"THE NEW REDDIT JOURNAL OF SCIENCE": PUBLIC EVALUATION AND UNDERSTANDING OF SCIENTIFIC INFORMATION BASED ON SOURCE FACTORS IN SOCIAL MEDIA

by

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A thesis submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Master of Arts in Communication

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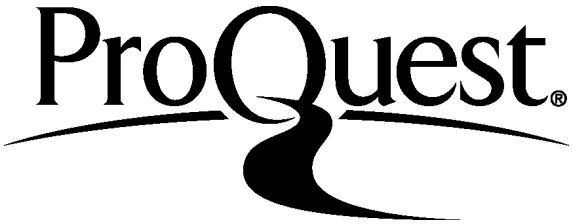

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by

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ABSTRACT

This project explores whether—and if so, how—citizens exposed to scientific information through social media use social media source factors to evaluate the credibility of this information. It also examines whether citizens attach more weight to social media factors or original source factors in making such evaluations. This project will draw on the Elaboration Likelihood Model (ELM) to develop hypotheses. The findings of this project will help explain how viewing scientific information through social media affects public understanding of science and also potentially add to the areas of research to which the ELM can be successfully applied

INTRODUCTION

As with many other young people in America, after graduating from college I was left with a predicament. I still wanted to learn more about the world, but I wasn't quite sure how. As a recent college graduate I no longer had access to the university courses and resources that I had previously used to learn. I knew that many adults are able to gain specialized knowledge by subscribing to journals, magazines, and newspapers. However, all of these sources require money – which is something that I definitely didn't have enough of to spend on luxuries such as a magazine subscription. Thus I was left with one option: the Internet.

The Internet can be a useful resource and there is extensive information available online for free. The only catch is that not all of this information is credible or accurate. One of the websites that I often used to learn about current events and to keep up to date on scientific discoveries was reddit. The users of reddit are very active, especially in the science sections of reddit, and I found that they often posted information before I saw it in the news or on other social media sites, such as Facebook.

When using reddit regularly I began to notice a pattern in the way that I viewed scientific articles. I implicitly trusted other redditors and used prior user comments on posts to determine whether or not certain article links were worth clicking on and reading in full. I almost never clicked on a link before first viewing the comments and seeing what other users had said about the credibility of the article and quality of the information provided within. If a post did not have any comments yet, then I wouldn't look at it. After realizing what I was doing, I wondered whether other redditors were using reddit in this way and what impact it might be having on the way that I, and other users, were learning. Luckily, at this point I began my Master's program at the University of Delaware and had the opportunity to explore this topic through academic research.

Chapter 1

SOURCE FACTORS AND PUBLIC UNDERSTANDING OF SCIENTIFIC INFORMATION

Public understanding of science is vital to the quality of public decision-making (Irwin & Wynne, 2004). With this in mind, a growing body of literature seeks to explain how citizens evaluate scientific information in the media. As Nelkin (1995) observes, media sources play critical roles in disseminating scientific information to the broader public. Most Americans not only depend on the mass media for science information, but also evaluate such information heuristically. A considerable body of research indicates that people often use the credibility of the messenger as a heuristic for deciding whether to accept communicative messages (see Eagly & Chaiken, 1993; Petty & Cacioppo, 1986). Using heuristics, such as source credibility, can provide citizens who may know little about the science related to specific issues with a way to evaluate conflicting scientific claims (Brewer & Ley, 2013).

Previous research on how media source factors influence evaluation and understanding of information has focused on "original" source factors (Pornpitakpen, 2004). For example, when people read a scientific article in a traditional mass media outlet such as a newspaper or magazine, they may evaluate the information in it using source factors for the article itself, including who wrote it and which newspaper or magazine published it. However, citizens are increasingly turning to online environments to find information about science and to follow scientific developments (Brossard, 2013). In particular, many are now acquiring scientific information from social media websites that link to articles from many other sources. Information encountered in these settings is not consumed in isolation; instead, it is almost always accompanied by cues such as the number of Facebook "likes," Twitter retweets, user comments, and other "Web 2.0" types of attributes, all of which have the potential to affect

readers' interpretations of the news (Brossard, 2013). Thus, citizens who encounter a scientific article that has been shared on a social media website may have the opportunity to rely on source factors that include both the original source factors and additional social media source factors, such as who posted or shared the article, how many comments accompany the post, what sorts of comments were made and by whom, and how many likes or dislikes the post has.

This project explores whether—and if so, how—citizens exposed to scientific information through social media use social media source factors to evaluate the credibility of this information. It also examines whether citizens attach more weight to social media factors or original source factors in making such evaluations. This project will draw on the Elaboration Likelihood Model (ELM) to develop hypotheses, which is a novel application of the ELM in the context of evaluating scientific information viewed through social media. In doing all of this, the project will focus on reddit, a social media site that plays an important role as a source of scientific information and that features a number of social media cues for source credibility. One of the sub-reddits specifically designed for discussing science information (/r/science), proclaims itself "The New Reddit Journal of Science." Reddit has received relatively little scholarly attention to date in the context of science communication, although a small body of research has examined it in the broader context of social media (see Germonprez & Hovorka, 2013; Casler, Bickel, & Hackett, 2013). The findings of this project will help explain how viewing scientific information through social media affects public understanding of science and also potentially add to the areas of research to which the ELM can be successfully applied

The Rise of Social Media as Sources of Scientific Information

As a whole, the American public has fairly low levels of science knowledge. A 2013 Pew Research Center poll found that while most Americans (78%) knew that the basic function of red blood cells is to carry oxygen to all parts of the body, only about half (51%) knew that fracking is a process that extracts natural gas, not coal, diamonds or silicon from the earth. Less than half (47%) understood that electrons are smaller than atoms, and just 20% could identify nitrogen as

the gas that makes up most of the atmosphere. Such low levels of science knowledge can lead members of the public to use cognitive shortcuts, or heuristics, when evaluating and interpreting scientific information. These low information reasoning strategies are useful to the public, as heuristics require less pre-existing knowledge and effort to evaluate information.

Historically, members of the public have tended to rely on mainstream media sources, such as newspapers and television, as primary sources of information about science (Nelkin, 1995). However, these traditional mass media sources may not be as relevant today as they once were. Science sections in mainstream news outlets are disappearing, and science communication is increasingly taking place through blogs and other online-only forums managed by former journalists, scientists, and lay individuals alike (Brossard, 2013). By 2004, the Internet was displacing traditional sources for information about science in the United States; television was still the top medium in terms of overall time spent interacting with science content, but the Internet had become the primary resource for those seeking information about science (NSF, 2006). Among respondents citing the Internet as their primary source of information about distinct scientific topics (60%), almost half (48%) reported relying on online sources such as blogs, social networks, Internet search tools, and other non-journalistic online sources to find out more about science (NSF, 2012).

Of these non-journalistic online sources, social networks have become an important source of science information. A recent study showed that most social media platforms are used by college students not only for social interactions or entertainment purposes, but also for information seeking in the academic context (Kim, Sin & He, 2013). Through new media platforms, individuals can access massive amounts of information about virtually anything, from anywhere, and without much cognitive effort (Brossard, 2013). Furthermore, college students are not the only ones looking for science information online. Scientists are also using social media to stay up-to-date with scientific developments in their own field or others. For example, in 2010 one in five American neuroscientists reported using blogs to follow news about scientific issues (Allgaier, Dunwoody, Brossard, Lo & Peters, 2013). In the field of medical science, one in four

physicians used social media one or more times a day to stay up-to-date on medical information and innovations (McGowan et al., 2012). Social media not only provide ways for users to access content; they also provide more opportunities for users to create content. Users now have greater opportunities to respond, participate and contribute to the sciences -- for example, through data collection and analysis as part of citizen science initiatives or via online debates and consultations about scientific developments (Holliman, 2011).

Due to the large amount of information available through online sources, there can be some difficulty for users in deciding what science information is trustworthy and accurate. Unlike traditional news outlets, blogs and other online information sources often do not clearly separate "opinions" and "news" (Brossard, 2013). Furthermore, users may not even be sure where the information they are looking at originated, as social network users can access news through links provided on their social networking sites or through news aggregators independent from the original producer (Brossard, 2013). Thus, users often rely on contextual cues to determine what information can be trusted.

Online users can interact with others through social media and make sense of information they are exposed to using contextual cues, such as Facebook "likes" and blog comments, they encounter (Brossard, 2013). A recent study found that the level of civility of the comments following an objective online news item on potential risks related to a technology impacted readers' perceptions of such risks. Among those supportive of nanotechnology, those exposed to uncivil comments following the news item perceived more risks in the technology and more bias in the news story than those exposed to civil comments, even though all subjects saw the same news story (Anderson, Ladwig, Brossard, Scheufele, & Xenos, 2010). In addition, motivated individuals have a tendency to select science stories written by blog writers perceived as having greater expertise and tend to prefer messages presenting two sides of an argument over one-sided messages (Winter & Kramer, 2012). Essentially, the Internet is now a primary source of science information, but users do not passively accept all information about science they find online; instead, they assess the trustworthiness of the information encountered using contextual cues.

Reddit as a Source of Scientific Information

There are many social media websites that people may use to acquire scientific information. Among these, the current research will focus on reddit.com. According to a nationally representative survey conducted by Pew Research Center, 6% of all adult Internet users use reddit (Duggan & Smith, 2013). In the month of July 2014, reddit had more than 100 million unique visitors hailing from more than 190 different countries and viewing a total of 5 billion pages ("About reddit," 2014). Reddit is an online community where users post content on a variety of topics. Any user can create a community, called a subreddit, about a topic of the user's own choice. Besides being a popular social media website, reddit is also a potential source of scientific information. Reddit features many specific subpages designed for sharing science information, such as /r/science, /r/askscience, /r/technology, and /r/everythingscience. Reddit also hosts interviews, called AMA's (Ask Me Anything), which allow top scientists and researchers in the science community, such as Neil deGrasse Tyson and Bill Nye, to speak directly to reddit users about their area of expertise.

Reddit users, known as redditors, can post comments on any story on reddit to add information, context, and humor. Some subreddits, such as /r/science, have a system of verifying accounts for commenting, enabling trained scientists, doctors and engineers to make credible comments in the subreddit and helping the general public to distinguish between an educated opinion and a comment from someone without a background related to the topic. Redditors also vote on which stories and discussions are important, which then determines the order of the stories shown on each page. An upvote from another user grants the original poster +1 karma and a downvote results in -1 karma. This karma number is displayed next to the user's name and indicates to other users that the submitter is an active and respected participant on reddit. The amount of time a reddit account has been active is also viewable by all visitors to the site, and relatively new accounts are often treated with suspicion, as they could be spammers. The social rating and commenting system makes reddit the ideal choice for this project—as does its simplistic design, which should be easy for even non-reddit users to understand.

Theoretical Framework

The theoretical framework for this project is the Elaboration Likelihood Model (ELM), which seeks to explain how people understand and process information based on their levels of cognitive motivation and ability (Petty & Cacioppo, 1986). According to the model, there are two routes a person can use to process information: the central route and the peripheral route. The central route involves effortful processing of attitude-relevant information to determine the merits of a communication. The peripheral route involves heuristic processing of information using cognitive shortcuts. Central processing of information is thought to lead to a longer lasting persuasive effect than peripheral processing of information. A person's likelihood to elaborate is determined by their attitude, motivation, and ability to elaborate.

Previous communication research has shown that the ELM can help explain how audience members react to online information. The ELM has been successfully applied to many topics, including communication about genetically modified foods (Frewer, Scholderer, & Bredahl, 2003), online consumer reviews (Sher & Lee, 2009), and web-based health information (Yi, Yoon, Davis, & Lee, 2013). Yi et al. (2013) applied the ELM to the field of health communication in their research on disseminating health-related information on the Internet. Their study explored the roles of several factors, including message source and user perceptions of information quality, in an individual's decision to trust health information they found online (Yi et al., 2013). The study's results highlight the central role of perceived information quality in developing trust in Web-based health information and indicate that rather than directly influencing trust in this context, individuals use source expertise to judge the quality of the information in question (Yi et al., 2013). Winter & Kramer (2012) used the ELM as a framework in studying how source cues, message sidedness, and need for cognition influenced user's selection of blog posts about scientific topics. Results indicated a general preference among users for texts composed by users with greater expertise and for two-sided messages, with need for cognition magnifying the effect of message sidedness (Winter & Kramer, 2012). These studies

show that the ELM can be successfully applied to the evaluation of online content and the selection of science stories.

This project will apply the ELM framework and focus on the impact of source factors. Although the ELM predicts that source effects should be limited to those who have less interest in a topic, the importance of source factors may be particularly high in the setting of science communication: In a domain where laypersons must rely heavily on others, the question of whom to believe might be more important than in domains where the merits of arguments are more apparent and can be inferred more easily by the readers themselves (Bromme, Kienhues, & Porsch, 2010). According to the ELM, most people are cognitive misers and will use the peripheral route to process information when they can. In this project, using the original source factors to evaluate a scientific article would indicate processing through the peripheral route while using secondary source cues from social media to evaluate a scientific article would indicate processing through an even more peripheral route.

The ELM predicts that attitude changes that result from more central—or, in this case, less peripheral—processing of information will result in longer lasting attitude changes. This suggests that those who evaluate scientific articles they view online based on original source factors will be more likely to experience lasting attitude changes than those who use social media source factors to evaluate these articles. Also, the ELM predicts that attitude changes that result from more peripheral processing are less likely to be based on the argument's strength. This suggests that those who evaluate scientific articles they view online based on social media source factors may be persuaded by weaker arguments than those who use original source factors to evaluate these articles. The ELM states that the likelihood of elaboration is situated on a continuum, dependent on cognitive motivation and ability. Thus, those who possess greater knowledge will also tend to possess higher levels of ability and motivation and will engage in greater argument scrutiny. This suggests that people who are more knowledgeable about science may be more likely to evaluate scientific articles they view online based on original source factors than those who are less knowledgeable about science.

Overall, the theoretical tenets of ELM and findings from past research suggest that, in the context of Web-based science information, source factors should play an important role in influencing user evaluations of credibility[1]

Hypotheses

Building on previous research, I predict that the credibility of original source factors will influence users' evaluation and interpretation of science information. Articles that are attributed to a high credibility source will be perceived as more trustworthy than articles attributed to a low credibility source and thus will have a stronger impact on viewers' attitudes toward the article topics:

- H1a: Compared to an article attributed to a low credibility source, an article attributed to a high credibility source will have a stronger impact on readers' attitudes towards the article topic.

For example, an article about hydraulic fracturing arguing that fracking is safe should be more likely to lead to more favorable evaluations of fracking if it is attributed to a high credibility source than if it is attributed to a low credibility source. Similarly, an article about herbal remedies arguing that herbal remedies can be unsafe should be more likely to lead to more negative evaluations of herbal remedies if it is attributed to a high credibility source than if it is attributed to a low credibility source.

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[1] Besides the ELM there have been other dual-route processing models proposed, such as the Heuristic-Systematic Model of Information Processing (Chaiken, 1980). The ELM is not necessarily superior to the Heuristic-Systematic Model of Information Processing (HSM) or other dual-process perspectives that have been developed in social cognition. Like the ELM, other dual-process models also suggest that individuals are flexible information processors who, depending on a range of factors, can be more or less engaged in the way that they process and evaluate information. There are not critical differences between these two models, the ELM and the HSM, as they share many of the same concepts and ideas. Here, I focus on the ELM given that it is extensively cited in the literature and the experiments that support the ELM have been replicated many times in different situations and with diverse variables.

I also predict that, along with original source factors, source cues from social media will influence viewers' evaluation and interpretations of science information. Articles that are accompanied by positive social media source factors rather than negative social media source factors will be perceived as more trustworthy and thus will have a stronger impact on viewers' attitudes toward the article topics:

- H1b: Compared to an article accompanied by negative social media source factors, an article accompanied by positive social media source factors will have a stronger impact on readers' attitudes towards the article topic.

For example, an article about hydraulic fracturing arguing that fracking is safe should be more likely to lead to more favorable evaluations of fracking if it is accompanied by positive social media factors than if it is accompanied by negative social media factors. Similarly, an article about herbal remedies arguing that herbal remedies can be unsafe should be more likely to lead to more negative evaluations of herbal remedies if it is accompanied by positive social media factors than if it is accompanied by negative social media factors.

Furthermore, I want to explore whether source cues from social media or original source factors will be more important to viewers when they are evaluating and interpreting science information. According to the ELM, most people will use the peripheral route to process information when they can. In this project, using the original source factors to evaluate a scientific article would indicate processing through the peripheral route while using secondary source cues from social media to evaluate a scientific article would indicate processing through an even more peripheral route. At present, however, we do not know how people who encounter scientific information through social media will weigh these two types of source cues against one another:

- RQ1: Will social media source factors or original source factors matter more for readers' evaluation and interpretation of science information?

I also want to explore whether viewers' levels of science knowledge will impact whether they use original source factors or social media source factors to evaluate and interpret science

information. The ELM states that those who possess greater knowledge will also tend to possess higher levels of ability and motivation and will engage in greater argument scrutiny. This suggests that people who are more knowledgeable about science may respond to original and social media source factors differently than those who are less knowledgeable about science:

- RQ2: Will the effects of original source factors and/or social media factors differ depending on readers' science knowledge?

Besides science knowledge, reader's level of interest in science could impact whether they use original source factors or social media source factors to evaluate and interpret science information. The ELM states that the likelihood of elaboration is situated on a continuum, dependent on cognitive motivation and ability. This suggests that people who are more interested in science will be more motivated to engage in greater argument scrutiny and, thus, may respond to original and social media source factors for scientific articles they view online differently than those who are less interested in science:

- RQ3: Will the effects of original source factors and/or social media factors differ depending on readers' science interest?

Additionally, readers' familiarity with reddit as a social media site could impact whether they use original source factors and social media source factors to evaluate and interpret science information. There are multiple possibilities for how this could play out. For example, if readers who are more familiar with reddit tend to trust reddit, then they may be more influenced by the social media source cues than those who are less familiar with reddit. Alternatively, if readers who are more familiar with reddit tend to be more skeptical about information from reddit then they may be less influenced by the social media source cues than those who are less familiar with reddit. There has not been much research thus far on reddit as a source; thus, a research question is appropriate here:

- RQ4: Will the effects of original source factors and/or social media factors differ depending on readers' familiarity with reddit?

We do not know much about how people process scientific information gained through social media, so it is useful to explore their responses to this type of information in their own words. For example, such responses could reveal if, and how, readers are impacted by scientific information viewed online and how they may decide whether such information is accurate or credible.

- RQ5: How do readers respond in their own words to scientific information they encounter through reddit?

In sum, this study uses the Elaboration Likelihood Model to examine how people respond to both original source factors and social media source factors in the context of viewing scientific information online. It also explores the role of individual characteristics such as level of science knowledge, interest in science, and familiarity with the social media site reddit. The results of the current research will help to determine whether, and if so how, original source factors and social media source factors shape readers' evaluations of scientific information seen on social media sites, as well as what types of people are influenced most by these factors.

Chapter 2

METHODS

A survey of actual reddit users provided a foundation for the main study. Building on the survey results, an experiment used two case studies, fracking and herbal remedies, in manipulating source factors to determine how people respond to both original source factors and social media source factors in the context of viewing scientific information online.

Reddit Survey

The survey of reddit users, which included both quantitative and qualitative items, consisted of fifteen questions about reddit as a potential source of scientific information as well as the ways in which typical users engage with reddit (see Appendix A).

In all, 135 participants completed the survey. Participants were recruited through posts on either reddit or Facebook between August 27 and September 12, 2014. Of these participants, 54% were men, 44% were women, and 2% were other. A majority of the participants (83%) were between the ages of 18 and 29. In terms of race and ethnicity, 87% self-identified as White, 7% as Asian/Pacific Islander, 5% as Hispanic/Latino, 3% as Black/African American, and 2% as other (participants were allowed to select multiple categories). In terms of education, 31% of respondents had completed some college, 27% were college graduates, and 16% had completed a post-graduate degree.

A majority of the survey respondents (78%) had used reddit for more than one year. Of the participants, 40% reported spending 1-2 hours on reddit per day. Of the total time respondents spent on reddit, 61% of respondents reported spending 0-24% of their time on science related topics. Only 2% of respondents said they were not at all interested in science, while 5% said they were not much interested in science, 26% said they were somewhat interested

in science, 35% said they were interested in science a good deal, and 33% said they were interested in science a great deal.

When asked what they liked about reddit as a source of science information, 33% of respondents mentioned the discussion in the comments on posts as being insightful (”A lot of science news that you wouldn't hear about on the regular news, and the discussion in the comments is usually very insightful and thought-provoking”), correcting misinformation in the article (“If someone makes an incorrect statement, there will be dozens of comments underneath saying why the person is wrong”), or adding new helpful information (“In the comments, there are often critical reviews of articles, more information that the link may not have gone into, simple explanations”). One user said about reddit, “It's the first place I can find out about scientific information and the comments generally tell you whether the article is to be trusted and usually add to and explain things.” Another user said that the “Upvote/Downvote system and comments are like peer review.”

When asked what they disliked about reddit as a source of science information, many respondents mentioned that the content can be repetitive (“Quite often the same information is repeated several times in different subreddits”), the headlines can be sensationalized or misleading (“The post titles are always wildly optimistic and misleading. I always go to the comments for someone to have read the article and picked out the pertinent information and cut out all the crap”), and that the site is hard to use to find specific information (“It's almost impossible to find something you're looking for; reddit is good for seeing what's new or what's popular, but it isn't good for finding a specific item of personal interest”).

Table 1 compares the self-reported importance of several social media factors to participants when they are choosing to view a scientific article on reddit and when they are evaluating the credibility of a scientific article on reddit. The factors were rated on a scale of one to five, with one being the least important and five being the most important. In both situations, it appears that participants rated the identity of the article poster as least important and where the article was published as most important. The number of reddit comments on article, nature of

reddit comments on article, and number of upvotes/downvotes on the reddit post were all rated as more important when choosing to view an article than when evaluating the credibility of an article.

Experiment

These survey results were useful in designing the main study for this project, which was an online, between-subjects posttest-only experiment conducted using Qualtrics (N = 322 University of Delaware students). In the experiment, participants viewed two scientific articles from a social media website, reddit, and then answered questions capturing their evaluations and understandings of the articles' content.

The current research focuses on determining the impact of the most highly rated source factors from each category (original and social media) on users' evaluations of scientific information. Based on the results of the reddit pre-survey, the original source factors most important to users when evaluating the credibility of a scientific article were where the article was published (credible source or non-credible source) and who wrote the article (credible source or non-credible source). The social media source factors most important to users when evaluating the credibility of a scientific article were the nature (positive or negative) of comments on the reddit post and the ratio of upvotes/downvotes (high or low) on reddit post. In the experiment, these four factors were manipulated through random assignment to conditions on two case topics: hydraulic fracturing (fracking) and herbal remedies.

Case Selection

Hydraulic Fracturing

Hydraulic fracturing is a technology used to extract shale gas. Shale rock formations can contain vast amounts of natural gas, but until recently most of this gas was not economically obtainable because shale is far less permeable than the rock formations exploited for conventional gas (Howarth, Ingraffea, & Engelder, 2011). Hydraulic fracturing, in which high-

pressure water with additives is used to increase fissures in the rock, is used in combination with precision drilling of wells that can follow the contour of a shale layer closely (Howarth, Ingraffea, & Engelder, 2011). The selected article about hydraulic fracturing discusses a September 2014 study, which concluded that tainted drinking water in areas where natural gas is produced from shale is most likely contaminated by leaky wells rather than the process of hydraulic fracturing (Fountain, 2014). The topic of hydraulic fracturing, or fracking, was chosen for this experiment because the participants may have heard of it but may not already have pre-formed opinions about it that could influence their evaluation and interpretation of the experimental stimuli. According to the aforementioned national survey conducted by the Pew Research Center, only about half (51%) of the American public knows that fracking is a process that extracts natural gas, not coal, diamonds or silicon from the earth. The potential environmental risks and economic rewards involved with fracking make it an important topic to investigate. Also, the topic of hydraulic fracturing has been discussed often on the social media site reddit, which makes it a useful topic to examine when exploring how people evaluate science information seen through social media sites.

Herbal Remedies

Alternative medicine is the broad term for any practice that is presented as having the healing effects of medicine, but is not based on scientific evidence. Alternative medicine is present in the US, with a national survey finding 88% of Americans agree that there are some good ways of treating sickness that medical science does not recognize (NSF, 2002). One category of alternative medicine is herbal remedies. The effectiveness of herbal remedies, along with other alternative medicines, is either unproven or disproved by the scientific method. There has been controversy over herbal remedies, as they are not sufficiently regulated which can lead to health risks. The selected article about herbal remedies discusses an October 2013 study, which used DNA testing to determine the authenticity and safety of various popular herbal remedies (O'Connor, 2013). The topic of herbal remedies was chosen for this experiment

because it is fairly popular in the United States so most participants will have heard of it. Additionally, there is considerable information about herbal remedies on the Internet, much of which is inaccurate and potentially dangerous (Evans, 2001). The health risks involved with herbal remedies makes it an important choice to use while investigating how people evaluate science information seen through social media sites.

Experimental Design

Participants

University of Delaware students who were enrolled in COMM330: Communication and Interpersonal Behavior in Fall 2014 were invited to participate in this study through an email from their professor. Of the respondents (N= 322), 24.2% were male and 75.8% were female. In terms of academic classifications, 1.2% of the participants were freshman, 63.4% were sophomores, 18.9% were juniors, 15.5% were seniors, and 0.9% were other. The majority of respondents (51.9%) were 19 years old; fully 97.6% were between the ages of 18 and 22. In terms of race and ethnicity 82.9% of the participants self-identified as white, 8.7% identified as African American/black, 6.2% identified as Hispanic, 5.6% identified as Asian/Pacific islander, and 2.8% identified as other (participants were allowed to select multiple categories). Politically, 41.6% of participants were moderate, 29.8% were somewhat liberal, 15.5% were somewhat conservative, 10.6% were very liberal and 2.5% were very conservative. Of the respondents, 23% identified as Republican (6.5% were strong Republicans and 15.2% were not very strong Republicans), 36.3% identified as Democrat (12.4% were strong Democrats and 22.4% were not very strong Democrats) and 40.7% identified as independent or other (15.5% of those leaned more to the Republican Party and 21.4% leaned more to Democratic Party). Fully 82.3% of participants reported spending no time on reddit per day, 13% spent less than 1 hour on reddit per day, 3.7% spent 1-2 hours on reddit per day and less than 1% spent 3 hours or more on reddit per day.

Participants in the experiment were randomly assigned to view two articles. Random assignment for each article was done independently. For the first article, participants viewed one of four manipulated articles on hydraulic fracturing or a control article. For the second article, participants viewed one of four manipulated articles on herbal remedies or a control article. The control articles were unrelated to either scientific topic; the first control article addresses the raising of minimum wage in San Francisco to $15/hour and the second control article covers the possibility of using on-body cameras for police officers in the Los Angeles Police Department.

Treatments

There were four manipulated articles for each case (hydraulic fracturing and herbal remedies; see Appendix B). The original content for these stimuli was found on reddit between August 16, 2013 and September 16, 2014. The content was then edited to fit the various conditions of the experiment using Adobe InDesign and PhotoShop.

Hydraulic Fracturing

The hydraulic fracturing stimuli articles were manipulated to display the following attributes: (Article 1) high credibility publication source of article, positive comments on reddit post; (Article 2) high credibility publication source of article, negative comments on reddit post; (Article 3) low credibility publication source of article, positive comments on reddit post; and (Article 4) low credibility publication source of article, negative comments on reddit post. The text of the articles was kept consistent, but the source of the article was varied for the high credibility original source condition and the low credibility original source condition. The high credibility publication source used was *The New York Times* science section. The low credibility publication source used was *Marcellus Drilling News: Helping People and Businesses Profit from Northeast Shale Drilling*.

Above the article title and text, each condition showed a screenshot from reddit displaying a user generated comment about the article that was either positive or negative. The positive comment (128 words) read:

> I'm surprised at the responses so far. I have some experience in this study and would be the first to call out alarmist BS. However, this research is actually legitimate in that they're identifying the source of these compounds using isotopic analysis. Comments saying that water in petro areas would be expected to have these compounds show peoples ignorance on the topic. Water in these areas would be expected to have biogenic compounds, not thermogenic. This research indicates a correlation between petro compounds arising from e&p being present in drinking water, not naturally occurring biogenic compounds. Comments about concentrations not being harmful are equally ignorant, this research has nothing to do with toxicity or risk, it's about demonstrating that e&p can affect drinking water, not by how much.

The negative comment (129 words) read:

> Billions of gallons of fresh water are being destroyed (contaminated without any current technology to remediate) in fracking operations across america every year. Where is the water going to come from once we frack it all up? Supporter of oil & gas? I hope you can eat money because that's all you'll be left with. Wash it down with a nice cool glass of gasoline. Nothing disturbs me more than lack of knowledge about what's happening. I had a buddy go to some speech by an oil & gas PR rep then tell me that I should educate myself on fracking. I've spent the last 5 years learning about this and forgive me but an oil & gas PR rep is not going to be giving an unbiased opinion.

Herbal Remedies

The herbal remedy stimuli articles were manipulated to display the following attributes: (Article 1) high credibility author of article, high ratio upvotes/downvotes on reddit post; (Article 2) high credibility author of article, low ratio upvotes/downvotes on reddit post; (Article 3) low credibility author of article, high ratio upvotes/downvotes on reddit post; and (Article 4) low credibility author of article, low ratio upvotes/downvotes on reddit post. The text and source of the articles were kept consistent, but the author of the article was varied for the high credibility original source condition and the low credibility original source condition. The author of the high credibility condition was listed as, 'Anahad O'Connor, Senior Science Reporter' while the author of the low credibility condition was listed as, 'News Staff'.

Above the article title and text, each condition showed a screenshot from reddit displaying an upvote/downvote ratio of the reddit post that was either high or low. For the high ratio condition, the post was shown to have 3,626 points (95% upvoted). For the low ratio condition, the post was shown to have 0 points (48% upvoted).

Posttest

After participants viewed their assigned articles, they took a short post-test (see Appendix C). The posttest began with set of questions intended to misdirect participants from the study's purpose. These items asked participants to rate how well a series of terms described the article. Along with these items, the posttest included measures for the variables of interest as well as additional distractor items (including items related to the control articles).

Demographics

Several questions at the end of the posttest assessed participant demographics, including gender, student classification, age, race/ethnicity, and political views.

Fracking perceptions

One key dependent variable in the analyses was participant attitude towards fracking. There were five questions designed to measure fracking perceptions. The questions for this variable asked participants to indicate, on 7-point scales, their attitudes towards different aspects of fracking. The first question (M=3.09, SD=1.30) asked, "What is your overall opinion of hydraulic fracturing (fracking)?" The ends of the scale were labeled "Very unfavorable" (coded as 1) and "Very favorable" (coded as 7). The second question (M=2.79, SD=1.25) asked, "How safe do you think hydraulic fracturing (fracking) is?" The ends of the scale were labeled "Not at all safe" (coded as 1) and "Very safe" (coded as 7). The third question (M=2.95, SD=1.33) asked, "How risky do you think hydraulic fracturing (fracking) is?" The ends of the scale were labeled "Not at all risky" (coded as 1) and "Very risky" (coded as 7). The fourth question (M=3.22, SD=1.29) asked, "How much do you favor or oppose the use of hydraulic fracturing

(fracking)?" The ends of the scale were labeled "Strongly oppose" (coded as 1) and "Strongly favor" (coded as 7). The last question (M=2.74, SD=1.27) asked, "How much do you favor or oppose stricter regulation of hydraulic fracturing (fracking)?" The ends of the scale were labeled "Strongly oppose" (coded as 1) and "Strongly favor" (coded as 7).

I reverse coded the third question and the last question so that, as with the other questions, higher numbers indicate a more favorable attitude towards fracking and lower numbers indicate a less favorable towards fracking. After analyzing the five items to test whether they formed a reliable index, which they did (Cronbach's alpha=0.79), I then created a Fracking Attitude index (M=2.96, SD=0.95) by averaging across the five items.

Herbal Remedy perceptions

Another key dependent variable in the analyses was participant attitude towards herbal remedies. There were five questions designed to measure herbal remedy perceptions. The questions for this variable asked participants to indicate, on 7-point scales, their attitudes towards different aspects of herbal remedies. The first question (M=3.97, SD=1.66) asked, "What is your overall opinion of over-the-counter herbal remedies?" The ends of the scale were labeled "Very unfavorable" (coded as 1) and "Very favorable" (coded as 7). The second question (M=4.06, SD=1.51) asked, "How safe do you think over-the-counter herbal remedies are?" The ends of the scale were labeled "Not at all safe" (coded as 1) and "Very safe" (coded as 7). The third question (M=4.07, SD=1.54) asked, "How risky do you think over-the-counter herbal remedies are?" The ends of the scale were labeled "Not at all risky" (coded as 1) and "Very risky" (coded as 7). The fourth question (M=3.93, SD=1.48) asked, "How much do you favor or oppose the use of over-the-counter herbal remedies?" The ends of the scale were labeled "Strongly oppose" (coded as 1) and "Strongly favor" (coded as 7). The last question (M=3.06, SD=1.68) asked, "How much do you favor or oppose stricter regulation of over-the-counter herbal remedies?" The ends of the scale were labeled "Strongly oppose" (coded as 1) and "Strongly favor" (coded as 7).

I reverse coded the third question and the last question so that, as in the other questions, higher numbers indicate a more favorable attitude towards herbal remedies and lower numbers indicate a less favorable towards herbal remedies. After analyzing the relevant dependent variables to see if they formed a reliable index, which they did (Cronbach's alpha=0.79), I created an Herbal Remedy Attitude index (M=3.82, SD=1.17).

Science knowledge and interest

The analyses also examined participant levels of science knowledge. There were five questions designed to measure science knowledge, taken from a 2013 Pew Research Center study on public knowledge about science. The first question (31% correct versus 47% in the Pew study) asked, "True or False: Electrons are smaller than atoms". The second question (59% correct versus 48% in the Pew study) asked, "True or False: Lasers work by focusing sound waves". The third question (52% correct versus 20% in the Pew study) asked, "Which gas makes up most of the Earth's atmosphere: Hydrogen, Nitrogen, Carbon Dioxide, Oxygen, Don't know". The fourth question (28% correct versus 66% in the Pew study) asked, "Which is an example of a chemical reaction: Water boiling, Sugar dissolving, Nails rusting, Don't know". The last question (36% correct versus 58% in the Pew study) asked, "Which gas do most scientists believe causes temperatures in the atmosphere to rise? Is it: Carbon Dioxide, Hydrogen, Helium, Radon, Don't know". Overall science knowledge among the participants was low, with only 16% of respondents getting all five science knowledge questions correct.

I recoded participant responses to the relevant questions to reflect correct (coded as 1) and incorrect (coded as 0) answers. After analyzing the knowledge items to confirm that they formed a reliable index, which they did (Cronbach's alpha=0.61), I created a Science Knowledge index (M=0.59, SD=0.30) by averaging across them. Interest in science was also included as a single-item measure (M=3.84, SD=1.97): "How interested are you in science?" The ends of the scale were labeled "Not at all" (coded as 1) and "A great deal" (coded as 7).

Reddit familiarity

In addition, the analyses examined participant familiarity with the social media site reddit. There was a single-item measure (M=3.46, SD=2.07) which asked, "How familiar are you with the website, reddit.com?" The ends of the scale were labeled "Not at all familiar" (coded as 1) and "Very Familiar" (coded as 7).

Qualitative

To better understand how participants responded to the experimental treatments, the post-test included two open-ended questions, one for each topic. Each question stated: "In the space below, please describe your reaction to the article you just viewed." I conducted qualitative analyses of the answers to these questions along several dimensions. These dimensions of interest emerged from an initial examination of all of the responses.

Emotion

To explore participants' emotional responses to the articles I read their open-ended responses and highlighted those that were related to emotions. The keywords that I used were: shock, amaze, confuse, angry, anger, surprise, surprising, disturbing, outrage, scary, horrifying, and distress.

Interest and relevance

To explore participants' interest in and perceived relevance of the articles I read their open-ended responses and highlighted those that addressed interest and/or relevance. The keywords that I used were: interest, relevant, relevance, relate, relatable, boring, and bored.

Science

To explore participants' perception of science in the articles I read their open-ended responses and highlighted those that were related to science. The keywords that I used were: know, science, scientific, jargon, and technical.

Social Media

To explore participants' perception of the social media source cues in the articles I read their open-ended responses and highlighted those that were related to social media. The keywords that I used were: reddit and comment.

Chapter 3

RESULTS

This chapter presents the quantitative results for both experimental cases, fracking and herbal remedies, as well as results for the open-ended responses. For the case of fracking, the treatment article should have led to more favorable evaluations of fracking. For the case of herbal remedies, the treatment article should have led to less favorable evaluations of herbal remedies. The analyses here focus on the extent to which any such effects varied depending on exposure to original source factors and social media source factors.

Quantitative Results

Fracking Condition

My first hypothesis (H1a) predicted that compared to an article attributed to a low credibility source, an article attributed to a high credibility source will have a stronger impact on participant attitudes towards the article topic. My second hypothesis (H1b) predicted that compared to an article accompanied by negative social media source factors, an article accompanied by positive social media source factors will have a stronger impact on participant attitudes towards the article topic. To test both hypotheses, mean levels for the Fracking Attitudes index and the five individual fracking survey items were compared across experimental conditions (see Table 2). The results of one-way ANOVAs with Bonferonni post-hoc tests failed to support either prediction for the index, $F(4,315) = 0.54$, p=n.s., or any of the individual items: overall opinion of fracking, $F(4,317) = 0.42$, p=n.s.; safety of fracking, $F(4,317) = 1.10$, p=n.s.; riskiness of fracking, $F(4,316) = 0.42$, p=n.s.; use of fracking, $F(4,317) = 0.92$, p=n.s.; stricter regulation of fracking, $F(4,316) = 0.31$, p=n.s.

Research Question 1 asked whether social media source factors or original source factors matter more for participants' evaluation and interpretation of science information. As neither H1a nor H1b was supported by the results, this question seems moot in the case at hand.

Research Question 2 asked whether levels of scientific knowledge among participants will moderate the effects of original source factors and social media source factors. To answer this question, a median split sub-sample analysis was conducted for the Fracking Attitude index (see Table 3). There were no significant differences in Fracking Attitude means between experimental conditions among participants with low levels of science knowledge (≤ 0.6, as measured by SciKnow index), $F(4, 182) = 0.20$, p=n.s. Nor were there significant differences in Fracking Attitude means between experimental conditions among participants with higher levels of science knowledge (≥ 0.7, as measured by SciKnow index), $F(4, 128) = 0.98$, p=n.s.

Research Question 3 asked whether the effects of original source factors and/or social media factors differ depending on participants' science interest (see Table 4). There were no significant differences in Fracking Attitude means between experimental conditions among participants with low levels of science interest (≤ 3), $F(4, 139) = 0.69$, p=n.s. Similarly, there were no significant differences in Fracking Attitude means between experimental conditions among participants with higher levels of science interest (≥ 4), $F(4, 163) = 0.62$, p=n.s.

Research Question 4 asked whether the effects of original source factors and/or social media factors differ depending on participants' familiarity with reddit. To answer this question, a median split sub-sample analysis was conducted (see Table 5). There were no significant differences in Fracking Attitude means between experimental conditions among participants with higher levels of familiarity with reddit (≥ 4), $F(4, 138) = 0.27$, p=n.s. Nor were there significant differences in Fracking Attitude means between experimental conditions among participants with lower levels of familiarity with reddit (≤ 3), $F(4, 172) = 0.56$, p=n.s.

Herbal Remedy Condition

Again, my first hypothesis (H1a) predicted that compared to an article attributed to a low credibility source, an article attributed to a high credibility source will have a stronger impact on participant attitudes towards the article topic. Similarly, my second hypothesis (H1b) predicted that compared to an article accompanied by negative social media source factors, an article accompanied by positive social media source factors will have a stronger impact on participant attitudes towards the article topic. To test these hypotheses, mean levels of Herbal Remedy Attitudes were compared across experimental conditions, as were mean levels for each of the five herbal remedy attitude items (see Table 6). The results of one-way ANOVAs with Bonferonni post-hoc tests showed significant differences across conditions for the index, $F(4,314) = 3.66$, $p<.01$ as well as for three of the individual items: overall opinion of herbal remedies, $F(4,315) = 5.45$, $p<.01$; use of herbal remedies, $F(4,315) = 3.31$, $p<.01$; and stricter regulation of herbal remedies, $F(4,314) = 3.67$, $p<.01$. However, for the other two items—safety of herbal remedies, $F(4,315) = 2.64$, p=n.s., and riskiness of herbal remedies, $F(4,315) = 1.77$, p=n.s.—there were no significant differences across conditions.

For the Herbal Remedy Attitude index, there were significant differences between the control condition (M=4.20, SD=0.97) and both the high credibility/negative social media condition (M=3.61, SD=1.21) and the low credibility/negative social media condition (M=3.53, SD=1.29).

For overall opinion of over-the-counter herbal remedies, there were significant differences between the control condition (M=4.46, SD=1.39) and both the high credibility/negative social media condition (M=3.61, SD=1.73) and the low credibility/negative social media condition (M=3.52, SD=1.66). There were also significant differences between the high credibility/positive social media condition (M=4.45, SD=1.64) and both the high credibility/negative social media condition and the low credibility/negative social media condition.

For attitude about the use of over-the-counter herbal remedies, there were significant differences between the control condition (M=4.25, SD=1.26) and the low credibility/negative social media condition (M=3.50, SD=1.53). There were also significant differences between the high credibility/positive social media condition (M=4.24, SD=1.53) and the low credibility/negative social media condition.

For attitude about stricter regulations of over-the-counter herbal remedies, there were significant differences between the control condition (M=3.69, SD=1.34) and both the high credibility/positive social media condition (M=2.88, SD=1.62) and the high credibility/negative social media condition (M=2.64, SD=1.74).

Although there were significant differences across experimental conditions for the Herbal Remedy Attitude index and three of the five individual items, there were no consistent differences between two high credibility source conditions and the two low credibility source conditions or between the two high credibility source conditions and the control condition. The only instance where the two high credibility source conditions differed significantly from the control condition was in relation to attitude about stricter regulation of over-the-counter herbal remedies. Here, participants exposed to high credibility source conditions were more likely to support stricter regulations of over-the-counter herbal remedies than control participants. Participants who were exposed to low credibility source conditions did not differ significantly from the control condition in relation to attitude about stricter regulation of over-the-counter herbal remedies. In sum, there was little evidence for H1a.

When looking at participants in both negative social media source factor conditions together, these participants differed significantly from the control participants on the Herbal Remedy Attitude index and overall opinion of over-the counter herbal remedies in terms of mean attitudes towards Herbal Remedies. When looking at participants in both positive social media source factor conditions together, these participants did not differ significantly from the control condition in terms of mean participant attitudes towards Herbal Remedies. This suggests that negative social media source factors negatively influenced participant attitudes toward Herbal

Remedies relative to participant attitudes in the control condition. In contrast, positive social media source factors did not significantly impact participant attitudes toward Herbal Remedies. Thus, there was little evidence for H1b.

Research Question 1 asked whether social media source factors or original source factors matter more for participants' evaluation and interpretation of science information. Given that neither H1a nor H1b was supported by the results, it seems that there is no clear 'winner' between social media source factors and original source factors when it comes to which matters more for participants' evaluation and interpretation of science information. If anything, these results suggest that low credibility original sources and negative social media source factors may have more influence on participants' attitudes toward the article topic than high credibility original sources or positive social media source factors.

Research Question 2 asked whether participants' levels of scientific knowledge will moderate the effects of original source factors and social media source factors. To answer this question, a median split sub-sample analysis was conducted (see Table 7). There were no significant differences in Herbal Remedy Attitude means between experimental conditions among participants with low levels of science knowledge (≤ 0.6, as measured by SciKnow index), $F(4, 181) = 1.39$, p=n.s. However, there were significant differences in Herbal Remedy Attitude means between experimental conditions among participants with higher levels of science knowledge (≥ 0.7, as measured by SciKnow index), $F(4, 128) = 2.49$, $p<.05$. Although the F value shows significant differences in Herbal Remedy Attitude means between experimental conditions for participants with higher levels of science knowledge, the Bonferonni post-hoc tests did not reveal any specific significant differences.

Research Question 3 asked whether the effects of original source factors and/or social media factors differ depending on participants' science interest (see Table 8). There were no significant differences in Herbal Remedy Attitude means between experimental conditions among participants with low levels of science interest (≤ 3), $F(4, 137) = 0.92$, p=n.s. In contrast, there were strong significant differences in Herbal Remedy Attitude means between

experimental conditions among participants with higher levels of science interest (≥ 4), $F(4, 164) = 3.69$, $p<.01$. For participants with high levels of science interest, there were significant differences between the control condition (M=4.41, SD=1.09) and both the low credibility/positive social media condition (M=3.54, SD=1.30) and the low credibility/negative social media condition (M=3.36, SD=1.21).

Research Question 4 asked whether the effects of original source factors and/or social media factors differ depending on participants' familiarity with reddit. To answer this question, a median split sub-sample analysis was conducted (see Table 9). There were no significant differences in Herbal Remedy Attitude means between experimental conditions among participants with higher levels of familiarity with reddit (≥ 4), $F(4, 138) = 1.22$, p=n.s. There were significant differences in Herbal Remedy Attitude means between experimental conditions among participants with lower levels of familiarity with reddit (≤ 3) , $F(4, 171) = 2.79$, $p<.05$. Although the F value shows significant differences in Herbal Remedy Attitude means between experimental conditions for participants with lower levels of familiarity with reddit, the Bonferonni post-hoc tests did not reveal any specific significant differences.

Qualititative Results

Research Question 5 asked how participants respond in their own words to scientific information they encounter through reddit. In order to answer this question, I analyzed the open-ended questions along four content dimensions: social media, science, interest and relevance, and emotional response.

Social Media

Participants in the fracking conditions were more likely to mention social media factors, particularly reddit, than participants in the herbal remedy conditions – potentially because of the aspect of reddit shown (comments vs. ratio of upvotes/downvotes). Participants who did mention reddit tended to characterize it negatively, as in the following examples:

"I had never been on reddit before, but know the demographic of its contributors is largely young, white, ignorant males"

"Herbal supplement ideas from reditt are not very credible"

"it was more informative than I am used to seeing on reddit"

Participants in the fracking condition who mentioned reddit seemed to be put off by the comments used. For example, one participant said of the positive social media comment that "the reddit comment just seemed overcomplicated and pretentious, maybe just because I didn't understand the arguments brought up." Similarly, another participant called the negative social media comment "overly aggressive". Participants in both conditions seemed to be confused by the design of the displayed articles:

"Confused because of the blending of Reddit and the New York Times"

"(Didn't) Understand the connect between the Reddit statement and the NYT article"

"It seemed like there were two articles on the page, though, one overlapping the other. The first seemed to be from Reddit and the second from a trustworthy news source"

"I viewed two contradictory articles about the cause of contaminated water"

Misunderstanding of the design of the displayed articles could be a potential weakness of the experimental design.

Science

Many participants in the fracking condition seemed to perceive their article as being too scientific:

"Because I am not an expert in environmental sciences, during some parts of the article is was difficult to comprehend some of the terms used"

"its lingo was very scientific and I did not fully understand the details"

> "I got very bored, very quickly. Although it was informational, I was bogged down by the jargon and the large bodies of text that the information I read did not stick with me"
>
> "I thought it was pretty boring and a little too technical for an uninformed reader"
>
> "I'm not familiar with too many of the terms described, so I wasn't able to absorb too much information or take a lot away from it"
>
> "I have a hard time focusing on scientific based articles. After reading the article, I am bored and not entirely sure what the point was"
>
> "I'm not really a science person so the article personally didn't interest me especially since it was very objective and not super opinionated which is good because its not biased but it was just not interesting for me to read"

No participants in the herbal remedy condition had such complaints. Indeed, a few seemed to perceive their article as not scientific enough:

> "I think it was lacking in concrete scientific evidence for both the studies shown on the makeup of the herbal pills as well as the effects herbal remedies realistically have"
>
> "This article was very general and I wish there was more scientific research behind it"

These perceptions could impact participants' interest and engagement with the articles.

Interest and Relevance

There is a strong connection between relevance of topic and interest in article. In the fracking condition, one participant said, "I thought it was interesting to find the water in Pennsylvania is contaminated. I live in PA and it is scary to know that fracking has such a big impact on the water we consume." In contrast, another said, "I'm not really a science person so the article personally didn't interest me".

In the herbal remedies condition, one participant said, “I thought it was interesting because I take supplements like the article was talking about. It had relevancy to my life” whereas another said, “I was very uninterested in the article because I do not like or ever take herbal medicine”. Overall, more respondents reported that the herbal remedy article was relevant to them than reported that they felt uninterested in it. Of the participants who commented, 48% reported feeling interested in the fracking article, whereas 34% reported feeling uninterested in fracking article. In addition 14% reported that the fracking article was relevant to them, and 14% reported that the fracking article was not relevant to them. For the herbal remedy article, 44% of respondents who commented reported feeling interested in it, versus 19% who reported feeling uninterested. Moreover, 39% reported that the herbal remedy article was relevant to them, compared to 17% who reported that the herbal remedy article was not relevant to them.

Emotional Response.

Overall, more respondents in the herbal remedy condition (76) reported having an emotional response to their article than did respondents in the fracking condition (52).

Fully 62% of respondents in the fracking condition who reported having an emotional response to their article said they felt surprised/shocked, 21% felt scared/alarmed, 12% felt confused, 5% felt sad, and 5% felt angry/upset after viewing their article.

Meanwhile, 63% of respondents in the herbal remedy condition that reported having an emotional response to their article said they felt shocked/surprised, 20% felt scared/alarmed, 13% felt angry/upset, 4% felt sad, 4% felt disgusted, and 1% felt confused after viewing their article. Respondents in the herbal remedy condition were less confused and more angry/upset after viewing their article than participants in the fracking condition. Whereas no participants in the fracking condition reported feeling disgusted after reading their article, 4% of respondents in the herbal remedy condition who reported having an emotional response to their article said they felt disgusted/repulsed after reading their article. These reactions could impact respondent engagement and interest in their article and respondent attitudes toward their topic.

Chapter 4

DISCUSSION

This project explored whether—and if so, how—citizens exposed to scientific information through social media use social media source factors to evaluate the credibility of this information. It also examined whether citizens attach more weight to social media factors or original source factors in making such evaluations.

Based on my survey of actual reddit users, conducted before the main study, it seems that reddit users are generally interested in science and many use reddit to view science information. Both when they are choosing to view a scientific article on reddit and when they are evaluating the credibility of a scientific article on reddit, reddit users rated where the article was originally published as the most important criterion. This suggests that original source factors matter to reddit users when choosing to view an article and when evaluating the credibility of an article. Social media factors, such as the number of reddit comments on article, nature of reddit comments on article, and number of upvotes/downvotes on the reddit post, were all rated as more important when choosing to view an article than when evaluating the credibility of an article. The results of this survey are novel contributions in and of themselves; furthermore, they provided a foundation for the main study, the results of which I discuss below.

My first hypothesis (H1a) predicted that compared to an article attributed to a low credibility source, an article attributed to a high credibility source will have a stronger impact on participant attitudes towards the article topic. My second hypothesis (H1b) predicted that compared to an article accompanied by negative social media source factors, an article accompanied by positive social media source factors will have a stronger impact on participant attitudes towards the article topic. The quantitative analysis of the data failed to support either prediction for the fracking condition or the herbal remedies condition.

Although there were significant differences across experimental conditions for the Herbal Remedy Attitude index and three of the five individual items, there were no consistent differences between the two high credibility source conditions and the two low credibility source conditions or between the two high credibility source conditions and the control condition. Thus, there was little evidence for H1a. When looking at social media source factor conditions, there were no consistent differences between the two positive social media source conditions and the two negative social media source conditions or between the two positive social media source conditions and the control condition. Thus, there was little evidence for H1b.

Research Question 1 asked whether social media source factors or original source factors matter more for participants' evaluation and interpretation of science information. As neither H1a nor H1b was supported by the results for either case, it seems that it is unclear whether social media source factors or original source factors matter more for participants' evaluation and interpretation of science information. If anything, the herbal remedy results suggest that high credibility original sources and negative social media source factors could sway participants more than low credibility original sources and positive social media source factors, respectively. In addition, different types of source factors may impact different aspects of participant beliefs.

Research Question 2 asked whether levels of scientific knowledge among participants will moderate the effects of original source factors and social media source factors. There were no significant differences in fracking attitude means between experimental conditions among participants with low levels of science knowledge or among participants with higher levels of science knowledge. There were also no significant differences in herbal remedy attitude means between experimental conditions among participants with low levels of science knowledge. However, there were significant differences in herbal remedy attitude means between experimental conditions among participants with higher levels of science knowledge. Thus, it appears that higher levels of scientific knowledge may magnify the effects observed for some cases. Such a pattern is in line with the Elaboration Likelihood Model, which states that a

person's likelihood to elaborate is determined in part by their motivation and ability to elaborate. However, this finding is not consistent across both experimental cases.

Research Question 3 asked whether the effects of original source factors and/or social media factors differ depending on participants' science interest. There were no significant differences in fracking attitude means between experimental conditions among participants with low levels of science interest or among participants with higher levels of science knowledge. There were also no significant differences in herbal remedy attitude means between experimental conditions among participants with low levels of science interest. In contrast, there were strong significant differences in herbal remedy attitude means between experimental conditions among participants with higher levels of science interest. Thus, it seems that higher levels of scientific interest may strengthen the effects observed for some cases. This makes sense in the context of the Elaboration Likelihood Model; people who are more interested in science should be more motivated to engage in effortful processing of scientific content compared to those who are less interested in science and therefore process information differently. Again, however, the pattern was not consistent across both experimental cases

Research Question 4 asked whether the effects of original source factors and/or social media factors differ depending on participants' familiarity with reddit. There were no significant differences in fracking attitude means between experimental conditions among participants with higher levels of familiarity with reddit or among participants with lower levels of familiarity with reddit. Likewise, there were no significant differences in herbal remedy attitude means between experimental conditions among participants with higher levels of familiarity with reddit. However, there were significant differences in herbal remedy attitude means between experimental conditions among participants with lower levels of familiarity with reddit. This finding can be better understood in the context of participants' open-ended responses.

Research Question 5 asked how participants respond in their own words to scientific information they encounter through reddit. In order to answer this question, I analyzed the open-ended responses along four content dimensions: social media, science, interest and relevance,

and emotional response. Participants in the fracking conditions were more likely to mention social media factors, particularly reddit, than participants in the herbal remedy conditions – potentially because of the aspect of reddit shown (comments vs. ratio of upvotes/downvotes). Participants who did mention reddit tended to characterize it negatively. Participants in the fracking condition who mentioned reddit seemed to be put off by the comments used. The general negative attitude towards reddit among participants could explain why those who were less familiar with reddit, and presumably less critical of reddit, may be more impacted by the experimental stimuli, which involved the messages through reddit.

Participants in both conditions seemed to be confused by the design of the displayed articles, which could be a potential weakness of the experimental design. Many participants in the fracking condition seemed to perceive their article as being too scientific, and 12% of respondents said they felt confused after viewing their article. No participants in the herbal remedy condition had such complaints about their article being too scientific, and only 1% of respondents said they felt confused after viewing their article. These perceptions could impact participants' interest and engagement with the articles. Overall, more respondents reported that the herbal remedy article was relevant to them (39%) than reported that the fracking article was relevant to them (14%). Of the participants who commented, 19% reported feeling uninterested in the herbal remedies article while 34% reported feeling uninterested in the fracking case. This could help explain why there were no significant differences found in the fracking case but several significant differences found in the herbal remedies case; perhaps respondents felt that the herbal remedy article was more relevant to them, and thus more interesting and worth paying more attention to than the fracking article.

Overall, the research hypotheses were not supported and the results were not as expected. There were several key limitations of the current research. First, the case selection was based simply on topics that had been discussed on reddit recently. Of the topics recently discussed on reddit, I tried to choose topics that most people would be familiar - but not deeply familiar - with. Reconsidering the selection of cases, particularly in light of the differences between the fracking

results and the herbal remedy results, it could be that the cases fall in different areas of science communication. The fracking case could be interpreted as environmental science while the herbal remedy case could be classified as health science, which may impact the ways that readers approach these topics. Also, the herbal remedy case seemed to be more important and relevant to the student participants than the fracking case, which could be another reason that there were not any significant differences found in the fracking conditions. Other cases may have been more appropriate to use in this study.

If future researchers chose topics that most people were less familiar with then participants may not have as fixed opinions about the topics and could be interested in learning more about the topics. Alternatively, participants who are unfamiliar with the topics could also tune out the information provided about the topics. If future researchers chose topics that most people were more familiar with then participants may already have well developed opinions about the topics, and it may be hard to influence those opinions. Either way, I believe that future researchers should choose cases that fall in the same area of science communication and that are felt to be of similar importance and relevance to the participants.

Second, the sample for the main experiment was comprised of undergraduate college students from a mid-Atlantic university and thus is not representative of the general public when looking at age, gender, or education level. However, this sample is more appropriate in the context of reddit users, who tend to be young and educated (Duggan & Smith, 2013). According to a nationally representative survey conducted by Pew Research Center, 6% of all adult Internet users use reddit and 11% of all internet users ages 18-29 say they use reddit (Duggan & Smith, 2013), while 17.7% of participants in my experiment reported spending at least some time on reddit per day. The main issue with the current sample as compared to reddit users is gender. Some 15% of male internet users ages 18-29 say that they use reddit, compared with 5% of women in the same age (Duggan & Smith, 2013), but there were more women than men in the current sample. Future research should try to use a sample that is representative of reddit users.

The current study looks at both users and non-users of reddit but another option for future research would be to look at only reddit users, which could yield more interesting results.

Third, the treatments used could be limited in a few different ways. In retrospect, the credibility manipulations may have been too subtle or visually confusing to produce the intended impact on the participants. In order to make the credibility manipulations more effective the differences between source cue conditions should be more blatant and presented in a clearer way. Readers also may not have attended to the credibility manipulations due to the artificiality of the setting, which may have encouraged central route processing and, thus, less reliance on source cues. An alternative for future research could be to do a 'live link' experiment, which would be more representative of how people typically find science information online. However, this method could add complications if users don't follow the link provided.

Future research is needed to help determine the impact of viewing scientific information through social media sites. This research should attempt to avoid the limitations of the current research by using stronger credibility manipulations (and clearer visual design of experimental stimuli) and measuring both short term and long-term impact of stimuli on a representative sample of the population. The current research only measured immediate responses to the stimuli and did not look at long-term attitude changes. Future research could also focus on social media sites other than reddit to widen the scope of findings. It could be that focusing only on reddit versus other social media sites was a limiting factor in the current study and this may help explain why my study design produced largely null results.

However, there are other explanations for the null results of this study unrelated to potential design flaws. One possibility is that people don't always pay that much attention to source factors. Maybe the importance of source factors in general, and social media source factors in particular, is overstated when it comes to evaluating scientific information online. Although the respondents in the pre-survey said that they used source factors, and social media source factors, in their evaluations this may not actually be accurate due to possible differences in reported behavior versus actual behavior. In this case, it would make sense that the readers

were largely unaffected by the source cues included in the different experimental conditions. Another possibility is that social media source factors could matter more for gate-keeping and attention getting purposes, which were not captured by my study design, rather than serving an evaluative function. From the reddit user survey results it seems that social media source factors may matter more to reddit users when they are choosing to view an article while original source factors may matter more to reddit users when they are evaluating the credibility of an article. This could also lead to readers seeming unaffected by the source cues included in this study.

Additionally, the application of the Elaboration Likelihood Model may have contributed to the null results of this study. Perhaps the ELM is not the best theory to use for the theoretical framework of the current research. Other theories may better explain how people react to science information in social media. Uses and Gratifications Theory is one theory that may be a better fit than the ELM, especially in the case of herbal remedies where readers felt that the topic was important and relevant to them. Uses and Gratifications Theory (UGT) is an audience-centered approach to understanding why and how people actively seek out specific media to satisfy specific needs. According to Brossard (2013), empirical research suggests that lay audiences search for information about specific scientific issues based on different motivations and with different learning and attitudinal outcomes. In other words, it is clear that motivational processes behind online information seeking for scientific issues, and the potential outcomes of these searches, are complex and that research is only beginning to shed light on them (Brossard, 2013). UGT has often been applied in the context of social media to help explain how and why people are using such websites. Future research could use a theoretical framework based around UGT in order to determine whether this theory provides a better explanation than the ELM for how people react to science information in social media.

Based on the differences found across conditions in the experimental results, it is clear that the overall message of the herbal remedies article did influence viewers even though the social media source factors were not as effective as expected. This is an important finding, especially in light of recent public debates on herbal remedies and supplements, which often play

out on social media. Two notable examples that come to mind are John Oliver's critique of Dr. Oz and *Gawker*'s critique of the blogger Food Babe. The herbal remedy results indicate that high credibility original sources and negative social media source factors could have more sway on participants than low credibility original sources and positive social media source factors, respectively. Higher levels of science knowledge or higher levels of scientific interest may strengthen the effects observed for some cases but this was not found consistently across both experimental cases. The implications of these findings suggest that further research on how readers are impacted by messages about herbal remedies could be fruitful.

Citizens are increasingly finding information about science and following scientific developments through online environments, including social media, so it is crucial for us to figure out the potential impact of the Internet on audiences' knowledge and attitudes toward science (Brossard, 2013). Knowing how people are using social media to view science information could contribute to the development of better ways to disseminate science information to segments of the public that typically report low levels of science interest and knowledge or who traditionally haven't had access to this type of information. Internet use, in general, appears to be reducing gaps in science knowledge that have been documented between groups with different levels of education, by helping the less-educated online users gain comparatively more knowledge about science (Brossard, 2013). Social media, specifically, could have the potential to further reduce these science knowledge gaps as social media sites are widely used across America and provide opportunities for individuals to be exposed to scientific information they would not otherwise seek out or view. Through research efforts such as this one, public understanding of science in the United States, which is currently fairly low, could rise and lead to a promising new era for science in America.

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Appendix A

SURVEY OF REDDIT USERS

1. How long have you been a Reddit user?
    a. Less than 1 month
    b. 1-5 months
    c. 6 months-1 year
    d. More than 1 year
2. How much time do you spend on Reddit per day?
    a. Less than 1 hour
    b. 1-2 hours
    c. 3-4 hours
    d. More than 4 hours
3. What types of topics do you like to read about on Reddit?
4. How interested are you in science?
    a. A great deal
    b. A good deal
    c. Somewhat
    d. Not much
    e. Not at all
5. Out of the total time you spend on Reddit, how much time do you spend on science-related topics?
    a. 0-24%
    b. 25-49%
    c. 50-74%

d. 75-100%

6. What, if anything, do you like about Reddit as a source of scientific information?
7. What, if anything, do you dislike about Reddit as a source of scientific information?
8. How much do you like each of these subreddits (r/science, r/askscience, r/technology, r/everythingscience, Other) as a source of scientific information?
    a. A great deal
    b. A good deal
    c. Somewhat
    d. Not much
    e. Not at all
9. How likely is each of the following factors (Who wrote the article, Where the article was published, Who posted article on Reddit, Number of Reddit comments on article, Nature (positive or negative) of Reddit comments on article, Number of upvotes/downvotes on Reddit post, Other) to influence whether you view a scientific article on Reddit?
    a. Very unlikely
    b. Unlikely
    c. Undecided
    d. Likely
    e. Very likely
10. When you evaluate the credibility of a scientific article on Reddit, how important is each of the following factors (Who wrote the article, Where the article was published, Who posted article on Reddit, Number of Reddit comments on article, Nature (positive or negative) of Reddit comments on article, Number of upvotes/downvotes on Reddit post, Other)?
    a. A great deal
    b. A good deal
    c. Somewhat

d. Not much

e. Not at all

11. What other websites, if any, do you use to view scientific articles?

12. What is your gender?

a. Male

b. Female

13. What is your age?

a. 18-29 years

b. 30-49 years

c. 50-64 years

d. 65 years and over

14. Please specify your ethnicity. Check all that apply:

a. White

b. Hispanic of Latino

c. Black or African American

d. Native American or American Indian

e. Asian or Pacific Islander

f. Other

15. What is the highest level of education you have completed?

a. Some high school

b. High school graduate

c. Some college

d. Trade/technical/vocational training

e. College graduate

f. Some post-graduate work

g. Post graduate degree

Appendix B

EXPERIMENTAL TREATMENTS

Control Condition 1:

CNNMoney

San Francisco votes in $15 minimum wage
By Ben Rooney @ben_rooney November 5, 2014: 2:34 PM ET

NEW YORK (CNNMoney)

San Francisco on Tuesday became the second U.S. city to raise its minimum wage to $15 an hour.

Voters overwhelmingly approved a ballot measure to gradually raise the city's minimum wage from $10.74 currently. It passed with 77% of the vote, according to initial results reported by local authorities.

The decision follows Seattle's approval in June to raise its minimum wage to $15, the highest level in the nation. Under the new law, wages will rise to $11.05 on Jan.1, then $12.25 in May before increasing every year until they reach $15 in 2018. After that, increases will be tied to inflation in the Bay Area.

San Francisco Mayor Edwin Lee applauded the result and said voters "sent a message loudly and clearly" that "we can take on the growing gap between rich and poor."

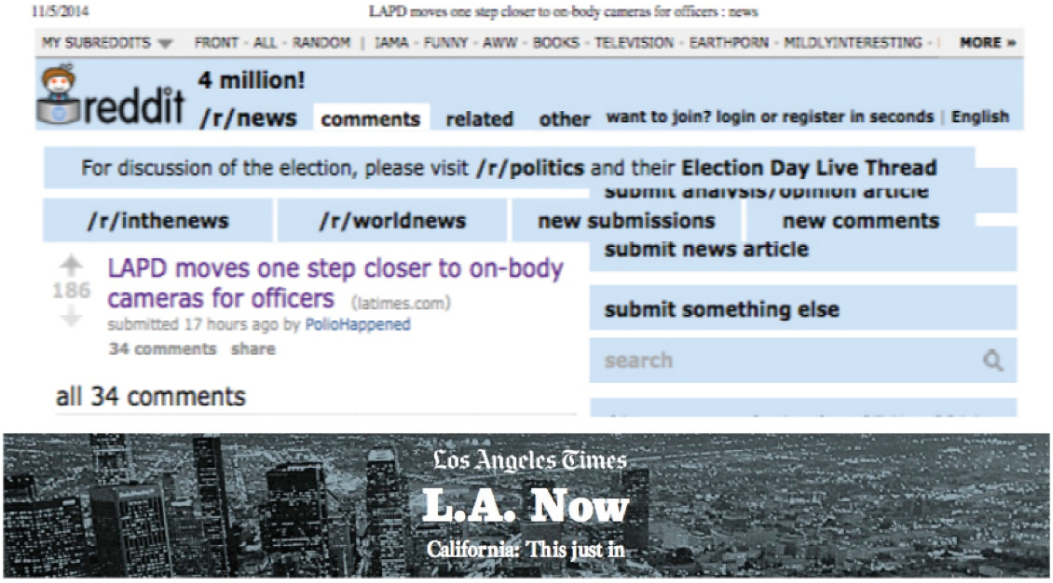
The move by San Francisco is part of a growing push in cities and states across the nation to give workers a so-called living wage.

Alaska, Arkansas, Nebraska and South Dakota all approved proposals to raise the minimum wage on Tuesday. Those states join 12 others and Washington, D.C., all of which have moved in the past two years to raise their state minimums.

Action at the state and city level has far exceeded that in Congress. The push by Democrats to raise the federal minimum to $10.10 an hour from $7.25 was stalled even before legislation was introduced.

President Obama, meanwhile, issued an executive order requiring companies with federal contracts to pay their workers at least $10.10.

Control Condition 2:



LAPD moves one step closer to on-body cameras for officers
By KATE MATHER NOVEMBER 4, 2014, 6:49 PM

A fter months of testing, Los Angeles police officials have picked the company they would like to use to outfit hundreds of officers with on-body cameras.

It remains unclear when officers will start to use the cameras -- no contract has been signed and the department has yet to draft a policy on the use of the equipment -- but the LAPD's decision to use Taser International as its vendor marks the department's latest move in its effort to utilize the new technology.

The LAPD's chief information officer and a department technology expert informed the Police Commission of the decision Tuesday, calling Taser "absolutely the preferred vendor" of two companies whose products were tested. The other company, Coban Technologies Inc., has been used previously to outfit LAPD patrol cars with in-car cameras.

Advocates say on-body cameras will be a valuable tool for the department. Having audio and video recordings of police encounters with the public, they say, could help guard against officer misconduct and clear cops who are falsely accused of wrongdoing. LAPD Chief Charlie Beck has said he sees the technology as "the future of policing."

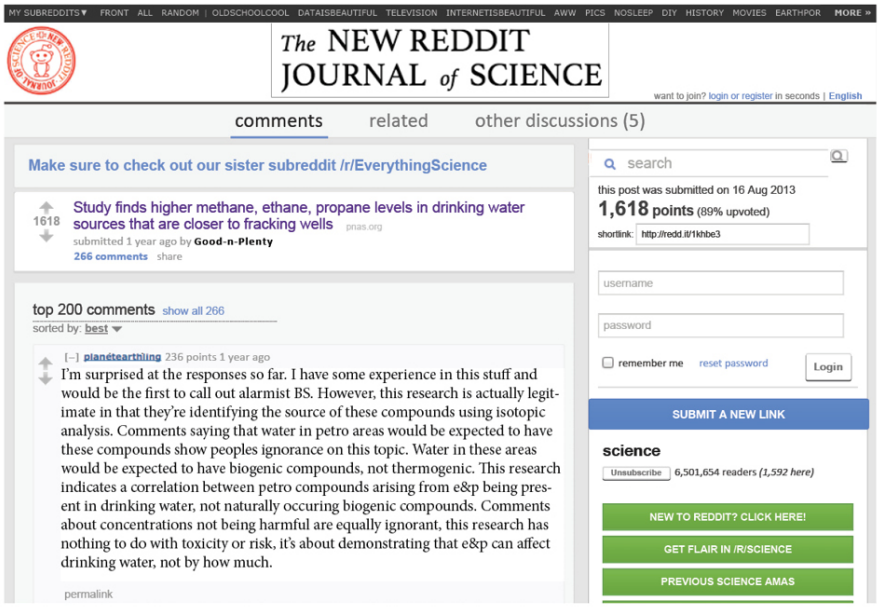
When asked by the commission if the shortfalls would prohibit the effectiveness of the cameras, Gomez said he was confident that they would meet the department's needs even if put on the street without improvements.

Taser provided two camera models to the LAPD: one that can be clipped to the side of an officer's glasses or collar, and a second box-like device that can be pinned to an officer's uniform in the center of the chest. Gomez said most of the officers who tested the devices preferred the chest model.

Goodrich said department officials would meet with the company this week to begin discussing its contract, then meet internally in the coming weeks to talk about what the on-body camera policy should include. She said the LAPD would meet with the ACLU again by the end of the year.

Funding for the cameras will come from more than $1 million raised through private donations, avoiding City Hall budget constraints and bureaucracy that have hampered efforts to install cameras in LAPD patrol cars.

Fracking Condition 1:



The New York Times

SCIENCE

Well Leaks, Not Fracking, Are Linked to Fouled Water
By HENRY FOUNTAIN SEPT. 15, 2014

A study of tainted drinking water in areas where natural gas is produced from shale shows that the contamination is most likely caused by leaky wells rather than the process of hydraulic fracturing used to release the gas from the rock.

The study looked at seven cases in Pennsylvania and one in Texas where water wells had been contaminated by methane and other hydrocarbon gases. Both states have extensive deposits of gas-bearing shale that have been exploited in recent years as part of a surge in domestic energy production. Some environmental groups have suggested that hydraulic fracturing, or fracking, could cause the gas to migrate into drinking water aquifers.

Shale-gas producers commonly drill a deep vertical well that is then extended horizontally in several directions into the rock, like spokes from a hub. In fracking, water and chemicals are injected at high pressures into these spokes, creating fissures and releasing the natural gas trapped within.

But in their analysis, published Monday in The Proceedings of the National Academy of Sciences, the researchers found no evidence that fractured shale led to water contamination. Instead, they said cement used to seal the outside of the vertical wells, or steel tubing used to line them, was at fault, leading to gas leaking up the wells and into aquifers.

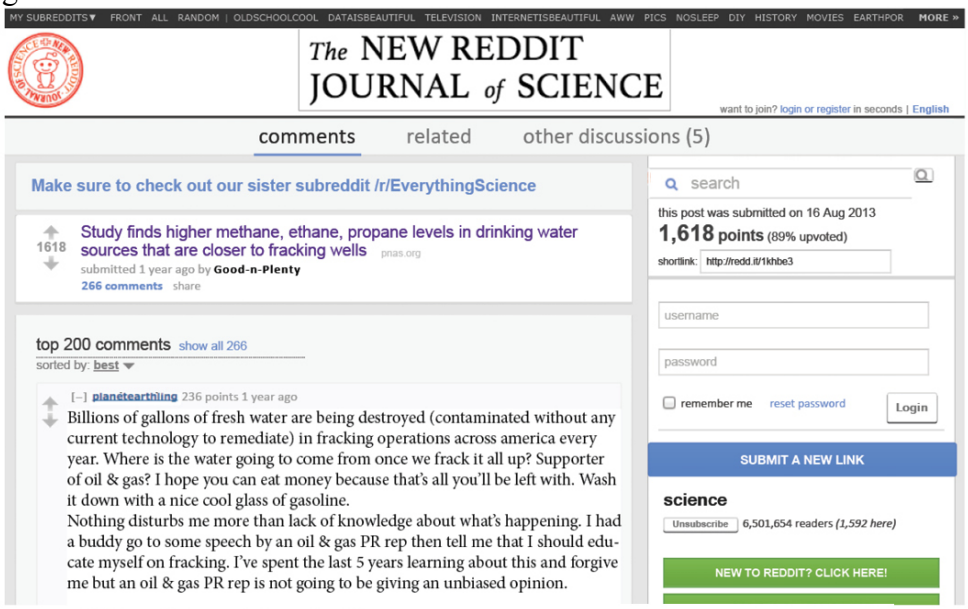
"In all cases, it basically showed well integrity was the problem," said Thomas H. Darrah, a researcher at Ohio State University and the study's lead author. The gas that leaked, he added, most likely came from shallower gas-rich pockets that the vertical wells were drilled through on their way to the shale formations, rather than from the shale itself.

"The good news is, improvements in well integrity can probably eliminate most of the environmental problems with gas leaks," Dr. Darrah said.

Well integrity is a widespread problem in the oil and gas industry, with one often-quoted statistic suggesting that 15 percent of all cement sealing of wells may be imperfect, said Scott Anderson, who studies energy production issues for the Environmental Defense Fund. The BP oil spill in the Gulf of Mexico four years ago was related in part to problems with cement that was supposed to act as a gas barrier in the well.

Mr. Anderson said there were many steps that producers could take to eliminate leaks, including basic ones like making sure the proper cement or steel tubing was used, and monitoring pressures both during well construction and later while gas is flowing. Companies should also be more aware of any gas pockets in the formations they are drilling through, he said.

Fracking Condition 2:



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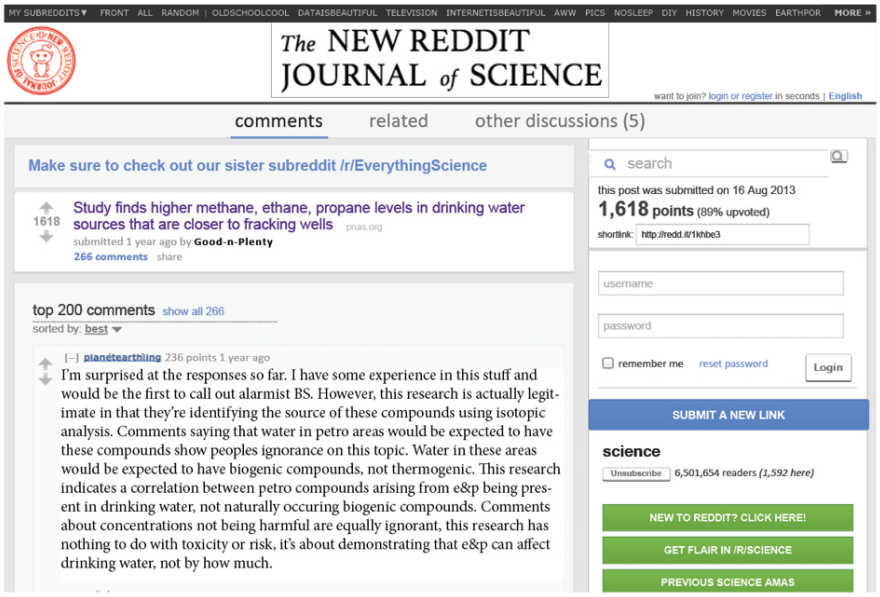

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Make sure to check out our sister subreddit /r/EverythingScience

1618 Study finds higher methane, ethane, propane levels in drinking water sources that are closer to fracking wells pnas.org

submitted 1 year ago by Good-n-Plenty

266 comments share

top 200 comments show all 266

sorted by: best

[–] planéteartthing 236 points 1 year ago

I'm surprised at the responses so far. I have some experience in this stuff and would be the first to call out alarmist BS. However, this research is actually legitimate in that they're identifying the source of these compounds using isotopic analysis. Comments saying that water in petro areas would be expected to have these compounds show peoples ignorance on this topic. Water in these areas would be expected to have biogenic compounds, not thermogenic. This research indicates a correlation between petro compounds arising from e&p being present in drinking water, not naturally occuring biogenic compounds. Comments about concentrations not being harmful are equally ignorant, this research has nothing to do with toxicity or risk, it's about demonstrating that e&p can affect drinking water, not by how much.

search

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Marcellus Drilling News

Helping People & Businesses Profit from Northeast Shale Drilling

Well Leaks, Not Fracking, Are Linked to Fouled Water
By HENRY FOUNTAIN SEPT. 15, 2014

A study of tainted drinking water in areas where natural gas is produced from shale shows that the contamination is most likely caused by leaky wells rather than the process of hydraulic fracturing used to release the gas from the rock.

The study looked at seven cases in Pennsylvania and one in Texas where water wells had been contaminated by methane and other hydrocarbon gases. Both states have extensive deposits of gas-bearing shale that have been exploited in recent years as part of a surge in domestic energy production. Some environmental groups have suggested that hydraulic fracturing, or fracking, could cause the gas to migrate into drinking water aquifers.

Shale-gas producers commonly drill a deep vertical well that is then extended horizontally in several directions into the rock, like spokes from a hub. In fracking, water and chemicals are injected at high pressures into these spokes, creating fissures and releasing the natural gas trapped within.

But in their analysis, published Monday in The Proceedings of the National Academy of Sciences, the researchers found no evidence that fractured shale led to water contamination. Instead, they said cement used to seal the outside of the vertical wells, or steel tubing used to line them, was at fault, leading to gas leaking up the wells and into aquifers.

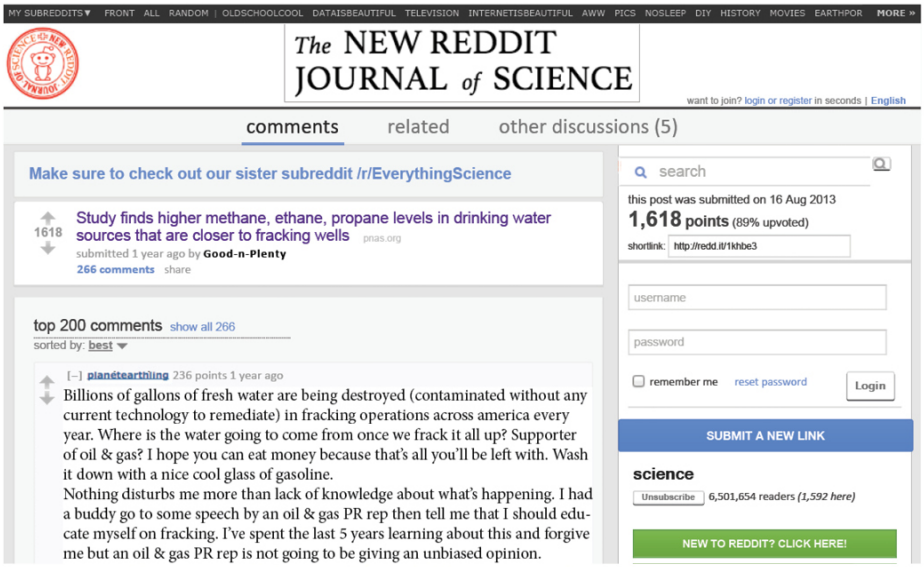
"In all cases, it basically showed well integrity was the problem," said Thomas H. Darrah, a researcher at Ohio State University and the study's lead author. The gas that leaked, he added, most likely came from shallower gas-rich pockets that the vertical wells were drilled through on their way to the shale formations, rather than from the shale itself.

"The good news is, improvements in well integrity can probably eliminate most of the environmental problems with gas leaks," Dr. Darrah said.

Well integrity is a widespread problem in the oil and gas industry, with one often-quoted statistic suggesting that 15 percent of all cement sealing of wells may be imperfect, said Scott Anderson, who studies energy production issues for the Environmental Defense Fund. The BP oil spill in the Gulf of Mexico four years ago was related in part to problems with cement that was supposed to act as a gas barrier in the well.

Mr. Anderson said there were many steps that producers could take to eliminate leaks, including basic ones like making sure the proper cement or steel tubing was used, and monitoring pressures both during well construction and later while gas is flowing. Companies should also be more aware of any gas pockets in the formations they are drilling through, he said.

Fracking Condition 4:



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1618 Study finds higher methane, ethane, propane levels in drinking water sources that are closer to fracking wells pnas.org

submitted 1 year ago by Good-n-Plenty

266 comments share

top 200 comments show all 266

sorted by: best

[–] planétearthling 236 points 1 year ago

Billions of gallons of fresh water are being destroyed (contaminated without any current technology to remediate) in fracking operations across america every year. Where is the water going to come from once we frack it all up? Supporter of oil & gas? I hope you can eat money because that's all you'll be left with. Wash it down with a nice cool glass of gasoline.

Nothing disturbs me more than lack of knowledge about what's happening. I had a buddy go to some speech by an oil & gas PR rep then tell me that I should educate myself on fracking. I've spent the last 5 years learning about this and forgive me but an oil & gas PR rep is not going to be giving an unbiased opinion.

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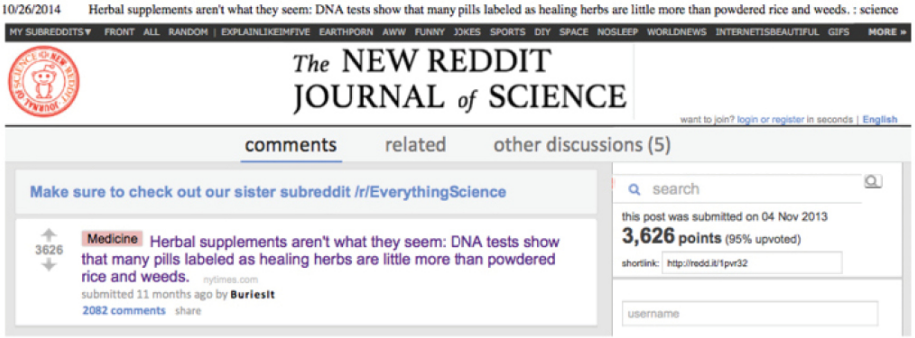

The New York Times

SCIENCE

Herbal Supplements Are Often Not What They Seem

By ANAHAD O'CONNOR, Senior Science Reporter November 3, 2013

Americans spend an estimated $5 billion a year on unproven herbal supplements that promise everything from fighting off colds to curbing hot flashes and boosting memory. But now there is a new reason for supplement buyers to beware: DNA tests show that many pills labeled as healing herbs are little more than powdered rice and weeds.

Using a test called DNA barcoding, a kind of genetic fingerprinting that has also been used to help uncover labeling fraud in the commercial seafood industry, Canadian researchers tested 44 bottles of popular supplements sold by 12 companies. They found that many were not what they claimed to be, and that pills labeled as popular herbs were often diluted — or replaced entirely — by cheap fillers like soybean, wheat and rice.

Consumer advocates and scientists say the research provides more evidence that the herbal supplement industry is riddled with questionable practices. Industry representatives argue that any problems are not widespread. Among their findings were bottles of echinacea supplements, used by millions of Americans to prevent and treat colds, that contained ground up bitter weed, Parthenium hysterophorus, an invasive plant found in India and Australia that has been linked to rashes, nausea and flatulence.

Two bottles labeled as St. John's wort, which studies have shown may treat mild depression, contained none of the medicinal herb. Instead, the pills in one bottle were made of nothing but rice, and another bottle contained only Alexandrian senna, an Egyptian yellow shrub that is a powerful laxative. Gingko biloba supplements, promoted as memory enhancers, were mixed with fillers and black walnut, a potentially deadly hazard for people with nut allergies.

Of 44 herbal supplements tested, one-third showed outright substitution, meaning there was no trace of the plant advertised on the bottle — only another plant in its place. Many were adulterated with ingredients not listed on the label, like rice, soybean and wheat, which are used as fillers. In some cases, these fillers were the only plant detected in the bottle — a health concern for people with allergies or those seeking gluten-free products, said the study's lead author, Steven G. Newmaster, a biology professor and botanical director of the Biodiversity Institute of Ontario at the University of Guelph.

The findings, published in the journal BMC Medicine, follow a number of smaller studies conducted in recent years that have suggested a sizable percentage of herbal products are not what they purport to be. But because the latest findings are backed by DNA testing, they offer perhaps the most credible evidence to date of adulteration, contamination and mislabeling in the medicinal supplement industry, a rapidly growing area of alternative medicine that includes an estimated 29,000 herbal products and substances sold throughout North America.

"This suggests that the problems are widespread and that quality control for many companies, whether through ignorance, incompetence or dishonesty, is unacceptable," said David Schardt, a senior nutritionist at the Center for Science in the Public Interest, an advocacy group. "Given these results, it's hard to recommend any herbal supplements to consumers."

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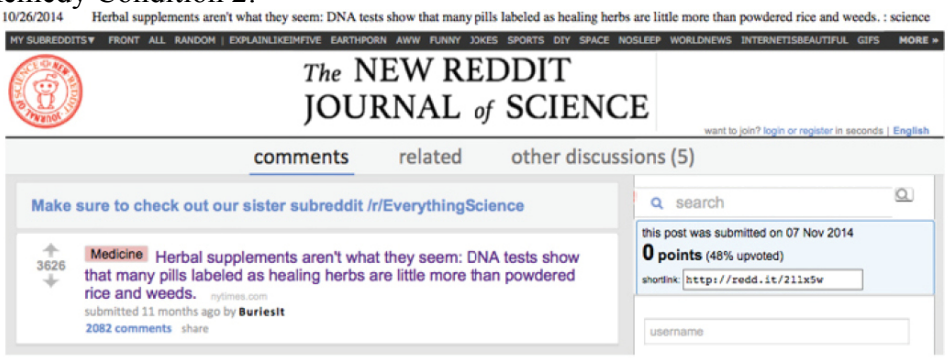
Herbal Remedy Condition 2:



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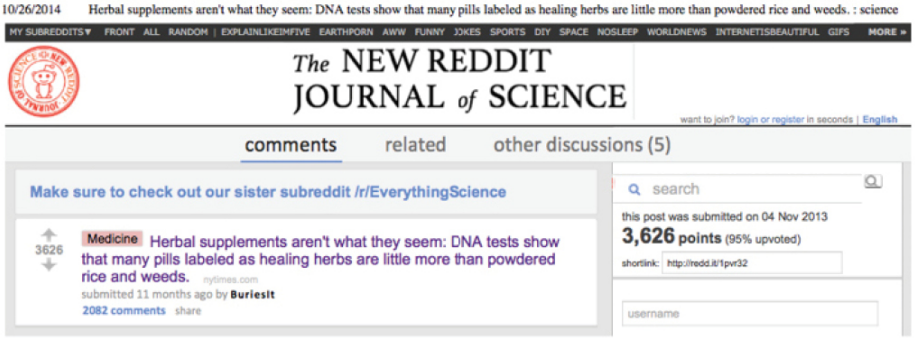

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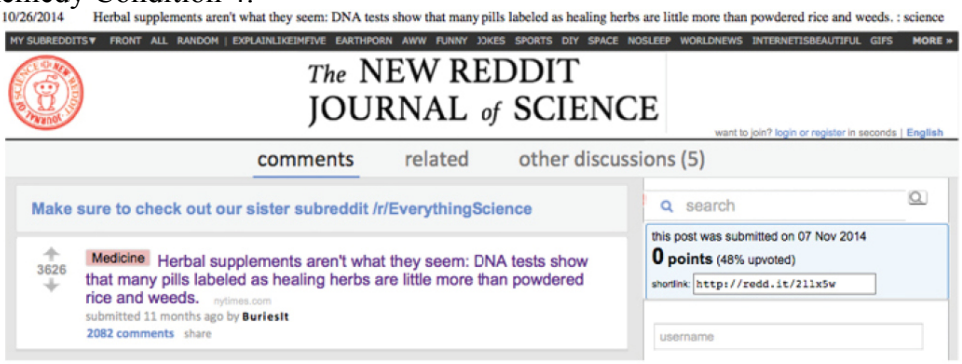

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Appendix C

EXPERIMENT POSTTEST

Below are the questions that were used in the post-test for this experiment:

1. Were you able to view the article?
2. In the space below, please describe your reaction to the article you just viewed.
3. Please indicate how well you think each of the following (Informative, Objective, Boring, Interesting, Biased, Accurate) describes the article you just viewed:
    a. Not at all
    b. Not very much
    c. Somewhat
    d. A good deal
    e. A great deal
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    a. Not at all
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    c. Somewhat
    d. A good deal
    e. A great deal
7. What is your overall opinion of hydraulic fracturing (fracking): Very unfavorable-Very favorable?
8. How safe do you think hydraulic fracturing (fracking) is: Not at all safe-Very safe?

9. How risky do you think hydraulic fracturing (fracking) is: Not at all risky-Very risky?
10. How much do you favor or oppose the use of hydraulic fracturing (fracking): Strongly oppose-Strongly favor?
11. How much do you favor or oppose stricter regulation of hydraulic fracturing (fracking): Strongly oppose-Strongly favor?
12. What is your overall opinion of over-the-counter herbal remedies: Very unfavorable-Very favorable?
13. How safe do you think over-the-counter herbal remedies are: Not at all safe-Very safe?
14. How risky do you think over-the-counter herbal remedies are: Not at all risky-Very risky?
15. How much do you favor or oppose the use of over-the-counter herbal remedies: Strongly oppose-Strongly favor?
16. How much do you favor or oppose stricter regulation of over-the-counter herbal remedies: Strongly oppose-Strongly favor?
17. How fair do you think the current federal minimum wage is: Not at all fair-Very fair?
18. How much do you favor or oppose raising the federal minimum wage: Strongly oppose-Strongly favor?
19. How helpful do you think on-body cameras would be for police officers: Not at all helpful-Very helpful?
20. How much do you favor or oppose requiring police officers to wear on-body cameras: Strongly oppose-Strongly favor?
21. How familiar are you with the social media site, reddit.com: Not at all familiar-Very familiar?
22. How much time do you spend on reddit.com per day?
    a. Less than 1 hour
    b. 1-2 hours
    c. 3-4 hours

d. More than 4 hours

e. None

23. How interested are you in science: Not at all-A great deal?

24. Electrons are smaller than atoms

a. True

b. False

c. Don't know

25. Lasers work by focusing sound waves

a. True

b. False

c. Don't know

26. Which gas makes up most of the Earth's atmosphere?

a. Hydrogen

b. Nitrogen

c. Carbon Dioxide

d. Oxygen

e. Don't know

27. Which is an example of a chemical reaction?

a. Water boiling

b. Sugar dissolving

c. Nails rusting

d. Don't know

28. What gas do most scientists believe causes temperatures in the atmosphere to rise? Is it:

a. Carbon dioxide

b. Hydrogen

c. Helium

d. Radon

e. Don’t know

29. Are you:

a. Male

b. Female

c. Other

30. What is your current student classification?

a. Freshman

b. Sophomore

c. Junior

d. Senior

e. Other

31. What is your age?

32. What is your race or ethnicity? Check all that apply:

a. White

b. Hispanic

c. African American/black

d. Asian or Pacific Islander

e. Other

33. In general, how would you describe your political views?

a. Very conservative

b. Somewhat conservative

c. Moderate

d. Somewhat liberal

e. Very liberal

34. In politics today, do you consider yourself a Republican, a Democrat, or an independent?

a. Republican

b. Democrat

c. Independent or other

35. What is your student identification number?

Appendix D

TABLES

Table 1. Social Media Factor Importance		
	Importance of Factor when Choosing to View Article (mean score)	Importance of Factor when Evaluating Credibility of Article (mean score)
Who wrote the article	2.77	3.57
Where the article was published	3.61	4.16
Who posted article on reddit	1.80	1.87
Number of reddit comments on article	3.18	2.22
Nature (positive or negative) of reddit comments on article	3.26	3.00
Number of upvotes/downvotes on reddit post	3.44	2.78
N	135	135

Table 2. Fracking Attitudes, by Experimental Condition							
	Control	High Credibility Source +Social Media	High Credibility Source -Social Media	Low Credibility Source +Social Media	Low Credibility Source -Social Media	Total	F
What is your overall opinion of hydraulic fracturing? (Very unfavorable: Very favorable)	3.11[a] (1.13)	3.09[a] (1.30)	2.94[a] (1.33)	3.06[a] (1.37)	3.23[a] (1.39)	3.09 (1.30)	0.42 (p=n.s.)
How safe do you think hydraulic fracturing is? (Not at all safe: Very safe)	2.82[a] (1.30)	2.79[a] (1.14)	2.60[a] (1.20)	2.68[a] (1.29)	3.03[a] (1.32)	2.79 (1.25)	1.10 (p=n.s.)
How risky do you think hydraulic fracturing is? (Very risky: Not at all risky)	2.92[a] (1.32)	3.01[a] (1.30)	2.98[a] (1.36)	2.78[a] (1.39)	3.06[a] (1.30)	2.95 (1.33)	0.42 (p=n.s.)
How much do you favor or oppose the use of hydraulic fracturing? (Strongly oppose: Strongly favor)	3.13[a] (1.19)	3.13[a] (1.22)	3.10[a] (1.20)	3.29[a] (1.49)	3.46[a] (1.31)	3.22 (1.29)	0.92 (p=n.s.)
How much do you favor or oppose stricter regulation of hydraulic fracturing?	2.84[a] (1.19)	2.84[a] (1.27)	2.68[a] (1.22)	2.68[a] (1.39)	2.66[a] (1.30)	2.74 (1.27)	0.31 (p=n.s.)

(Strongly favor: Strongly oppose)							
Fracking Attitude Index	2.96[a] (0.97)	2.97[a] (0.93)	2.86[a] (0.88)	2.90[a] (0.99)	2.74[a] (0.99)	2.96 (0.95)	0.54 (p=n.s.)
N	61	68	64	66	65	324	

Notes: Table entries are means; standard deviations are in parentheses. All variables ranged from 1 to 7. Means with different super-scripts differed significantly across conditions at $p \leq .05$ in Bonferonni post-hoc tests.

Table 3. Fracking Attitudes, by Experimental Condition and Science Knowledge							
	Control	High Credibility Source +Social Media	High Credibility Source -Social Media	Low Credibility Source +Social Media	Low Credibility Source -Social Media	Total	F
Low Knowledge	3.10[a] (0.97) (N = 33)	2.95[a] (0.94) (N = 43)	2.95[a] (0.68) (N = 34)	2.93[a] (1.01) (N = 40)	3.01[a] (1.00) (N = 37)	2.99 (0.93) (N = 187)	0.20 (p=n.s.)
High Knowledge	2.78[a] (0.95) (N = 27)	3.01[a] (0.91) (N = 24)	2.75[a] (1.07) (N = 29)	2.85[a] (0.97) (N = 25)	3.19[a] (0.98) (N = 28)	2.91 (0.98) (N = 133)	0.98 (p=n.s.)

Notes: Table entries are means; standard deviations are in parentheses. All variables ranged from 1 to 7. Means with different super-scripts differed significantly across conditions at $p \leq .05$ in Bonferonni post-hoc tests.

Table 4. Fracking Attitudes, by Experimental Condition and Science Interest							
	Control	High Credibility Source +Social Media	High Credibility Source -Social Media	Low Credibility Source +Social Media	Low Credibility Source -Social Media	Total	F
Low Interest	3.22[a] (0.90) (N = 21)	3.16[a] (0.76) (N = 37)	2.86[a] (0.84) (N = 26)	3.04[a] (0.82) (N = 25)	3.01[a] (0.94) (N = 35)	3.06 (0.85) (N = 144)	0.69 (p=n.s.)
High Interest	2.82[a] (0.99) (N = 39)	2.74[a] (1.08) (N = 29)	2.87[a] (0.93) (N = 36)	2.78[a] (1.10) (N = 38)	3.13[a] (1.07) (N = 26)	2.85 (1.02) (N = 168)	0.62 (p=n.s.)

Notes: Table entries are means; standard deviations are in parentheses. All variables ranged from 1 to 7. Means with different super-scripts differed significantly across conditions at $p \leq .05$ in Bonferonni post-hoc tests.

Table 5. Fracking Attitudes, by Experimental Condition and Familiarity with Reddit							
	Control	High Credibility Source +Social Media	High Credibility Source -Social Media	Low Credibility Source +Social Media	Low Credibility Source -Social Media	Total	F
Low Familiarity	3.06[a] (1.00) (N = 32)	2.91[a] (1.01) (N = 34)	2.84[a] (0.88) (N = 35)	2.93[a] (0.89) (N = 36)	3.13[a] (0.96) (N = 40)	2.98 (0.94) (N = 177)	0.56 (p=n.s.)
High Familiarity	2.84[a] (0.94) (N = 28)	3.04[a] (0.85) (N = 33)	2.89[a] (0.90) (N = 28)	2.86[a] (1.12) (N = 29)	3.02[a] (1.05) (N = 25)	2.93 (0.96) (N = 143)	0.27 (p=n.s.)

Notes: Table entries are means; standard deviations are in parentheses. All variables ranged from 1 to 7. Means with different super-scripts differed significantly across conditions at $p \leq .05$ in Bonferonni post-hoc tests.

Table 6. Herbal Remedy Attitudes, by Experimental Condition							
	Control	High Credibility Source +Social Media	High Credibility Source -Social Media	Low Credibility Source +Social Media	Low Credibility Source -Social Media	Total	F
What is your overall opinion of over-the-counter herbal remedies? (Very unfavorable: Very favorable)	4.46[a] (1.39)	4.45[a] (1.64)	3.61[b] (1.73)	3.72[ab] (1.62)	3.52[b] (1.66)	3.97 (1.66)	5.45 (p≤.01)
How safe do you over-the-counter herbal remedies are? (Not at all safe: Very safe)	4.33[a] (1.41)	4.13[a] (1.28)	3.98[a] (1.71)	4.03[a] (1.50)	3.78[a] (1.62)	4.06 (1.51)	1.16 (p=n.s.)
How risky do you think over-the-counter herbal remedies are? (Very risky: Not at all risky)	4.28[a] (1.51)	4.03[a] (1.40)	4.09[a] (1.65)	4.12[a] (1.46)	3.83[a] (1.65)	4.07 (1.53)	0.75 (p=n.s.)
How much do you favor or oppose the use of over-the-counter herbal remedies? (Strongly oppose: Strongly favor)	4.25[a] (1.26)	4.24[a] (1.53)	3.72[ab] (1.53)	3.88[ab] (1.44)	3.50[b] (1.53)	3.93 (1.48)	3.31 (p≤.01)
How much do you favor or oppose stricter regulation of over-the-counter herbal	3.69[a] (1.34)	2.88[b] (1.62)	2.64[b] (1.74)	3.00[ab] (1.84)	3.05[ab] (1.69)	3.06 (1.68)	3.67 (p≤.01)

	remedies? (Strongly favor: Strongly oppose)							
	Herbal Remedy Attitude Index	4.20[a] (0.97)	3.95[ab] (1.04)	3.61[b] (1.21)	3.75[ab] (1.22)	3.53[b] (1.29)	3.82 (1.17)	3.66 (p≤.0
	N	69	68	64	58	65	324	

Notes: Table entries are means; standard deviations are in parentheses. All variables ranged from 1 to 7. Means with different super-scripts differed significantly across conditions at $p \leq .05$ in Bonferonni post-hoc tests.

Table 7. Herbal Remedy Attitudes, by Experimental Condition and Science Knowledge							
	Control	High Credibility Source +Social Media	High Credibility Source -Social Media	Low Credibility Source +Social Media	Low Credibility Source -Social Media	Total	F
Low Knowledge	4.09[a] (0.92) (N = 36)	3.90[a] (1.00) (N = 46)	3.68[a] (1.22) (N = 34)	3.84[a] (1.10) (N = 30)	3.54[a] (1.31) (N = 40)	3.81 (1.12) (N = 186)	1.39 (p=n.s.)
High Knowledge	4.33[a] (1.03) (N = 31)	4.05[a] (1.14) (N = 21)	3.53[a] (1.20) (N = 30)	3.65[a] (1.35) (N = 27)	3.53[a] (1.27) (N = 24)	3.82 (1.23) (N = 133)	2.49 (p≤.05)

Notes: Table entries are means; standard deviations are in parentheses. All variables ranged from 1 to 7. Means with different super-scripts differed significantly across conditions at $p \leq .05$ in Bonferonni post-hoc tests.

Table 8. Herbal Remedy Attitudes, by Experimental Condition and Science Interest							
	Control	High Credibility Source +Social Media	High Credibility Source -Social Media	Low Credibility Source +Social Media	Low Credibility Source -Social Media	Total	F
Low Interest	4.06[a] (0.87) (N = 36)	3.95[a] (0.80) (N = 21)	3.60[a] (1.27) (N = 30)	4.02[a] (1.07) (N = 25)	3.76[a] (1.38) (N = 30)	3.88 (1.11) (N = 142)	0.92 (p=n.s.)
High Interest	4.41[a] (1.09) (N = 29)	3.93[ab] (1.16) (N = 44)	3.61[ab] (1.18) (N = 33)	3.54[b] (1.30) (N = 32)	3.36[b] (1.21) (N = 31)	3.77 (1.23) (N = 169)	3.69 (p≤.01)

Notes: Table entries are means; standard deviations are in parentheses. All variables ranged from 1 to 7. Means with different super-scripts differed significantly across conditions at $p \leq .05$ in Bonferonni post-hoc tests.

Table 9. Herbal Remedy Attitudes, by Experimental Condition and Familiarity with Reddit							
	Control	High Credibility Source +Social Media	High Credibility Source -Social Media	Low Credibility Source +Social Media	Low Credibility Source -Social Media	Total	F
Low Familiarity	4.17[a] (0.88) (N = 48)	3.97[a] (0.95) (N = 31)	3.57[a] (0.98) (N = 29)	3.63[a] (1.12) (N = 33)	3.49[a] (1.46) (N = 35)	3.80 (1.11) (N = 176)	2.79 (p≤.05)
High Familiarity	4.28[a] (1.19) (N = 19)	3.92[a] (1.12) (N = 36)	3.64[a] (1.38) (N = 35)	3.91[a] (1.35) (N = 24)	3.59[a] (1.07) (N = 29)	3.83 (1.23) (N = 143)	1.22 (p=n.s.)

Notes: Table entries are means; standard deviations are in parentheses. All variables ranged from 1 to 7. Means with different super-scripts differed significantly across conditions at $p \leq .05$ in Bonferonni post-hoc tests.

Appendix E

EXEMPT LETTER

RESEARCH OFFICE

210 Hullihen Hall
University of Delaware
Newark, Delaware 19716-1551
Ph: 302/831-2136
Fax: 302/831-2828

DATE: August 27, 2014

TO: Jessica McKnight
FROM: University of Delaware IRB

STUDY TITLE: [634805-1] Public Evaluation and Understanding of Science Information Based on Source Factors in Social Media

SUBMISSION TYPE: New Project

ACTION: DETERMINATION OF EXEMPT STATUS
DECISION DATE: August 27, 2014

REVIEW CATEGORY: Exemption category # *(2)*

Thank you for your submission of New Project materials for this research study. The University of Delaware IRB has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will put a copy of this correspondence on file in our office. Please remember to notify us if you make any substantial changes to the project.

If you have any questions, please contact Nicole Farnese-McFarlane at (302) 831-1119 or nicolefm@udel.edu. Please include your study title and reference number in all correspondence with this office.

cc:

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