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Attitudes toward hydraulic fracturing:

The opposing forces of political conservatism and basic knowledge about fracking

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Abstract

Hydraulic fracturing has become a contentious issue around the globe. In the present study, using a sample of American adults (*n*=412), the role of political orientation (conservative *vs*. liberal) and basic knowledge about fracking on fracking risk perception attitudes, fracking economic attitudes, energy reliance attitudes, trust of energy information sources, and preferred dwelling distance from energy operations was investigated. Basic knowledge about hydraulic fracturing as a possible moderating mechanism was also explored. Correlational and regression results revealed that political ideology and basic fracking knowledge are key predictors of fracking and energy source attitudes, and that the nature of the relation between ideology and fracking risk perceptions, fracking economic attitudes, reliance on natural gas, wind and solar, and distrust of government agencies, are influenced by an individual's basic knowledge about fracking.

Keywords: hydraulic fracturing attitudes; political ideology; knowledge; energy attitudes; risk perception.

1. Introduction

Policies on, and attitudes toward, gas and oil hydraulic fracturing (or fracking) vary considerably from place to place, and person to person ('hydraulic fracturing' and 'fracking' are used interchangeably). On May 15, 2015, for example, Governor Greg Abbot of Texas signed a law prohibiting cities from banning fracking within their boundaries (Malewitz, 2015), arguing that it will help protect private property as well as economic recovery. The states of Maryland and New York, in contrast, have banned fracking (Cama, 2015; Kaplan, 2014), citing environmental and health risks. Germany does not allow fracking within its territory, due to its potential environmental and health risks; the United Kingdom government—highlighting the potential economic benefits of fracking—has lifted a ban on fracking (Smith-Spark & Boulden, 2013; Tost, 2014). With high economic, health, and environmental stakes documented by the opposing sides (see Kester et al., 2015), fracking has become one of the most contentious environmental issues around the globe. Referring to one step in the process of drilling for natural gas from shale rock, hydraulic fracturing involves injecting high-pressure water, sand, and other chemicals into the rock to 'fracture' it and release natural gas (or shale gas). According to the Environmental and Energy Study Institute, there are two main types of fracking or drilling techniques: Vertical and horizontal. Vertical, or conventional fracking techniques, refers to in-depth drilling. Horizontal fracking or drilling, representing a more recent technique, allows drilling to take place laterally. While horizontal fracking covers a larger territory by conducting high volume fracking, it also uses "70 to 300 times more fluid than previous methods" (see e.g., Considine et al., 2010; EIA, 2012). Although fracking has been used since the late 1940s, its prevalence around the globe has risen dramatically with drilling sites being constructed increasingly closer to people's dwellings (see Adgate, Goldstein, & McKenzie, 2014; E.I.A.,

2015; Gold & McGinty, 2013; Witter, McKenzie, Stinson, Scott, Newman, & Adgate, 2013). These changes in fracking prevalence, proximity, and technology have prompted research on fracking outcomes and public opinion of fracking.

Mirroring this polarity of consequences, public opinion is also mixed, with some researchers noting an ideological divide (see Kester et al., 2015). What affects public opinion about fracking, however, is largely unknown. For example, it is possible that political conservatives and liberals possess different degrees of knowledge about fracking (as they do, for example, about health care, Gross et al., 2013) or hold divergent risk perspectives on the practice. Further, knowledge about fracking might also affect the influence of political ideology on attitudes. To address these important questions, we investigated the relations between political ideology and basic knowledge about fracking with: Fracking attitudes, trust in authorities, and preferences for reliance on and desired dwelling distance from various energy sources.

1.1 Benefits and drawbacks of hydraulic fracturing and other energy sources

Harvesting unconventional oil and natural gas (UNC) comprises several steps from well-development to production. Hydraulic fracturing is one step in this larger process. Recently, in an extensive review of over 100 studies published in the last decade, Sovacool (2014) identified the main benefits and drawbacks of hydraulic fracturing. In his review he noted that hydraulic fracturing used to extract shale gas is associated with many negative outcomes including high financial costs to operate, accidents and leakage, negative environmental impact such as water, air, and radiation pollution that affect peoples' health and climate change, reducing reliance on renewable energy sources because of shale gas' comparatively low cost, inciting resistance from a concerned public, heightening risk of earthquakes, and economic instability because of a multitude of factors (e.g., substantial production costs for quickly depleting wells, etc.). Shale

gas, however, also offers energy supply security, is less costly to produce and cheaper for consumers, has less of a negative impact on the environment than oil and coal, and presents several economic benefits (e.g., jobs, taxes) (see Sovacool, 2014, Table 8 for a summary; for additional studies and reviews on the effects of hydraulic fracturing see Adgate et al., 2014; Bamberger & Oswald, 2012; Considine, Watson, & Blumsack, 2010; IHS, 2012; Rabinowitz et al., 2015; Webb et al., 2014; Witter et al., 2008).

Other sources of energy—whether traditional or more recent—also have benefits and drawbacks. Coal and oil, for example, have large and diverse economic benefits (U.S National Mining Association, 2014), but have been criticized for posing serious health and environmental risks (Aneja, Isherwood, & Morgan, 2012; Fernandez-Narvarro et al., 2012; Hendryx, 2008, 2013). Nuclear energy also has economic advantages (NEI, 2014), but many people remain concerned about its potential health and environmental costs, especially in the wake of the accident in Fukushima, Japan (Buttler, Parkhill, & Pidgeon, 2011). Renewable energy sources—such as wind—do not have (at least at present) the economic benefits that oil or gas can offer (Adgate et al., 2014; Sovacool, 2014), but comparatively speaking, these methods confer reduced environmental and health risks (Ontario Ministry of Health and Long-Term Care, 2010; Knopper et al., 2014; McCunney, Mundt, Colby, Dobie, Kaliskii, & Blais, 2014).

In summary, traditional and renewable energy sources pose benefits and drawbacks in terms of economic, social, health, and environmental impacts. While the present study focuses primarily on fracking, the relations between political ideology and attitudes towards other sources of energy are also examined.

1.2 An ideological divide? Predicting attitudes toward energy sources

Energy source attitudes are intimately connected to people's politics (Boudet et al., 2014; Davis & Fisk, 2014; Karlstrom & Ryghaug, 2014; Kovacs, Eng, & Gordelier, 2010; O'Hara, Humphrey, Andersson, Jaspal, Nerlich, & Knight, 2014; see Kester et al., 2015 for a discussion). 'Politics' encompasses people's political ideologies (i.e., political attitudes and beliefs), political identification (i.e., politically liberal or political conservative), and party affiliation (e.g., Democrat, Republican, Independent). Fundamentally, political conservatives are resistant to social change, preferring tradition; in contrast, political liberals prefer social change (Jost, Nosek, & Gosling, 2008; Jost et al., 2003). These core ideological differences are evident in partisan divides related to energy sources in the U.S. According to a Pew Research Centre poll in 2011, for instance, 83% of liberal-leaning (*vs*. 53% of conservative-leaning) Americans favoured contributing more funding to research on alternative and newer sources of energy like wind, solar, and hydrogen. Conversely, 78% and 54% of conservative-leaning Americans (*vs*. 46% and 30% of liberal-leaning Americans) favoured traditional sources of energy like mining and drilling, and nuclear power, respectively. Hence, consistent with core ideological differences, liberals are more likely to support comparatively novel, less familiar renewable energy sources, consistent with their inclination for social change. Conservatives, on the other hand, tend to be opposed to newer technologies, preferring conventional energy technologies, consistent with their inclination for the status quo.

Public opinion on hydraulic fracturing is similarly apportioned along ideological lines. In a nationally representative sample, Boudet and colleagues (2014) noted that identifying as politically conservative (*vs*. liberal) predicted greater support for hydraulic fracturing. Davis and Fisk (2014) likewise found that identifying as Republican related to support of hydraulic

fracturing. Further, a recent survey by the PEW Research Centre in November 2014 revealed that 62% of Republicans (*vs*. 29% of Democrats) supported increased fracking. Thus, political liberals predominantly hold unfavourable attitudes toward fracking whereas conservatives' attitudes are favourable (see also O'Hara, Humphrey, Andersson, Jaspal, Nerlich, & Knight, 2014; and Kester et al., 2015 for a discussion). It is important to note that much of the research on politics and fracking attitudes has relied on single-item measures of support or opposition to fracking (e.g., Boudet et al., 2014) rather than comprehensive and nuanced indices of fracking attitudes, such as risk perceptions of fracking. Therefore, in the present research, we utilise a comprehensive multi-item measure of fracking attitudes.

Peoples' energy source opinions are likely connected to information they have gathered, with some information being deemed trustworthy and other information untrustworthy. Assessments of trust are related to political ideology. Political conservatives have become less trusting of scientists over time, whereas liberals' trust of scientists has remained constant (Gauchet, 2012). Trust of the government is dependent on who is in power; people are more likely to trust the government if the party they support is in power, but less likely if the party they do not support is in power (Keele, 2005). As an example, with respect to energy specific information, Michaud, Carlile, and Smith (2008) reported that Republicans were less likely than Democrats to believe that contact with raw petrol poses health risks, and less likely to believe environmental scientists claiming that drilling is risky; conversely, Democrats (*vs*. Republicans) were less likely to believe claims from the oil industry. These findings are aligned with earlier work showing that a key feature of political conservatism is a "…central importance of business and industry in society" (Kerlinger, 1984, p.17). One would expect, therefore, that conservatives would exhibit high trust in the industry, and diminished trust in government agencies and public

institutions (universities); liberals, in contrast, should manifest counter trends: Exhibiting high trust of government and public institutions, and limited trust of industry.

1.3 Risk perception

One aspect of attitudes towards fracking is risk perception, that is, how risky one perceives hydraulic fracturing to be. Researchers (e.g., Hanoch, et al., 2006; Slovic, 1987) have argued that risk perception is a key factor in willingness to engage in a wide spectrum of behaviours. Investigators, for instance, have reported an inverse relation between risk perception and willingness to accept gene technology (Siegrist, 2000), vaccination (Brewer et al, 2007), sea-food consumption (Jacobs, Sioen, Pieniak, Henauw, Maulvault, Reuver, et al., 2015), and travelling (Elias & Shiftan, 2012). More closely related to the present issue, researchers have also shown that risk perception is related to environmental and energy related matters: Visschers and Siegris (2013) noted that as risk perception increases willingness to accept nuclear power decreases; Leiserowitz (2006) argued that risk perception is associated with supporting efforts to reduce climate change; and Spence, Poortinga, and Pidgeon (2011) showed that higher risk perception of climate change leads to greater willingness to save energy.

1.4 Knowledge

Public awareness campaigns are employed to educate the general public and garner public support. Some research has noted that greater familiarity with fracking is associated with less support for fracking (Boudet et al., 2014). However, earlier studies, such as the one by Boudet et al., used only self-reported *familiarity* with fracking (e.g., how much have you heard about fracking) rather than actually examining objective *knowledge* about fracking. Although awareness and knowledge may be connected, they are fundamentally different in important ways; for instance, being aware of fracking does not mean a person has an accurate

comprehension of what it is. As such, the effect of increased knowledge for support of fracking is crucial, yet unknown.

Whereas some research notes that increased knowledge can lead to more supportive attitudes of renewable energy technologies (Pierce et al., 2009), other research reveals that increased knowledge of solar, wind and wave energy, for example, leads to decreases in support for alternative energy sources (Burger et al., 2015). Of particular relevance, there is evidence that the effect of knowledge on partisan attitudes is influenced by political ideology. Using Gallup Poll data from 10 different countries, McCright and Dunlap (2011) found that for liberals, greater knowledge about climate change related to climate change belief and concern about the effects of climate change; for conservatives, however, greater knowledge related to climate change scepticism and lower concern about the effects of climate change (see also Hamilton, 2011). The present study is the first to investigate the relation between objective knowledge of fracking and attitudes, as well as whether knowledge moderates the relation between political ideology and fracking attitudes.

1.5 The Present Research

The present study investigates the relation between political conservatism (*vs*. liberalism) and basic fracking knowledge with fracking and other-energy source attitudes, and the potential moderating function of basic fracking knowledge on the relations between political ideology and attitudes. First, we predict that political conservatism will be associated with more favourable (lower risk perception) attitudes towards hydraulic fracking (Hypothesis 1a), and that greater basic fracking knowledge will be associated with less favourable (higher risk perception) attitudes of hydraulic fracking (Hypothesis 1b). Second, we expect that political conservatism will relate to a desire to increase reliance on traditional energy sources like coal, fracking, and

other natural gases and a desire to decrease reliance on renewable energy sources like wind, solar, and hydroelectric (Hypothesis 2a); in contrast, we expect that basic fracking knowledge will relate to a desire to decrease reliance on traditional energy sources, and a desire to increase reliance on renewable energy sources (Hypothesis 2b). Third, we predict that political conservatism (*vs*. liberalism) will relate to less trust of environmental organizations, consumer protection organizations, colleges and universities, and government agencies, and more trust of industry (Hypothesis 3a); whereas basic fracking knowledge will relate to more trust of environmental organizations, consumer protection organizations, colleges and universities, and government agencies, and less trust of industry (Hypothesis 3b). Fourth, we predict that political conservatism (*vs*. liberalism) will relate to greater willingness to live closer to a hydraulic fracking site, coal operations, and a nuclear power plant, and less willingness to live near wind turbines (Hypothesis 4a); conversely, we expect that greater basic fracking knowledge will relate to less willingness to live closer to a hydraulic fracking site, coal operations, and a nuclear power plant, and greater willingness to live near wind turbines (Hypothesis 4b). Finally, our hypotheses concerning the possible moderating effect of knowledge are necessarily more exploratory. We anticipate that should knowledge emerge as a moderator, it will serve to strengthen the proposed relations between political ideology and attitudes.

2. Method

2.1 Participants and Procedure

American participants (*n*=469) were recruited using Amazon Mechanical Turk, or MTurk (see Buhrmester, Kwang, & Gosling, 2011); 57 participants did not provide information about their political orientation or demographics so were omitted from analyses leaving a final sample of 412. Participants recruited through MTurk are people who have registered with MTurk as a

"worker" and can complete human intelligence tasks (HITs), including research studies (see Paolacci & Chandler, 2014 for a review). Several studies have confirmed that MTurk samples are more representative of the general population than undergraduate samples, and that MTurk samples are reliable, replicating established psychological, economic, and political science findings (e.g., Berinsky, Huber, & Lenz, 2012; Goodman, Cryder, & Cheema, 2013; Horton, Rand, & Zeckhauser, 2011; Klein et al., 2014; Mullinix, Druckman, & Freese, 2014; Paolacci et al., 2010).

Participants were paid $0.50US (pay does not affect data quality, see Buhremester et al., 2011). Participants ranged in age from 18 to 78 (M_{age}=35.72, *SD*=13.33; 46.8% women) and self-identified as "liberal" (55.1%), "conservative" (19.7%), or "neither" (25.2%). Most had completed some college education (36.7%) or completed college degrees (38.1%; 0.2% less than high school; 13.3.1% completed high school; 9.5% master's degree; 2.2% doctoral degree). The breakdown of annual incomes was as follows: 13.3% earned less than US$15,000, 27.9% earned US$15–30,000, 20.1% earned US$30–45000, 16.7% earned US$45–60,000, 9.2% earned US$60–75,000, and 12.6% earned over US$75,000. Demographic variables have shown to relate to fracking attitudes (see, e.g., Boudet et al., 2014); hence, age, gender, and income were considered as possible covariates. Participants completed measures of political ideology, basic fracking knowledge, fracking attitudes, energy use attitudes, preferred distance from energy sources, and trust in authorities.

2.2 Measures

2.2.1 Political Ideology

To measure political ideology, participants responded to a single item: "We hear a lot of talk these days about liberals and conservatives. Where on the following scale of political

orientation would you place yourself?" Participants responded on a continuum from 1-*extremely liberal* to 11-*extremely conservative* (see Jost, 2006). Higher scores indicated greater political conservatism.

2.2.2 Basic knowledge about fracking

To measure participants' knowledge of the basic components of hydraulic fracking, a four item knowledge test was administered. The content of the test was based on information from sources including the UK government website, the UK Energy Research Centre, the Royal Academy of Engineering Report (2012), the U.S. government's energy statistics agency (AEO2012 Early Release Overview), Energy and Commerce Committee, and the Energy Information Administration (EIA). The test required participants to select the correct definitions of shale gas (i.e., the name of the natural gas that is retrieved through hydraulic fracturing), hydraulic fracking (i.e., the process by which gas is extracted from rock beds underground using pressurized water, sand, and chemicals), unconventional gas (i.e., typically "free gas" trapped in various naturally occurring rock formations such as carbonates, sandstones, and siltstones), and fracking fluid (i.e., the fluid containing sand and chemicals that is pumped under pressure in order to dislodge gas from the rock beds). For each question there were four options. Scores were created by adding up the number of correct responses with higher scores indicating greater knowledge of the basic components of fracking.

2.2.3 Fracking Attitudes

To measure participants' attitudes toward fracking, a 20-item scale was developed by the authors. The items were intended to assess risk perceptions associated with the relation between fracking and climate change and the environment, the financial impacts of fracking, government regulation preferences, and general perceptions of fracking as dangerous or safe. The items are

listed in Table 1. Twelve of the items were written such that stronger agreement indicated more favourable (lower risk perception) attitudes toward fracking and 8 items were worded such that stronger agreement indicated less favourable (higher risk perception) attitudes toward fracking. Participants responded to each item on a scale from 1-*strongly disagree* to 5-*strongly agree*. Participants' scores were created based on factor analysis results presented in the Results section and Table A.1.

2.2.4 Energy Use Attitudes

Participants responded to the question "Please tell me if you think the United States should increase, keep about the same, or decrease its use of each type of energy source" on a three-point scale: 1-*increase*, 2-*keep the same*, and 3-*decrease*. Participants indicated their responses for six energy sources: Coal, shale gas (fracking), wind power, solar power, hydroelectric power, and other natural gases. Higher scores indicated greater preference to decrease use of that energy source (see Krause, Carley, Warren, Rupp & Graham, 2014).

2.2.5 Distrust in Authorities

To measure trust in authorities, a measure from Krause et al. (2014) was modified. Participants indicated the degree to which they "would believe the information given to [them] about energy and environmental issues" from five sources: Environmental organizations, consumer protection organizations, industrial or trade organizations, colleges and universities, and government agencies. Participants responded on a scale from 1-*completely/would not doubt* to 4-*do not believe them at all*. Higher scores indicated greater distrust.

2.2.6 Distance from Energy Sources

Participants responded to four items, developed by the authors. The items asked participants to "imagine that a hydraulic fracturing company [or wind power or energy company]

has applied to drill [place a wind turbine/extract coal/build a nuclear power plant] near your home", and indicate "at what distance from your home would you be willing for the hydraulic fracturing to take place [a wind turbine to be placed/coal mining to take place/a nuclear power plant to be placed]?" Participants responded on a 7-point scale: 1 (*any distance*), 2 (*150 to 300 yards*), 3 (*301 to 1500 yards*), 4 (*1 to 5 miles*), 5 (*6 to 15 miles*), 6 (*16 to 50 miles*), 7 (*unhappy at any distance*). Lower scores indicated greater willingness to have that energy activities closer to their home.

3. Results

3.1 Descriptive Statistics

Table A.2 shows the means and standard deviations of the study variables. (For details of the correlations between all of the study variables please contact the first author.)

3.2 Fracking Attitudes: Scale Construction

A common factor analysis was conducted on the 20 items, applying an oblique rotation (promax, with kappa set to 4). Common factor analysis is an exploratory factor analysis technique in which the factor solution is based on estimates of shared variance among the items. The loadings of the items on the two promax-rotated factors are shown in Table A.1. The first factor was defined by items associated with perceptions of risk relating to the safety of fracking, government regulation preferences, and effects on climate change and the environment. Therefore, the first factor reflected (lower) risk perception attitudes toward fracking. The second factor was defined by items related to the impact of fracking on the economy, including job creation (and one negatively loading item about science and technology). Therefore, the second factor primarily reflected financially-relevant attitudes toward fracking. Two items, "There has been a negative impact on all communities located close to hydraulic fracturing drill sites" and

"Hydraulic fracking for shale gas has similar effects on the environment as other energy sources, such as coal or oil", did not load onto either of the two factors and were therefore dropped. The item "Current environmental problems associated with hydraulic fracturing will never be resolved through improvements in science and technology" was also dropped as it showed a weak loading on the financial factor but its face validity was low. Finally, the item "Hydraulic fracturing for shale gas is essential for the United States to meet its future energy needs" was also dropped; although it showed a strong loading on the first factor, its face validity was less consistent with perceptions of risk. The two factors were moderately correlated (r=.51). Two scales were created. The **fracking risk perception attitudes** scale was computed by averaging the remaining 10 items loading onto the first factor (α=.80). Relevant items were reverse-keyed so that higher scores indicated greater risk perceptions. The **fracking economic attitudes** scale was computed by averaging the remaining 6 items loading onto the second factor (α=.79). Relevant items were reverse-keyed so that higher scores indicated more favourable attitudes about the economic benefits of fracking.

3.3 Correlations with Ideology and Basic Fracking Knowledge

Political conservatism and knowledge about fracking were uncorrelated. Political conservatism and basic fracking knowledge were related to many of the study variables, but in opposing directions (see Table A.2). Political conservatism related to *lower* fracking risk perception attitudes, whereas knowledge related to *higher* fracking risk perception attitudes. Political conservatism related to more favourable attitudes about the economic benefits of fracking; knowledge was unrelated to economic fracking attitudes. Political conservatism related to a desire to increase (*vs*. decrease) the U.S.' energy reliance on coal, fracking, and natural gas, and a desire to decrease reliance on wind, solar and hydroelectric. In contrast, the more

knowledgeable participants were about the basic components of fracking, the greater their desire to decrease reliance on coal and fracking, and increase reliance on wind and solar. Political conservatism related to greater distrust of information from environmental organizations, consumer protection organizations, colleges or universities, and government agencies, and greater trust of industrial or trade organisations. Basic fracking knowledge related only to distrust of industrial or trade organisations. Finally, political conservatism related to greater willingness to live closer to fracking, coal and nuclear sites, but less willingness to live closer to wind turbines. Conversely, greater basic fracking knowledge related to less willingness to live closer to fracking, coal and nuclear sites, and greater willingness to live close to wind turbines.

3.4 Predictive Effects: Political ideology, basic fracking knowledge and their interaction

To test the relative predictive effects of political ideology and basic fracking knowledge, and whether knowledge moderated the relations between political ideology and attitudes, multiple regressions were conducted on each of the attitude variables using SPSS software. Political ideology and basic fracking knowledge were standardised and the standardised scores were used to create the interaction term. Significant interactions were probed using simple slope analyses and probed at 1SD above and 1SD below the mean on basic fracking knowledge (Aiken & West, 1991). Results are shown in Table A.3. (Multiple regression analyses were also run with age, sex, income, and level of education as covariates. The covariates generally were not significant. Importantly, the pattern and significance of the effects of political conservatism, basic fracking knowledge, and their interaction were identical whether the covariates were included or not. For brevity, we report the analyses without the covariates. Full details of the findings for the covariates are available from the first author.)

3.4.1 Fracking risk perception attitudes. Political conservatism and basic fracking knowledge exerted unique effects on fracking attitudes: Whereas political conservatism predicted lower risk perceptions of fracking, greater basic fracking knowledge predicted greater risk perceptions. The interaction was significant: The relation between political conservatism and fracking risk perception attitudes was significant; however, the magnitude of the relation was stronger among participants with greater (b=-.40, p<.001) than lesser (b=-.24, p<.001) basic knowledge about fracking (see Figure A.4).

3.4.2 Fracking economic attitudes. Political conservatism predicted more favourable attitudes about the economic benefits of fracking. Basic fracking knowledge was not a significant predictor. The interaction was significant: The relation between political conservatism and economic fracking attitudes was significant among those with greater basic fracking knowledge (b=.19, p<.001), but not among those with lesser (b=.05, p=.211) knowledge.

3.4.3 Energy use attitudes. The pattern of results for energy use of coal and fracking attitudes was the same: Political conservatism predicted a desire to increase reliance on coal and fracking, whereas greater basic fracking knowledge predicted a desire to decrease reliance on coal and fracking. The interactions were not significant. Desire to increase reliance on natural gas was also predicted by greater political conservatism; however, basic fracking knowledge was not a significant predictor. The interaction for predicting natural gas was also significant, such that political conservatism related to a desire to increase reliance on natural gas only among those higher in basic fracking knowledge (b=-.24, p<.001), but not lower (b=-.01, p=.772).

The pattern of results was the same for energy use of wind and solar attitudes: Political conservatism predicted a desire to decrease reliance on wind and solar, whereas greater knowledge predicted a desire to increase reliance on wind and solar. The interactions for wind

and solar were also significant (see Figure A.5). The links between political conservatism and a desire to decrease reliance on wind and solar were only significant among individuals with lesser basic knowledge about fracking (*b*=.13; *b*=.11, *ps*<.001, respectively); the relations were non-significant among those with greater knowledge (*b*=.05, *p*=.081; *b*=.03, *p*=.240, respectively). Desire to decrease reliance on hydroelectric was only significantly predicted by greater conservatism; the effect of knowledge was marginally significant, and the interaction was not significant.

3.3.4 Distrust of authorities. Political conservatism predicted greater distrust of information from environmental organisations, consumer protection organisations, colleges and universities, and government agencies, and greater trust of information from industry and trade organisations. Basic fracking knowledge only significantly predicted greater distrust of industry and trade organizations. The interaction was only significant for government agencies, such that greater conservatism related to distrust of government agencies among individuals with greater knowledge (*b*=.16, *p*=003) but not lesser knowledge (*b*=.00, *p*=.990) (see Figure A.6).

3.3.5 Distance from energy sources. Greater political conservatism predicted greater willingness to live closer to a fracking site, coal mining, and nuclear plant, but less willingness to live near a wind turbine. Conversely, greater basic fracking knowledge predicted less willingness to live close to fracking, coal, and nuclear power plants, and greater willingness to live closer to wind turbines. The interactions were not significant.

4. Discussion

Hydraulic fracturing is proving to be a highly divisive issue, with governments and citizens divided on their attitudes towards its usage and impact. Identifying the underpinnings of attitudes toward hydraulic fracturing will advance current understanding of this contentious

issue. Hence, in the present research we investigated the influence of political ideology and knowledge about fracking. Our findings revealed that political ideology plays a primary role, consistent with other research showing that attitudes toward energy sources are allied to politics (Boudet et al., 2014; Davis & Fisk, 2014; Karlstrom & Ryghaug, 2014; Kovacs et al., 2010; O'Hara et al., 2014; see Kester et al., 2015 for a discussion). As the first investigation to examine objective knowledge (*vs*. familiarity), our data clearly reveal that basic knowledge about fracking is important for understanding fracking and other energy source attitudes, and that basic knowledge can affect the relation between ideology and attitudes.

Individuals identifying as politically conservative (*vs*. liberal) perceived fracking as less risky and as presenting more economic benefits (Hypothesis 1a), as predicted. That is, conservatives underestimated the risks and overestimated the benefits. These relations are consistent with other research showing that political conservatives are more favourable toward fracking (Boudet et al., 2014; Davis & Fisk, 2014; Kester et al., 2015; O'Hara et al., 2014; PEW Research, 2011, 2014), and that political conservatives perceive traditional energy sources as less risky (e.g., Choma et al., 2013). Many traditional energy sources, including fracking, present considerable economic benefits. Thus, it is not surprising that conservatives, who value business and industry generally (Kerlinger, 1984), also perceive fracking as particularly advantageous.

A clear ideological divide also emerged with respect to preferences for reliance on specific energy sources and preferred dwelling distance from energy operations. Political conservatives indicated a greater desire to increase reliance on traditional energy sources, including fracking, coal, and natural gas, and a desire to decrease reliance on renewable energy sources, specifically, wind, solar, and hydroelectric (Hypothesis 2a). Those higher in political conservatism (*vs*. liberalism) were also more willing to live closer to traditional energy source

operations, but less willing to live close to wind turbines (Hypothesis 4a) – despite the heightened objective risk associated with fracking, coal, and natural gas. These associations imply that fracking risk perceptions, preferences for energy reliance, and preferred dwelling distance from energy operations are driven by ideology rather than objective assessments of potential harm. Indeed, these patterns of relations reflect core differences between conservatives and liberals, in that conservatives favour the status quo and liberals opt for change (Jost et al., 2003, 2008). Lower risk perception is associated with engaging in and endorsing relevant behaviours (Hanoch et al., 2006; Slovic, 1987); for example, perceiving nuclear as less risky is linked with support for nuclear power (Visschers & Siegris, 2013). Our findings extend this literature showing that conservatives (*vs*. liberals) were more supportive of and more willing to live closer to fracking – an energy source they perceived of as less risky.

Political conservatives were more trusting of industry and trade organisations, whereas liberals were more trusting of environmental organisations, consumer protection organisations, colleges/universities, and government agencies (Hypothesis 3a). That is, *both* conservatives and liberals were more trusting of entities espousing information consistent with their opinions and fundamental ideological characteristics (see also Gauchet, 2012; Keele, 2005; Michaud et al., 2008): Conservatives trusted entities in support of business, industry, and traditional energy sources, and liberals trusted (a Democratic) government, and scientific (college/university) and environmental entities highlighting the negative effects of traditional energy sources and benefits of alternative and greener energy sources. Therefore, trust appears to have little to do with the pedigree or self-interest of the information source, and more to do with ones' ideological stance.

We also explored the impact of objective knowledge, specifically, participants basic knowledge (*vs*. familiarity) about fracking such as identifying correct definitions of shale gas,

hydraulic fracturing, fracking fluid, etc. Unlike political ideology, basic fracking knowledge was unrelated to fracking economic attitudes, reliance on natural gas and hydroelectric sources, and trust (except industry/trade). The relations between knowledge and the remaining dependent measures were in opposing directions than those reported for political conservatism (*vs*. liberalism). Greater basic knowledge about fracking was related to greater risk perceptions, preferred decreased reliance on fracking and coal, preferred increased reliance on wind and solar, greater distrust of industry and trade organisations, less willingness to live close to fracking, coal, and nuclear operations, and greater willingness to live closer to wind turbines. These findings are consistent with previous research showing that familiarity with fracking related to less favourable attitudes of fracking (Boudet et al., 2014).

In general, political ideology related to more energy source attitudes than basic knowledge about fracking. In addition, the relations with political ideology were stronger in magnitude than those with basic fracking knowledge, with the exception of preferred distance from wind (basic knowledge was a stronger predictor) and preferred distance from nuclear (the magnitude was equivalent). Thus, our findings provide preliminary evidence that political ideology compared to basic knowledge about fracking is more central in predicting fracking risk perception and other energy source attitudes.

Basic fracking knowledge also affected the nature of the relation between political ideology and attitudes. For fracking risk perception attitudes, the relation between political conservatism (*vs*. liberalism) and lower risk perception was stronger among those who knew more (*vs*. less) about the basic components of fracking. Hence, even though knowledge predicted *greater* risk perception, it served to strengthen conservatives' belief that fracking does *not* present risks. The links between political ideology and fracking economic attitudes, reliance on

natural gas, and distrust of government agencies were only significant among participants who demonstrated greater basic knowledge about fracking such that political conservatives (*vs*. liberals) believed fracking presented more economic benefits, desired to increase reliance on natural gas, and held greater distrust of government agencies. Hence, for the issues consistent with conservatives' general ideological preferences, knowledge served to strengthen relations. These findings extend other research showing that knowledge can have opposing effects for conservatives and liberals (Hamilton, 2011; McCright & Dunlap, 2011). The links between political conservatism (*vs*. liberalism) with desire to decrease reliance on wind and solar was only significant among those with poorer knowledge. Therefore, for issues consistent with liberals' ideological proclivities, the effect of ideology was only relevant for those with poorer knowledge. In other words, it seemed that for these issues, people were more likely to rely on ideological scripts of what they should or should not support or oppose in the absence of objective knowledge. Therefore, the moderating effect of knowledge was far more complex than we proposed. Further, while our research indicates that basic fracking knowledge is relevant for fracking attitudes and other energy source attitudes, it is unclear why that it is, specifically. Future researchers might explore possible mechanisms for the role of knowledge.

The present results should be considered in light of some limitations. First, we relied on American women and men of a range of ages, education backgrounds, and incomes; our sample was recruited using MTurk, an increasingly popular recruitment tool for social scientists that offers more representative samples than undergraduate participants, but is nevertheless not a random or representative sample of the U.S. population. As such, this limitation should be considered when interpreting these results. Second, participants' geographic location within the U.S. was not assessed. It is possible that living closer or further from fracking sites may impact

participant's attitudes toward fracking and the nature of the findings uncovered here. For example, it is possible that living closer to fracking sites may strengthen the relations noted in the present research; future research is needed to address this possibility. Finally, basic fracking knowledge was conceptualised as a predictor of fracking risk perceptions. Perceiving fracking as risky, however, might also foster a desire to learn more about fracking. Future research is needed to explore the causal connection between knowledge and fracking risk perceptions.

4.1 Conclusion

Historically, Democrats and Republicans have not always been on opposing sides when it comes to environmental protection. Dunlap and McCright (2008), for example, remind us, that under the tenure of Franklin Roosevelt and Richard Nixon important and swiping environmental protection legislations were enacted. Our work, in contrast, provides additional indications that the gap between the two political groups has widened, at least with respect to fracking. One might wonder, therefore, how this work can inform policy makers, scientists and stakeholders. As we noted in our Introduction, different factors drive the discussion with regards to fracking. While some—such as the Governor of Texas—focus on the economics benefits, others—such as the German government—highlight the possible risks. The first implication of our results is the need to tailor information to different ideological groups. While Democrats tend to focus on the environmental and health risks associated with fracking, Republicans are more geared towards the financial benefits. Thus, providing Democrats with information about the financial benefits is unlikely to sway their attitudes, and likewise providing Republicans with more data about the risks will do little to change their minds.

Second, advocates of renewable energies—such as wind—need to improve social acceptance among Republicans and be better informed about their objections and reservations to

installing wind turbines—as illustrated in our findings showing Republicans worried about living close to wind turbines. To do so, it will probably require a leading Republican politician—as were Nixon and Roosevelt—to take a stand (for a similar line of argument see, Unsworth & Fielding, 2014). Republicans also tend to trust industry, and as such it is possible that companies involved in renewable energy might be well positioned to promulgate information.

Third, there is a need to improve knowledge among all individuals, a role that scientists and other stakeholders could assume. Indeed, Boudet et al. (2014) argued for the need to educate individuals about the broader implications of fracking, such as the social, health, economic, and environmental implications. The work presented here provides key insights as to how political affiliation affects attitudes towards fracking, as well as the need to further understand the link between basic knowledge and the formation of attitudes on such key matters. By better understanding the sources of information people draw on, and their attitudes towards fracking, the present research could help address, and possibly reduce, some of the political divisions that exist about fracking.

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Table A.1

Results of the common factor analysis on the fracking attitudes scale

	Factor 1	Factor 2
The methods used in hydraulic fracturing for shale gas are considered absolutely safe.	**.92**	-.20
People would be much better off if there were fewer government regulations on hydraulic fracturing companies.	**.83**	-.26
Hydraulic fracturing for shale gas will help slow down climate change.	**.81**	-.03
Hydraulic fracturing companies work hard to make sure that they take care of the environment.	**.81**	-.00
Hydraulic fracturing for shale gas is essential for the United States to meet its future energy needs.	**.67**	.26
Hydraulic fracturing for shale gas produces a "greener" fuel than other sources, such as coal or oil.	**.67**	.18
Hydraulic fracturing for shale gas will have a negative impact on the environment. (R)	**-.66**	.04
Shale gas can be removed from the earth through fracking with minimal environmental damage, if done correctly.	**.66**	.21
Hydraulic fracturing for shale gas is dangerous. (R)	**-.59**	-.00
The government should impose much stricter regulations on hydraulic fracturing companies.(R)	**-.49**	.01
Hydraulic fracturing for shale gas will have no effect on the progress of climate change.	**.49**	-.05
Hydraulic fracturing for shale gas will have a negative impact on the U.S. economy. (R)	.18	**-.79**
Hydraulic fracturing will not help create jobs in local communities close to drill sites. (R)	.31	**-.77**
Hydraulic fracturing for shale gas extraction will help create jobs locally and nationally.	.07	**.72**
Hydraulic fracturing for shale gas will be financially beneficial for the United States.	.17	**.65**
Hydraulic fracturing for shale gas in the United States will NOT help the country become gas self-sufficient. (R)	-.03	**-.59**
Hydraulic fracturing for shale gas will allow the United States to become self-sufficient in gas.	.45	**.48**
Current environmental problems associated with hydraulic fracturing will never be resolved through improvements in science and technology.	.08	**-.33**
There has been a negative impact on all communities located close to hydraulic fracturing drill sites. (R)	-.26	-.22
Hydraulic fracturing for shale gas has similar effects on the environment as other energy sources, such as coal or oil. (R)	.06	.01

Note. *N*=412. Loadings are pattern loadings in a promax-rotated solution (kappa=4).

Table A.2

Correlations between political conservatism and basic fracking knowledge with study variables

	M (*SD*)	Political Conservatism	Basic fracking knowledge
Political Conservatism	4.72 (2.76)	--	-.04
Basic fracking knowledge	2.78 (0.97)	-.04	--
Fracking Risk Perception Attitudes	3.63 (0.79)	-.41**	.29**
Fracking Economic Attitudes	2.30 (0.65)	.18**	.06
Energy use of: fracking	2.44 (0.73)	-.29**	.15**
coal	2.51 (0.66)	-.34**	.25**
natural gas	1.91 (0.71)	-.18**	.04
wind	1.13 (0.40)	.22**	-.23**
solar	1.09 (0.35)	.21**	-.23**
hydroelectric	1.29 (0.53)	.16**	-.09
Distrust of: EN-OR	2.21 (0.73)	.33*	.02
CPO	2.22 (0.68)	.22**	-.06
colleges or universities	2.05 (0.65)	.11*	-.05
government agencies	2.78 (0.79)	.10*	-.07
IN/Trade O	3.06 (0.74)	-.24**	.15**
Distance from: fracking	5.86 (1.41)	-.28**	.16**
coal	5.95 (1.25)	-.24**	.16**
nuclear	6.22 (1.12)	-.10*	.10*
wind	3.69 (1.66)	.15**	-.17**

Note. N=412 (except N=403 for fracking economic attitudes). **p<.010. *p<.05.

Table A.3

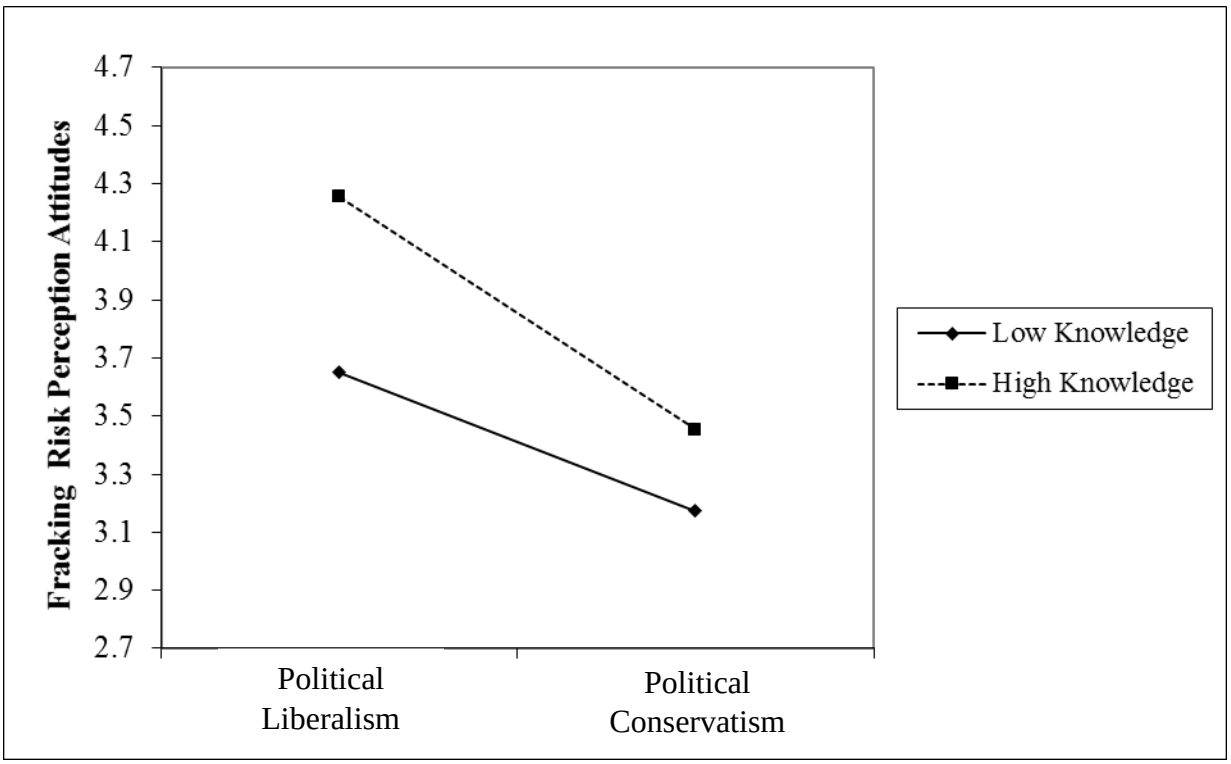
Regression results: Unstandardized coefficients

	Political Conservatism		Definition Knowledge		PC x DK		
	B	sr^2	B	sr^2	B	sr^2	R^2
Fracking risk perception attitudes	-.32**	.16	.22**	.08	-.08*	.01	.26
Fracking economic attitudes	.12**	.03	.04	.00	.07*	.01	.05
Energy use of: coal	-.22**	.11	.16**	.06	-.00	.00	.17
fracking	-.21**	.08	.10**	.02	-.02	.00	.10
wind	.09**	.05	-.09**	.05	-.04*	.01	.11
solar	.07**	.04	-.08**	.05	-.04**	.02	.11
hydroelectric	.08**	.02	-.05	.01	-.01	.00	.03
natural gas	-.13**	.03	.02	.00	-.11**	.03	.06
Distrust of: EN-OR	.24**	.11	.03	.00	.06	.01	.11
CPO	.14**	.04	-.04	.00	.05	.00	.05
IN/Trade O	-.17**	.05	.11**	.02	-.01	.00	.07
colleges or universities	.08*	.01	-.03	.00	.03	.00	.02
government agencies	.08*	.01	-.05	.00	.08*	.01	.03
Distance from: fracking	-.39**	.08	.21**	.02	-.04	.00	.10
wind	.23**	.02	-.29**	.03	.05	.00	.05
coal	-.29**	.06	.19**	.02	.02	.00	.08
nuclear	-.12*	.01	.12*	.01	.09	.00	.03

Note. **p<.010. *p<.05. N=412, except solar/hydroelectric, n=411.

Figure A.4

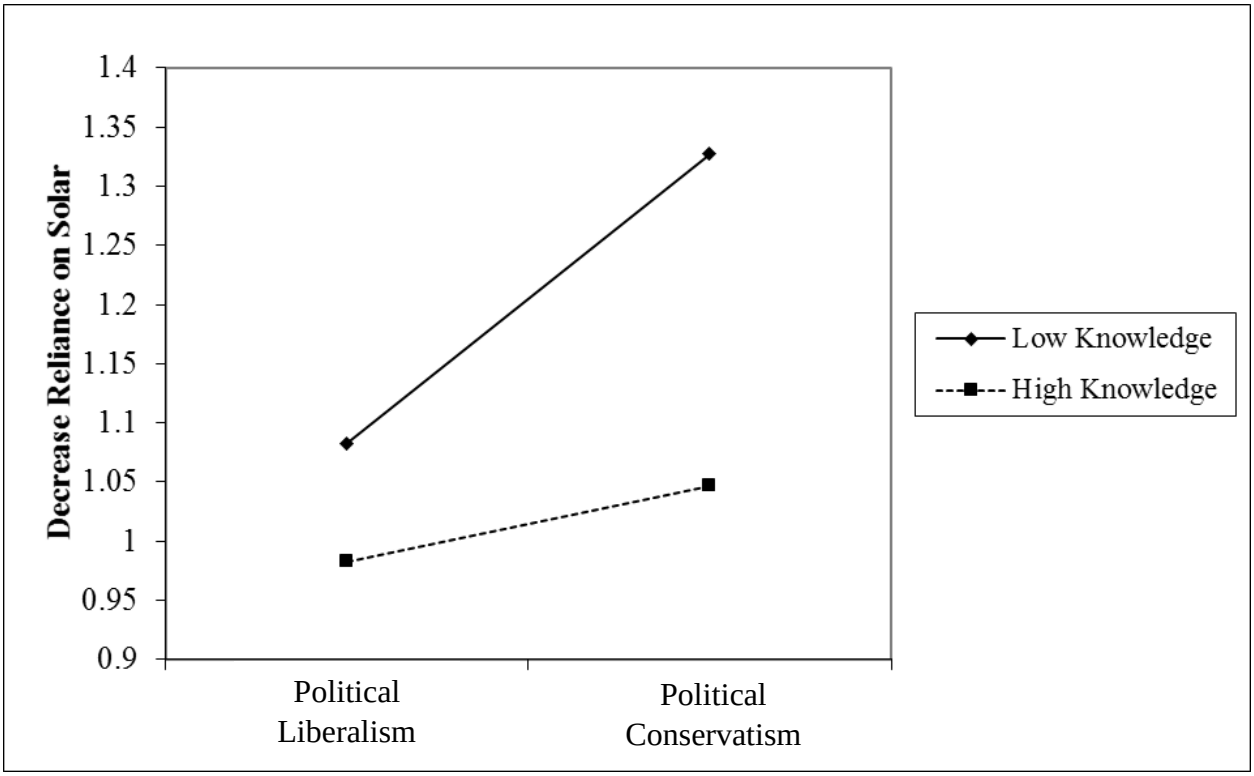
Interaction between political conservatism and basic fracking knowledge predicting fracking risk perception attitudes



Note. Slopes were plotted at 1SD above and below the mean on basic fracking knowledge.

Figure A.5

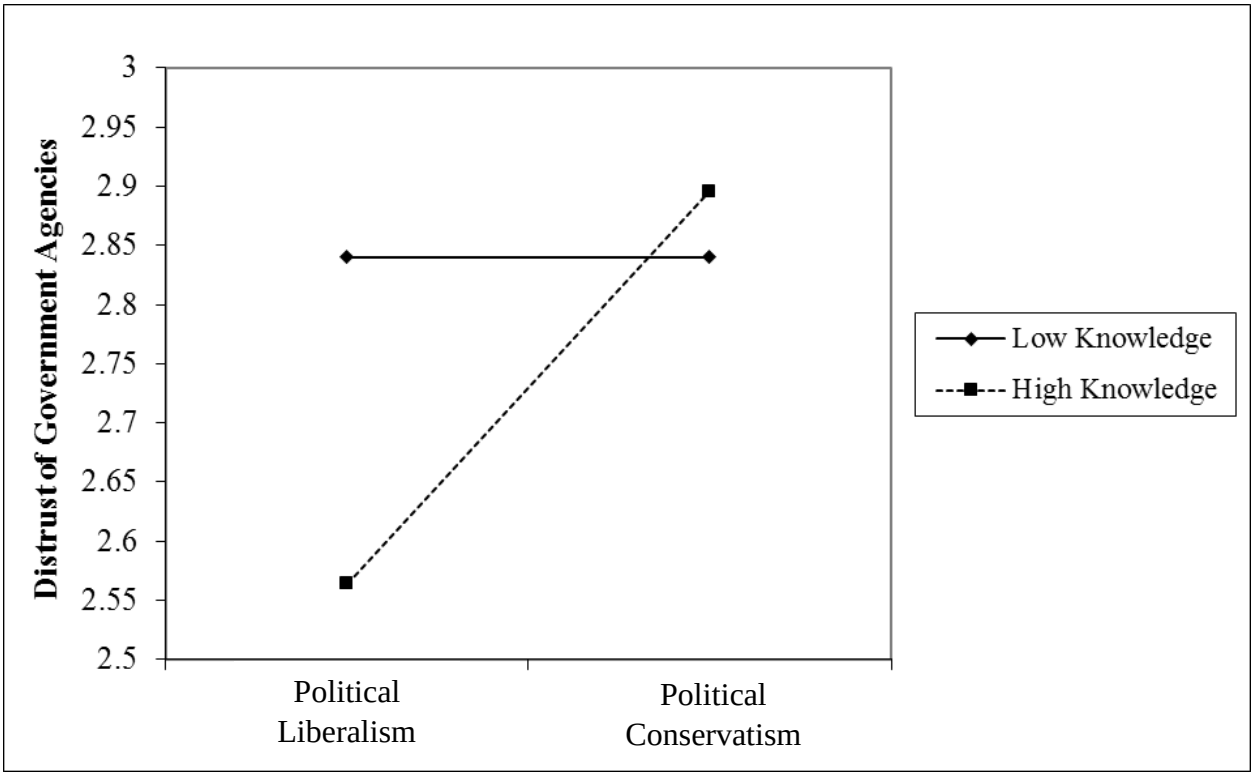
Interaction between political conservatism and basic fracking knowledge predicting energy reliance on solar



Note. The same pattern emerged for reliance on wind. Slopes were plotted at 1SD above and below the mean on basic fracking knowledge.

Figure A.6

Interaction between political conservatism and basic fracking knowledge predicting distrust of government agencies



Note. Slopes were plotted at 1SD above and below the mean on basic fracking knowledge.