Selective perceptions of hydraulic fracturing
The role of issue support in the evaluation of visual frames

Melanie A. Sarge, *Texas Tech University*

Matthew S. VanDyke, *Texas Tech University*

Andy J. King, *Texas Tech University*

Shawna R. White, *Texas Tech University*

ABSTRACT. **Hydraulic fracturing (HF) is a focal topic in discussions about domestic energy production, yet the American public is largely unfamiliar and undecided about the practice. This study sheds light on how individuals may come to understand hydraulic fracturing as this unconventional production technology becomes more prominent in the United States. For the study, a thorough search of HF photographs was performed, and a systematic evaluation of 40 images using an online experimental design involving $N = 250$ participants was conducted. Key indicators of hydraulic fracturing support and beliefs were identified. Participants showed diversity in their support for the practice, with 47 percent expressing low support, 22 percent high support, and 31 percent undecided. Support for HF was positively associated with beliefs that hydraulic fracturing is primarily an economic issue and negatively associated with beliefs that it is an environmental issue. Level of support was also investigated as a perceptual filter that facilitates biased issue perceptions and affective evaluations of economic benefit and environmental cost frames presented in visual content of hydraulic fracturing. Results suggested an interactive relationship between visual framing and level of support, pointing to a substantial barrier to common understanding about the issue that strategic communicators should consider.**

Key words: Hydraulic fracturing, fracking, visual framing, selective perception, economic benefit, environmental cost

The practice of hydraulic fracturing (HF), referred to colloquially as "fracking," has become a source of controversy in the United States. HF is a process of natural gas and oil extraction that uses horizontal drilling techniques and a mixture of fluids injected into the ground at a high pressure. The high-pressure fluid injection creates fractures in underground rock formations that trap natural gas and oil.[1] Upon creating these fractures, natural gas and oil can be extracted for energy production. From the public opinion research conducted thus far, most Americans seem to have little knowledge of and undecided opinions about the practice.[2] Among those with awareness or knowledge about hydraulic fracturing, controversy arises from a tension between beliefs about the economic benefits of this unconventional energy production practice and concerns about its environmental costs.[3,4,5]

Individual studies on hydraulic fracturing have focused largely on identifying broad political and demographic associations with overall support for (or opposition to) hydraulic fracturing.[6,7,8] Less empirical work has examined predispositions associated with specific perceptions of hydraulic fracturing as an economic or environmental issue, often assuming intuitive correspondence with support for (opposition to) the practice. Yet research on collective preferences suggests individuals' predispositions influence how they perceive risks and relevant policy options in science and environmental contexts.[9,10]

Given public uncertainty about the practice, the presentation and framing of hydraulic fracturing in the news media has great potential to influence issue

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Correspondence: Melanie A. Sarge, College of Media and Communication, Texas Tech University, 3003 15th Street, Lubbock, TX 79409-3082. Email: *m.sarge@ttu.edu*

interpretation, shape public attitudes, and stir public engagement.[11,12,13] In fact, media coverage may be one factor subtly promoting an economic or environmental interpretation of the issue without providing a clear understanding of the scientific facts surrounding the practice. Indeed, the way hydraulic fracturing is discussed in the media holds consequences for how those messages are interpreted and acted upon.[14] Yet message effects are also influenced by viewer predispositions, which color and shape how media messages are received. Recent research suggests that political partisanship biases cognitive processing and policy support.[15] Similarly, we posit that existing support should influence how images of hydraulic fracturing are perceived.

On a practical level, understanding how message frames complement or contradict preexisting beliefs (i.e., how they align with individual predispositions) should enable more effective communication efforts around the issue.[16] The study reported here examines economic and environmental issue perceptions of images associated with hydraulic fracturing, as well as affective responses to perceived benefit and risk. Level of support is investigated as a perceptual filter that facilitates biased processing and affective evaluations of differentially framed media content. Results of the study, which suggest an interactive relationship between visual framing and issue attitudes, point to a substantial barrier to common understanding about the issue that strategic communicators should consider.

Energy production forecasts suggest that natural gas production will likely increase over the next decade due to the competitively low market costs of natural gas and its potential for industrial use both domestically and internationally.[17] Domestic energy development and production is an area in which public understanding and issue evaluations can have notable implications—politically, economically, and socially. The U.S. Environmental Protection Agency's claim that hydraulic fracturing is an integral component of America's "clean energy future"[18] underscores the importance of evaluating public understanding of the issue, although much of the public remains unfamiliar with the process and practice of hydraulic fracturing.[19]

Public opinion of hydraulic fracturing

The social scientific literature about hydraulic fracturing thus far shows little public consensus and knowledge around the practice and associated concerns.[20] In particular, individuals living near hydraulic fracturing sites are found to have ambiguous feelings toward the issue consistent with the "dialectic of economic prosperity," which holds that enthusiasm for financial benefits is inevitably tempered by concerns about environmental degradation. Nevertheless, despite the environmental risks encountered in host communities,[21,22] research suggests that attitudes and beliefs about hydraulic fracturing change over time in communities where hydraulic fracturing occurs.[23,24,25]

While much of the American public is unfamiliar with hydraulic fracturing, opposition to hydraulic fracturing—among those with a defined attitude toward the practice—is more common among women, Democrats, urban residents, and those inclined to hold proenvironmental policy attitudes; opposition also increases with issue familiarity.[26,27] Support for hydraulic fracturing is more likely among older people, those with higher levels of education, and political conservatives.[28] Those who support hydraulic fracturing endorse it largely for economic reasons, including energy independence, job creation, and community enhancement.[29,30] In contrast, opponents frequently cite the potential for environmental risks, including groundwater and air contamination, environmental degradation, public health, and quality of life issues.[31,32,33]

In line with these findings, popular discourse seems to revolve around the economic and environmental consequences of hydraulic fracturing.[34,35,36] However, previous research has not empirically examined support as a predictor of these issue beliefs. Based on our review of the literature, support for hydraulic fracturing should be primarily associated with an economic benefits perspective; on the other hand, lack of support should be related to perceptions of hydraulic fracturing primarily from an environmental costs perspective. To corroborate previous findings and examine the relationship between support for hydraulic fracturing and economic and environmental issue outlooks, we first predict the following hypotheses:

H1. Previously identified demographic predictors (older age, male, higher educated, higher income, and more conservative) will be associated with higher levels of support for hydraulic fracturing.

H2. Support for hydraulic fracturing will be (a) positively associated with economic issue beliefs and (b) negatively associated with environmental issue beliefs.

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Although individual predispositions undoubtedly influence issue support, media research has repeatedly shown that message presentation elements can be highly consequential for issue understanding and interpretation.[37,38,39] Message production choices influence recipients' evaluations of content, particularly in information-ambiguous contexts or situations involving uncertainty.[40] The process of highlighting specific issue attributes and downplaying others in an attempt to persuade or influence message interpretations can be described as framing.[41,42]

Media framing

Media framing refers to the selection, emphasis, and presentation of particular message elements[43,44] with the potential to influence interpretations and evaluations of topics in the news and other media genres, such as advertising, documentaries, feature films, even posters, brochures, and other promotional materials. Framing devices make certain message elements salient, diminishing the importance of other message aspects.[45] As a result, media framing promotes particular interpretations of a message and can influence the ways in which an issue is perceived—particularly for emerging practices like unconventional forms of energy production about which people have little prior experience or background information.[46] Frames that appear in news may vary by genre, specific media outlet, or geographic location. Regional news coverage of natural gas development, for instance, has been shown to vary over time in terms of valence and in its discussion of social, economic, and environmental factors.[47]

The specific message elements that constitute frames may be textual (verbal) or image-based (visual). Surprisingly, considerably less scholarly attention has been given to visual framing research in comparison to verbal framing, even though scholars have noted the need for more research attention to the visual aspects of framing.[48] Such oversight is problematic because visual images in news coverage facilitate public understanding of issue information.[49,50] And the brain has evolved in such a way that humans are better equipped to process visual information than textual information.[51] To the extent that "seeing is believing," the use of visual information arguably reflects a higher degree of perceived truth or reality than verbal information.

Reflecting this reality, and the efficiency with which images are processed, news websites now have pages dedicated to the presentation of daily news featuring just photographs (e.g., the *Boston Globe's* "The Big Picture," NBC's "Week in Pictures," Yahoo's "Photos of the Day," and the BBC's "In Pictures"). Photojournalism offers individuals with less motivation or simply less time the opportunity to learn about the news through simple exposure to images related to an issue. Moreover, news images have been identified as a particularly effective framing tool to rely on when discussing controversial issues[52] such as hydraulic fracturing. Visual framing thus offers a unique opportunity to understand how subtle image characteristics may influence individuals' perceptions in issue contexts.

Previous scholarship has documented frequently occurring frame types that are typical of issue coverage in the media.[53,54,55] Among these, gain and loss frames[56] have been studied in a variety of health and environmental contexts.[57,58,59] Gain frames tend to discuss an issue in terms of its potential benefits. In contrast, loss frames characterize an issue in terms of its potential drawbacks, or negative consequences. From a more specific gain-loss dichotomization, environmental issues are often discussed in terms of economic benefits versus environmental costs.[60,61,62,63] Framing hydraulic fracturing in terms of its purported economic benefits or environmental costs would likely yield different public perceptions about the issue, particularly when the public knows relatively little about it.[64,65] If media coverage obviously reflects an economic prosperity or environmental hazard frame,[66] this contrasting presentation as either a potential gain or loss should influence individuals' issue understanding and perceptions of hydraulic fracturing more generally.

In addition to the cognitive faming effects driving issue interpretation, framing effects can also be affective in nature.[67] Affect, which may be experienced consciously or subconsciously, is a positive or negative feeling evoked in the process of experiencing some stimulus.[68] Media framing has been shown to evoke distinct affective responses across a variety of contexts,[69,70,71] and the emotion-laden images often used to portray risks are known to activate affective responses and influence issue perceptions, level of issue support, and perceptions of risk.[72,73,74]

Research on affective framing often examines a benefits-versus-costs tradeoff. Many studies have examined gain- and loss-framing of health information and documented associations between positive and negative responses to message content.[75] Shen and Dillard,[76] for example, tested health narratives presenting benefits versus costs, which they called advantage versus

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disadvantage framing. Advantage-framed messages were associated with higher levels of positive affect and lower levels of negative affect, whereas the reverse was true for disadvantage-framed messages. Visual framing effects should operate in a similar fashion. Moreover, visual framing effects are also consistent with theorizing on exemplification, where providing a visual representation of an issue or event impacts related perceptions, providing that individuals do not hold strong preexisting beliefs on the topic.[77] Persuasion studies have also found that, compared to no images, the presentation of visuals results in greater levels of affective response.[78,79]

Across different topics and contexts, existing research suggests that the use of visual representations to communicate about a controversial issue, such as hydraulic fracturing, has the potential to promote particular evaluations, both cognitive and affective, about the issue and its attributes. From this discussion, we therefore propose the following hypotheses:

H3. News images emphasizing economic benefits will promote greater perceptions of hydraulic fracturing as an economic issue, whereas images emphasizing environmental costs will promote greater perceptions of hydraulic fracturing as an environmental issue.

H4. News images emphasizing economic benefits will promote more positively valenced evaluations, whereas news images emphasizing environmental costs will promote more negatively valenced evaluations.

Despite these predictions, when contemplating the news media's potential influence on perceptions of hydraulic fracturing, it is insufficient to assume direct framing influence due to message content alone, especially for viewers holding preexisting attitudes toward the issue.[80,81,82,83] Message reception is not free from the influence of preexisting attitudes, regardless of how uninformed those attitudes may be.

Selective perception of media frames

Just as news media help individuals construct narratives to make sense of the social world,[84] so they facilitate the creation of cognitive representations, or mental models, of an issue's scope and meaning.[85] This concept of mental models is similar to what Entman describes as individual frames, which function as cognitive lenses through which individuals process new information.[86,87] Such biased processing draws on preexisting attitudes and other predispositions to influence subsequent evaluations of relevant content through mechanisms like selective perception. Selective perception is one of the many biases, or heuristics, people employ in the process of sense-making to direct attention, cognitive processing, and information storage in an efficient way.[88] Selective perception may be defined as a tendency to "see what you want to see" by prioritizing attitude-consistent message elements and ignoring other elements.[89,90] Individuals may evaluate the same image in completely different ways depending on which message elements are most consistent with their personal attitudes.

Thus, in the evaluation of media content, individual predispositions interact with media frames to influence the extent and nature of information processing.[91,92,93,94,95,96] Given the controversy surrounding hydraulic fracturing, preexisting attitudes in support of or opposition to this unconventional production technology should bias image perceptions, including evaluations of economic benefit and environmental cost framing. Individuals who are undecided on the issue should be more likely to perceive the media frames as intended, while those with more defined attitudes should be more likely to "see what they want to see." That is, those with stronger attitudes toward hydraulic fracturing should engage in more selective perception of the images presented, consistent with their preexisting attitude. Based on this discussion, we offer the following hypothesis:

H5. The influence of cost versus benefit framing on perceptions of hydraulic fracturing as either (a) an economic opportunity or (b) environmental hazard will vary by levels of issue support.

That is, participants with high support for hydraulic fracturing should be more likely to interpret images representing both visual frames as depicting hydraulic fracturing as an economic issue with net benefits than those with low support for hydraulic fracturing. Conversely, participants with low support for hydraulic fracturing should be more likely to interpret both economic opportunity and environmental hazard frames as an environmental issue with net risks than those with high support for hydraulic fracturing.

Finally, and consistent with the literature on affective framing, we offer the following hypothesis:

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H6. The influence of cost versus benefit framing on (a) positively valenced evaluations and (b) negatively valenced evaluations will differ by levels of support for hydraulic fracturing.

That is, supporters of hydraulic fracturing should be more likely to interpret images representing both economic opportunity and environmental hazard as positive depictions of hydraulic fracturing than those with low support for hydraulic fracturing. Meanwhile, participants with low support for hydraulic fracturing should be more likely to interpret images representing both visual frames as negative depictions of hydraulic fracturing than those with high support for hydraulic fracturing.

Given the current state of the literature on public perceptions of hydraulic fracturing, visual framing, and individual-level effects, the present study sought to integrate these contexts rather than treating each one separately to advance theory and practice.

Method

To address the above questions, data for the present study were collected online May 11–13, 2014, using a repeated measures experimental design. Participants responded to items asking about their preexisting attitudes and beliefs regarding hydraulic fracturing and then evaluated a series of news photos coded as either presenting the issue's economic benefits or environmental costs. Participants reported the extent to which individual images prompted them to perceive hydraulic fracturing as an economic or environmental issue and whether these frames were positively or negatively valenced.

Participants

Data were collected from a national adult sample of 250 participants using Amazon's Mechanical Turk (MTurk) online sampling service. Samples of MTurk respondents have been found to be more representative of American demographic distributions than student participant pools and other convenience samples.[97] Sample demographics reflected a diverse participant pool. Respondents ranged in age from eighteen to sixty-nine ($M = 36.19$, $SD = 12.07$), and 56 percent ($n = 139$) indicated they were male. In terms of race, a majority of the sample (69 percent, $n = 173$) reported their ethnicity as Caucasian. The majority of participants' household annual gross income was at or between $25,000 and $49,999, and 40 percent ($n = 101$) held a bachelor's degree or higher. To determine political ideology, participants were asked if they generally consider themselves to be more liberal or conservative on a 5-point response scale (1 = *very liberal*; 2 = *liberal*; 3 = *moderate*: *middle of the road*; 4 = *conservative*; 5 = *very conservative*). Forty-three percent ($n = 107$) identified as liberal or very liberal, 31 percent ($n = 77$) as moderate: middle of the road, and 25 percent ($n = 62$) as conservative or very conservative.

Procedure

Through MTurk, participants read a study announcement and elected to participate by clicking on a link directing them to the study. After completing a set of preliminary questions, including how much they had heard or read about fracking, their level of support for (opposition to) hydraulic fracturing, and willingness to live near a fracking site, participants were then randomly presented with seven of forty potential news images representing the economic benefit and environmental cost visual frames to evaluate. After viewing each image, participants answered a series of questions measuring the extent to which they perceived the image illustrated hydraulic fracturing as an economic or environmental issue. Affective evaluations of each image were also collected. The total number of responses for all images was $N = 1{,}750$, resulting in about 43 responses per image and 875 per frame. Lastly, participants completed items capturing general economic and environmental beliefs about hydraulic fracturing, political ideology, and demographic information.

News image selection

Real photojournalism was evaluated for use in the study, free of visual manipulation. To identify ecologically valid stimuli, a team of five researchers followed a multistep procedure to select the economic benefit and environmental cost-framed news images used in the study. Team members read news stories, blog posts, advocacy pages, and consulted other information sources that included both visual and textual information about hydraulic fracturing (both for and against the issue). Team members each selected twenty-four images they felt best represented the economic benefits and environmental costs visual frames. These images were compiled, and any duplicates were removed and replaced. The resulting initial sample included 120 images, or 60 images per frame.

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To narrow the sample further, the initial 120 images were viewed on a slide show and evaluated by team members in a group setting. Candidate images were removed for being too ambiguous, unrelated to hydraulic fracturing, or too similar to other images. Approximately sixty-four images (thirty-four economically framed and thirty environmentally framed) remained after the group evaluation. These sixty-four images were placed within an online questionnaire using the Qualtrics platform, and team members anonymously selected the twenty images that best represented each frame out of the sixty-four provided. The twenty images for each frame category (forty total) with the highest vote totals were again presented to the entire research team to confirm that the final selection of images was acceptable for research purposes.

The final sample then consisted of forty news images: twenty presenting economic benefits related to hydraulic fracturing and twenty presenting environmental costs. These photographs were predominantly taken by Associated Press and Getty photo staff members or appeared in known news outlets such as *USA Today*, *National Geographic*, *Bloomberg Businessweek*, *Cleveland Plain-Dealer*, *Wall Street Journal*, *Washington Times*, *Economist*, and *NBC News*, among others. A full list of images and sources is available from the first author. See the Appendix for example images.

Measures

Support for hydraulic fracturing. To determine preexisting support for hydraulic fracturing, participants provided a response to the following statement borrowed from related research:[98] "Hydraulic fracturing (fracking) is a way to extract natural gas from shale rock deep underground. Based on what you have heard or read about fracking, do you . . ." Response options ranged from 1 = *strongly oppose* to 5 = *strongly support* ($M = 2.60$, $SD = 1.17$). Support for hydraulic fracturing was employed as a moderator in the media framing analyses. For these analyses, level of support ($M = 1.74$, $SD = 0.79$) was transformed into a categorical variable and collapsed into three levels (1 and 2 = *low*, 3 = *undecided*, 4 and 5 = *high*). Prior to viewing the images, 47 percent ($n = 118$) of participants reported low support for hydraulic fracturing, 31 percent ($n = 78$) reported that they were not sure or were undecided on the issue, and 22 percent ($n = 54$) reported high support.

Economic and environmental issue beliefs. Economic issue belief ($M = 3.82$, $SD = 1.80$), which captures the extent to which participants consider hydraulic fracturing to be an economic issue, asked participants how strongly they agreed or disagreed with the following statement: "I view hydraulic fracturing as an economic issue (of creating jobs and bringing money into a community)" (1 = *strongly disagree*, 7 = *strongly agree*). Similarly, environmental issue belief ($M = 5.49$, $SD = 1.52$) tapped the extent to which participants considered hydraulic fracturing to be an environmental issue by having them respond to the following statement: "I view hydraulic fracturing as an environmental issue (of potentially harming the environment)." These items serve as dependent variables for the second hypothesis.

Economic and environmental image perceptions. Participants next indicated on a 7-point scale how strongly they agreed or disagreed with three statements describing an economic emphasis presented in each image and three statements describing an environmental emphasis presented in each image. These statements were adapted from existing framing studies in science communication.[99]

The following economic image perception statements were summed for the twenty economic benefit images and again for the twenty environmental cost images: "The image illustrates how hydraulic fracturing (fracking) enriches communities and improves the quality of life"; "The image illustrates how hydraulic fracturing (fracking) promotes economic investment/global competitiveness"; and "The image illustrates how hydraulic fracturing (fracking) is a public good." The totals for each statement were averaged to create an economic image perception scale measuring the extent to which participants perceived that the images presented hydraulic fracturing as an economic issue. Separate variables captured economic issue perceptions of the twenty economic benefit images ($\alpha = 0.942$; $M = 12.31$; $SD = 6.31$) and twenty environmental cost images ($\alpha = 0.953$; $M = 7.81$; $SD = 4.93$).

The same technique was used to construct environmental issue perception scales, which measured the extent to which participants perceived that the images presented hydraulic fracturing as an environmental issue, for both the economic benefit ($\alpha = 0.943$; $M = 13.03$; $SD = 6.98$) and environmental cost images ($\alpha = 0.950$; $M = 18.01$; $SD = 7.65$). The environmental cost frame statements were worded as follows: "The image illustrates the need for precaution when it comes to potential catastrophes related to hydraulic fracturing (fracking)";

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"The image illustrates how hydraulic fracturing (fracking) raises serious moral or ethical questions"; and "The image illustrates how hydraulic fracturing (fracking) exploits ordinary citizens to the benefit of industry and economic elites."

Positive and negative image evaluations. To measure valence perceptions of the visual frames, separate questions were asked to assess the extent to which the content of each image was positive and negative (1 = *not at all*, 7 = *very much*). Affective evaluations for each image were summed for the economic benefit ($M_{positive}$ = 12.44; $SD_{positive}$ = 7.07; $M_{negative}$ = 13.43; $SD_{negative}$ = 7.28) and environmental cost images ($M_{positive}$ = 7.78; $SD_{positive}$ = 4.64; $M_{negative}$ = 18.93; $SD_{negative}$ = 7.82). As discussed below, there were significant differences between issue, image, and valence perceptions for our visual frames.

Results

Hierarchical multiple regressions were conducted in order to test H1 and H2, which predicted associations between demographics (i.e., older age, male, higher educated, higher income, and more conservative), support for hydraulic fracturing, and economic and environmental issue beliefs about hydraulic fracturing. All model statistics and *t*-tests are reported in text while regression coefficients are reported in Table 1. For all framing analyses addressed by H3 through H6, repeated measures ANOVAs with between-subjects factors were run to assess the influence of level of support on issue perceptions and affective evaluations.

Predictors of hydraulic fracturing support

To test H1, a hierarchical multiple regression was performed. The first block, or step, of variables included familiarity with hydraulic fracturing as a control. However, it had no significant association with level of support. At step 2 all demographic variables, including age, sex, education, income, and political ideology, were entered. Results indicated that the model was statistically significant, suggesting partial support for H1, $R^2\Delta = 0.203$, $F(5, 230) = 11.94$, $p < 0.001$. About 22 percent of the variance in the model was accounted for by these five variables. Political conservatism was positively associated with support for hydraulic fracturing, $t(230) = 6.63$, $p < 0.001$, as was being male, $t(230) = 2.92$, $p = 0.004$ (see Table 1 for regression coefficients).

Table 1. Hierarchical regression predicting support for hydraulic fracturing, economic issue beliefs, and environmental issue beliefs.

Predictor	Support for HF	Economic beliefs about HF	Environmental beliefs about HF
	B	*B*	*B*
Step 1			
Familiarity with HF	−0.120	0.018	0.021
Step 2			
Age	−0.008	−0.017	0.003
Sex	0.417**	0.606**	−0.136
Education	0.090	0.201*	0.093
Income	0.026	0.034	−0.106
Political ideology	0.433***	0.552***	−0.421***
Step 3			
Support for HF		0.674***	−0.588***

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.
Abbreviations: HF = hydraulic fracturing.

Predictors of economic and environmental issue beliefs

Two additional regression analyses were conducted for H2. One analysis used economic issue beliefs about hydraulic fracturing as the dependent variable and the other environmental issue beliefs. The same predictors were entered into the regression analysis in three separate blocks for each dependent variable: step 1 was again the control variable, familiarity with hydraulic fracturing; step 2 included the five demographic variables; and step 3 was support for hydraulic fracturing.

The results of both regression analyses demonstrated support for H2. Notably, adding support for hydraulic fracturing in step 3 of the model predicting economic issue beliefs resulted in a significant increase in variance explained, $R^2\Delta = 0.148$, $F(1, 229) = 49.08$, $p < 0.001$, and produced a positive association between support and economic beliefs about hydraulic fracturing (H2a), $t(229) = 7.01$, $p < 0.001$. In the second analysis predicting environmental issue beliefs, adding support for hydraulic fracturing in step 3 of the model, also resulted in a significant increase in variance explained, $R^2\Delta = 0.161$, $F(1, 228) = 49.90$, $p < 0.001$, and produced a negative association between support and environmental beliefs about hydraulic fracturing (H2b), $t(228) = -7.06$, $p < 0.001$ (see Table 1 for regression coefficients).

Media framing analyses

Direct framing effects on cognitive perceptions and affective evaluations were proposed in hypotheses 3 and 4. Mean differences were examined to establish

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that the economic benefit-framed images fostered perceptions of hydraulic fracturing as an economic issue (H3) and presented the issue in a more positive light (H4) than the environmental cost-framed images. Mean differences were also examined to test whether the environmental cost-framed images fostered perceptions of hydraulic fracturing as an environmental issue (H3) and presented the issue in a more negative light (H4) than the economic benefit-framed images.

Two single-factor repeated measures ANOVAs were conducted to address H3, one with economic image perception as the two-level within-subjects factor (sum for the twenty economic benefit images and twenty environmental cost images) and one with environmental image perception as the within-subjects factor (again, the sum for the economic benefit images and environmental cost images). Mean scores for perceptions of the economic benefit-framed images illustrating economic issues were significantly higher than mean scores for perceptions of the environmental cost-framed images illustrating economic issues ($Ms = 12.14, 7.79$; $SDs = 6.00, 4.93$), $F(1, 244) = 81.82$, $p < 0.001$. Similarly, mean scores for perceptions of the environmental cost-framed images illustrating environmental issues were significantly higher than mean scores for the economic benefit-framed images ($Ms = 17.93, 12.92$; $SDs = 7.55, 6.82$), $F(1, 244) = 41.50$, $p < 0.001$. Thus, on average, the economic benefit-framed images were significantly more likely to be perceived as emphasizing economic issues, and the environmental cost-framed images were significantly more likely to be perceived as emphasizing environmental issues, providing support for H3.

Two more single-factor repeated measures ANOVAs were conducted to address H4, but here positive and negative image evaluations served as the within-subjects factors. Positive evaluations of the economic benefit-framed images were significantly higher than the environmental cost-framed images ($Ms = 12.11, 7.75$; $SDs = 6.44, 4.63$), $F(1, 244) = 78.00$, $p < 0.001$. By contrast, negative evaluations of the environmental cost-framed images were significantly higher than the economic benefit-framed images ($Ms = 18.84, 13.29$; $SDs = 7.73, 7.05$), $F(1,244) = 48.59$, $p < 0.001$. Thus, on average, the economic benefit-framed images were significantly more likely to evoke positively valenced evaluations, and the environmental cost-framed images were significantly more likely to evoke negatively valenced evaluations, producing support for H4.

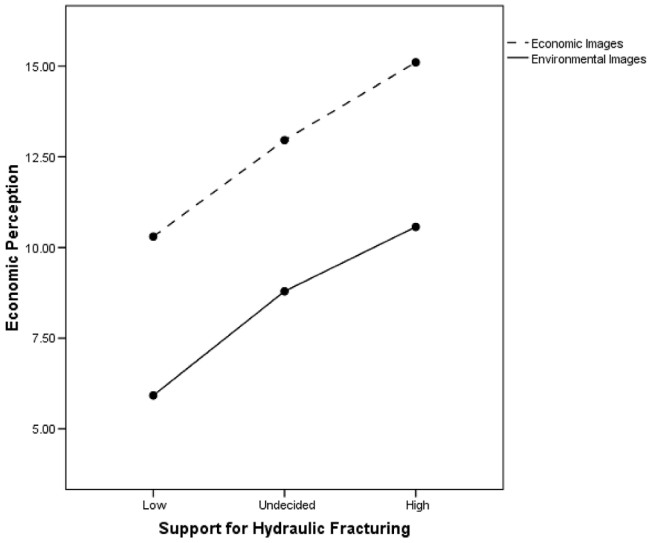

Figure 1. Economic issue perceptions of images by support for hydraulic fracturing.

Selective perception hypotheses

To observe the effect of potential bias in processing due to preexisting attitudes about hydraulic fracturing, another set of repeated measures ANOVAs were conducted, this time with the three-level support variable as a between-subjects factor. Hypotheses 5 and 6 predicted that issue perceptions and valence evaluations of the economic benefit and environmental cost frames would differ by level of support for hydraulic fracturing.

For H5a, economic image perceptions served as the within-subjects factor and support for hydraulic fracturing variable as the between-subjects factor. The between-subjects effect was significant, indicating that differences in economic image perceptions varied by level of support, $F(2, 242) = 35.49$, $p < 0.001$. Games-Howell comparisons (not assuming equal variances) were conducted, and differences were observed between all levels of support (see Figure 1). Those with high levels of support for hydraulic fracturing perceived both the economic benefit and environmental cost-framed images to illustrate economic issues ($M = 12.84$, $SE = 0.50$) significantly more than those with low levels of support ($M = 8.11$, $SE = 0.33$). Thus, H5a was supported. In addition, economic image perceptions of both visual frames among those who were undecided about their support for hydraulic fracturing ($M = 10.88$, $SE = 0.40$) were significantly different from both low ($p < 0.001$) and high issue supporters ($p = 0.036$).

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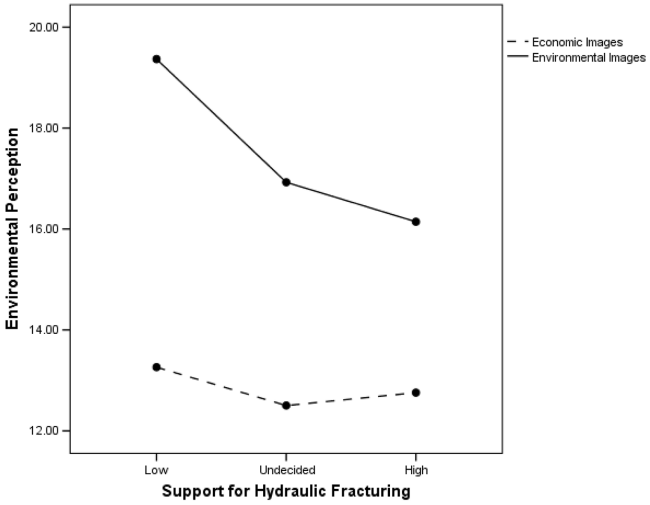

Figure 2. Environmental issue perceptions of images by support for hydraulic fracturing.

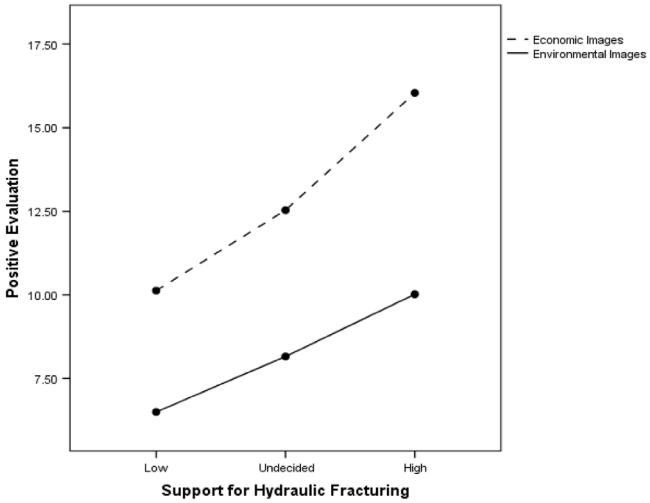

Figure 3. Positive evaluations of images by support for hydraulic fracturing.

From H5b, the environmental image perception variable served as the within-subjects factor, and another mixed between and within-subjects ANOVA model was run. The between-subjects effect was significant, indicating that environmental image perceptions also varied by level of support, $F(2, 242) = 6.39$, $p = 0.002$. Games-Howell comparisons were again conducted to observe mean differences (see Figure 2). Those with low levels of issue support perceived *both* the economic benefit and environmental cost-framed images as illustrating environmental issues ($M = 16.32$, $SE = 0.35$) to a significantly greater extent than those with high levels of support ($M = 14.45$, $SE = 0.53$). Environmental image perceptions among undecideds ($M = 14.71$, $SE = 0.43$) were also significantly different from those with low support ($p = 0.008$) but not significantly different from those with high support ($p = 0.921$). These results provide support for H5b.

H6a predicted that those with high support for hydraulic fracturing would be more likely to evaluate all images more positively than those with low support. Another repeated measures ANOVA was run with positive evaluations as the within-subjects factors and level of support as the between-subjects measure. The between-subjects effect was significant, indicating that differences in positive image evaluations varied by level of support, $F(2, 242) = 30.33$, $p < 0.001$. Games-Howell comparisons were conducted, and differences were observed between all levels of support (see Figure 3). Those with high levels of support evaluated *both* the economic benefit and environmental cost-framed images as significantly more positive than those with low levels of support ($Ms = 13.03, 8.31$; $SEs = 0.51, 0.34$), $p < 0.001$. Thus, H6a was supported. In addition, positive evaluations among undecided participants ($M = 10.34$, $SE = 0.42$) were significantly different from the evaluations of both high ($p = 0.003$) and low ($p < 0.001$) issue supporters ($Ms = 13.03, 8.31$; $SE = 0.51, 0.34$).

The negative evaluation variable served as the within-subjects factor for the final ANOVA model, and level of support again as the between-subjects factor. The between-subjects effect was significant, indicating differences in negative image evaluations varied by level of support, $F(2, 242) = 29.44$, $p < 0.001$. Games-Howell comparisons again revealed differences were observed between all levels of support (see Figure 4). Those with low levels of support for hydraulic fracturing evaluated images from both visual frames as significantly more negative than those with high levels of support ($Ms = 17.73, 13.28$; $SEs = 0.33, 0.50$), $p < 0.001$. Negative evaluations among undecideds ($M = 15.40$, $SE = 0.41$) were also significantly different from the mean evaluations of both low ($p < 0.001$) and high issue ($p = 0.007$) supporters ($Ms = 17.73, 13.28$; $SEs = 0.33, 0.50$). Thus, H6b was supported.

Discussion

Recent studies in environmental and science communication have begun to account for how individuals'

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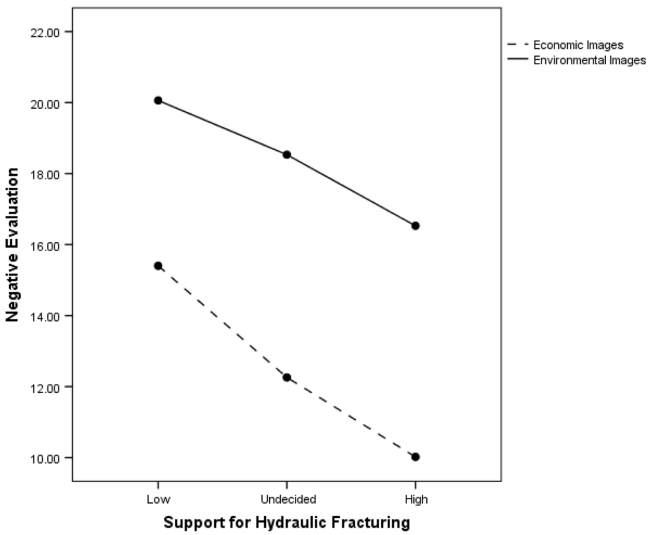

Figure 4. Negative evaluations of images by support for hydraulic fracturing.

emotions and motivational characteristics interact with message features to influence message processing, subsequent evaluations of content, and the understanding of and policy support for science, environment, and energy issues.[100] Although hydraulic fracturing is quickly becoming a salient topic in energy and environmental discussions, relatively few studies to this point have considered public understanding and perceptions of hydraulic fracturing.[101]

Inconsistent with previous research, our findings showed a fairly diverse range of support for (opposition to) hydraulic fracturing, albeit with a somewhat limited experimental sample, rather than indicating a majority of respondents are undecided on the issue. Partially replicated results from prior survey research[102,103] identified significant demographic predictors of support for hydraulic fracturing. Men were more likely than women to report support for hydraulic fracturing, as were political conservatives. However, despite these associations with sex and ideology, education and income were not significant predictors of support for hydraulic fracturing.

Findings from the present study also reinforce a connection between support for hydraulic fracturing and economic or environmental issue beliefs by first demonstrating a positive association between support and perceptions of this emerging production technology as an economic issue (of creating jobs and bringing resources into a community) and, second, a negative association between support and perceptions of hydraulic fracturing as an environmental issue (of potentially harming the environment). Further, these associations remained significant after accounting for a series of demographic controls.

Consistent with selective perception theory, supporters of hydraulic fracturing were more likely to perceive both the economic benefit and environmental cost-framed images as illustrating the economic issues of hydraulic fracturing and evaluated the images more positively than those with low support. Those with low support were more likely to perceive the images as illustrating the environmental issues of hydraulic fracturing and evaluated each visual frame more negatively than those with high support. For the most part, image perceptions and valence evaluations of those who were undecided about hydraulic fracturing were positioned in the middle of—and were significantly different from—the perceptions and evaluations of low and high issue supporters.

These results provide evidence for selective perception and reinforce the idea that viewers "see what they want to see" through the filter of their preexisting support for hydraulic fracturing. While selective perception is often discussed or strategically assumed, scant empirical research has attempted to observe this phenomenon systematically by issue or in relation to media images as opposed to texts. A growing number of news outlets are presenting options for photo-only news feeds, making the perceptual and evaluative consequences of visual framing all the more relevant. Yet limitations are apparent in the simplicity of the dichotomous economic benefits and environmental costs visual framing used in this study. Future research should investigate more nuanced content or structural features within images, such as emotional appeals or compositional elements to determine if slight changes could alleviate the influence of issue support. It also should be noted that most news images (such as those used in the present study) are accompanied by narrative content, which can also have an impact on issue perceptions and evaluations. Subsequent research should focus on examining textual and visual framing interactions.

Often motivated by the desire to educate and inform, journalists and other public communicators may neglect to take into account or anticipate the impact that images used to illustrate issues may have on differing segments of the news audience. This is something that typically does not escape the attention of strategic communicators working on one side of an issue. Hence, public

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communicators who simply wish to disseminate information about hydraulic fracturing should recognize that the images they use may convey a message different from the one intended. If maintaining neutrality is the goal, then presenting countervailing visual frames in information will cause audiences to see both sides of the issue—and less bias in the presentation. Visually presenting two sides of an issue may allow comparisons to be drawn and facilitate more complete understanding, whereas one-sided presentations could unintentionally reinforce preexisting attitudes or encourage selective (i.e., biased) processing.

Biased processing poses quite a challenge for strategic message designers who hope to influence those who are already decided as issue supporters or opponents. Based on the present study, the presentation of more extreme exemplar images may be necessary to break through an individual's cognitive bias and offset their preexisting attitude. For viewers opposed to hydraulic fracturing, extreme economic benefit may have to be apparent in an image before they would be open to perceiving the image content as an economic issue with possible benefit. For supporters, an extreme environmental risk may have to be clearly depicted before an image is perceived as an environmental issue worthy of attention. However, this suggestion should not be applied without further research examining the impact of extreme image frames on viewers with opposing issue positions. While this strategy may help make biased viewers more likely to perceive the framed image as intended, there is also research that shows such attitude incongruent information could impact their engagement with the message. Selective exposure research and theory would suggest that strong attitude holders would spend less time with or avoid incongruent message all together.[104,105,106,107]

Results of the present study perhaps of most interest and use to strategic message designers are the findings related to those undecided about their position on hydraulic fracturing. For those without a firm issue position, the type of visual frame presented significantly influenced perceptions and evaluations of the message conveyed by the image. For these undecided individuals, who constituted nearly a third of participants, an ambiguous or perhaps ambivalent position on the issue made them particularly susceptible to framing effects. Therefore, media framing that emphasizes a particular issue interpretation through the use of carefully selected visuals could be effective in swaying this segment of the public. Even so, media message competition is a notorious feature of the strategic communication environment, which makes one-sided frame exposure implausible. Further, this research only examined issue perceptions and affective evaluations after forced exposure to framed images. While the current study suggests undecided individuals interpret the image as intended, future research should investigate visual framing effects under conditions of free choice to determine the content factors necessary to produce engagement with hydraulic fracturing content in a more naturalistic context.

The current research demonstrates that attitudes toward a controversial issue, whether supportive, opposed, or undecided, serve as a perceptual filter that influences affective and evaluative responses. As with other contested policy areas, science communication faces an ongoing challenge due to the ever-changing nexus between technology, society, and the political climate surrounding issues like unconventional energy production. The identification of biased perceptions and affective evaluations of visual frames whose meaning would seem obvious unveils yet another barrier that strategic communicators with attitude conversion ambitions must consider. Follow-up studies could enhance our understanding of this dynamic process by not only investigating the impact of perceptual biases on other steps in the message engagement process, such as message selection and processing, but also on a broader range of measures including information search, interpersonal discussion, and other participatory outcomes so that informed, effective message-tailoring strategies can be developed.

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Appendix

Sample Images

Economic Benefit Frame

Environmental Cost Frame

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