e.g., human-induced climate change) implausible. In contrast, competing, nonscientific explanations may often be seen as more plausible than those offered by scientists. This situation creates a *plausibility gap*, which has been theorized to act as a barrier to learning scientifically accurate conceptions (Lombardi, Sinatra, & Nussbaum, 2013). Understanding how this plausibility gap forms and how it can be bridged may be especially relevant to educational researchers and instructors who are interested in promoting deep learning or conceptual change about scientific topics. A key factor may be how individuals perceive the source of scientific messages. The purpose of the present study was to examine how college students' perceptions about source characteristics, specifically source validity, relate to plausibility judgments about the controversial but scientific model of human-induced climate change.

Plausibility

Lombardi et al. (2013) theorized that plausibility is a judgment on the relative potential truthfulness of competing explanations, which could involve conflicting ideas (e.g., two models explaining the causes of climate change) and/or situations of cognitive conflict (e.g., when incoming information competes with background knowledge). Plausibility judgments are tentative in nature and do not necessarily represent firm epistemic commitments for or against a particular explanation (Rescher, 1976). When confronted with incoming information, an individual most often may make plausibility judgments through (1) implicit (i.e., automatic) cognitive evaluations, which may be influenced by the emotions an individual has about a topic, and (2) inclinations toward knowledge and knowing (i.e., epistemic dispositions and motives). However, in certain situations, individuals can explicitly evaluate plausibility judgments (see, for example, Richter, 2011). Explicit evaluation may be influenced by an individual's motivation to purposefully consider the connections between evidence and explanations through the process of critical evaluation (Chinn & Brewer, 2001). Instruction that is specifically targeted toward critical evaluation and plausibility reappraisal has been found to be effective in reconstructing middle school students' knowledge about human-induced climate change (Lombardi et al., 2013). In addition, individual perceptions about the source of information may influence their plausibility judgments (Maier & Richter, 2012; Richter, 2011). Lombardi et al. (2013) label this source validity pre-processing and view this type of processing as occurring before either the implicit or explicit evaluation processing. They view such preprocessing as an implicit and parallel cognitive process akin to automatic impressions.

Source Validity

The idea of source preprocessing comes from the philosophical work of Nicholas Rescher (1976), where he proposes that source characteristics influence our plausibility judgments about incoming information. In line with Rescher, we categorically consider sources to be, but not limited to, people, text, sensory perceptions, rules of logic and probability, and/or validating principles. Sources have characteristics that are associated with the content itself and the content's messenger. For example, characteristics that relate specifically to the content could be perceptions of message complexity (the degree to which a message is a convoluted and extended explanation) and certainty (the degree to which a message's premise is based on conjecture; Connell & Keane, 2006). On the other hand, characteristics of the explanation's messenger may include social psychological factors such as perceptions of source credibility (i.e., perceptions of the source's trustworthiness and expertise; Petty & Wegener, 1998). Lombardi et al. (2013) consider both characteristic sets—messenger and content—to be subcategories under the construct of source validity.

Source validity perceptions that occur during reading may be influenced by an epistemic validation process such that individuals monitor incoming information for internal consistency (Schroeder, Richter, & Hoever, 2008). Furthermore, Richter and Schmid (2010) assert that plausibility judgments are made when relating incoming information to knowledge about a topic. Epistemic validation may often be an automatic cognitive process in which inconsistencies between incoming information and an individual's mental model may render text implausible (Black, Freeman, & Johnson-Laird, 1986). In certain situations, individuals may engage in explicit and purposeful cognitive elaboration to resolve inconsistencies and increase plausibility perceptions of incoming information (Maier & Richter, 2012). However, in both cases—implicit monitoring or explicit elaboration—the notions of epistemic evaluation seem to cover only the characteristics of the content, not the characteristics of the messenger. A primary motivation for the present study was to examine how both content characteristics (perceptions of certainty in the message's claims) and messenger characteristics (perceptions of source credibility) are related to plausibility judgments.

Perceptions of Certainty in Message Claims

According to Connell and Keane (2006), plausibility increases when an individual perceives the content to have a relatively low degree of conjecture (i.e., "avoids the introduction of hypothetical entities," p. 99). Lombardi et al. (2013) theorized that such plausibility judgments may likewise be associated with perceptions of certainty in a message's claims. Individuals' perceptions of certainty in claims have been the subject of a large body of educational research

(see, for example, Allchin, 2011; Carey & Smith, 1993; DeBoer, 2000; Metz, 2004; Sadler & Zeidler, 2009). In many of these studies, understanding of scientific uncertainty is related to individuals' knowledge about the nature of science and, more specifically, about the tentative nature of scientific explanations. For example, Duschl and Osborne (2002) suggest that argumentative discourse in a science classroom promotes the development of students' cognitive skills of evaluation because students weigh the uncertainty and tentativeness associated with alternative claims. This connection between uncertainty and tentativeness also highlights a potential relationship between perceptions of certainty and plausibility judgments.

Certainty of claims may be especially relevant for the topic of climate change. As Lombardi and Sinatra (2012) report, "scientific projections of future climate change are often bounded by ranges of potential impacts" (p. 213) with uncertainty estimates. However, when climate scientists use the term uncertainty, it represents a quantitative statement about the degree of accuracy and precision in a model prediction. However, for laypersons, uncertainty may be interpreted to mean that scientists are guessing (i.e., scientists are uncertain about their explanation; Joyce, 2010). Weber and Stern (2011) suggest that scientists use "probability theory to gauge and express [their level of certainty] . . . in possible future events" (p. 319), whereas laypersons respond affectively, qualitatively, and negatively to any degree of predictive uncertainty in scientific messages. Because scientific messages about climate change may be thought of as uncertain by laypersons, scientific concepts such as climate change may be deemed implausible.

Source Credibility Perceptions

Plausibility judgments may also be influenced by heuristics and biases that individuals may possess about a message's source (Lombardi et al., 2013). In the persuasion literature, source credibility has been shown to be a particularly important heuristic or peripheral cue (i.e., a mental short cut, with low cognitive elaboration; see, for example, Briñol & Petty, 2009). Source credibility usually refers to the level of *expertise* and *trustworthiness* associated with a source. Expertise is a gauge of a messenger's knowledge and ability to provide accurate information. Trustworthiness is a perception about the degree of a messenger's honesty (Hovland, Janis, & Kelley, 1953; Petty & Wegener, 1998). Source credibility can also refer to other factors (e.g., a messenger's charisma; Whitehead, 1968); however, for this study, we focused on expertise and trustworthiness because these components may be particularly relevant to the topic of climate change. In a recent study, Bråten, Strømsø and Salmerón (2011) found that readers were able to distinguish the trustworthiness of different information sources about climate change. In particular, textbooks and official government documents were perceived as more trustworthy than newspapers or

commercially produced information. The results of this study corroborate previous research that shows that trustworthiness perceptions (like plausibility perceptions) may strongly relate to background knowledge when the topic is complex and controversial (Strømsø, Bråten, & Britt, 2010).

Source credibility not only influences attitudes (Johnson, Maio, & Smith-McLallen, 2005) but also comprehension (Sparks & Rapp, 2011) and reasoning (Copeland, Gunawan, & Bies-Hernandez, 2011). Source credibility may also influence plausibility judgments, particularly in cases where individuals are exposed to scientific information that contradicts other information sources. For example, in an educational setting that involves socioscientific issues (i.e., a classroom where the students and teachers discuss controversial science issues that are important to society as a whole; Sadler, Chambers, & Zeidler, 2004), students may read about scientific explanations of global climate change that do not correspond with explanations provided by media outlets. As students recognize an inconsistency between explanations provided by these different sources (media vs. scientific) during processing of text information, they may attempt to engage in further cognitive elaboration and evaluation to comprehend the nature of the inconsistency (Sinatra & Broughton, 2011). However, further processing of the inconsistent explanations may be hampered by their perceptions of plausibility. When students are exposed to a new explanation (e.g., climate is not the same as weather) that contradicts their preexisting situation model (e.g., climate and weather are the same), it may decrease the plausibility of the explanations and create doubt and uncertainty in both explanations.

Decreased perceptions of plausibility may impede further processing and decrease overall message understanding. With a lowered ability to engage in elaboration, readers may rely on peripheral cues to make sense of the message in lieu of effortful processing. For example, they may turn to source credibility and base their evaluation about the text on cues such as which source is more honest or possesses more expertise. This reasoning is in line with previous research by Scharrer, Bromme, Britt, and Stadtler (2012), which showed that more understandable scientific arguments are related to increased trust in an individual's own personal evaluation of the argument and a reduced desire to rely on an experts' evaluation of the argument. Building on these findings, we surmise that in a situation with inconsistencies between arguments, plausibility judgments may impede the ability to carefully scrutinize message contents and promote an increased desire to focus on source credibility.

It is important to stress that we only expect these effects in situations of inconsistencies between arguments or with controversial topics. When readers process information that is consistent, particularly with their situation models, they may display a tendency to overlook source credibility (see Sparks & Rapp, 2011). In this way, individuals' perceptions of source credibility may be associated with plausibility judgments through a dynamic exchange involving

evaluations about information sources that occur during reading. This last assertion is certainly speculative but is based on the view that reading refutation text (i.e., with refutation inducing plausibility judgments between competing explanations) "involves a complex interplay of ... unintentional and intentional, and automatic and self-regulated processes" (Sinatra & Broughton, 2011, p. 388). Examining this complex cognitive interplay between source validity and plausibility judgments was another motivation for the present study.

Present Study

Our purpose in conducting the present study was to examine the relationships between perceptions of source validity and plausibility perceptions about climate change. With regard to source validity, we specifically examined perceptions of certainty of message claims and source credibility (i.e., trustworthiness and expertise of the source). As we discussed earlier, certainty is an aspect of source validity that relates specifically to the content of the message itself, in contrast to perceptions of trustworthiness and expertise, which relate to the characteristics of the source's messenger.

Research questions. To achieve our study purpose, we specifically asked the following research question: After reading a text about climate change, do perceptions of (1) certainty in claims made in a text and (2) source credibility (trustworthiness and expertise) predict plausibility perceptions of scientific statements about climate change? This question was considered while taking into account differences in individuals' knowledge about human-induced climate change.

Hypotheses. We hypothesized that perceptions of certainty about claims made in a text about climate change would relate to individuals' plausibility perceptions about scientific statements of climate change. Specifically, higher levels of certainty should be associated with higher plausibility. Likewise, we hypothesized that perceptions of source credibility (trustworthiness and expertise) would also positively relate to plausibility perceptions. That is, more trustworthiness and expertise should be associated with higher plausibility perceptions. These hypotheses were based on the research reviewed above and the plausibility model developed by Lombardi et al. (2013).

METHOD

Participants

Participants were enrolled at a university in Southern California and were part of the Psychology Department's subject pool. Participants were required to be 18

years of age to participate in the study and received extra course credit for their participation. Of the 397 students who volunteered for the study, 271 fully completed all measures and were retained as study participants. These 271 participants were between 18 and 38 years of age ($M = 20.3$, $SD = 2.12$), comprising 9% freshmen, 28% sophomore, 39% juniors, and 24% seniors. Fifty-nine participants were Republicans (22%), 161 were Democrats (59%), 38 were Independents (14%), and 13 reported their political affiliation as "other" (5%). In terms of ethnicity/race, participants were predominantly White ($N = 128$, 47%) and Asian American ($N = 83$, 31%), with 10 (4%) African-Americans, 29 (11%) Hispanics/Latinos, 13 (5%) mixed ethnic groups, and 8 (2%) other.

Because of an error connected with the computerized survey software, information pertaining to participants' gender for this sample was not collected. However, one of the authors obtained a list of all students who were eligible to participate in the psychology subject pool (students in 19 courses total). The university's registrar supplied anonymous information regarding the gender distribution of students in each course. During the semester when data were collected for this study, 1,243 women and 532 men were enrolled in courses eligible to participate in the subject pool. Demographic data from another study sampled from the same subject pool population during the same period of time as the current study showed a distribution of 116 men and 313 women (roughly a 1:3 ratio). We surmise that a similar male-to-female ratio was likely for the current sample.

Materials

Climate change text. The participants read a text about climate change and policies for ameliorating future impacts of climate change. The text was derived from an editorial that appeared in the *New York Times* on May 10, 2012 (Hansen, 2012). The editorial was written by Dr. James Hansen who headed NASA's Goddard Institute for Space Studies and is a noted climatologist and activist working to ameliorate human-induced global warming. The article was particularly useful for this study because of the dual nature of the text. The first two-thirds of the text (592 words in length) discussed the scientific evidence for current climate change and the evidence connecting human activities to current climate change. The last one-third of the text (314 words in length) discussed a policy proposal to mitigate future climate change. Because of this dual nature, we considered it plausible that either a scientist or a politician could have written the article. Furthermore, we considered the article to be persuasive based on the definition provided by Chambliss and Garner (1996), where a persuasive text "is structured to counter the current beliefs of a typical reader as well as to present new ones by capitalizing on a reader's existing knowledge and beliefs" (p. 294). Dr. Hansen argues in the text against the idea that climate

change is uncertain and that there is nothing we can do to reduce the impacts of future climate change. We made some slight modifications to the text to increase the ambiguity about who wrote the article. The readability was 9.8 according to the Flesch-Kincaid Index (for the complete text, see the Appendix).

Knowledge about human-induced climate change. We used a 27-item knowledge assessment of human-induced climate change developed in prior research (human-induced climate change knowledge [HICCK]; Lombardi et al., 2013) to measure participants' knowledge about the topic. This instrument is designed to measure conceptions about the current scientific consensus on human-induced climate change based on a study that surveyed American citizens on their understanding of scientific phenomena related to global warming (Leiserowitz & Smith, 2010), the latest summative report produced by a UN expert panel (Intergovernmental Panel on Climate Change, 2007), and common alternative conceptions about human-induced climate change (Choi, Niyogi, Shepardson, & Charusombat, 2010). Participants rated each item on a 5-point Likert scale gauging the level of agreement they thought *climate scientists* would indicate for each statement, ranging from 1 = strongly disagree to 5 = strongly agree, for example, "current climate change is caused by an increase in the Sun's energy." By asking what climate scientists believe, rather than what the participants believe, the instrument was designed to assess what participants know about the scientific consensus position and not what their personal beliefs are in regard to accepting the scientific point of view. For the present study, overall reliability of the HICCK was above the "good" threshold of 0.8 (George & Mallery, 2009), with Cronbach's $\alpha = .81$.

Perceptions of certainty in message claims. We used four items to measure participants' perceptions of certainty of claims made in the persuasive text: (1) the certainty of the claim that climate is changing globally, (2) the certainty of the claim that carbon dioxide levels in the atmosphere have been increasing, (3) the certainty of the claim that human activities are causing current global climate change, and (4) the certainty of the claim that future climate change will cause severe problems unless humans take immediate action. For each item, we asked participants to rate the level of certainty in these claims on a 7-point Likert scale, ranging from 1 = very uncertain to 7 = very certain. The dependent measure of certainty perceptions reflected average certainty ratings across the four items. Overall reliability of the four-item certainty of claims measure was above the "excellent" threshold of 0.9 (George & Mallery, 2009), with Cronbach's $\alpha = .93$.

Perceptions of author trustworthiness. We adapted four items from Kirkpatrick and Locke's (1996) trust in leadership scale to measure participants' perceptions of author trustworthiness. For each item, we asked participants to rate

their level of agreement on a 7-point Likert scale, ranging from 1 = strongly disagree to 7 = strongly agree. The items asked participants to rate their agreement with the following statements: (1) I have complete trust in the author, (2) I find it difficult to trust the author (we reverse coded this item), (3) I do not believe what the author says (reverse coded), and (4) The author was trustworthy. The dependent measure of perceptions of author trustworthiness reflected average certainty ratings across the four items. Overall reliability of the four-item trustworthiness measure was just below the "good" threshold of 0.8 (George & Mallery, 2009), with Cronbach's $\alpha = .79$.

Perceptions of author expertise. We used six items to measure participants' perceptions of author expertise. Because the persuasive text covered both scientific explanations of climate change and political policy recommendations for mitigating future climate change, we used these items to measure perceptions of expertise in science and policy. The first three items concerned scientific expertise and asked about participants' level of agreement that the author is: (1) "an expert in global climate change science," (2) "knowledgeable about global climate change science," and (3) "is qualified to give an expert opinion about the science underlying global climate change." The next three items concerned policy expertise and asked participants' level of agreement that the author is: (1) "qualified to give an expert opinion about the policies to address global climate change," (2) "an expert in global climate change policy," and (3) "knowledgeable about global climate change policy." We again used a 7-point Likert scale on these expertise items, with 1 = strongly disagree to 7 = strongly agree. The dependent measures of perceptions of the author's scientific and policy expertise reflected average certainty ratings across the three items for each category, respectively. Reliability of both the three science expertise items (Cronbach's $\alpha = .83$) and three policy expertise items (Cronbach's $\alpha = .86$) were above the "good" threshold of 0.8 (George & Mallery, 2009).

Plausibility perceptions of climate change. To measure participants' plausibility perceptions of climate change, we used the Plausibility Perceptions Measure (Lombardi & Sinatra, 2012). This instrument has eight statements about climate change based on the latest summative report produced by a UN expert panel (Intergovernmental Panel on Climate Change, 2007). The measure's statements matched the major conclusions made in the report. This includes, for example, the following: "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level" (Intergovernmental Panel on Climate Change, 2007, p. 2). Participants rated each statement on a 0–10 plausibility scale (0 = greatly implausible or

even impossible and 10 = highly plausible). For the present study, overall reliability of the Plausibility Perceptions Measure was above the "excellent" threshold of 0.9 (George & Mallery, 2009), with Cronbach's $\alpha = .95$.

Procedure

Students participated in the current study online (on their own computers) through the psychology department's subject pool website. They volunteered to participate in the study on "Global Climate Change" in exchange for course credit. They completed the experiment via computerized survey software (Qualtrics Research Suite, Qualtrics, Provo, Utah). As they opened the link to the survey, participants learned through an informed consent form that they would be asked to read an editorial and answer questions regarding their beliefs and knowledge. After participants provided their consent to participate in the study, they completed various items including their political affiliation and how much they identified with their political party. These variables were not analyzed in the current study.[1]

Next, participants read the editorial on global climate change. After reading the editorial, all participants were immediately prompted to complete the dependent measures outlined above in the following order: plausibility, knowledge (as measured by the HICCK), perceptions of certainty, trustworthiness, expertise ratings, and demographic variables such as ethnicity/race and year in school. All items belonging to particular scales were grouped together and labeled accordingly. No filler items were used. A variety of exploratory questions (e.g., attitudes) were also included in the questionnaire but were not analyzed for the purposes of the current study. Once measures were completed, all participants were debriefed through a written online debriefing statement. All in all, it took students approximately 25 to 45 minutes to participate in all parts of the experiment.

RESULTS

Descriptive Statistics and Associations

Table 1 shows the means, standard deviations, and correlations for the measured variables: perceptions of certainty of message claims, trustworthiness of the author, expertise of the author, knowledge, and plausibility perceptions of

[1] Note that the current study was part of a larger study that manipulated source status (ingroup and outgroup) before text reading. In the current study, we focused specifically on certainty claims and source credibility.

TABLE 1
Bivariate Correlations and Descriptive Statistics for the Study Variables ($N = 271$)

Variable	*1*	*2*	*3*	*4*	*5*	*6*
1. Certainty	–					
2. Trustworthiness	.256[a]	–				
3. Expertise-science	.114	.636[a]	–			
4. Expertise-policy	.107	.620[a]	.796[a]	–		
5. HICCK	.563[a]	.206[a]	.052	.021	–	
6. PPM	.613[a]	.367[a]	.216[a]	.201[a]	.508[a]	–
M	5.91	4.15	4.37	4.29	100.8	8.20
SD	.993	1.04	1.16	1.18	9.68	1.53

Scores of perceptions of certainty (in claims made in the persuasive text), trustworthiness of author, and scientific and policy expertise of author are all out of a maximum possible of 7; HICCK scores are out of a possible 135; Plausibility Perceptions Measure (PPM) scores are out of a possible 10.
[a] $p < .01$.

climate change. Strong and statistically significant positive correlations ($r > .7$; Cohen, 1988) existed between perceptions of science and policy expertise of the author. Moderate and statistically significant positive correlations ($.3 < r < .7$; Cohen, 1988) existed between perceptions of the certainty of message claims, knowledge, and plausibility perceptions. Moderate and statistically significant positive correlations also existed between perceptions of author trustworthiness and plausibility perceptions and between trustworthiness and both expertise variables. Weak and statistically significant positive correlations ($.2 < r < .3$; Cohen, 1988) existed between certainty and trustworthiness and between both expertise variables and plausibility.

Predictors of Plausibility Perceptions

We conducted a hierarchical multiple regression analysis to examine how well perceptions of certainty of the message claims, trustworthiness of the author, and expertise of the author predicted plausibility perceptions of climate change, above and beyond knowledge (as measured by HICCK scores). Before conducting the regression, we screened the results and found that our analysis met the normality and linearity assumptions inherent in linear regression designs. There were no multivariate outliers (as measured by Mahalanobis distance); however, we did have four univariate outliers (z values > 3) in two variables (plausibility perceptions, $N = 2$; certainty of message claims, $N = 2$). Because of the controversial nature of the study's topic (climate change), we decided to retain these outlier data.

In the hierarchical multiple regression analysis predicting plausibility perceptions, we first entered HICCK scores to account for participants' knowledge about human-induced climate change. In the second block, we

TABLE 2
Hierarchical Regression Results Showing Predictions of Plausibility Perceptions of Climate Change ($N = 271$)

Block	ΔR^2	ΔF	*Variable*	*B*	*t*	*p*
1	.255	92.2	HICCK	.505	9.60	$<.001$
2	.197	23.9	Certainty	.434	7.76	$<.001$
			Trustworthiness	.184	2.91	.004
			Expertise-science	.027	.344	.731
			Expertise-policy	.014	.182	.856

entered perceptions of certainty of message claims, trustworthiness of the author, and expertise of the author. Table 2 summarizes the results of our analysis. For the full model, R^2 was significant, $F(5,270) = 43.8$, $p < .001$, with about 45% of the variance in plausibility perceptions explained by the independent variables. Knowledge (as measured by HICCK scores) accounted for about 25% of the variance. The predictor variables (perceptions of certainty of message claims, trustworthiness of the author, and expertise of the author) accounted for an additional 20% of the variance above knowledge.

Perceptions of certainty of the message claims and trustworthiness of the author were significant predictors of plausibility perceptions (Table 2). Specifically, participants who expressed more certainty in the message claims found scientific claims about climate change more plausible. Likewise, participants who found the author to be more trustworthy also found the message more plausible. Perceptions of the author's expertise in science and policy were not significant predictors of plausibility perceptions.

The direction of the relationship (i.e., trustworthiness, expertise, and certainty perceptions as predictors of plausibility) is related to our hypotheses, which is supported by our research review and Lombardi et al.'s (2013) theoretical plausibility model. However, it is entirely possible that alternative directionalities may exist for these variables. We can speculate that the significant predictors of plausibility (certainty and trustworthiness) may in fact be criterion variables. In other words, plausibility may influence perceptions of message certainty or evaluations of author trustworthiness.

To gauge directionality, we conducted an additional analysis comparing three regression models. The first regression model had certainty and trustworthiness as predictor variables and plausibility as the criterion variable (as per our hypothesized relationship). As with our main analysis, Model 1 showed that both certainty and trustworthiness were significant predictors of plausibility (certainty, $\beta = .552$, $p < .001$; trustworthiness, $\beta = .225$, $p < .001$), with $F(2,270) = 96.8$, $p < .001$, $R^2_{adj} = .415$. The second regression model had plausibility and certainty as predictors and trustworthiness as the criterion. Model 2 showed only

plausibility as a significant predictor of trustworthiness ($\beta = .335$, $p < .001$), with $F(2,270) = 21.1$, $p < .001$, $R^2_{adj} = .130$. The third regression model had plausibility and trustworthiness as predictors and certainty as the criterion. Similar to Model 2, Model 3 showed only plausibility as a significant predictor of certainty ($\beta = .596$, $p < .001$), with $F(2,270) = 79.8$, $p < .001$, $R^2_{adj} = .369$. In predictive regression models, we can consider R^2_{adj} to be an indicator of a model's goodness of fit. The R^2_{adj} value for Model 1 is appreciably greater than Models 2 and 3. Therefore, Model 1 has a better goodness of fit than Models 2 and 3. These two characteristics of Model 1 (i.e., that both the predictors were significant and higher goodness of fit value) provide some support for our hypothesized direction of certainty and source credibility affecting plausibility, although no definitive claim regarding directionality can be made based on our findings.

DISCUSSION

The study showed that perceptions of certainty about claims made in a text about climate change and source credibility (trustworthiness) predicted plausibility perceptions of scientific statements about climate change. These effects held after accounting for participants' knowledge about human-induced climate change. As predicted, more certainty and trustworthiness were associated with higher plausibility perceptions. This finding partially supported our hypotheses that certainty and source credibility would predict plausibility. Our hypotheses are only partially supported because another aspect of source credibility, author expertise, was not a significant predictor of plausibility. Both the nature of the climate change text and the topic may have contributed to this null expertise finding. The topic of climate change is highly complex and the author's discussion of the topic using clear and concise terminology and specific facts and figures may have resulted in relatively homogeneous perceptions of expertise.

The results provide support for Lombardi et al.'s (2013) theoretical model of plausibility judgments, particularly with regard to source validity preprocessing. In this preprocessing phase, incoming information could make an impression based on a variety of factors that fall under the larger construct of source validity; however, this notion is still speculative. Before this study, no empirical evidence (to our knowledge) existed showing the relationship between source validity and plausibility judgments, but this study showed that perceptions of certainty in message claims and trustworthiness of the author were significant predictors of plausibility perceptions. However, we should note that even though increases in perceptions of certainty in message claims and author trustworthiness rendered the topic as more plausible, this would not necessarily result in acceptance of human-induced climate change. Other factors, such as topic emotions and epistemic motives

and dispositions, may render alternative explanations as more plausible, which in turn would prevent a shift toward accepting the scientific model (Lombardi et al., 2013). Classrooms that promote critical evaluation of competing explanations (i.e., weighing the connections between evidence and alternatives) might be particularly effective in dampening topic emotions and epistemic motives and dispositions that act as barriers to viewing human activities as the most plausible cause of current climate change.

The results of this study suggest that both instructors and students should be aware that plausibility judgments may be influenced by both the characteristics of the message (e.g., certainty in the message) and the messenger (e.g., trustworthiness). In this way, plausibility judgments about text may parallel comprehensibility, where increased understanding is associated with awareness of source features (e.g., associating discrepant accounts of an event to different authors; Braasch, Rouet, Vibert, & Britt, 2012). Science educators may therefore wish to promote goal-directed reading of text to evaluate the biases that readers may have about sources (i.e., as a form of top-down and effortful processing; Sinatra & Broughton, 2011) when having their students read about climate change and other complex and/or controversial topics. Schroeder et al. (2008) argued that readers should engage in explicit epistemic evaluation of sources, which is a strategic cognitive process where the reader detects inconsistencies between the text and their background knowledge. However, our study suggests that epistemic evaluation should be carried a step further, at least for complex and controversial topics. The reader should examine their own use of heuristics and biases in making quick and automatic judgments about text information. Again, critical evaluation of completing explanations (i.e., where one explanation is the readers' prior knowledge and beliefs) may be one way to facilitate explicit plausibility appraisal.

Certainly, a limitation of this study is the population from which the participants were drawn (i.e., undergraduate psychology students at a major university). More research is needed with different populations to increase our confidence that these results are generalizable. The study was also limited because it used a single text from a single author about a single topic. Additional studies are needed to look at the relationship between source validity and plausibility when multiple texts, multiple authors, and multiple/different topics are involved. More studies are also needed to better establish the directionality of the relationship between source validity and plausibility. Finally, we did not measure specific learning or memory of the text and, consequently, cannot explicitly state whether participants carefully read the text. The promising results nonetheless point toward the need for additional studies about the source factors that shape the formation of plausibility judgments. Such understanding is crucial as we endeavor to improve educational practices about topics with a large plausibility gap between scientific consensus and laypeople's understanding, such as global climate change.

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APPENDIX: CLIMATE CHANGE TEXT

Global warming isn't a prediction. It is happening. That is why I was so troubled to read a recent interview with an American Senator in *Rolling Stone*. He said that Canada would exploit the oil in its vast tar sands reserves "regardless of what we do."

If Canada proceeds and we do nothing, it will be game over for the climate.

Canada has extremely large quantities of fossil fuels obtained from tar sands. Tar sands are a type of unconventional petroleum deposit. The tar sands consist of loose sand containing naturally occurring mixtures of sand, clay, and water, saturated with a dense and extremely viscous form of petroleum. Canada's tar sands contain twice the carbon compared to regular drilling. If we fully exploit this new oil source and continue to burn conventional fossil fuels supplies, carbon dioxide in the atmosphere will exceed levels not seen since 2.5 million years ago, when sea level was at least 50 feet higher than it is now. This would assure that the disintegration of the ice sheets would accelerate out of control. Sea levels would rise and destroy coastal cities. Global temperatures would become intolerable. Twenty to 50 percent of the planet's species would be driven to extinction. Civilization would be at risk.

That is the long-term outlook. But near-term, things will be bad enough. Over the next several decades, the Western United States and the Great Plains from North Dakota to Texas will develop semi-permanent drought. Rain, when it does come, would occur in extreme events with heavy flooding. Economic losses would be incalculable. More and more of the Midwest would be a dust bowl. California's Central Valley could no longer be irrigated. Food prices would rise to unprecedented levels.

If this sounds apocalyptic, it is. This is why we need to reduce emissions dramatically. The U.S. government has the power to deny tar sands oil additional access to Gulf Coast refining, which Canada desires in part for export markets, and also to encourage economic incentives to leave tar sands and other dirty fuels in the ground.

The global warming signal is now louder than the noise of random weather. Extremely hot summers have increased noticeably. We can say with high confidence that the recent heat waves in Texas and Russia, and the one in Europe in 2003, which killed tens of thousands, were not natural events—they were caused by human-induced climate change.

We have known since the 1800s that carbon dioxide traps heat in the atmosphere. The right amount keeps the climate conducive to human life. But add too much, as we are doing now, and temperatures will inevitably rise too high. This is not the result of natural variability, as some argue. The earth is currently in the part of its long-term orbit cycle where temperatures would normally be cooling. But they are rising—and it's because we are forcing them higher with fossil fuel emissions.

The concentration of carbon dioxide in the atmosphere has risen more than 40% over the last 150 years. The tar sands contain enough carbon—240 billion tons—to add an additional 30%. Oil shale—another dirty fossil fuel source that is found mainly in the United States—contains at least an additional 300 billion tons of carbon. If we turn to these dirtiest of fuels rather than finding ways to phase out our addiction to fossil fuels, there is no hope of keeping carbon concentrations below a level that would, as earth's history shows, leave our children a climate system that is out of their control.

We need to start reducing emissions significantly, not create new ways to increase them. We should impose a **Gradually Rising Carbon Fee** collected from fossil fuel companies. We could distribute 100 percent of the collections to all Americans every month. The government would not get a penny. This market-based approach would stimulate innovation, jobs and economic growth, while also avoiding bigger government or having it pick winners or losers. Except for the heaviest energy users, American citizens

would get more back than they paid in increased prices. Not only that, reductions in oil use resulting from the carbon fee would be nearly six times greater than oil supplies from Canada's tar sands. This makes the extracting oil from the tar sands superfluous.

But instead of placing a rising fee on carbon emissions to make fossil fuels pay their true costs and leveling the energy playing field, the world's governments are forcing the public to subsidize fossil fuels with hundreds of billions of dollars per year. This encourages a frantic stampede to extract every fossil fuel through mountaintop removal, tar sands and oil shale extraction, and deep ocean and Arctic drilling.

Our leaders must speak candidly to the public—which yearns for open, honest discussion explaining that our continued technological leadership and economic well-being demand a reasoned change of our energy course. History has shown that the American public can rise to the challenge, but leadership is essential.

The science of the situation is clear—it's time for the politics to follow. This is a plan that can unify conservatives and liberals, environmentalists and business. Every major national science academy in the world has reported that global warming is real, caused mostly by humans, and requires urgent action. The cost of acting goes far higher the longer we wait—we can't wait any longer to avoid the worst and be judged immoral by coming generations.