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“Fracking” controversy and communication: Using national survey data to understand public perceptions of hydraulic fracturing

Hilary Boudet ^{a,*}, Christopher Clarke ^b, Dylan Bugden ^a, Edward Maibach ^b,
Connie Roser-Renouf ^b, Anthony Leiserowitz ^c

^a School of Public Policy, Oregon State University, 318 Fairbanks Hall, Corvallis, OR 97331, USA

^b Department of Communication, George Mason University, USA

^c School of Forestry and Environmental Studies, Yale University, USA

HIGHLIGHTS

- We conducted a survey of Americans' views on hydraulic fracturing in September 2012.
- A majority of Americans have heard little or nothing about hydraulic fracturing.
- Many Americans do not know if they support/oppose it or are undecided.
- Those who have made a decision are evenly split between support and opposition.
- Predictors of support include education, media use and top of mind associations.

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ABSTRACT

The recent push to develop unconventional sources of oil and gas both in the U.S. and abroad via hydraulic fracturing (“fracking”) has generated a great deal of controversy. Effectively engaging stakeholders and setting appropriate policies requires insights into current public perceptions of this issue. Using a nationally representative U.S. sample ($N=1061$), we examine public perceptions of hydraulic fracturing including: “top of mind” associations; familiarity with the issue; levels of support/opposition; and predictors of such judgments. Similar to findings on other emerging technologies, our results suggest limited familiarity with the process and its potential impacts and considerable uncertainty about whether to support it. Multiple regression analysis ($r^2=.49$) finds that women, those holding egalitarian worldviews, those who read newspapers more than once a week, those more familiar with hydraulic fracturing, and those who associate the process with environmental impacts are more likely to oppose fracking. In contrast, people more likely to support fracking tend to be older, hold a bachelor's degree or higher, politically conservative, watch TV news more than once a week, and associate the process with positive economic or energy supply outcomes. Based on these findings, we discuss recommendations for future research, risk communication, and energy policy.

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1. Introduction

The rapid development of unconventional sources of oil and natural gas using hydraulic fracturing has generated a great deal of controversy. Supporters have argued that fracking will spur economic growth, lead to more secure domestic energy supplies, and facilitate a rapid transition away from carbon-intensive, coal-based electricity generation (The Perryman Group, 2008;

Considine et al., 2010; Hultman et al., 2011; US Environmental Protection Agency, 2011). Opponents have focused on potential adverse impacts on public health, the environment, and communities in close proximity to these energy sources (Colorado Department of Public Health and Environment, 2010; Osborn et al., 2011; Perry, 2012; Stedman et al., 2012). Given these conflicts, understanding public support and opposition is critical for planners tasked with addressing siting disputes and other issues (Boudet and Ortolano, 2010); for government agencies attempting to establish appropriate regulations (New York State Department of Environmental Conservation, 2013); and for researchers, advocates, and others interested in communicating about potential impacts (Clarke et al., in press). Using a nationally

* Corresponding author. Tel.: +1 541 737 5375.

E-mail addresses: hilary.boudet@oregonstate.edu, hilschaf@gmail.com (H. Boudet).

representative sample ($N=1061$), we examine Americans' perceptions of hydraulic fracturing (i.e. "top of mind" associations); familiarity with the issue; levels of support/opposition; and predictors of such judgments. We draw on scholarship on public perceptions of emerging technology and discuss implications related to risk communication and energy policy.

1.1. What is hydraulic fracturing?

Hydraulic fracturing ("fracking") is a technique for tapping unconventional oil and gas reserves that are otherwise inaccessible. In the early 2000s, energy companies began combining horizontal (or directional) drilling with hydraulic fracturing to tap these reserves (Armstrong et al., 1995). The process involves drilling horizontally through a rock layer and injecting a pressurized mixture of water, sand, and other chemicals that fractures the rock and facilitates the flow of oil and gas (Pye and Pye, 1973). These combined methods have allowed for expanded oil/gas development in shale and other formations in the U.S., Europe, Asia, Australia, and elsewhere (Clarke et al., in press; Walsler and Pursell, 2007). The rapid expansion of fracking is projected to make the U.S. a net exporter of natural gas in the coming years (David, 2013) and potentially the world's largest oil producer by 2017 (Mackey, 2012). Shale gas, which currently accounts for 23% of the nation's natural gas production, is projected to increase to 49% by 2035 (US Energy Information Administration, 2012).

1.2. Impacts associated with hydraulic fracturing and unconventional oil/gas development

Hydraulic fracturing is just one part of the unconventional oil/gas development process, which also includes clearing land for well pads; construction of access roads and ancillary infrastructure (e.g., pipelines, compressor stations); transporting and processing fossil fuels extracted; transporting millions of gallons of water and wastewater for treatment/disposal; and bringing large (and often transient) populations to a community. These activities involve potential economic, environmental, social, and health impacts associated with rapid population growth in communities and boom-bust cycles of energy extraction (Jacquet, 2009). Both the extent and management of these impacts depend on numerous factors, including the development time frame (short- vs. long-term) and characteristics of the impacted area, such as population and the history of fossil fuel extraction (Brasier et al., 2011). We summarize some of the major issues that have emerged.

One of the biggest areas of contention involves the potential economic benefits of development, including job creation; increased income and wealth for individuals who sign gas leases on private lands; expanded local business opportunities for those who directly (i.e., construction) and indirectly service the energy industry (i.e., hotels and restaurants); and rising tax revenue for communities (Kay, 2011). For example, Theodori's (2009) key informants in two Texas counties with natural gas drilling in the Barnett Shale perceived increasing city revenues, property values, retail business, and household income; an expanding job market; and improving public services. Anderson's and Theodori's (2009) survey respondents from the same counties perceived a higher availability of good jobs. However, communities may face strains on public services such as schools, recreation facilities, water and sewage, and healthcare as well as infrastructure such as roads, all due to increased demand as new workers and industry move into an area (Jacquet, 2009). Anderson and Theodori's (2009) informants, for example, expressed concerns about increased truck traffic and damage to local roads as a result of nearby drilling.

A second major impact relates to water availability and quality. Hydraulic fracturing requires 2–10 million gallons of water per

well per fracture (Soeder and Kappel, 2009), which raises concerns about depletion of surface or ground water sources. Also, contamination of subterranean and surface water can occur because of the release into rivers and streams of inadequately treated drilling wastewater with potentially toxic materials; surface spills of chemicals; and methane migration from gas wells into aquifers (Kargbo et al., 2010). Instances of water contamination allegedly tied to unconventional oil/gas drilling (Osborn et al., 2011) have prompted the Environmental Protection Agency (2011) to examine the relationship between hydraulic fracturing and drinking water quality from an environmental and a public health perspective. Federal and state agencies have also issued regulations related to the disclosure of the chemical components of hydraulic fracturing fluid (Groeger, 2012). Such issues have influenced public perceptions of hydraulic fracturing. For example, Anderson's and Theodori's (2009) Texas informants listed water availability and groundwater depletion as concerns. Theodori's (2009) survey respondents stated that the "amount of freshwater used by gas producers," the "depletion of aquifers," and "water pollution" were all increasing.

Social impacts are a third area of focus, as they involve a community's ability to accommodate the frenzied activity associated with an energy development boom. Brasier et al. (2011) noted that social impacts include "[increased] stress, [changing] patterns of interactions within communities, [decreased] community cohesion, and [changing community] character" as new people move to a community to seek employment (p. 36). As a result, "individuals' quality of life, ties to community members, and mental and physical health [could] also be affected, leading to increases in social problems" (p. 36). For example, Theodori's (2009) respondents believed that "crime," "respect for law and order," and "disagreements among local residents" were becoming worse due to natural gas drilling. However, evidence suggests that, over time, communities can adapt to at least some of these changes (Brown et al., 2005).

1.3. Opinion polling data on public perceptions of hydraulic fracturing

Numerous national and state-level public opinion polls have focused on public perception of unconventional oil/gas development using hydraulic fracturing. National polling data points to somewhat strong public support for hydraulic fracturing, but with a sizable minority unsure or lacking familiarity with the issue. For example, a Pew Research Center for the People and the Press (2012) poll found that only 26% of Americans had heard a lot about the issue, 37% had heard a little, and 37% had heard nothing at all. Among those who had heard of it, 52% favored its use, and 35% were opposed. Similarly, the National Energy Opinion Poll (Vedlitz, 2012) found that only 21% of respondents reported "significant knowledge" about hydraulic fracturing, and a non-representative 2012 University of Texas Energy Poll (2013) found that just 32% of respondents were familiar with it.

Opinion polling in states with active and/or proposed unconventional oil/gas development suggests more familiarity with hydraulic fracturing than at the national level. A 2011 survey of Pennsylvania residents found that 48% followed natural gas drilling in the Marcellus Shale "somewhat" or "very" closely. Forty-one percent felt that it was generating more benefits than problems; 33% said the problems were exceeding the benefits; and 26% said that benefits and problems were emerging in equal proportions. For perceptions of future benefits and problems, the figures were 50% expecting more benefits than problems, 32% more problems than benefits, and 17% about equal (Rabe and Borick, 2011). Similarly, a Quinnipiac University (2012a) poll found that 64% of Ohio residents believed that the economic benefits of hydraulic fracturing outweighed the environmental risks, and 85%

believed it would bring jobs to the state. In New York, where the process is on hold pending environmental review, residents were more divided. Forty-four percent of New Yorkers were opposed and 43% in favor. Also, 45% believed that the economic benefits would outweigh environmental concerns; 81% felt drilling would create jobs; and 48% thought it would damage the environment (Quinnipiac University, 2012b).

2. Literature review

Opinion polls offer insights into public perceptions of hydraulic fracturing as well as overall levels of support and opposition. However, they tell us little about what factors shape these perceptions. In the following sections, we explore relevant factors and present hypotheses about the forces driving support/opposition by drawing on several strands of literature. The first is literature on perceptions of locally unwanted land uses (LULUs). Hydraulic fracturing involves substantial changes in land use to accommodate well pad drilling, the construction of access roads and pipelines, and other facets of the development process (Jacquet, 2012). It also entails potential conflict over impacts associated with these activities and the distribution of risks and benefits. The second is the literature on public perceptions of emerging technologies and energy development specifically. Unconventional oil/gas development is arguably an emerging technology involving a novel combination of horizontal drilling and hydraulic fracturing. Thus, public perceptions are likely a product of factors that have been the focus of considerable investigation in other contexts: socio-demographics; perceptions of risks and benefits; affective imagery; geographic proximity; and worldviews (Hunter and Leyden, 1995; Scheufele and Lewenstein, 2005; Leiserowitz, 2006; Besley, 2010; Visschers and Siegrist, 2013).

2.1. Socio-demographics

Socio-demographic characteristics have figured prominently in studies of public support/opposition to energy and non-energy technologies (Ho et al., 2011). Women tend to have a higher perception of risks and are less supportive of emerging technologies than males (Siegrist et al., 2007). Similar patterns hold for racial minorities. For example, Ansolabehere and Konisky (2009) found that minorities and women were more strongly opposed to the siting of natural gas, coal, nuclear, and wind power facilities within 25 miles of their home. Scholars have offered several possible explanations of this “white male effect” – that white males tend to report lower risk perceptions than others – including “reduced social and formal decision-making power held by women and minorities as compared with white men; to women’s greater role as caregivers; to the greater likelihood of exposure to environmental harm facing members of minority groups; and to income, education, and political orientation” (Flynn et al., 1994; Satterfield et al., 2004, p. 116; Kahan et al., 2007).

Evidence related to age, income level, and formal education is less consistent. Older age predicts opposition to new energy technologies, such as wind power (Firestone and Kempton, 2007). Higher education and income are associated with opposition to natural gas drilling (Jacquet, 2012) but support for wind power (Firestone and Kempton, 2007).

To our knowledge, no academic studies have focused on how socio-demographic factors predict hydraulic fracturing support/opposition. Opinion polls, however, have shown a strong gender divide, with more men in favor and more women opposed (Quinnipiac University, 2012b). In addition, education has been associated with awareness of the issue. The Pew Research Center

for the People and the Press (2012) poll found that 80% of those with college degree had heard about hydraulic fracturing versus 64% with some college (but no degree) and 51% with a high school diploma or less. To the extent that more formal education prompts individuals to seek more information about hydraulic fracturing and provides them with the skills to interpret what is found – a proposition consistent with work in other areas (Niederdeppe, 2008) – it is possible that awareness and information may focus on negative impacts (a phenomena we describe below).

Overall, the role of socio-demographics in predicting support of/opposition to energy development may depend on the type of energy in question (i.e. renewable versus fossil fuel-based). Based on such insight, we propose the following hypotheses:

- H1: Age will be positively associated with support for hydraulic fracturing;
- H2: Higher income levels will be negatively associated with support;
- H3: Females will have lower levels of support than males;
- H4: Formal education will be negatively associated with support; and,
- H5: Non-white minority race will be negatively associated with support.

2.2. Risk/benefit perception and affective imagery

Regardless of the type of energy development, perceived risks and benefits are consistently strong predictors of opposition or support – on both the individual and community level (Lesbirel and Shaw, 2005; Pidgeon and Demski, 2012; Visschers and Siegrist, 2013). Specific issues include environmental impacts such as damage to the landscape or wildlife; esthetic impacts associated with visible features such as wind turbines; and economic considerations such as local job creation and the cost of electricity (Devine-Wright, 2005; Firestone and Kempton, 2007). Moreover, scholars increasingly recognize that these judgments reflect not only the likelihood of an impact occurring and its consequences but also psychological, social, moral, and cultural considerations (Leiserowitz, 2005). In particular, the role of affect and affective imagery is gaining more widespread attention. Leiserowitz (2005, p. 1436) defined affect as “the specific quality of ‘goodness’ or ‘badness’ experienced as a feeling state (with or without conscious awareness) or the positive or negative quality of a stimulus.” Since reliance on affect is a quicker and more efficient way to process information, it helps direct “fundamental psychological processes such as attention, memory, and information processing” (Slovic et al., 1998, p. 292), including perceptions of risks and benefits. In particular, affect can orient us to risks and benefits that evoke a negative or positive reaction. These reactions, in turn, are based on recall of affect-laden images from memory (Lorenzoni et al., 2006).

Affective imagery is “broadly construed to include sights, sounds, smells, ideas, and words, to which positive and negative affect or feeling states have become attached through learning and experience” (Slovic et al., 1998, p. 3). Building on the availability heuristic (Keller et al., 2006), which suggests that information that is more easily recalled is more readily used in decision-making, affective images serve as “top of mind” associations that influence perceptions of risks and benefits as well as support/opposition to specific issues (Lee et al., 2005). For example, Leiserowitz (2005) argued that one reason climate change evokes relatively low levels of concern among Americans is that it conjures images of more distant, non-human risks such as melting glaciers that do not evoke an affective reaction. Moreover, Keller et al.’s (2012) study of Swiss perceptions of replacing aging nuclear reactors with new reactor technology found that opponents were more likely to

associate nuclear power plants with negative images such as accidents, radioactivity, waste disposal, military uses, and consequences for health and environment. In contrast, supporters associated nuclear power plants with positive connotations such as energy, necessity, and the “appearance” or “look” of the plants.

Applying this research to hydraulic fracturing would suggest that support/opposition is informed by perceptions of positive or negative impacts, which in turn are a function of the affect-laden images that people associate with such impacts. On one hand, positive connotations of jobs in local economies and rising wealth for landowners who would profit from oil/gas drilling leases likely make perceived benefits loom large. On the other hand, images of contaminated drinking water and strains on communities are likely to make perceived risks more salient. Since it is difficult to hypothesize the types of images that may emerge a-priori, we offer the following research questions:

RQ1: What affective images do people associate with hydraulic fracturing?

RQ2: How do specific images relate to hydraulic fracturing support/opposition?

2.3. Geographic proximity and location

Geographic proximity to areas of energy development, such as distance from one's home, is an often-studied predictor of support/opposition, although scholars have found mixed results (Braunholtz, 2003; Johansson and Laike, 2007; Swofford and Slattery, 2010). The NIMBY (Not in My Backyard) phenomenon is a common explanation for a situation where close proximity is associated with strong opposition. However, NIMBY remains an insufficient and overly simplistic explanation, especially when distance is associated with *greater* support (Devine-Wright, 2005). For example, Jacquet's (2012) study of wind turbines and natural gas wells in northern Pennsylvania found that the closer survey respondents lived to wind turbines, the more positive their attitudes. However, no relationship was found between distance and attitudes towards the gas wells. Some scholars, therefore, have called for moving beyond geographic notions of proximity to explore more abstract concepts such as emotional and psychological attachment to a given place. For example, scholars studying perceptions of wind farm development often find that people are concerned that it will mar a landscape's esthetic value, even if turbines are located offshore and relatively far from residences (Devine-Wright, 2005).

Unfortunately, our present study does not allow us to explore more abstract notions of proximity in relation to perceptions of hydraulic fracturing. However, we believe that focusing on a respondent's geographic *location* still has value given the spread of unconventional oil and gas drilling to all areas of the country and the potential for different types of experiences and impacts depending on location. At the same time, research specific to hydraulic fracturing has found mixed evidence for the role of geographic location in shaping perceptions of this issue. A Pew Research Center for the People and the Press (2012) survey found no substantive difference in perceptions as a function of the respondents' geographic location (i.e. Northwest, Midwest, South, and West), although the large-scale of these categories may mask importance within region variation. Vedlitz (2012) found that respondents from the Northeastern and Western U.S. were more opposed. Thus, given the lack of clear empirical data on this issue, we offer the following research question:

RQ3: Does hydraulic fracturing support/opposition differ depending on geographic location?

2.4. Worldviews

In recent years, scholars have increasingly focused on how worldviews shape risk perception and decision-making. Based on Douglas and Wildavsky (1983) work on risk and cultural theory, worldviews are “general social, cultural, and political attitudes toward the world” that help explain “how individuals and groups interpret the world in different, yet patterned ways” (Leiserowitz, 2006, p. 49). Douglas's worldview types are a product of an individual's orientation toward or avoidance of social groups/interactions as well as views on the appropriateness of societal rules in constraining individual behavior. From this two- (high/low group orientation) by-two (positive/negative views on behavioral constraint) matrix, four types of worldviews emerge: hierarchist, fatalist, individualist, and egalitarian. An individual's attention to and perception of specific risks that threaten these worldviews, and preferred management for those risks, differ according to his or her worldview (Kahan et al., 2009). For example, hierarchists are wary of risks that threaten a perceived status quo in society and believe strongly in risk management by ‘experts’. Individualists are concerned with risks that threaten personal autonomy and the sanctity of markets, such as government regulation. Egalitarians are sensitive to issues associated with social injustice, including perceived unfair distribution of risks and benefits within and across social groups.

In the context of hydraulic fracturing, we would expect these worldviews to predict support/opposition in different ways. For example, individualists may favor it, and drilling for oil/gas overall, in deference to the status quo (i.e. a society that relies heavily on fossil fuels) and the power of markets to decide whether/where unconventional oil and gas development is economically feasible. However, egalitarians may be more opposed out of concern that the benefits and risks of development – both to humans and the environment – may be asymmetrically distributed (Dake, 1992). Issues of equity have featured prominently in debates over many energy and non-energy technologies (Mnyusiwalla et al., 2003; Brasier et al., 2011). For example, Jacquet (2012, p. 677) noted that “public debate in the U.S. around energy development has largely characterized landowners who have the potential to receive direct benefit (in the form of lease payments and royalties for energy production) as vehement supporters of energy development and those who will not receive such benefits (because they do not own land that is suitable for energy development) as chief opponents.” Based on these findings and relationships, we offer the following hypotheses related to hydraulic fracturing:

H6: Egalitarian worldviews will be negatively associated with support for hydraulic fracturing;

H7: Individualist worldviews will be positively associated with support.

2.5. Political ideology

Political attitudes can also shape support or opposition to potentially risky technologies (Rothman and Lichter, 1987; Wildavsky and Dake, 1990). Political ideology may be of particular importance in the case of energy and environmental issues, in which partisan divisions color much of the debate (Kamieniecki, 1995; Smith, 2002). National polling on energy development has shown that conservatism is a strong predictor of support for fossil fuel development (Pew Research Center for the People and the Press, 2012). Polling specific to hydraulic fracturing has shown that Republicans/conservatives are more supportive and Democrats/liberals more opposed (Pew Research Center for the People and the Press, 2012). Thus, we hypothesize that:

H8: Liberals will have lower levels of support than conservatives.

RQ5: Does hydraulic fracturing support/opposition differ depending on familiarity with the issue?

2.6. Media use

Risk communication research suggests that media coverage can affect risk perception and acceptance of new technologies, serving an important agenda-setting function by determining what is “newsworthy” (McCombs and Shaw, 1972; Flynn et al., 1998). However, the magnitude and direction of this effect depends on the medium, message, and viewer.

In terms of medium, scholars contend that television coverage provides less in-depth, more emotional coverage based on particular events, and an orientation toward individual episodes or situations. In contrast, newspapers provide more information and analysis, presenting coverage with an orientation toward broader themes and processes (Iyengar, 1991; Driedger, 2007). Fewer studies examine the role of internet or radio in public acceptance of new technologies. However, some scholars have suggested that, because of its increased speed of information flow and accessibility, the potential for advocacy on the internet is far greater than for other channels of communication (Krimsky, 2007). What these findings mean for perceptions of hydraulic fracturing is unclear. For example, both potential positive impacts (such as an in-depth look at job creation in an energy “boomtown”) and negative impacts (such as a community experiencing environmental harm) potentially lend themselves to event-driven reporting. Thus, the content of the message, not just the medium, becomes important to consider.

Analysis of newspaper coverage of hydraulic fracturing has shown it to be largely negative and focused on environmental issues, particularly water quality impacts (Evensen et al., in press; Davis and Hoffer, 2012). We are unaware of work aimed at understanding the content of such news coverage in other media. However, comparisons of print and online coverage of other emerging technologies has found online coverage to be more varied and environmentally-themed (Cacciatore et al., 2012) but also more biased and less comprehensive (Gerhards and Schäfer, 2010). Of course, any effects of such coverage on perceptions of hydraulic fracturing would be contingent on audience characteristic, such as motivations for engaging with the information presented. To the extent that people with an already strong view on this issue seek out media sources and messages that reaffirm this viewpoint, a scenario consistent with research on selective exposure (Stroud, 2008; Williams, 2011), news media coverage would be expected to reinforce public opinion. Given the lack of clear empirical data on this issue, we offer the following research question:

RQ4: Does hydraulic fracturing support/opposition differ depending on media use?

2.7. Familiarity

In general, risks that are perceived to be ‘unknown’ have engendered opposition (Slovic, 1987). Thus, we might expect limited familiarity of hydraulic fracturing to be associated with opposition. However, given that content analysis has found coverage of hydraulic fracturing to be largely negative, we might expect those who are more familiar with hydraulic fracturing to oppose it. Recent polling, moreover, indicates that more familiarity leads to opposition (Brooks, 2013). Given these competing views, we offer the following research question:

3. Methods

3.1. Survey sample

We included four¹ questions about hydraulic fracturing as part of the September 2012 Climate Change in the American Mind (CCAM) survey, a biannual online survey of a representative sample of Americans on issues related to climate change. CCAM surveys are fielded by Knowledge Networks, which recruits a large-scale, nationally representative participant panel using random digit dialing and address-based sampling to ensure that cell phone-only households are also included in the sampling frame. The company provides small incentives as well as a free netbook and internet service to those without computers to help ensure their participation. The survey was conducted from the 7th to the 13th of September 2012. From an initial sample of 1960 Americans, 1061 completed the survey – a completion rate of 54.1% and a cumulative response rate of 5.2% (Callegaro and DiSogra, 2008). The margin of error was 3% at the 95% confidence level. The CCAM survey took about 10 to 15 minutes to complete. Results are weighted to conform to the demographic structure of the U.S. population.

3.2. Variable measurements

Table 1 provides a full list of all variable measures, including socio-demographics, geographic location; political ideology; worldviews; media consumption; respondent familiarity with hydraulic fracturing; and support/opposition. Below, we briefly discuss two variables that required additional analysis: affective imagery and worldviews.

To measure affective imagery, respondents were asked the first thing that comes to mind when they think of “fracking” (see also Leiserowitz, 2005, 2006; Lorenzoni et al., 2006). Affective images were categorized using an iteratively developed coding scheme. The third author then coded all entries, and the second author double-coded a subset to establish inter-coder reliability. The first subset of 120 entries (11% of the sample) yielded a Krippendorff’s alpha of .75 (where 1.0 indicates perfect agreement and reliability). We discussed discrepancies, made revisions to the coding scheme, and analyzed 30 more entries. The second round of coding achieved an alpha of .91, which is considered strongly indicative of reliability.

Worldviews were operationalized using a reduced set of eight questions adapted from Dake (1991, 1992), Peters and Slovic (1996), and Rippl (2002). Respondents were asked to endorse statements using the scale 1 (strongly disagree) to 4 (strongly agree). Principle components analysis revealed a 2-factor solution that is consistent with previous research. Factor 1 (Eigenvalue=3.242; 40.5% of variance explained; all factor loadings >.79) reflected three questions pertaining to egalitarian worldviews. All three questions were averaged to form a composite index. Factor 2 (Eigenvalue=2.028; 25.5% of variance explained; all factor loadings >.63) reflected five questions pertaining to individualist worldviews. All five such questions were averaged to form a composite index.

¹ The fourth question asked whether the respondent thought fracking is a “good or a bad thing” on a scale from –3 to +3. Responses to this question were highly correlated with fracking support/opposition and thus are not included in this analysis.

Table 1
Variable measurements and descriptive statistics.

Variable	Question(s)/categories	Descriptive statistics
Age	What is your age?	$M=49.94$, $SD=16.8$
Household income	What is your annual household income? A range of income levels was provided in increments of \$2499. The final category was "\$175,000 or more".	61.5% of respondents earned \$50,000 per year or more
Gender	0=Male 1=Female	48.4% female
Educational attainment	1=Less than high school 2=High school 3=Some college 4=Bachelor's degree or higher	12% – Less than high school 30% – High school 29% – Some college 29% – Bachelor's degree or higher
Race/ethnicity	1=White, non-Hispanic 2=Black, non-Hispanic 3=Other, non-Hispanic 4=Hispanic 5=2+ Races, Non-Hispanic	67% – White, non-Hispanic 12% – Black, non-Hispanic 6% – Other, non-Hispanic 14% – Hispanic 1% – 2+ Races, non-Hispanic
Geographic location	1=Northeast 2=Midwest 3=South 4=West	18% – Northeast 23% – Midwest 36% – South 23% – West
Worldviews	Please tell us whether you agree or disagree with the statements below: 1=Strongly disagree 2=Somewhat disagree 3=Somewhat agree 4=Strongly agree	–
Egalitarian worldviews	The world would be a more peaceful place if its wealth were divided more equally among nations. In my ideal society, all basic needs (food, housing, health care, and education) would be guaranteed by the government for everyone. I support government programs to get rid of poverty.	$M=2.42$; $SD=.8$; $\alpha=.76$
Individualist worldviews	If the government spent less time trying to fix everyone's problems, we'd all be a lot better off. Our government tries to do too many things for too many people. We should just let people take care of themselves. The government interferes too much in our everyday lives. Government regulation of business usually does more harm than good. People should be allowed to make as much money as they can, even if it means some make millions while others live in poverty.	$M=2.69$; $SD=.77$; $\alpha=.86$
Political ideology	In general, do you think of yourself as... 1=Very liberal 2=Somewhat liberal 3=Moderate/middle of the road 4=Somewhat conservative 5=Very conservative	$M=3.14$; $SD=1.08$
Media use	How often do you turn to the following media sources to keep up with current news and world events? Television (traditional or online) Radio (traditional or online) Newspapers (print or online) Internet-only sources (i.e. blogs) 1=Less than once a month 2=About once a month 3=Several times a month 4=About once a week 5=Several times a week 6=Every day	% of sample consuming media ≥ once a week: Television (76%) Radio (53.8%) Newspapers (61.2%) Internet (41%)
Familiarity with fracking	How much have you ever heard or read about fracking? 1=Not at all 2=A little 3=Some 4=A lot	$M=2.15$; $SD=1.1$
Fracking support/opposition	"Fracking" is a way to extract natural gas from shale rock deep underground. Based on anything you may have heard or read about fracking, do you... 1=Strongly oppose it 2=Somewhat oppose it 3=Somewhat support it 4=Strongly support it	$M=2.6$; $SD=1.1$

3.3. Data analysis

We first ran descriptive statistics on all variables (see Table 1). To examine predictors of hydraulic fracturing support/opposition, we developed a hierarchical multiple regression model, which allowed us to enter specific variables into separate blocks and explore the changes in explained variance in the overall model as each block was added to the analysis.

4. Findings

4.1. Americans' familiarity with and perceptions of hydraulic fracturing

Most of our 1061 respondents answered the questions about how much they had heard or read about hydraulic fracturing ($N=1060$) and the extent to which they supported or opposed it ($N=1056$). In terms of the former, 13% did not know how much they had heard; 39% had heard nothing at all; 16% heard "a little"; 22% heard "some"; and 9% heard "a lot." In terms of support/opposition, 58% did not know/were undecided; 20% were somewhat/strongly opposed; and 22% were somewhat/strongly supportive. Only those who were supportive or opposed were included in the regression analysis ($N=435$).²

4.2. Affective imagery – "Top of mind" associations with fracking

As part of RQ1, we explored respondents' "top of mind" associations related to hydraulic fracturing. All but one respondent (1060) provided an association. Fifty-eight percent specifically indicated that they did not know anything about the issue or responded with a statement that we considered irrelevant (such as "Battlestar Galactica") or lacking specific detail to determine its relevance (i.e. "breaking" or "cracking"). A further 32% provided associations specifically related to oil/gas or the process of hydraulic fracturing (such as "drilling for natural gas" and "pumping silica sand into shale formations underground to extract natural gas").

Comparatively few respondents mentioned impacts associated with hydraulic fracturing, including environmental impacts such as water quality/contamination (7%); economic or energy supply/independence impacts such as "job creation" and "cheap energy" (3%); and social impacts such as "effects on property and people" in energy development communities (1%).

4.3. Regression results predicting hydraulic fracturing support/opposition

In organizing our hierarchical multiple regression model (see Table 2), demographics (age, income, gender, education and race) were the first variables entered, followed by geographic location, worldviews, political ideology, media use frequency, familiarity with fracking, and "top of mind" associations. Results of the analysis ($R^2 = .49$) supported some, but not all of our hypotheses, and provided crucial insight into our research questions. Overall, the following hypotheses were supported:

H1: Age was positively associated with support ($\beta=.129$, $p < .01$);

H3: Female gender was a negative predictor of support ($\beta = -.174$, $p < .001$);

H6: Egalitarian worldviews were negatively associated with support ($\beta = -.284$, $p < .001$); and,

H8: Conservative political ideology was a positive predictor of support ($\beta = .28$, $p < .001$).

The following hypotheses were *not* supported:

H2: Household income was not predictive of support;

H4: Formal education, which we hypothesized to be negatively related to support, in fact *positively* predicted support ($\beta = .114$, $p < .01$);

H5: Race (white/non-white) was not predictive of support; and,

H7: Individualist worldview was not predictive of support.

In terms of our research questions, RQ2 explored whether specific "top of mind" associations for hydraulic fracturing were predictive of support/opposition. We found that mentioning environmental impacts was negatively associated with support ($\beta = -.281$, $p < .001$), while mentioning economic or energy supply/independence outcomes positively predicted support ($\beta = .098$, $p < .05$). In terms of RQ3 (the potential predictive role of geographic location), we did not find any significant results. For RQ4 (the role of media use), frequent TV use was a strong positive predictor of support ($\beta = .163$, $p < .001$), while frequent newspaper use was a strong negative predictor ($\beta = -.162$, $p < .001$). Finally, for RQ5, we found that increasing familiarity with hydraulic fracturing was negatively associated with support ($\beta = -.089$, $p < .05$).

5. Summary and discussion

In this study, we explored factors that shape Americans' views on hydraulic fracturing, which is becoming an increasingly large part of unconventional oil/gas development. We drew on a wide array of literature across different disciplines and focused on the role of socio-demographics, geographic location, worldviews, political ideology, media use, issue familiarity, and affective imagery. Our findings have important implications for energy policy and risk communication. Broadly speaking, our results paint a picture of an American populace that is largely unaware of and undecided about this issue. Over half of those surveyed had heard nothing at all or only a little about it, and more than half didn't know or were undecided about whether to support or oppose it. Among the minority who has formed an opinion, respondents were nearly split between support and opposition. In one sense, these findings are not particularly surprising. Polling has frequently found the public to be uninformed about specific issues (Smith, 1989; Carpini and Keeter, 1997; Althaus, 2003; Klick and Smith, 2010).

Our regression results indicate that, among those who have taken a position, opponents tend to be women, hold egalitarian worldviews, read newspapers more than once a week, are more familiar with hydraulic fracturing, and reference environmental impacts associated with hydraulic fracturing. In contrast, supporters tend to be older, hold a bachelor's degree or higher, are politically conservative, watch TV for news more than once a week, and reference economic or energy supply impacts.

Our findings related to socio-demographics parallel the findings from literature on risk perception and public acceptance of emerging technologies (Besley, 2010), with the exception of education. We hypothesized that increased education would lead to less support for hydraulic fracturing but found the opposite. This result may relate to the controversial role of natural gas in our

² Using the entire sample, we also ran an analysis with similar predictors and a binary dependent variable (did not state an opinion on fracking vs. stated an opinion) using logistic regression. However, our model was unable to classify those who did not state an opinion.

Table 2
Hierarchical multiple regression predicting determinants of hydraulic fracturing support (coded high).

	(β)	T (sig)
(Constant)		6.364***
Age	.129**	2.994
Household income (1 = \geq \$50,000/year)	-.032	-.766
Gender (1 = Female)	-.174***	-4.483
Education (1 = Bachelor's degree or higher)	.114**	2.671
Race (1 = Non-white)	.027	.679
R ² change	.059	-
F-Change (4, 412)	4.375**	-
Geographic location – South	.008	.155
Geographic location – Northeast	-.035	-.72
Geographic location – West	-.082	-1.676
R ² change	.023	-
F-Change (1, 405)	2.826*	-
Egalitarian worldview index	-.284***	-6.209
Individualist worldview index	.059	1.539
R ² change	.204	-
F-Change (2, 410)	49.033***	-
Political ideology (very liberal – very conservative)	.28***	6.182
R ² change	.094	-
F-Change (1, 405)	51.707***	-
TV use frequency (1 = Once a week or more)	.163***	3.758
Radio use frequency (1 = Once a week or more)	-.037	-.837
Newspaper use frequency (1 = Once a week or more)	-.162***	-3.662
Internet use frequency (1 = Once a week or more)	.011	.264
R ² change	.043	-
F-Change (4, 406)	6.246***	-
Heard “some” or “a lot” about fracking (1 = Yes)	-.089	-2.079
R ² change	.014	-
F-Change (1, 404)	8.258**	-
General (open-ended) comments about oil, gas, and energy; references to the process of fracking (1 = Yes)	.009	.227
References to environmental impacts associated with fracking (1 = Yes)	-.281***	-6.9
References to economic, energy supply impacts associated with fracking (1 = Yes)	.098*	2.495
References to social impacts associated with fracking (1 = Yes)	.000	.007
R ² change	.082	-
F-Change (5, 399)	14.196***	-
Overall F (20, 333)	17.92***	
Overall adjusted R²	.49	

Note: Significant regression coefficients are in **BOLD** (not including un-standardized constant); pairwise deletion used to address missing data.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

energy future – either as a bridge to renewable energy or a bridge to nowhere because of continued reliance on fossil fuels (Boudet, 2011). Perhaps those with more education are more aware of this debate and increasingly side with the bridge to renewables argument: a hypothesis that should be explored in future work.

While the regional location block proved significant, specific regional coefficients did not. A large body of literature suggests that public perceptions of energy development vary across spatial scales, with location sometimes, but not always, predicting support and opposition. Future work should analyze the role of geographic location in shaping public perceptions of hydraulic fracturing in a more nuanced manner. Such work will be of particular importance for policy makers seeking to balance the needs of local communities grappling with unconventional oil/gas development with those of broader regional populations. These areas may be impacted by such development in different ways. Jacquet (2012), moreover, suggested that researchers focus less on the region and proximity to development and instead examine personal experience with it. For example, Jacquet found that northern Pennsylvania respondents with ties to the natural gas industry, including those leasing land for development or having

worked for the industry, tended to express greater support for natural gas drilling.

Egalitarian worldviews, political ideology, and affective (“top of mind”) imagery proved to be particularly strong predictors of support/opposition. Again, this finding is not unexpected given other work on how people form judgments about the perceived risk of emerging technologies and issues, both energy and non-energy related (Keller et al., 2012). However, survey space constraints prevented us from examining other, potentially robust predictors of support/opposition, including trust in oil/natural gas industry, government, and other actors. Trust – which reflects considerations such as shared values, expertise and competence – is often a robust predictor of support of, or opposition to, emerging technologies (Boudet and Ortolano, 2010; Anderson et al., 2011). We hope to further explore this area in future work.

What can these findings tell us about implications for energy policy and risk communication associated with unconventional oil/development using hydraulic fracturing? Along with energy prices and technological advancement, public attitudes will likely play a critical role in shaping the degree to which unconventional oil/gas reserves are developed – in the same way that public

support/opposition shapes the potential viability of other emerging technologies. One need look no further than the differing approaches to development in states such as Pennsylvania – where natural gas drilling in the Marcellus Shale is nearly a decade old and citizens tend to be more supportive than opposed (Theodori et al., 2012) – and New York State, where Marcellus Shale drilling is on-hold pending environmental and regulatory review and citizens are comparatively more opposed (Quinnipiac University, 2012b). At the same time, both our own survey data, as well other public opinion and academic survey findings, suggest that the majority of Americans lack a clear understanding of hydraulic fracturing and remain unaware, if not uncertain, about its potential impacts. In our sample, many “top of mind” associations reflected respondents' lack of familiarity with hydraulic fracturing. The proportion who mentioned specific environmental, economic, or social impacts were few but indicated a general division that characterizes many energy issues: environment (i.e. water quality) versus economy (i.e. job creation). Future work should examine what factors constrain individuals from forming an opinion on the issue. While a lack of knowledge, familiarity, time and interest likely play a role, such indecisiveness could also be related to the “information haze” that often surrounds siting conflicts because of “conflicting, contradictory, multiparty, multi-directional communications that fail to clarify the risks” (Futrell, 2003, p. 365).

Risk communication efforts can help increase awareness of these impacts. However, “risk communication” refers to a variety of strategies whose success and appropriateness depends on the underlying goals they work to achieve (Clarke et al., in press; Juanillo and Scherer, 1995). Groups in favor of, or opposed to, unconventional oil/gas development and hydraulic fracturing may focus on “informing and educating stakeholders” to “change the misperceptions...associated with energy development” (Haut et al., 2010, p. 747). However, a more engagement-based approach stresses outcomes aside from acceptance or rejection, including building knowledge and trust among stakeholders. Haut et al. (2010, pp. 746–747) argued for “dialog among members of the general public, community leaders, representatives of oil and gas associations, regulatory agency personnel, non-governmental organization representatives, and other interested individuals [about] potentially positive aspects and negative consequences of energy development” (see also Scherer et al., 1999). Yet, these approaches – while important – often depend on people's willingness to engage with information that challenges strongly held views on an issue (Clarke et al., in press). Moreover, many of the factors shown to drive support/opposition to emerging technologies, including energy development, reflect fundamental predispositions – such as worldviews and political ideology – that are not necessary amenable to informational or persuasive messages.

One promising area for future risk communication research is expanding people's thinking of hydraulic fracturing beyond the process of extracting oil and gas to a broader awareness of the diverse social, health, economic, and environmental impacts associated with the various stages of unconventional oil/gas development over time. For example, research on public perception of such development (Anderson and Theodori, 2009; Jacquet, 2012) and associated media coverage (Evensen et al., in preparation) suggests that environmental and economic impacts loom large in people's minds. While such impacts certainly deserve focus, there is comparatively less attention to social impacts: physical and psychological changes communities face throughout the various stages of development-related boom and bust, as resource production increases, decreases, and eventually ceases (Jacquet, 2009). Such issues include strains on infrastructure, changes to residents' sense of community, and changes to interpersonal relationships as people riding the wave of energy

development enter the picture (Krannich, 2012). Community residents and local/state/federal officials can only prepare for the impacts of energy development that are salient in their thinking. Thus, we see an opportunity for a broader discourse on these impacts. The news media can play a potentially important role through television specials/documentaries and in-depth newspaper coverage of energy “boomtowns” in Pennsylvania (Marcellus Shale), Texas (Barnett Shale), and North Dakota (Bakken Shale) (see, for example, Brown, 2013; Dobb, 2013). Furthermore, the role of media use – both news and entertainment – in shaping hydraulic fracturing support and opposition demands additional inquiry. For example, what content attributes might account for television use as a positive predictor of hydraulic fracturing support and newspaper use as a negative predictor? What is the role of films like *Gasland* and *Promised Land* in shaping perceptions of the industry?

All of these areas add up to a complex portrait of the nation's perceptions of, and attitudes towards, unconventional oil/gas development using hydraulic fracturing. Fracking is quickly becoming a cornerstone of the nation's energy future; therefore, it is high time to pursue a wide-ranging and inclusive public dialog about its potential risks and benefits.

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