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Science Exemplars in the Eye of the Beholder: How Exposure to Online Science Information Affects Attitudes on Science Topics

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Drawing on exemplification theory and confirmation bias, this study examined exposure to online science information and subsequent attitude impacts. Participants freely browsed online messages manipulated to feature (a) either exemplar or numeric information and (b) opposing viewpoints, resulting in a 2 (exemplar vs. numeric) x 2 (supporting vs. opposing technology) within-subjects design. Online search findings pertained to four different topics: fracking, biofuels, GM foods, and nanotechnology. Attitudes towards science topics were measured before and after exposure. Exemplar messages fostered longer reading among high-empathy individuals but less exposure among high-numeracy individuals. Participants preferred attitude-consistent messages, which produced attitude shifts.

Keywords: selective exposure, confirmation bias, exemplification, attitudes, individual differences

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Communicating science to the public is pivotal for taking full advantage of scientific innovations and to enable discourse on ethics and policies pertaining to subsequent societal change. The question of what message features might attract lay audiences to science information is paramount in determining how the messages should be presented for effective science outreach. A key challenge for science communication results from recipients' *confirmation bias* toward messages that align with their preexisting attitudes and values (e.g., Kahan, Jenkins-Smith, & Braman, 2011), which hinders constructive discourse and fosters polarization. The present study aims to identify message features that attract individuals to science messages and to examine how exposure to science messages subsequently affects attitudes on science issues. With regard to *selective exposure* as a phenomenon, it draws on a broader definition than the confirmation bias and considers *any* "systematic bias in selected messages that diverges from the composition of accessible messages" (Knobloch-Westerwick, 2015, p. 3) to reflect selectivity. That is, when individuals choose and spend more time reading certain types of messages, showing a consistent pattern instead of reflecting the type of messages available, message exposure is said to be *selective.* This study builds both on exemplification theory (Zillmann, 1999) and theories of confirmation bias (Festinger, 1957; Taber & Lodge, 2006) to investigate how online users (a) select from messages on science topics with opposing viewpoints that are either exemplar-based versus statistics-based, (b) how online users' attitudes are affected by the subsequent exposure, (c) and how individual differences in responsiveness to empathetic depictions versus quantitative information might moderate selections and attitude shifts. Those three features of the study provide unique contributions that build on and extend previous research on selective exposure to science communication (e.g., Jang, 2014). In the following, we discuss relevant theoretical frameworks along with key empirical findings and elaborate on selective exposure as a guiding research paradigm. Derived hypotheses are tested in an online field study, where participants viewed online science information via a search portal.

Exemplification, Selective Exposure, and Attitude Impacts

The often abstract nature of scientific information may deter many lay recipients, who are generally thought to find personalization in media coverage appealing (e.g., Bennett, 2009). The present study draws on exemplification theory (Zillmann, 1999), which conceptualizes the use of vivid, concrete exemplars (case illustrations) in contrast to the use of perceptually pallid statistics (statistical, baserate information in numeric formats) in media messages. Exemplars "describe causes, importance, and consequences of the problem under consideration from the unique perspective of an individual" (Brosius & Bathelt, 1994, p. 48), which may be a more accessible, intuitive format to present science information to lay audiences. Empirical research has yielded significant effects of inclusion of exemplars in news—such news affects opinions on controversial topics more strongly (Perry & Gonzenbach, 1997), yields more narrative engagement (Kim, Bigman, Leader, Lerman, & Cappella, 2012), and affects issue perceptions as well as behavior beyond short-term effects, for up to two weeks (Gibson & Zillmann, 1994; Knobloch-Westerwick & Sarge, in press; Zillmann, Gibson, Sundar, & Perkins, 1996).

The outlined research implies that exemplars in science information could make such messages more attractive and foster more exposure to science information. At least in the context of health news, exemplars have yielded a positive effect on exposure when compared to statistics-based news (Authors, in press; Hastall & Knobloch-Westerwick, 2013). On the other hand, however, science information with statistics may convey more "scientificness" (Thomm &

Bromme, 2012) and thus attract more exposure, despite less intuitive appeal. Based on exemplification theory (Zillmann, 1999) and related empirical work (Authors, in press; Hastall & Knobloch-Westerwick, 2013), the following hypothesis will be tested:

H1: The use of exemplars in science messages fosters greater exposure compared to the use of numeric information in science messages.

As it is possible that different recipients approach science information very specifically, and because science news often features much numeric information (Griffin, 1999) as opposed to the otherwise often case-illustrated news and media messages (Bennett, 2009; Zillmann, 1999), it is proposed that information consumers' characteristics will affect the impact put forward in H1. Drawing further on exemplification research (Gibson, Callison, & Zillmann, 2011) as well as scholarship on numeracy (Peters, 2012), the relative attraction to exemplars or statistics in science information should depend on recipients' numeracy and trait empathy. Numeracy involves greater attentiveness to quantitative versus qualitative information (Zillmann, Callison, & Gibson, 2009), whereas trait empathy (Davis, 1980) should facilitate perceived emotional connection with portrayed individuals that serve as exemplars.

H2: The impact of exemplars in science messages suggested in H1 is influenced by information consumers' numeracy, such that high-numeracy individuals prefer numeric information over exemplar information.

H3: The impact of exemplars in science messages suggested in H1 is influenced by information consumers' trait empathy, such that high-empathy individuals prefer exemplar information over numeric information.

Given earlier indications of effects of exemplification on perceptions, attitudes, and behavior (Gibson & Zillmann, 1994; Knobloch-Westerwick & Sarge, in press; Perry &

Gozenbach, 1997; Zillmann et al., 1996), a research question on the role of exemplification for persuasive effects will be examined.

RQ1: Does the use of exemplars versus statistics in science information affect persuasive impacts of exposure?

Online Science Information

As internet users commonly access science messages online (e.g., Harrigan, 2006), the present study will examine science information use in the online context. Further, scholars have called for research to address web-based seeking of science information (e.g., M. Nisbet & Goidel, 2007; see also Becker, Dalrymple, Brossard, Scheufele, & Gunther, 2010; Weeks, Friedenberg, Southwell, & Slater, 2012). The online information search context differs from exposure to science information in traditional media in that users will typically encounter several messages on a topic lined up together—on the same online search results list, contradictory scientific information may appear. This circumstance affects the information selection and processing in important ways.

Experimental evidence has yielded that readers of science information are more uncertain regarding the issue if a *single* presented science message presents conflicting information on that matter, as opposed to a single message featuring only consensus (Dixon & Clarke, 2013). Yet other similar work did not find consistent effects on certainty across different science topics (Jensen & Hurley, 2012). Experimental work on how lay recipients respond to conflicting science information from *several* web messages has yielded that those messages that are deemed more plausible are more likely to be recalled and integrated into a broader understanding of the topic at hand (Maier & Richter, 2013), similar to a confirmation bias of selective exposure, processing, and recall (e.g., DeFleur & Ball-Rokeach, 1989). Several studies (e.g., Bråten &

Strømsø, 2006; Stadtler, Scharrer, Brummernhenrich, & Bromme, 2013) demonstrated that lay recipients of science information notice and integrate conflicting evidence to a greater extent if they read several messages, as opposed to reading the same text presented in one message. Hence, the online presentation of conflicting science messages might instigate more elaboration and subsequent attitude impacts than messages in traditional formats. But will online users indeed attend to conflicting and counter-attitudinal messages, if they are free to select?

The Role of Values and Attitudes in Science Information Use

Following the perspective of the science literacy model (as explained by Miller, 1998), a higher level of science knowledge in the general population is thought to foster more favorable attitudes. However, the suggested relationship between knowledge and attitudes is relatively weak in empirical studies, as a large cross-national meta-analysis found (Allum, Sturgis, Tabourazi, & Brunton-Smith, 2008). Hence, more recent work emphasizes general values and specific attitudes held by lay recipients of science information, as those may greatly affect the information intake and processing and then, in turn, knowledge and support for science (Ho, Brossard, & Scheufele, 2008; E. Nisbet, Hart, Myers, & Ellithorpe, 2013; M. Nisbet & Goidel, 2007). Citizens' values and attitudes appear to channel their involvement with science information—"Faced with a daily torrent of news, citizens use their value predispositions (such as political or religious beliefs) as perceptual screens, selecting news outlets and Web sites whose outlooks match their own" (M. Nisbet & Mooney, 2007, p. 56). Such bias from preexisting attitudes and values on what science information is selected for actual consumption has important implications because it fosters polarization in society regarding risks and scientific innovation (e.g., Kahan, 2012).

Unfortunately, the existing research on biased processing of science information cannot shed light on some of the most crucial processes involved. Specifically, with much of the related research relying on cross-sectional data (e.g., Besley & Shanahan, 2005; Brewer & Ley, 2011; Feldman, Maibach, Roser-Renouf, & Leiserowitz, 2012; Zhao, 2009), it is difficult to disentangle whether the attitudes were shaped by media exposure or whether the attitudes led individuals to select certain science messages from the media. In the realm of exposure to *political* messages, numerous studies have recently corroborated what Festinger's (1957) theory of cognitive dissonance already suggested nearly six decades ago—individuals favor messages that align with preexisting views (e.g., Garrett, 2009; Knobloch-Westerwick & Meng, 2009; Taber & Lodge, 2006). With regard to science information, only one study has, to our knowledge, examined selective exposure. Jang (2014) largely adopted the research design and procedure that Knobloch-Westerwick and Meng (2009) had applied to study exposure to political messages in the context of an online magazine, but employed messages that pertained to controversial science topics (stem cell research, genetically modified foods, global warming, and evolution). Jang (2014) found that, for two of the four topics (stem cell and GM foods), participants were more likely to click on attitude-discrepant science messages and also spent more time on them, compared to attitude-consistent messages (however, global warming and evolution did not yield any significant choice patterns). This finding appears to contradict the majority of the above-mentioned findings from political communication research, which calls for further tests of the matter for the science communication domain. Jang's findings also highlight the necessity of accounting for relevant individual differences and their effects on exposure, because individuals high on religiosity and on political knowledge did exhibit an attitude-consistent bias in exposure (Jang, 2014). These results were interpreted as demonstrating that individuals high on certainty regarding scientific issues were most likely to engage in confirmation bias, while those who were less certain (either less knowledgeable or less religious) sought out novel information from attitude-discrepant science articles. Finally, mixed patterns of results by topic may relate to beliefs about science and technological risk, which are influenced by cultural values such as individualism and egalitarianism (cf. Kahan et al., 2011). Thus, it remains important to continue to examine and account for differences and similarities between topics in their patterns of message exposure and effects.

Given that research on political messages has consistently found a confirmation bias in exposure and only one selective exposure study on science messages found an effect in the opposite direction, the present study test for the following hypothesis on this matter:

H4: Users prefer attitude-consistent science information over attitude-discrepant science information.

Additionally, the previous research by Jang (2014) did not consider differences in how news articles were framed and presented, and it is unclear if issue stances may have been confounded with information presentation. Specifically, the present investigation examines exemplars and numerics and relevant ways of presenting science information. As exemplars are thought to attract greater exposure (see H1), it is worth exploring in a research question whether this exemplification effect might even override the confirmation bias suggested in H4.

RQ2: Does the use of exemplars affect the effect suggested in H4?

Numeracy has further been suggested to affect the extent to which individuals engage in motivated reasoning regarding science information to bolster existing views; yet theoretical predictions and empirical evidence have been inconsistent (Kahan et al., 2012). Thus a research question will examine whether numeracy moderates the confirmation bias in exposure suggested in H4.

RQ3: Does numeracy affect the effect suggested in H4?

Processing and Attitude Impacts of Science Information

Recent work has examined how science information exposure shapes opinions regarding science topics and what role factual evidence plays in that process: For instance, Druckman and Bolsen's (2011) findings revealed limited influence of factual information on initial opinions, which did not exceed the influence of pre-existing values and science credibility perceptions. Further, supplementing message frames with factual information did not exert more impact on opinion formation than frames without facts. Moreover, Druckman and Bolsen (2011) concluded that recipients process additional factual information in a biased, opinion-consistent fashion once they have formed an initial opinion; evidence is viewed as more compelling if it aligns with preexisting opinions, and impartial facts are likely perceived as corroborating preexisting opinions. Similarly, an experiment found that pre-existing beliefs (but not topic familiarity) predicted reinforcing effects of information exposure regarding nanotechnology (Kahan, Braman, Slovic, Gastil, & Cohen, 2009).

However, the existing work on attitudinal impact of science information did not enable recipients to select and sample from science messages, as they would in a regular online use setting. Thus the present study examines how exposure to science information influences attitudes regarding the science topics. Although much work in the political communication context (e.g., Taber & Lodge, 2006) suggests that media users not only prefer attitude-consistent messages over attitude-discrepant messages (e.g., Knobloch-Westerwick & Meng, 2009) but also process information in attitude-bolstering fashion, evidence on how this exposure to science information affects attitudes is lacking. Specifically, Jang's (2014) findings imply that recipients of science information might be *more* open to selecting attitude-challenging content but did not capture impacts on attitudes. Based on the perspective that information recipients engage in motivated reasoning and process information such that existing attitudes are reinforced (e.g., Taber & Lodge, 2006), we hypothesize only an attitude-reinforcing effect of exposure to attitude-congruent messages:

H5: Exposure to science information that aligns with preexisting attitudes on the science topic reinforces these attitudes.

Method

Overview

A single session online field study was conducted with 229 participants, using an online research procedure created with Microsoft Silverlight. Participants' attitudes towards four science and technology issues were measured (dichotomously and with Likert-type scales, embedded among distracter topics), followed by attitude certainty. The four target topics were fracking, genetically modified (GM) food, biofuels, and nanotechnology. The next section assessed participants' numeracy, trait empathy, and media use habits. Participants were then permitted to view alleged online search results and browse articles for each of the four target topics, and read whichever articles they liked for a period of 2 minutes per topic while a computer program recorded exposure to each article. This time frame aligns with typical online search behavior, as search result pages are typically examined for 18 to 30 seconds before making a selection (Buscher, White, Dumais, & Huang, 2012; Lorigo et al., 2006) and 102 seconds is the average time then spent on a website accessed through an online search (Mitchell, Jurkowitz, & Olmstead, 2014). After reading articles about the four topics, the participants completed another computer-based questionnaire to measure shifts in topic attitudes, the covariates of religiosity, scientific knowledge, and attitudes toward science and technology, as well as basic demographic information.

Participants and Recruitment

A total of 276 participants were recruited from a large Midwestern university's research pool of undergraduate students in communication or received extra credit for their participation. After screening out 33 participants who did not complete the online session and 14 participants who appeared inattentive (i.e., they either spent more than 90 seconds on a search results overview page or more than 240 seconds in total on the four overview pages), complete and valid entries were obtained for 229 participants. Of this sample, 56.3% of participants were female; 74.6% White/Caucasian, 12.3% Asian, 8.3% African-American, 0.4% Native American, 4.4% other; $M_{\text{age}} = 21.84$, $SD = 3.84$.

Stimuli and Stimuli Pretest

Online information portal. An experimental site with the masthead "Wired" was employed to present alleged search results, one topic at a time (see example of search results overview page in Figure 1). To ensure ecological validity, the look of an actual site was mimicked by the experimental site. One of four topical keywords appeared in the search box, such as "fracking," followed by four headlines with corresponding lead paragraphs relating to the search topic. Participants picked articles they wanted to read by clicking. During this time, their message exposure was recorded by logging each hyperlink click and the seconds spent on each page. Then participants were able to return to the search results overview page at any time by selecting the "back to search results" button to select other articles.

Topics. The four target topics of fracking, genetically modified food, biofuels, and nanotechnology were selected based on high and roughly equivalent levels of press coverage during the preceding two years (as indicated by LexisNexis search results). Furthermore, this selection of topics featured two energy issues and two issues pertaining to technology at the molecular level. Moreover, for both the energy domain and the molecular-level technology domain, one topic was anticipated to be overall viewed negatively (fracking and GM foods) and one positively (biofuels and nanotechnology), as reported below under “Attitudinal Measures.”

Headlines, leads, and articles. Sixteen total articles (four per topic) were compiled from news and advocacy sources and edited for length, stance, and clarity of content. Articles had a mean length of 703.5 words (SD = 7.7). For each issue, the researchers created headlines (four to five words each) and lead paragraphs (25 words each; see Table 1 for a complete list of headlines and leads), two in support of the particular technology or scientific innovation, and two in opposition. Article headlines and leads featured either exemplar or numeric information as evidence. For each topic, two of four articles featured exemplars—one supporting and one opposing the science innovation or technology—and two featured numeric information—one in support and one in opposition. The individuals mentioned in the exemplar articles had first names that are commonly used for both genders (e.g., Morgan) so that participants of both sexes would be equally likely to relate to these characters.

The manipulations of stimuli were tested with an online survey, offered as an extra credit assignment in an undergraduate communication course at a large Midwestern university. A total of 12 men and 24 women participated in the pretest (M_{age} = 21.85, SD = 3.53). Participants were asked to examine the headlines and leads and indicate the presence of either “numbers and statistics” or “examples and case descriptions.” Specifically, the prompts "I expect the article to feature many numbers and statistics" and "I expect the article to feature examples and case descriptions" were used with a 7-point scale with *strongly disagree* and *strongly agree* as anchor labels. Participants also indicated the extent to which they perceived each article would support or oppose the issue in question based on the prompt "I expect the article to support…" on a 7-point scale with *strongly disagree* to *strongly agree* (see Table 2). As reported in Table 2, all utilized leads were perceived as desired: For each topic, two of four articles featured exemplars—one in support and one opposing the science innovation or technology—and two featured numeric information—one in support and one opposing the science innovation or technology.

Sources. To rule out that the sources (URLs) influenced the patterns of interest through varying levels of credibility or other impacts, all used URLs were established to have equally high perceived credibility. To this end, 12 women and 6 men (M_{age} = 21.44, *SD* = 1.20) from the same study population completed an online questionnaire on online source perceptions to earn extra credit. For various sites, they were asked to indicate "based on the website name and URL above, I expect the website to be credible," 1 = *Strongly disagree* to 7 = *Strongly agree*) in order to identify homogenous sets of high-credibility sources for use in the main study. Sixteen sources and their URLs (e.g., National Academy of Sciences, www.nasoline.org) were selected, with a grand mean of 5.71 (*SD* = 0.19) and no significant pairwise differences among them.

Stimuli rotations and randomization. On the overview page for each issue, headlines and leads were randomized in a 2 (attitude-consistent or -discrepant) x 2 (exemplar or numeric) factorial design. Each participant saw each of the four issues (fracking, GM foods, biofuels, and nanotechnology) in the same sequence. For each issue, the placement of headlines and leads on the search results page was randomized, with one attitude-consistent exemplar, one attitude-consistent numerics article, one attitude-discrepant exemplar, and one attitude-discrepant numeric, all available for reading. Further, each news headline was paired with a high credibility source as described above, in a rotated fashion.

Attitudinal Measures

Attitudes (dichotomous). Attitudes were measured as a dichotomous variable (oppose or support). Participants were first given a task to familiarize themselves with the protocol (see Knobloch-Westerwick & Meng, 2011, for further details of the procedure). Participants were asked to place one finger on the "z" key and one finger on the "/" key. Each symbol corresponded to either a negative or positive attitude. Participants then evaluated eight distracter topics as well as the four science and technology issues. The specific cues used for the four target issues were "Genetically modified foods," "Biofuels," "Nanotechnology," and "Fracking." Whether they selected "z" or "/" reflected either *oppose* or *support* as response option labels. Participants were instructed to complete the procedure as quickly as possible without compromising accuracy (see Table 3 for proportions of support and opposition).

Attitude shift. Explicit attitudes towards each of the four target technologies as well as six distracter topics were measured with the prompt "Please indicate how STRONGLY you support or oppose the following issues" on 7-point anchored scales (1 = *Strongly oppose* to 7 = *Strongly support*) both before and after exposure to the articles (see Table 3). Again, the specific cues used for the four target issues were "Genetically modified foods," "Biofuels," "Nanotechnology," and "Fracking." *Attitude shift* is the difference in pre- versus post-exposure attitudes, which is then reverse scored for those who oppose the issue, so that the personal stance (pro or against) does not affect scores (see Table 3).

Attitude certainty. The first set of attitude measures, before the message exposure task, included a rating task with the prompt "how certain are you of your opinion toward the following issues," with a 7-point scale ranging from *not at all certain* to *extremely certain*. Descriptive statistics for attitude certainty are included in Table 3. Across the four measures, the mean *attitude certainty* was at $M = 4.21$ ($SD = 1.33$).

Message Exposure

Exposure was measured in the time spent reading each particular kind of news article. The software application was designed to measure participants' *message exposure* in seconds to online articles with either attitude-consistent or attitude-discrepant positions. Prior work has validated this exposure measure and found it to be highly correlated with reading behavior reflected in eyeball movement and recalled reading extent (Authors, 2001, 2003). Dichotomous attitude measurements from the first task were used to determine whether message exposure was attitude-consistent or attitude-discrepant. Dichotomous and explicit attitude measures were strongly correlated for each topic (*r*s of .65, .68, .47, and .55 for fracking, GM food, biofuels, and nano, all $p < .001$), indicating that the dichotomous measure provided a valid means of categorizing exposure as attitude-consistent or -discrepant. In addition, whether the lead included numeric or exemplar information was coded accordingly, creating four exposure variables for each of four topics: (a) attitude-consistent exemplar, (b) attitude-consistent numeric, (c) attitude-discrepant exemplar, and (d) attitude-discrepant numeric (see Table 3 for mean exposure times). This allows for testing whether exposure is selective, i.e., if particular types of messages are viewed at a disproportionate rate. Likewise, these differentiated measures of time spent reading news articles allow for testing effects of reading certain message types on subsequent attitudes.

Of the 120 s afforded for browsing each set of results, an average of 29.61 s (*SD* = 23.62) was spent on the overview page. This time was greater for the first presented topic, fracking, *M* = 36.27, *SD* = 25.33, a significant difference with the overview browsing time for other topics, all pairwise comparisons $p < .001$. Participants exercised selectivity in viewing search results, typically clicking on just about half of the articles for each topic, *M* = 2.10, *SD* = 0.95. When an article was selected for reading, it was viewed for *M* = 56.76 s, *SD* = 32.09.

Trait Measures

Numeracy. A measure of *numeracy* (Schwartz, Woloshin, Black, & Welch, 1997) consisted of three questions designed to measure the individual's ability to comprehend and perform basic mathematic expressions. This is important, as numeric information obviously deals with numbers and statistics. Items such as "Imagine that we flip a fair coin 1,000 times. What is your best guess about how many times the coin would come up heads in 1,000 flips? <fill in blank> times out of 1,000" were presented, and open-ended answers were coded dichotomously as correct (1) or incorrect (0). A participant score on the index represents the sum of these three questions, *M* = 2.06, *SD* = 0.95.

Trait empathy. Participants responded to 14 items pertaining to two relevant dimensions of Davis' (1980) multidimensional approach to empathy index, empathic concern and perspective taking. Agreement with items such as "When I see someone being taken advantage of, I feel kind of protective towards them," and "I believe that there are two sides to every question and try to look at them both," was reported on 5-point Likert-type scales (1 = *Does not describe me well* to 5 = *Describes me very well*). A participant's measure on this index is the result of the mean of their 14 responses, *M* = 3.66, *SD* = 0.53, α = .785. *Trait empathy* and *numeracy* were not significantly correlated ($r = .11$, *n.s.*).

Covariates. Three additional traits—*religiosity*, *science knowledge*, and *attitude toward science*—were measured as well, as they are found to play a role in beliefs about science topics and in responses to science communication (e.g., Dudo et al., 2011; Scheufele, Corley, Shih, Dalrymple, & Ho, 2009), and could confound the influence of attitudes or other traits.

Given the important role played by religion in determining attitudes towards science, particularly in the U.S., religiosity was measured with the Duke University Religion Index (Koenig, Meador, & Parkerson, 1997), which assesses three major dimensions of religiousness including institutional, non-institutional, and intrinsic religiousness. The scale consists of two questions that assess the frequency of a participant's engagement in various religious behaviors (e.g., "How often do you attend church or other religious meetings?" 1 = *Never* to 6 = *More than once a week*) and three questions about the role of religion (e.g., "In my life, I feel the presence of the Divine [i.e., God]" 1 = *Definitely not true of me* to 5 = *Definitely true of me*). The index for *religiosity* represents an average of the five responses, $M = 2.84$, $SD = 1.25$, $\alpha = .898$. It was not significantly correlated with *numeracy* or *trait empathy* (*n.s.*).

Science knowledge was assessed with 13 true-false questions (e.g., "The center of the Earth is very hot") from the civic scientific literacy measure (Miller, 1998). Items were coded as correct (1) or incorrect (0). A participant's measure on the index represents the sum of these items, $M = 8.11$, $SD = 2.52$, $\alpha = .641$. *Science knowledge* was significantly correlated with *numeracy* ($r = .27$, $p < .001$) and *religiosity* ($r = -.22$, $p = .001$). Finally, participants were asked to evaluate six statements (adopted from Kawamoto, Nakayama, & Saijo, 2011) regarding their *attitude toward science* as a benefit to society (e.g., "I hope scientific thinking prevails more in the society") on anchored 7-point scales (1 = *Strongly disagree* to 7 = *Strongly agree*). A higher mean response represents a more positive attitude toward science as a benefit to society, $M =$

5.23, *SD* = 1.12, α = .885. *Attitude toward science* correlated with *numeracy* (*r* = .18, *p* = .008), *trait empathy* (*r* = .18, *p* = .008), and *science knowledge* (*r* = .23, *p* = .001).

Results

Impacts on Exposure to Science Information Online

An ANCOVA with *message exposure* as within-group factors (4 x 2 x 2, differentiated by topic, attitude consistency, and exemplification) and the variables *trait empathy*, *numeracy*, *religiosity*, *science knowledge*, and *attitude toward science* as covariates was conducted. It yielded only one main effect, which emerged for attitude consistency, $F(1, 222) = 10.6$, $p = .001$, $\eta^2_{partial} = .046$: Participants spent $M = 191.4$ s ($SD = 92.8$) on attitude-consistent messages, compared to $M = 181.6$ s ($SD = 94.3$) on attitude-discrepant. Favoring attitude-consistent content was more pronounced among participants with higher *trait empathy*, $F(1, 222) = 7.6$, $p = .006$, $\eta^2_{partial} = .033$ (see also regression analyses below). Exemplification did not have a main effect (*n.s.*), but interactions between exemplification and *trait empathy*, $F(1, 222) = 5.7$, $p = .018$, $\eta^2_{partial} = .025$, and between exemplification and *numeracy*, $F(1, 222) = 4.9$, $p = .029$, $\eta^2_{partial} = .021$, emerged. Specifically, participants with higher *trait empathy* allotted more time to exemplar messages, while participants with higher *numeracy* spent less time on exemplar messages (see details in regression analyses below). Topic as within-group factor did not affect these patterns; the only impact from topic emerged in interaction with science knowledge, $F(3, 666) = 6.7$, $p < .001$, $\eta^2_{partial} = .029$, because participants with higher *science knowledge* spent more time overall reading about the first topic of fracking while others took more time to examine the overview page while orienting with the first presented topic (see descriptives above for *message exposure* variables). Regarding influences of specific topics on hypothesized effects, no interactions between attitude consistency and topics ($p = .583$) or exemplification and topic (*p*

= .236) as within-group factors emerged. When this ANOVA model was extended with the overall *attitude certainty* level as covariate, to account for possible influences of familiarity with the topic, the same results emerged as before.

Further, to clarify how the covariates in the ANCOVA reported above affected *message exposure*, regression analyses were performed. The variables *trait empathy*, *numeracy*, *science knowledge*, *religiosity*, and *attitude toward science* served as predictors for *exposure* to (a) attitude-consistent messages, (b) attitude-discrepant messages, (c) numeric messages, and (d) exemplar messages as criteria. For *exposure* to attitude-consistent messages, only *trait empathy* had a significant effect with *beta* = .15, $p = .029$. Similarly, *exposure* to attitude-discrepant messages was also linked to *trait empathy*, with *beta* = -.17, $p = .013$. Individuals with greater *science knowledge* spent more time with numeric messages, *beta* = .21, $p = .004$. Exemplar messages attracted less exposure among participants with higher *numeracy*, *beta* = -.14, $p = .048$ and longer exposure among participants with higher *trait empathy*, *beta* = .14, $p = .040$.

Impacts of Exposure on Attitude Shift

Multiple regression analyses examined whether *exposure* to (a) attitude-consistent messages, (b) attitude-discrepant messages, (c) numeric messages, and (d) exemplar messages as predictors in turn affect attitude shift while controlling for the variables *trait empathy*, *numeracy*, *religiosity*, *science knowledge*, and *attitude toward science*. Only exposure to attitude-consistent messages emerged as a significant predictor for *attitude shift*, with *beta* = .20, $p = .019$. When running this regression model for each topic separately (excluding exposure to exemplar information to avoid multicollinearity), the results showed that exposure to attitude-consistent messages on fracking (*beta* = .24, $p = .024$) and on biofuels (*beta* = .25, $p = .012$) had such attitude-reinforcing effects, whereas no significant impacts emerged for GM food and nanotechnology.

To shed light on influences of message types on *attitude shift* more specifically, a follow-up regression used (a) attitude-consistent exemplar messages, (b) attitude-discrepant exemplar messages, (c) attitude-consistent numeric messages, and (d) attitude-discrepant numeric messages as predictors and the same control trait variables. Overall, only exposure to attitude-consistent numeric messages had a significant impact on *attitude shift*, with *beta* = .21, p = .007. When running this regression model for each topic separately (excluding exposure to dissonant exemplar information to avoid multicollinearity), significant impacts emerged for both exposure to attitude-consistent numeric messages and exposure to attitude-consistent exemplar messages for fracking (*beta* = .24 and .26, respectively, $p \leq .001$) and nanotechnology (*beta* = .24 and .20, respectively, $p \leq .008$), while biofuels yielded a significant impact of exposure to attitude-consistent exemplar messages (*beta* = .19, p = .012) but no significant impact of exposure to attitude-consistent numeric messages (*beta* = .12, p = .118). For GM food, none of the impacts approached significance.

These mixed findings for attitude shift are in keeping with the notion that topic characteristics may moderate effects. Although topic did not moderate patterns of exposure in the present data (cf. Jang, 2014), the effects of that exposure on *attitude shift* were qualified by topic. It is noteworthy that attitude-consistent fracking messages consistently reinforced attitudes, as this topic had a low level of *attitude certainty* (Table 3), so that perhaps there was more potential for attitude shift. Biofuels and nanotechnology showed moderate certainty and some attitude reinforcement, while the more certain attitudes for GM food did not show any exposure effects on attitude shift. Indeed, adding attitude certainty as a moderator in the regression models indicated that lower certainty was linked to stronger effects of attitude-consistent messages for fracking (*beta* = -.382, $p = .029$). However, this interaction fell short of significance for biofuels (*beta* = -.213, $p = .254$) and nanotechnology (*beta* = -.168, $p = .345$).

Discussion

When seeking information about science topics, lay individuals commonly use online search engines to access information about scientific knowledge and innovation. This experiment presented participants with the opportunity to freely browse a series of alleged online search results on four relevant issues in science and technology. The leads of the online science information were manipulated to make use of either exemplar or numeric evidence. Further, online article leads were also manipulated to indicate supportive or oppositional stances regarding the scientific innovations in question: fracking, GM foods, biofuels, and nanotechnology.

Regarding H1, no main effect of the message characteristic (exemplar versus numeric) on message exposure emerged. However, exposure to exemplar versus numeric messages depended on individual differences: Users with high trait empathy dedicated more time to reading exemplar information, while those high on numeracy dedicated more time to reading numeric information. These findings provide support for H2 and H3. These effects persisted across topics, and after controlling for religiosity, science knowledge, and attitude toward science. Additionally, analyses found that higher trait empathy was associated with greater exposure to attitude-consistent articles, and higher science knowledge was associated with greater exposure to articles featuring numbers.

Regarding H4, results corroborated the suggested confirmation bias in participants' exposure behavior, as online information users favored attitude-consistent messages. This confirmation bias emerged across all four topics. Inclusion of exemplars did not affect this pattern (RQ2). Even though some scholarly work suggests that recipients' numeracy might affect the extent of confirmation bias (Kahan et al., 2012), the present data did not find such a moderating effect (RQ3) on the confirmation bias in exposure to science information. Shifts in attitudes were also examined as consequences of exposure to the different types of online science information. Exposure to attitude-consistent messages was found to reinforce existing attitudes. This finding supports H5 but did not emerge uniformly across all topics, only for fracking and biofuels. Also, while numeric attitude-consistent exposure emerged as specifically influential across all four topics, examination for specific topics yielded that both exemplar and numeric attitude-consistent reinforced attitudes. Thus, no clear evidence regarding differential persuasive effects of numeric versus exemplar messages emerged in response to RQ1.

Limitations of the present investigation include the finite number of science topics used, which restricts the generalizability of the results. Although the issues were relatively diverse in their baseline support (Table 3) and relative appeal to conservatives or liberals, all four represent technological innovations that pose environmental risks, which are typically seen as more beneficial and less risky by hierarchical-individualists, compared to communitarian-egalitarians (Kahan et al., 2009, 2011). This is in contrast to topics such as stem-cell research or evolution (Jang, 2014) that relate differently to cultural beliefs. Future work should examine more topics.

Another limitation is the use of a sample comprised of college students, which may have more knowledge of, and more positive attitudes in general towards, science than the overall population. For example, the average participant answered 61% of items correctly on the science knowledge measure, compared to 55% for the average Western adult (Miller, 1998). In contrast to the cultural cognition model, the scientific literacy perspective (Miller, 1998) emphasizes the role of knowledge in informing attitudes toward science. This perspective can help reconcile the findings with those of Jang (2014). On the surface, the present finding of a general confirmation bias (H4), regardless of topic, contrasts with the previous study of selective exposure to online science information (Jang, 2014), which found a preference for attitude-discrepant exposure for at least for two of the four topics. However, in Jang's sample, those with high perceived science knowledge and high religiosity showed attitude-consistent exposure patterns instead, which was attributed to attitude certainty. While the studies' sample sizes were comparable, Jang's study featured 238 participants from a stratified quota sampling method and the present study built on a convenience sample of 229 students. The use of a representative sample by Jang may account for that study's main effect of selective exposure to attitude-discrepant messages, as many respondents may have held relatively minimal science knowledge, and subsequently uncertain attitudes. This corresponds with the confirmation bias seen in the present study's sample of university students. Their relatively high scores on science literacy, and moderately certain attitudes, may account for their confirmation bias. In addition to a relationship of literacy and certainty with selective exposure (as illustrated by Jang), the present results also show a link in which greater attitude *uncertainty* is associated with more attitude reinforcement from attitude-consistent messages. This pattern may reflect an attitude formation process, and future research should consider the interplay between scientific literacy and cultural cognition, rather than treating them as mutually exclusive propositions (e.g., Kahan et al. 2009). It appears both must be considered.

An additional limitation is that, given that exposure was tested as a self-selection phenomenon and was not experimentally assigned, there is the potential for spurious correlations between selectivity in message exposure and subsequent attitude shift. However, the inclusion of control variables helps in suggesting that it is indeed selective exposure to attitude-consistent numeric information that has a positive effect on attitude shift after exposure.

In addition to the differences in topics, samples, and moderating trait variables used in both studies, a number of methodological differences between Jang's (2014) setup and the present study exist, that could also contribute to the differences in findings. First of all, both studies manipulated the *stance* of the messages to include supporting and opposing views, but Jang also included a neutral view. The presence of moderate views might dampen perceptions of ideological conflict that could otherwise activate confirmation bias (Dixon & Clarke, 2013; Jensen & Hurley, 2012; Maier & Richter, 2013). *Message length* in the present study was considerably longer, even after accounting for time available for browsing; accordingly, participants in the present study had 704 words of attitude-consistent material available per browsing minute, whereas Jang's participants had only 300 words of attitude-consistent material available per browsing minute and thus may have run out of material that they preferred. This difference in total browsing time window could help account for the time spent with attitude-discrepant articles in Jang's (2014) study, as readers often view attitude-consistent articles first and then move toward reading attitude-discrepant articles (Authors, 2013). Finally, the present study manipulated the messages to emphasize either *exemplar or numeric* information, message characteristics which influenced participants' exposure. Accounting for differences in information presentation in the present study removes any possible confounds of presentation style, and allows for a more precise assessment of whether attitude-consistent or -discrepant articles are chosen at differential rates.

The present study demonstrated that confirmation bias in message exposure was evident across multiple topics, providing support in the science communication setting for the classic pattern of selective exposure seen in political and other contexts. However, although a consistent effect, the size of that effect was modest (4.6% of variance explained). This is in line with Garrett's (2009) emphasis on the distinction between selective exposure and *selective avoidance*. Although individuals may select attitude-consistent messages at a higher rate, it does not follow that they completely cocoon themselves off from attitude-discrepant messages and reside in echo chambers. In the present study, participants did spend a substantial (albeit lesser) amount of time with science articles that challenged their attitudes. Even when accounting for moderating traits, selectivity remained modest, and the absolute amount of time spent with attitude-discrepant information did not approach zero. This lack of selective avoidance is consistent with Jang's (2014) findings, where some participants (depending on individual differences) even spent more time reading attitude-discrepant information. Furthermore, the lack of selective avoidance has important implications, as demonstrated by the results, because exposure to attitude-discrepant information does not have the same polarizing effect on attitude shift that exposure to attitude-consistent information does.

In addition to testing for selective exposure in the science communication context, the present study built on previous work (Jang, 2014) by also considering how exemplification (Zillmann, 1999) might affect message exposure. Using vivid case studies and personal stories is a promising technique for conveying science information to the public. However, exemplification had a surprisingly limited influence. Individual differences played an key role, as empathetic people spent more time viewing articles with exemplars, while people high on numeracy spent more time viewing articles with numeric information. Additional findings indicated that empathy heightened the extent of confirmation bias, but attitude certainty did not. However, attitude certainty appears to have played a role in the effects of message exposure on subsequent attitudes. The selection of attitude-consistent messages produced reinforcing effects on attitudes, but these effects were inconsistent across science topics. Attitude-consistent numeric messages were most likely to consistently produce reinforcing attitude shifts. Future research is needed to examine how exposure to different types of science communication messages have to potential to contribute to public awareness of science, but also polarize public opinion regarding controversial technological advances.

Scientific innovation can benefit societal change, but change also depends on public opinion and individual attitudes. It is pivotal to understand how individuals select information about science and how the subsequent exposure shapes their attitudes. The present work may aid the tailoring of science information to different population segments—for instance, for information users with high numeracy, the present evidence suggests that the use of exemplars might deter them from closer reading of online content. On the other hand, population segments with high trait empathy should be more drawn to science information that features exemplars. An important challenge for general outreach appears to reside in preexisting attitudes—once an attitude on a topic has been formed, it can be difficult to attract information consumers to messages that do not align with said attitudes. Along these lines, the present data showed a bias toward attitude-confirming content. Given that scientific discovery often yields contradictory evidence, and expert consensus evolves only over time, lay individuals may often stick with a view formed earlier that may no longer converge with state-of-the-art scientific knowledge. With these dynamics in the development of scientific knowledge, confirmation bias may be particularly harmful toward spreading scientific advancements to the general population.

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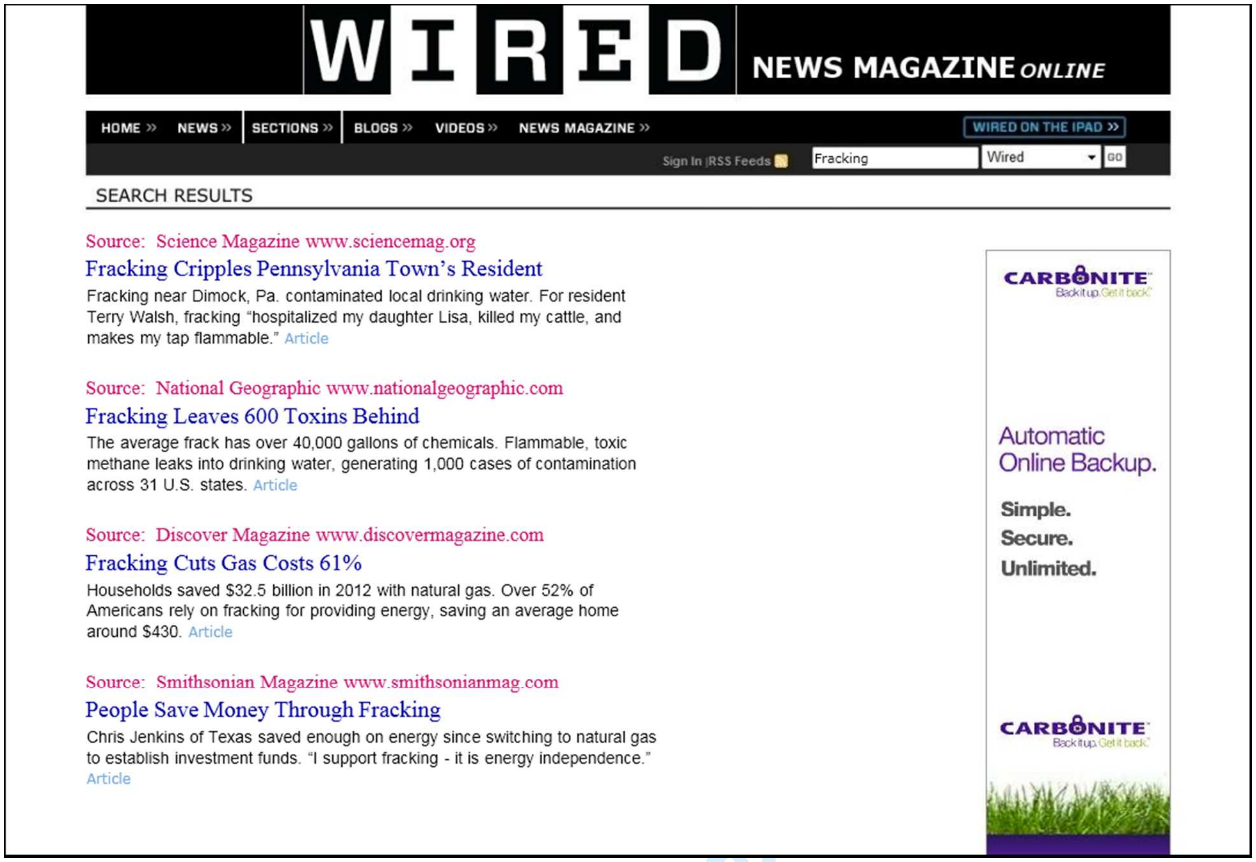

Figure 1. Example of online search results overview page, for fracking topic.

Table 1: *Stimuli Headlines and Leads*

Fracking	Support	Oppose
Exemplar	*People Save Money Through Fracking* Chris Jenkins of Texas saved enough on energy since switching to natural gas to establish retirement funds. "I support fracking - it is energy independence."	*Fracking Cripples Pennsylvania Town's Resident* Fracking near Dimock, Pa. contaminated local drinking water. For resident Terry Walsh, fracking "hospitalized my daughter Lisa, killed my cattle, and makes my tap flammable."
Numeric	*Fracking Cuts Gas Costs 61%* Households saved $32.5 billion in 2012 with natural gas. Over 52% of Americans rely on fracking for providing energy, saving an average home around $430.	*Fracking Leaves 600 Toxins Behind* Over 40,000 gallons of chemicals go in the average frack. Flammable, toxic methane leaks into drinking water, generating 1,000 cases of contamination across 31 states.
Genetically modified foods	Support	Oppose
Exemplar	*Genetically-Enhanced Cows Aid Minnesota Family* Minnesota farmer Pat Harkins: "Genetic enhancement makes my cows produce more milk. Since I can produce more with fewer cows, I am making food affordable."	*Genetically Altered Beef Harms Consumers* St. Louis resident Sam Watson: "GMO beef has antibiotics, hormones, more fat and less essential vitamins. I am worried it is making my family sick."
Numeric	*Genetically-Enhanced Dairy 18% More Efficient* Bovine Growth Hormone allows 843,000 cows to produce the milk of 1,000,000, saving 2.3 million tons of feed and 540,000 acres of farmland for crops.	*Genetically-Modified-Hormones Increase Udder Infections 79%* Bovine Growth Hormone causes serious udder infections in a 6 million dairy cattle, resulting in 8 illegal antibiotics being found in 20% of U.S. milk.
Biofuels	Support	Oppose
Exemplar	*Biofuels Let Citizen Breathe Easy* Chicago's Morgan Ellis is enthusiastic about biofuels. "Ethanol means cleaner air, and that matters because I care about the environment and my child has asthma."	*Biofuels Leave Vulnerable Workers Hungry* "We can't afford these prices anymore. I can't feed my family," says Alex Douglas, Nebraska. Biofuel demand disrupts American corn markets, threatening those like Douglas.
Numeric	*Biofuels 30% Cleaner, Boost Economy* Forty percent of U.S. corn is now for ethanol production. Nearly 15% of fuel demand is met by clean, sustainable biofuels, growing agricultural markets six-fold.	*Biofuel Raises Food Costs 7%* Nine million acres of U.S. corn produce fuel, only reducing gasoline consumption 0.5%. Food prices are subsequently soaring. Over 260 million people face biofuel-related famine.
Nanotechnology	Support	Oppose
Exemplar	*Nanotechnology Detects American's Heart Disease* Tracy Reynolds, Kentucky: "I worry because heart disease runs in my family. As nanotechnology reduces my risk of heart attack, I am all for it."	*Nanotechnology Threatens Privacy, Worries Student* Iowa's Jamie Nichols fears undetectable, microscopic nanobots already threaten privacy. "I don't want to worry that the fly on the wall is listening to me."
Numeric	*Nanotechnology: Saving 600,000 Lives Annually* One in 4 American deaths result from heart disease. Nanotechnology can prevent roughly 715,000 heart attacks a year, saving 108.9 billion dollars on medical bills.	*Nano-Surveillance: Millions Under Invisible Scrutiny* Nanotubes 100,000 times smaller than a human hair and nanoparticles 1,000,000 times smaller than an ant would allow untraceable NSA spying to increase to everyone.

Table 2

Stimuli Pretest Results for Article Leads Shown as Online Search Results

	Support/Oppose (7-point scale)		Exemplar/Numeric (7-point scale)	
	M	*SD*	*M*	*SD*
Fracking				
Pro Exemplar	6.03^{a}	1.11	0.58^{a}	1.54
Pro Numeric	5.75^{a}	1.23	-0.56^{b}	1.16
Anti Exemplar	1.86^{b}	1.51	1.19^{c}	1.82
Anti Numeric	2.36^{c}	1.88	-0.39^{b}	1.10
Genetically modified foods				
Pro Exemplar	5.89^{a}	1.24	1.03^{a}	1.72
Pro Numeric	5.92^{a}	1.16	-0.72^{b}	1.43
Anti Exemplar	2.58^{b}	2.09	1.58^{c}	1.83
Anti Numeric	2.39^{b}	1.90	-0.47^{b}	1.23
Biofuels				
Pro Exemplar	6.11^{a}	1.14	1.14^{a}	1.59
Pro Numeric	6.08^{a}	1.08	-0.67^{b}	1.24
Anti Exemplar	2.50^{b}	1.84	0.75^{c}	1.52
Anti Numeric	2.92^{c}	2.06	-0.47^{b}	1.44
Nanotechnology				
Pro Exemplar	6.08^{a}	1.23	1.36^{a}	1.62
Pro Numeric	6.19^{a}	1.06	-0.42^{b}	1.13
Anti Exemplar	2.06^{b}	1.57	0.78^{c}	1.61
Anti Numeric	3.42^{c}	1.68	-0.33^{b}	1.69

Note. Means pertaining to the same topic with different superscripts differ at $p < .05$ in multiple comparisons with Sidak correction. Support/Oppose was measured with a single item for each article lead, 1 = *strongly oppose* to 7 = *strongly support.* Exemplar/Numeric score is the difference between an item rating the presence of examples and case descriptions and an item rating the presence of numbers and statistics (1 = *strongly disagree* to 7 = *strongly agree*).

Table 3

Descriptive Statistics for Main Experiment Sample

	Fracking	Genetically modified foods	Biofuels	Nano-technology
Pre-Exposure Attitude (dichotomous, % support)	24[a]	31[a]	81[b]	76[b]
Pre-Exposure Attitude (Likert, 1-7)	2.96[a] (1.67)	2.75[a] (1.82)	4.86[b] (1.55)	4.62[c] (1.56)
Pre-Exposure Attitude Certainty (Likert, 1-7)	3.88[a] (2.12)	4.79[b] (1.88)	4.22[c] (1.80)	3.94[a] (1.81)
Post-Exposure Attitude (dichotomous, % support)	33[a]	32[a]	74[b]	67[b]
Post-Exposure Attitude (Likert, 1-7)	3.21[a] (1.76)	2.88[b] (1.74)	4.66[c] (1.52)	4.34[d] (1.66)
Attitude Shift (computed range -6 to 6)	-0.40[a] (1.46)	-0.39[a] (1.72)	-0.39[a] (1.61)	-0.34[a] (1.53)

Note. Values in a row with different superscripts differ significantly ($p < .05$) in paired t-tests.

Revision Memo

Manuscript ID SC-14-0139.R1 entitled "Science Exemplars in the Eye of the Beholder: Selective Exposure to Online Science Information Affects Attitudes on Science Topics"

EDITOR COMMENTS

EDITOR COMMENT: The first review pasted below (marked reviewer #2) recommended rejection, based on the perception that his/her earlier concerns were not adequately addressed. The other two recommended acceptance contingent on further changes but also noted substantial issues remain - these contingencies are fairly major, in other words. The issues they raised are actually not dissimilar to the issues raised by the first reviewer, although these reviewers' overall conclusions differed. While second revisions are actually unusual for us, in deference to the majority who recommended acceptance contingent on additional changes, I am therefore offering you a second chance at revision, but important work remains needed here.

> RESPONSE/REVISION: The manuscript has been revised to address the comments from each reviewer, as well as to more fully address the earlier comments from each reviewer in the first round of reviews.

EDITOR COMMENT: Please resist the tendency to "side-step" questions such as consideration of what might be the substantive implications of this study versus previous work including but not limited to that by Jang (which two of the three reviews seem to have stressed - we don't mean a list of methodological differences), the definition and operationalization of "selective" exposure (which again at least two reviews stressed), etc. To be a little bit blunt in the interests of being clear, we really shouldn't have to ask you to address the same major issues twice. The current set of reviews provide clear guidance, I believe, as to what remains to be accomplished for this to get a "green light" for publication. However, please be sure to inquire if you do not know what they are getting at; if I can't help sort it out for you myself, I'll consult with the reviewers for more clarity. Or, if you should decide to send this elsewhere instead, please let me know.

> RESPONSE/REVISION: Revisions have been made throughout the manuscript to more directly respond to each reviewer comment and avoid any side-stepping. The methodological differences with Jang have been rewritten to only focus on those that have substantive, theoretical consequences for explaining how the results from each study can be explained and reconciled with each other. Selective exposure has been more careful described and more clarity has been added regarding the operationalization. The other issues mentioned by the reviewers have also been carefully responded to. We believe that we understand the reviewers' requests and have made full efforts to revise the manuscript accordingly. If we have missed or misconstrued a reviewer comment, we are happy to take any further steps to bring the manuscript in line with reviewer suggestions.

REVIEWER 2 COMMENTS

REVIEWER 2 COMMENT: I continue to think this paper takes up an interesting topic and that the experiment is well executed. However, I do not find that the revision and accompanying revision memo adequately address the vast majority of issues raised in the previous round of review.

Perhaps the most glaring case of this relates to what I had previously identified as the most significant limitation to the paper -- it's failure to articulate a clear argument for what this study contributes to an identifiable body of research in the field. The response given that "A number of methodological differences exist between Jan's study and the present work," does not explain how this study advances our understanding of either selective exposure, or science information seeking.

> RESPONSE/REVISION: The manuscript now more clearly articulates what the unique contributions of the study are. This is done with a sentence on pp. 2-3 that focuses attention on three enumerated features of the study that extend it beyond earlier work, and with a new paragraph on pp. 25-26 that discusses and summarizes the unique contributions of the study (i.e., consideration of exemplars, post-exposure effects, and moderating traits).

REVIEWER 2 COMMENT: The response to the second issue raised in the previous review is equally if not more non-responsive. It's literally like ships passing in the night. Reviewer: 'the manuscript does not address whether the findings, while statistically significant, may not be all that substantively significant. There is also an important distinction related to a core concept of the paper that is not addressed. Look, here is the name of someone who writes about that distinction.' Author: 'the findings are relevant because they contrast with another study, and also they are consistent with other findings from this study.'

> RESPONSE/REVISION: The manuscript now features a new paragraph on pp. 24-25 that elaborates on the selective exposure/avoidance distinction articulated by Garrett. The effect size for confirmation bias is discussed in terms of substantial impact, and the absence of true selective avoidance or echo chambers are clarified. This is further discussed in the context of attitudinal effects and polarization.

REVIEWER 2 COMMENT: Another issue that leads me to recommend rejection at this stage is that of "selective exposure." Like other reviewers and readers, I found the use of the term in the manuscript misleading. In my version of articulating this issue, I simply asked whether it might be possible to simply delete all appearances of "selective" without any loss of meaning. The response here appears to merely be a citation for a very broad conception of "selective exposure," and an announcement early on in the manuscript that this is how the term will be used here. I suppose this is responsive at some level, but in all seriousness I do not think it addresses the fundamental conceptual issue. Why is it better for us to think of selective exposure in this way (essentially abandoning the way that most readers also think of it)?

> RESPONSE/REVISION: The manuscript has been extensively revised to much more carefully use the term “selective exposure.” In most cases, the manuscript simply uses the

term “exposure” or “message exposure.” In contrast, “selective exposure” is only used to describe situations where there is a significant, systematic bias in exposure to different types of message (e.g., a confirmation bias in exposure, or a bias in favor of exposure to exemplars). In a few other cases, “self-selected exposure” or “freely browse” are used to precisely describe the nature of a situation without implying that a bias or pattern will necessarily exist. These changes are also reflected in a revised title for the manuscript.

REVIEWER 2 COMMENT: To be fair -- kudos for controlling for participant familiarity with Wired Magazine.

On the final issue - in the previous round I suggested that greater theoretical discussion of similarities and differences among the four issues would help the paper. A new sentence essentially explaining that the issues are all different, and are in fact distributed across two dimensions of difference does not constitute a theoretical discussion.

RESPONSE/REVISION: The manuscript now features more discussion of differences between science topics, and works to ground those discussions in two theoretical perspectives (cultural cognition and scientific literacy). The expanded treatment appears on pp. 8, 9, 20-21, 22, and 25-26. This also entails analyses that consider attitude certainty as a between-topic difference that partially explains differences in attitude shift effects (pp. 20-21).

REVIEWER 1 COMMENTS

REVIEWER 1 COMMENT: The author is to be commended for his/her careful revisions. In my view, the paper now offers a much clearer and interesting contribution. For example, the emphasis on numeracy, exemplification theory, and trait (empathy) from the beginning clarifies the importance of the findings. Additionally, hypotheses were made clearer. I appreciate the substantial amount of time and effort the authors put into this revision. Still, I am a little concerned about the discussion section.

RESPONSE/REVISION: The discussion section in particular has been extensively revised in the new version of the manuscript. It emphasizes the interpretation of results and highlights the unique contributions of the study, especially on pp. 24-26.

REVIEWER 1 COMMENT: When the reviewers seek for the explanations of inconsistent findings, they do not ask for a list of differences. Instead, it should be clearly stated that how the methodological difference A may yield the different outcome B. See page 23 below.

(“Additional differences between the two studies exist in the contexts and sources with which the messages were displayed: Jang showed all on one site labeled "sciencenews.com" without further source indication… whereas the present study presented messages on four separate online search results pages on a search portal labeled "WIRED" with high-credibility source indications for each message. Both studies included messages on four science topics, with Jang using stem cell research, GM foods, global warming, and evolution, while the present work used fracking, biofuels, GM foods, and nanotechnology. Jang's study scheduled four minutes of total browsing time, compared to eight minutes in the current study. Both studies manipulated the stance of the messages to include supporting and opposing views, but Jang also included a neutral view; however, Jang's stimuli pretest did not show clear differences between neutral and the other views (only omnibus tests were reported) and thus the "neutral" stimuli may have been ambiguous in stance. Message length in the present study was considerably longer, with 11,250 words total and 5,630 words in attitude-consistent messages alone, compared to 3,600 words total and 1,200 words in attitude-consistent messages alone in Jang's study; accordingly, participants in the present study had 704 words of attitude-consistent material available per browsing minute, whereas Jang's participants had only 300 words of attitude-consistent material available per browsing minute and thus may have run out of material that they preferred. For the selective exposure measure, Jang did not specify what "behavior tracking device" was used…"

> RESPONSE/REVISION: The discussion of methodological differences has been reworked to remove any differences or details that do not have clear, substantive consequences for explaining effects or for reconciling results of the present study and the Jang study. The remaining differences drawn between the studies have been elaborated on to explain how they can explain differences in results (pp. 22-24).

REVIEWER 1 COMMENT: As we all know, all studies, even similar ones cannot be the same. What reviewers want is to understand how specific methodological differences are the cause of the different findings – any discussion or explanations or at least reasonable speculations about this, not a whole list of differences that do not provide any clue of why we are reading these. Wired vs. sciencenews.com? 11250 vs 5630 words? neutral vs no neutral? the name of software? What can we learn from these? How do these differences matter? I suggest, these paragraphs should be dropped entirely unless the authors can theoretically link these differences to the causes of different outcomes.

> RESPONSE/REVISION: The small details about study differences have been removed from the manuscript. Only study features that are theoretically linked to different findings are discussed (pp. 22-24). In particular, differences between the samples in knowledge and attitude certainty are discussed (pp. 22-23) as an account of the differential effects (in keeping with the moderating effects of certainty in Jang 2014 that show a confirmation bias for high-certainty individuals).

REVIEWER 1 COMMENT: I am not yet satisfied with 'sensitization' or 'heightened awareness' explanations either. Suppose sensitization is minimized in this study, why would minimized sensitization lead to confirmation bias and why would more sensitization make participants prefer dissonant information? In a similar vein, it is still unclear how social desirability bias toward science information can lead participants to prefer attitude-dissonant information. In my view, attitude consonance or dissonance seems to have nothing to do with social desirability because attitude consonance is simply conceptualized by consistency between audience views and article views. If participants are sensitized, they will be more likely to seek attitude-dissonant information? It is quite difficult to follow. If the authors cannot provide clear explanations of how sensitization/social desirability may lead to information seeking for attitude-dissonant information, this explanation also should be dropped.

RESPONSE/REVISION: Because the reviewers found this line of argumentation unconvincing, and because there were more plausible and theoretically meaningful differences between studies that could account for findings, this sensitization argument has been removed from the manuscript.

REVIEWER 1 COMMENT: Finally, although this revised ms stresses the role of numeracy, exemplification theory, and trait (empathy), we do not find much discussion about the implications. In my view, this part is one of the main contributions of this ms. I believe discussion should be extended accordingly.

RESPONSE/REVISION: The discussion section has been expanded, especially to discuss these unique contributions of the study (pp. 25-26).

REVIEWER 2 COMMENTS

REVIEWER 3 COMMENT: The authors have successfully revised the manuscript. It is much clearer and focused than the original version. I only have two concerns:

1) The p.2 definition of "selective exposure" is still rather unclear. If the authors mean "time spent reading a type of story given a set of other options", they should just say this upfront.

RESPONSE/REVISION: The manuscript now more judiciously uses the term "selective exposure" to refer to patterns of bias in exposure, and just "exposure" or "message exposure" when referring to the reception of media messages in general. The definition of selective exposure on p. 2 has been extended, in simple terms, to provide more clarity. Likewise, the section on the operationalization of exposure (p. 15) now more directly states that selective exposure is indeed indicated by differences in the amounts of time spent reading different types of stories.

REVIEWER 3 COMMENT: 2) It is still unclear exactly how "selective exposure" is operationalized in the regression models both as an outcome (p.18) and predictor (p.19) variable. Is it simply the time spent on that type of story? If so, it really is exposure, not selective exposure that is being measured. While there was a 120 second allocation to each topic, the time spent viewing the search results by each respondent will have varied, resulting in different total reading time for each R. Therefore, exposure does not automatically correlate with the proportion of time spent on one type of story vs. another. This is unlikely to matter in practice or change the results, but the authors should be clear about the operationalization (i.e., is it simply time spent reading, or the proportion of total time spent reading spent on a certain type of story?).

RESPONSE/REVISION: The description of the operationalization of exposure (p. 15) has been revised to clarify that selectivity is time spent reading "particular types of messages are viewed at a disproportionate rate" and that measuring time spent on each of type of message allows for "testing" this (p. 15). In no case was the total reading time for a participant used as a DV or an IV. As articulated in the Method and reiterated throughout the Results section, the study makes use of “four exposure variables for each of four topics: (a) attitude-consistent exemplar, (b) attitude-consistent numeric, (c) attitude-discrepant exemplar, and (d) attitude-discrepant numeric.” (p. 15). The results also specify whenever measures are computed from combinations of those four variables (e.g., all “attitude consistent messages” (p. 19), or when results are examined topic-by-topic). The use of these exposure variables as IVs in the attitude-shift regression models is also now specified on p. 15.