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To cite this article: Kristina Janét , Othello Richards & Asheley R. Landrum (2020): Headline Format Influences Evaluation of, but Not Engagement with, Environmental News, Journalism Practice, DOI: [10.1080/17512786.2020.1805794](https://doi.org/10.1080/17512786.2020.1805794)

To link to this article: <https://doi.org/10.1080/17512786.2020.1805794>



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Headline Format Influences Evaluation of, but Not Engagement with, Environmental News

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ABSTRACT

Sparked by a collaboration between academic researchers and science media professionals, this study sought to test three commonly used headline formats that vary based on whether (and, if so, how) important information is left out of a headline to encourage participants to read the corresponding article; these formats are traditionally-formatted headlines, forward-referencing headlines, and question-based headlines. Although headline format did not influence story selection or engagement, it did influence participants evaluations of both the headline's and the story's credibility (question-based headlines were viewed as the least credible). Moreover, individuals' science curiosity and political views predicted their engagement with environmental stories as well as their views about the credibility of the headline and story. Thus, headline formats appear to play a significant role in audience's perceptions of online news stories, and science news professionals ought to consider the effects different formats have on readers.


KEYWORDS

Environmental news;
Headlines; Political party;
Science curiosity; Science
communication; Science
journalism

Introduction

Millennials, individuals born between 1981 and 1996, are among the generations that actively engage with news on social media. A survey by the Media Insight Project—a joint research initiative by the American Press Institute and the AP-NORC Center for Public Affairs—finds that millennials engage with online media in a variety of ways. For example, 70% of millennials report regularly reading or watching news stories posted by others on Facebook, 60% report engaging with posted stories by “liking” those stories, 42% report engaging by regularly posting or sharing news stories, and 34% said they regularly comment on news stories (Media Insight Project 2015). However, because more than 5,000 articles are published online every day, millennials (and those of other generations) have to make decisions about which media to consume (Hamborg, Meuschke, and Gipp 2018), and media organizations struggle to compete with each other for attention on a story-by-story basis (Pearson and Kosicki 2017; Webster and Ksiazek 2012). Whether audiences attend to and engage with these stories depends

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 Supplemental data for this article can be accessed <https://doi.org/10.1080/17512786.2020.1805794>

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both on their own characteristics as well as the characteristics of the stories. This study investigates the roles of science curiosity, political ideology, and headline format for evaluation of and engagement with environmental news.

Characteristics of the Audience

There are many characteristics of audience members that influence their decisions about whether to consume certain media and their reactions to media, such as their dispositions, developmental stages, and perceptions of social norms. The Differential Susceptibility to Media Effects Model (Proposition 3), for example, describes how media effects are conditional: an individual's characteristics influence media use (role 1) and moderate the relationship between media used and the cognitive, emotional, and/or excitative response states (i.e., role 2), which, in turn, influence any media effects (Valkenburg and Peter 2013). For example, research shows that individuals often seek out, consciously or subconsciously, media content that aligns with their own values and beliefs and avoid content that is incongruous (i.e., "selective exposure," see Stroud 2008). Political partisanship, in particular, plays a significant role in this type of selective exposure (An, Quercia, and Crowcroft 2013; Feldman and Hart 2018; Garrett 2009). For instance, Feldman and Hart (2018) found that political conservatives were less likely to select, and spend time reading, stories about climate change. Thus, people's decisions to read and engage with environmental news (and the extent to which they find the information credible) is likely to be contingent on their political ideology.

Interestingly, however, an individual's science curiosity may reduce the likelihood of their use of politically-motivated selective exposure. This measure of dispositional science curiosity was developed by Kahan, Landrum, and their colleagues, to predict engagement with science documentaries and science-relevant news (Kahan et al. 2017; Landrum et al. 2016; Motta et al. 2019; Kahan et al. 2019). The authors define the construct as a "general disposition, variable in intensity across persons, that reflects the motivation to seek out and consume scientific information for personal pleasure" (Kahan et al. 2017). Using this construct, the authors found that readers with higher science curiosity were more likely than their non-science curious counterparts to select to read an article about climate change that is inconsistent with their political party's views on the topic (Kahan et al. 2017). Therefore, we predict that participants' science curiosity and political ideology will influence their selection of and attention to science and environmental news (see hypotheses 2 through 4 below). Understanding how individuals' dispositional characteristics (e.g., their science curiosity, their political ideology) influence their responsiveness to editorial choices helps elucidate whether, and if so, to what extent, those editorial choices resonate with some audiences and not with others.

Characteristics of the Stories

In addition to characteristics of the audiences, characteristics of the stories also influence audience selection of and engagement with news stories. Sometimes with insights about specific target audiences in mind, media outlets alter aspects of their articles, such as photos, leads, and even emojis, to encourage individuals to read their content (Welbers and Opgenhaffen 2019). One of the most important tools, that is also the one most often manipulated by journalists and their editors is the headline (Kuiken et al. 2017).

Once upon a time, the function of a headline was to give newspaper readers a quick synopsis about the content of an article (Van Dijk 1988). However, the purpose of headlines has shifted with time, from summarizing information to attracting the attention of potential readers (Iarovici and Amel 1989; Bell 1991; Nir 1993; Van Dijk 1988).¹ And, with the availability of engagement metrics (e.g., click-through data, number of page views), which help determine potential ad revenue for otherwise freely available content (e.g., Assman and Diakopoulous 2017), this shift in style and purpose has become more prevalent. For example, journalists participating in an ethnographic study reported relying on engagement metrics and web analytics to inform the crafting of headlines in ways that will attract more “clicks” (Tandoc 2014). Certain features of headlines, such as the use of upper case letters, quotations, and exclamations, have been shown to attract more clicks (Biyani, Tsioutsoulouklis, and Blackmer 2016; Kim et al. 2016; Lamprinidis, Hardt, and Hovy 2018), and many journalists have strategically manipulated these features in an effort to improve their metrics (Bazaco, Redondo, and Sánchez-García 2019).

Besides the features of headlines, the format can also be altered to increase audience attention, such as writing headlines that pose questions or that are forward referencing (Blom and Hansen 2015; Lai and Farbrot 2014; Tenenboim and Cohen 2015). Question-based headlines are those that pose a question that the article is presumed to answer (e.g., “How did Florida Man Get out of Going to Work?”). Forward-referencing headlines are those that emphasize excluded information and often use signal words like “this,” “why,” or “what” (e.g., “You’ll never guess what Florida Man did to Get out of Work”). Because both of these formats leave out just enough detail to entice audiences to click for further information, some researchers have referred to these headline types as “curiosity headlines” (e.g., Scacco and Muddiman 2019).

The term “clickbait” has also been used as an umbrella term for the variety of techniques that are used to entice a potential reader into clicking on a headline (Kuiken et al. 2017). The artfulness of clickbait techniques can vary from the use of creative stylistic devices (e.g., metaphor) to highlighting gossipy, sensational, or provoking content (e.g., mentioning a young actress’s private parts, Tandoc 2014; Blom and Hansen 2015). Perhaps unsurprisingly, using these attention-grabbing strategies has not always been beneficial for journalistic outlets. Some outlets are criticized for tastelessly altering headlines to get more clicks, calling it “the new yellow journalism” (Potthast et al. 2018).

Associations with the more tawdry and sensationalist techniques and outlets could lead audiences to question the credibility of stories that use attention-grabbing strategies more generally. For instance, forward-referencing headlines are more commonly used on commercial and tabloid media (Blom and Hansen 2015), and tabloids often are perceived to be much less credible (Mackay and Bailey 2016). Thus, audiences who read question-based or forward-referencing headlines may also perceive the headline and its story as “fake news,” or as generally lacking credibility, even if they still click to read it. Journalism is founded on credibility (France 1999) and, as Cecillie Gaziano stated in her 1988 essay:

... public inability to believe the news media severely hampers the nations’ ability to inform the public, to monitor leaders, and to govern. Decreased public trust also can lead to diminished freedom of the press and can threaten the economic health of the media. (Gaziano 1988)

Individuals may still consume news they don’t trust (Tsfati and Cappella 2005), but consuming news and internalizing its message are different actions.

Scacco and Muddiman (2019), too, compared traditional (summative) headlines, forward-referencing headlines, and question-based headlines on a variety of outcomes. The authors found that individuals were likely to rank both forward-referencing headlines and question-based headlines as being uninformative and of low quality. These expectations of the article and its content play a role in whether the individual is likely to consider reading the article further and/or to what extent they take the information in the article seriously. In their field test, Scacco and Muddiman (2019) found that curiosity headlines were associated with significantly fewer page views. When an individual perceives that the article will provide sufficient information, the potential reward for information seeking increases, meaning they will gain more valuable information from the article (Sundar and Limperos 2013). Understanding which headlines attract attention, encourage engagement, and communicate credibility is important to both academia and industry.

Current Study

This study is part of an ongoing collaboration between academic researchers and science media professionals that seeks to increase millennial engagement with science media, including stories about the environment. Millennials are the largest adult generation in the United States, currently making up 30 percent of U.S. adults (Frey 2018). The future of critical public policy decisions, such as those related to the adverse effects of global climate change, will require millennials to not only understand the scientific data and findings reported in today's vast media landscape but also to be able to connect this information back to the extreme weather events in their own geographic locations. Thus, it is important that they read and internalize the environmental news stories that provide much of this information. Organizations often gauge whether audience members have "read" a story based on engagement metrics such as clicks, shares, and comments; however, just because an individual clicks on (or even reads) an article, does not mean they believe the story is credible. Thus, it is important to measure perceptions of credibility in addition to engagement.

As previously stated, prior work is mixed on whether question-based and forward-referencing headlines lead to increased engagement. Here, we test the hypothesis that these types of headlines *do* lead to increased engagement (given that these strategies are continuously applied by professional media producers), but we also test the hypothesis that these types of headlines will be perceived as less credible.

Hypothesis 1_{a–b}. Question-based and forward-referencing headline formats will (a) increase engagement (e.g., click, read, share, comment), but (b) will lead to the perception that the stories and their headlines are less credible than traditional, summary headlines.

As mentioned previously, the Differential Susceptibility to Media Effects Model helps predict which individuals might be more likely to consume certain types of media based on certain characteristics, such as individuals' beliefs and values. Indeed, one challenge to encouraging individuals to engage with environmental news is the influence of political ideology. As one researcher put it, "Ideology works as a powerful selection device in deciding what is scientific news, i.e., what the relevant 'facts' are, and who are the authorized 'agents of definition' of science matters" (Carvalho 2007, 223). A plethora of research has examined how political views influence attention to and engagement with

environmental news (e.g., Feldman and Hart 2018). U.S. conservative Republicans are less likely than liberal Democrats to be concerned about global warming (Zia and Todd 2010), and U.S. liberal Democrats are more likely than conservative Republicans to trust climate scientists (Leiserowitz et al. 2013) and to engage in pro-attitudinal behaviors, such as recycling, using public transportation, buying “green” products, and using reusable shopping bags (Dunlap, Xiao, and McCright 2001; Jost, Nosek, and Gosling 2008; Hart and Nisbet 2012; Myers et al. 2013). Therefore, we also hypothesize that:

Hypothesis 2_{a–b}. Democrats will be more likely than Republicans (a) to engage with environmental news stories (e.g., click, read, share, comment) and (b) to perceive the stories and their headlines as credible, regardless of headline format.

Moreover, we anticipate that the effect of partisanship on engagement with and perceived credibility of environmental news will depend on how polarizing the topic is. Views on environmental issues are generally politically polarized (Dunlap, Xiao, and McCright 2001), but climate change is more dividing than pollution (e.g., Hart and Feldman 2018). To this end, we included stories about environmental topics that vary from highly polarizing (i.e., “climate change”), mildly polarizing (i.e., “pollution”), and not polarizing (i.e., “earthquakes”). We hypothesize that:

Hypothesis 3_{a–b}. The effect of political party affiliation on (a) engagement with environmental news stories (e.g., click, read, share, comment) and (b) perceptions of the stories and their headlines as credible, will be conditional on the story topic.

Specifically, we anticipate greater differences between the political parties on the topic of climate change and smaller differences on the topic of earthquakes.

One factor that appears to interrupt the influence of ideology on selection of science and environmental news stories, as described earlier, is dispositional science curiosity (Kahan et al. 2017). This prior work suggests that people who are more science curious are also more likely to select to read a climate change news story that goes against their political views (i.e., Republicans choosing articles that describe an increase in the influence of global warming and Democrats choosing articles that describe a decrease in the influence of global warming), when those stories are framed as “surprising” (Kahan et al. 2017). This result was encouraging because motivated reasoning and selective attention and exposure often lead people to read only content that is identity congenial (e.g., Stroud 2008). Therefore, we also hypothesize that:

Hypothesis 4_{a–b}. People who are more science curious will be more likely to engage with environmental news stories (e.g., click, read, share, comment) and to perceive the stories and their headlines to be credible, regardless of headline format.

Kahan and his colleagues had mused that creating “surprising” headlines (by explicitly using the word “surprising”) may have evoked curiosity and increased the likelihood that science curious people would read it. This finding also informs our first hypothesis that “curiosity headlines,” as forward-referencing and question-based headlines have been described, ought to increase engagement.

In addition to examining the effects of these variables, we also examined the potential differences between millennials (ages 23–38 in 2019)² and older generations, and we looked at potential influences of race, ethnicity, and gender.

Method

Sample

We requested 900 participants from TurkPrime, a platform managed by Amazon's Mechanical Turk (or MTurk). The survey was set up to automatically drop participants who did not match standard study inclusion criteria (e.g., were under 18, did not live in the U.S., and/or missed the attention check question); 968 individuals started the survey and the final sample was 904. Using the TurkPrime platform sampling options, we sampled participants in four groups that varied based on two criteria: generation (millennial & younger vs. older generations) and race/ethnicity (white vs. persons of color). The resulting sample is: 53% White, 22% Black, 12% Hispanic/Latinx, and 14% Asian. Approximately half of the sample are millennials or a few years younger ($n = 456$, $M_{\text{age}} = 30.08$, $SD = 4.71$, range = 20–37 years in 2018) and half are of older generations ($n = 448$, $M_{\text{age}} = 49.58$, $SD = 9.33$, range = 38–83 years in 2018). Regarding gender, 51% identify as female and 49% as male (no participants identified as transgender, intersex, non-binary, or otherwise diverse). Participants were awarded two dollars for completing the approximately 10-minute long questionnaire.

Variables

Manipulated Variables

Our experiment manipulated two factors: the format of the headline (traditional, forward-referencing, and question-based) and the story topic (earthquakes, air pollution, and climate change). For example, the traditionally-formatted headline for the earthquake story was "Scientists Still Don't Know if Little Earthquakes Lead to a Big One," the forward-referencing headline was, "Here's what Little Earthquakes Tell Scientists About the Likelihood of the Big One," and the question-based headline was "Do Little Earthquakes Mean the Big One is Close at Hand?" Each of the headlines and the associated graphics were from real stories run by our professional science media collaborators. Participants saw the headline as they would see it on their social media feed with a graphic and a dateline (see [Figure 1](#)).

Dependent Variables

Behavioral item. First, participants were shown four story headlines (with images) and asked, "If you came across the following in your newsfeed, which article, if any, would you click to read first?" (see [Figure 1](#)). Of the four stories, one was a business story, one an entertainment story, one a sports story, and one was an environmental story. All participants saw the same business, entertainment, and sports headlines. The environmental story headline varied based on our experimental manipulation (see the *Manipulated Variables* section above). The order of the four headlines displayed was randomized between participants. If the forward referencing and question-based headlines act as click bait, then we would expect that the probability of participants clicking the environmental story (over the other three stories) would be greater in the forward-referencing and question-based conditions than in the traditional format conditions.

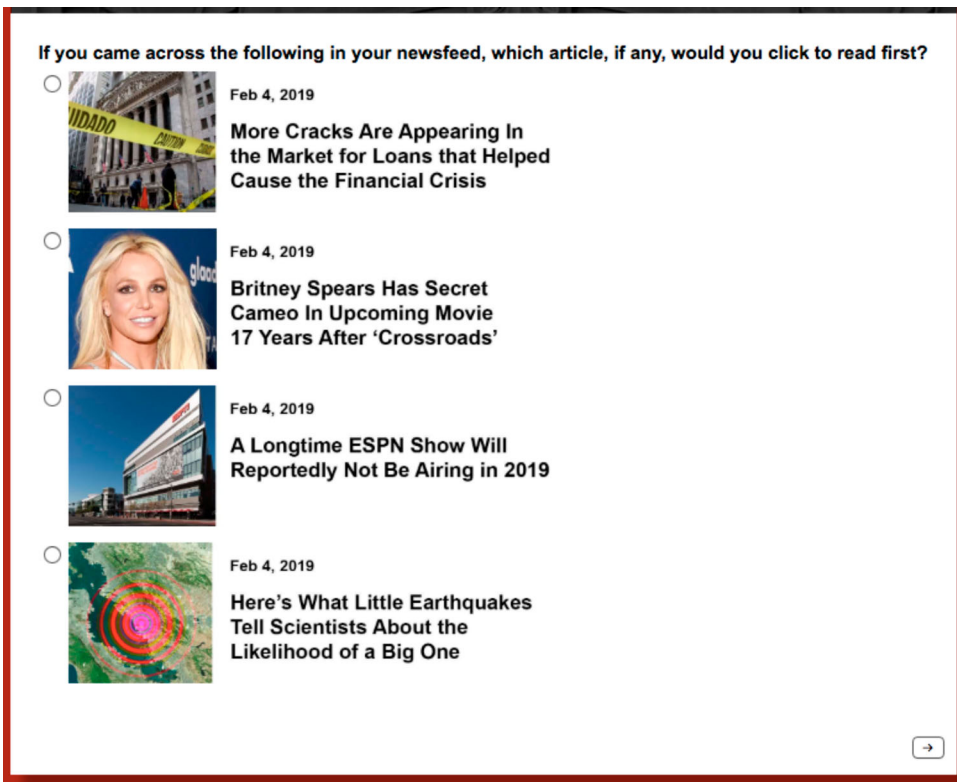


Figure 1. Behavioral item. Headlines were displayed with an image similar to what one would see on their social media feed. The order of the four articles displayed was randomized between participants.

Categorization. Following the behavioral item, we showed participants only the environmental news headline that they were shown for the previous item and asked them questions about it. Importantly, as with the previous item, which environmental news headline participants saw varied based on their condition assignment. First, we asked participants whether they would categorize that headline as real news (stories that are true and accurate), fake news (stories that are false or inaccurate), satirical news (stories that use humor, irony, and or/exaggeration to make a larger point about society), or other (please specify). Categorizing the story as “real” was coded as 1 and all other responses were coded as 0. If click bait-style headline formats (i.e., forward-referencing and question-based formats) are perceived as less credible than traditionally-formatted headlines, then we would expect that participants who saw the environmental news headlines formatted in this way would be less likely to categorize the environmental news story as “real” than participants who saw the environmental news headline formatted in the traditional way.

Hypothetical engagement. Second, we asked whether participants would likely share the article, read the article, comment on the article, or ignore the article. Participants were told to select all that apply. We combined the share, read, and comment items into an index of engagement using item response theory (2PL model). Engagement scores varied from -0.89 to 3.59 and the distribution was bimodal, with a large sub-distribution of

participants centering around -0.50 (moderately low engagement) and a smaller sub-distribution centering around 2 (very high engagement). If engagement with environmental news stories varies based on headline format, then we would expect the engagement scores to differ between the different headline conditions.

Headline credibility. Third, participants were asked to rate the credibility of the headline using a series of eight semantic differential scales (e.g., untrustworthy vs. trustworthy, clear vs. confusing, boring vs. interesting; see the supplementary materials for all 8 items). We combined these items into an index of headline credibility ($\alpha = 0.88$) using item response theory (graded response model, Samejima 1969). Scores were centered and ranged from -3.33 to 1.63 ($M = 0$, $SD = 0.92$) and were negatively skewed. Like for the categorization item, if click bait-style headline formats (i.e., forward-referencing and question-based formats) are perceived as less credible than traditionally-formatted headlines, then we would expect that participants who saw the environmental news headlines formatted in this way would report lower headline credibility scores than participants who saw the environmental news headline formatted in the traditional way.

Story credibility. Lastly, participants were asked to what extent they agreed or disagreed with a series of 10 statements about what they expected to be true regarding the article content (e.g., *I expect that the content in the article can be trusted; I expect that the content in the article is unbiased*; see the supplementary materials for all 10 statements). We combined these items into an averaged index of expected story credibility ($\alpha = 0.93$; $M = 4.40$, $SD = 0.94$). Scores ranged from 1 (strongly disagree) to 6 (strongly agree) and were negatively skewed. If click bait-style headline formats (i.e., forward-referencing and question-based formats) lead to assumptions that the content of a story is less credible than the assumptions made from traditionally-formatted headlines, then we would expect that participants who saw the environmental news headlines formatted in this way would report lower story credibility scores than participants who saw the environmental news headline formatted in the traditional way.

Measured Variables

In addition to effects based on the experimental manipulation, it was also possible that participants' evaluation of the headlines would vary based on their generation (Millennial vs. Older), their science curiosity scores (H4; see Kahan et al. 2017), their political affiliations (H3; e.g., Democrat, Republican, or other), and their race and ethnicity.

Science curiosity. Science curiosity was measured using the scale developed by Kahan, Landrum, and colleagues (Kahan et al. 2017). The scale combines a series of self-report and behavior items that ask about a variety of topics in addition to science (e.g., entertainment, business, sports, politics) to hide its primary focus. Scores are calculated using item response theory (graded response model, Samejima 1969). The scores on the science curiosity scale, among this sample, were approximately normally distributed and ranged from -2.95 – 3.12 ($M = 0$, $SD = 0.94$). For more information, see the supplementary materials.

Political affiliation. Political party affiliation was determined by asking participants whom they typically vote for in important elections: the Democratic candidate ($n = 504$), the

Republican candidate ($n = 219$), or an Independent or third-party candidate ($n = 69$). Participants were also given the option to choose “I tend not to vote” ($n = 81$) or “I choose not to answer” ($n = 31$). These last three responses (third-party, no vote, and no answer) were combined into one category of “other.”

Results

Selecting the Environmental Article

First, we wanted to know whether headline format influences the probability that participants choose the environmental article (over the entertainment, sports, and business articles). To do this, we conducted a logistic regression with headline format, story, generation, race, gender, political party, and science curiosity as predictors (see Table 1). We found that the probability of selecting the environmental article increased with increasing science curiosity (supporting Hypothesis 4a), replicating prior work (e.g., Kahan et al. 2017). In addition, Democrats (52%) were more likely than Republicans (39%) to select the environmental story (supporting Hypothesis 2a), females (56%) were more likely than males (41%) to select the environmental story, and people who identify as Black or African American (42%) were less likely than those who do not identify this way (51%) to choose the environmental story. Finally, millennials (46%) were less likely than older adults (53%) to choose the environmental story. Headline format and story topic were not significant predictors.

Evaluating the Credibility of the Headline

We also wanted to know whether headline format influences perceived credibility of the headline. To examine this question, we conducted a regression analysis (see Table 2). Unlike for the behavioral item above, we did find significant effects from the headline format and the story topic, including a significant interaction between topic and format, $F(4, 866) = 2.69, p = .030$, and a significant three-way interaction between topic, format, and generation, $F(4, 866) = 3.11, p = .015$. For millennials, the differences in perceptions of headline credibility between the pollution and climate change stories is largest for the question-based headlines. The pollution headline, in particular, when phrased as a question, was seen as not very credible. For older generations, the difference in credibility of the headlines

Table 1. Results from the logistic regression predicting the probability that individuals selected the environmental article over the other articles. Coefficients are not standardized.

	<i>b</i>	95% Confidence interval		exp(<i>b</i>)
		Low	High	
(Intercept)	−0.06	−0.47	0.35	0.94
Story: CCv s EQKE	0.12	−0.22	0.46	1.13
Story: CC vs PLTN	−0.10	−0.44	0.24	0.91
Format: TRADITIONAL vs QUESTION	0.03	−0.30	0.37	1.03
Format: TRADITIONAL vs FORWARD	0.26	−0.08	0.59	1.29
Millennials vs. Older Generations	−0.30*	−0.58	−0.01	0.74*
Black vs. Non-Black	−0.59**	−0.94	−0.25	0.55**
Female vs. Male	0.69***	0.41	0.97	1.99***
Democrat vs. Republican	−0.66***	−1.01	−0.31	0.52***
Democrat vs. Other	0.00	−0.36	0.36	1.00
Science Curiosity	0.45***	0.30	0.61	1.57***

Note: *** $p < .001$, ** $p < .01$, * $p < .05$.

Table 2. Results from the regressions predicting headline credibility ratings score, expectations for story credibility, and hypothetical engagement scores.

	Headline credibility			Story credibility			Hypothetical engagement		
	<i>b</i>	95% CI		<i>b</i>	95% CI		<i>b</i>	95% CI	
		Low	High		Low	High		Low	High
<i>(Intercept)</i>	0.61	0.35	0.87	4.73	4.46	5	-0.03	-0.32	0.26
Story: CC vs EQKE	-0.42*	-0.78	-0.06	-0.06	-0.44	0.31	0.02	-0.38	0.43
Story: CC vs PLTN	-0.58**	-0.92	-0.24	-0.3	-0.66	0.05	-0.04	-0.42	0.35
Type: TRADITIONAL vs QUESTION	-0.43*	-0.75	-0.1	-0.29	-0.63	0.05	-0.25	-0.61	0.12
Type: TRADITIONAL vs FORWARD	0.16	-0.18	0.5	0.48**	0.13	0.84	0.11	-0.27	0.49
Millennial vs. Older Generations	-0.31	-0.64	0.01	-0.01	-0.35	0.33	0.14	-0.22	0.51
Black	0.12	-0.02	0.26	-0.03	-0.17	0.11	0.24**	0.09	0.4
Latinx	-0.04	-0.22	0.13	0.06	-0.13	0.24	0.05	-0.14	0.25
Female vs. Male	0.01	-0.1	0.12	0.06	-0.06	0.18	0.09	-0.03	0.22
Democrat vs. Republican	-1.05***	-1.31	-0.8	-1.25***	-1.52	-0.99	-0.32*	-0.6	-0.03
Democrat vs. Other	-0.56***	-0.8	-0.32	-0.73***	-0.97	-0.48	0.07	-0.2	0.34
Science Curiosity	0.21*	0.04	0.38	0.16	-0.01	0.34	0.47***	0.28	0.66
Story (CC vs EQKE) × Type (TRAD vs QUE)	0.46	-0.02	0.93	0.1	-0.39	0.59	0.34	-0.19	0.87
Story (CC vs PLTN) × Type (TRAD vs QUE)	0.56*	0.1	1.02	0.39	-0.08	0.87	0.14	-0.38	0.66
Story (CC vs EQKE) × Type (TRAD vs FORW)	-0.2	-0.67	0.28	-0.50*	-0.99	-0.01	-0.28	-0.81	0.25
Story (CC vs PLTN) × Type (TRAD vs FORW)	-0.02	-0.49	0.45	-0.33	-0.82	0.16	-0.08	-0.61	0.44
Story (CC vs EQKE) × Generation	0.05	-0.41	0.52	-0.15	-0.63	0.34	-0.44	-0.96	0.08
Story (CC vs PLTN) × Generation	0.39	-0.07	0.85	0.24	-0.24	0.73	-0.18	-0.7	0.34
Type (TRAD vs QUE) × Generation	0.53*	0.07	1	0.42	-0.06	0.9	-0.12	-0.64	0.4
Type (TRAD vs FORW) × Generation	-0.17	-0.64	0.3	-0.43	-0.91	0.06	-0.31	-0.84	0.21
Story (CC vs EQKE) × (DEM vs REPUB)	0.96***	0.61	1.31	1.07***	0.7	1.43	0.55**	0.16	0.94
Story (CC vs PLTN) × (DEM vs REPUB)	0.49**	0.16	0.82	0.59**	0.25	0.94	0.28	-0.09	0.66
Story (CC vs EQKE) × (DEM vs OTHER)	0.36*	0.02	0.7	0.59**	0.24	0.94	-0.06	-0.44	0.32
Story: CC vs PLTN × DEM vs OTHER	0.21	-0.16	0.57	0.18	-0.19	0.56	-0.13	-0.54	0.28
Type: TRAD vs QUE × Science Curiosity	-0.01	-0.15	0.13	0.05	-0.1	0.2	-0.12	-0.28	0.04
Type: TRAD vs FORW × Science Curiosity	-0.04	-0.19	0.11	-0.03	-0.19	0.12	-0.02	-0.18	0.15
Black × Science Curiosity	-0.02	-0.16	0.12	-0.08	-0.23	0.07	-0.09	-0.25	0.07
Female × Science Curiosity	0.04	-0.08	0.16	-0.01	-0.13	0.12	0.01	-0.12	0.15
Millennial × Science Curiosity	-0.06	-0.18	0.06	-0.03	-0.16	0.1	-0.05	-0.19	0.09
DEM vs REPUB × Science Curiosity	0.11	-0.04	0.27	0.09	-0.07	0.26	-0.01	-0.18	0.17
DEM vs OTHER × Science Curiosity	0.11	-0.04	0.26	0.04	-0.11	0.19	-0.03	-0.2	0.13
Story (CC vs EQ) × Type (T vs Q) × Generation	-0.63	-1.29	0.02	-0.41	-1.1	0.27	-0.07	-0.81	0.67
Story (CC vs PN) × Type (T vs Q) × Generation	-0.85*	-1.51	-0.19	-0.6	-1.29	0.08	0.36	-0.38	1.1
Story (CC vs EQ) × Type (T vs F) × Generation	0.37	-0.29	1.03	0.54	-0.14	1.22	0.48	-0.26	1.22
Story (CC vs PN) × Type (T vs F) × Generation	-0.15	-0.81	0.51	0.07	-0.61	0.76	0.42	-0.32	1.16

Note: *** $p < .001$, ** $p < .01$, * $p < .05$.

between stories was largest when the headlines were formatted in the traditional way. For these older participants, the climate change story was seen as much more credible when using a traditional, summary headline than when using a question-based one (see Figure 2).

Evaluating the Expected Credibility of the Story

We measured participants' expectation of story credibility in two ways. First, we looked at whether they categorized the story as "real news." Then, we looked at their expectations for the story's credibility based on the headline. It is important to highlight that

participants did not see the full story; these ratings were based on the headline only. After all, researchers have found that article impressions are often formed from the headline only (Ecker et al. 2014), and one study found that about 60% of shared URLs on Twitter, for example, were not opened by the user before sharing (Gabelkov et al. 2016). Therefore, expectations of a story based on the headline are important to understand.

Story Categorization

Based on the headline, did participants think the story was real news, fake news, satire, or something else? Collapsed across headline format, most participants (76%) categorized the story they saw as “real news.” A logistic regression found a significant effect of headline format: participants were more likely to categorize a story as real news if they saw the forward-referencing headline than if they saw the traditional or the question-based headline (see Figure 3). In addition, there was an interaction effect of story topic by political party. Although Democrats were more likely than Republicans to categorize each of the stories as real news (supporting Hypothesis 2b), the difference was most drastic for the climate change story (supporting Hypothesis 3b, see Figure 4).

Expectations of Story Credibility

We also looked at whether the headline format influenced participants’ ratings of how credible they expected the story to be based on the headline. As with ratings of headline

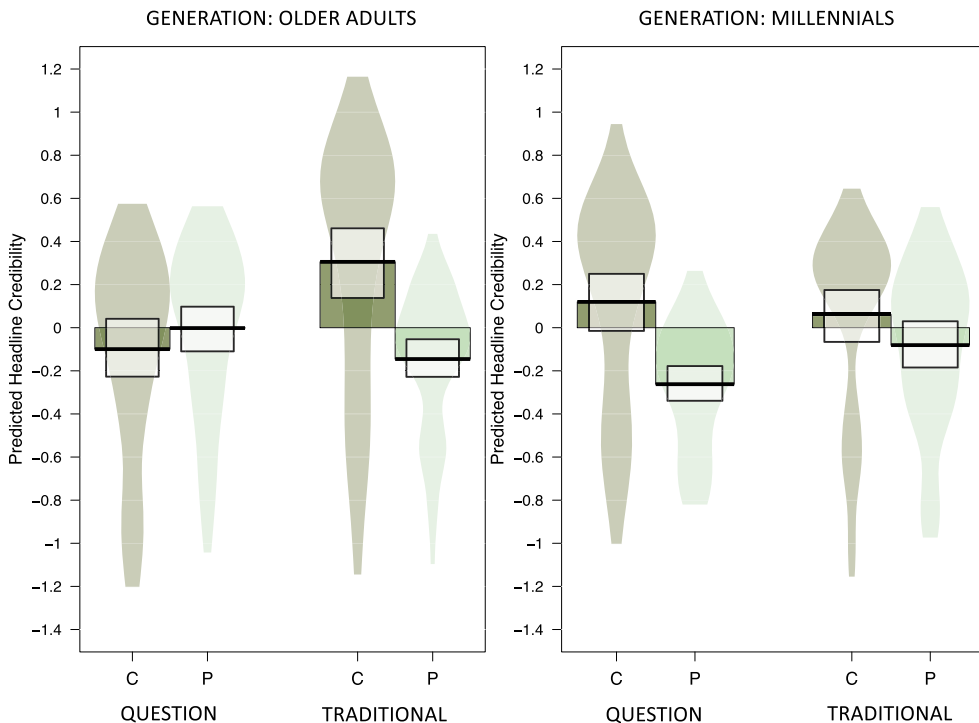


Figure 2. Three-way interaction effect between story (C: climate change vs P: pollution), headline format (Q: question vs. T: traditional), and generation (Millennial vs. Older adults). The earthquakes story and the forward-referencing headline conditions were removed to simplify the image.

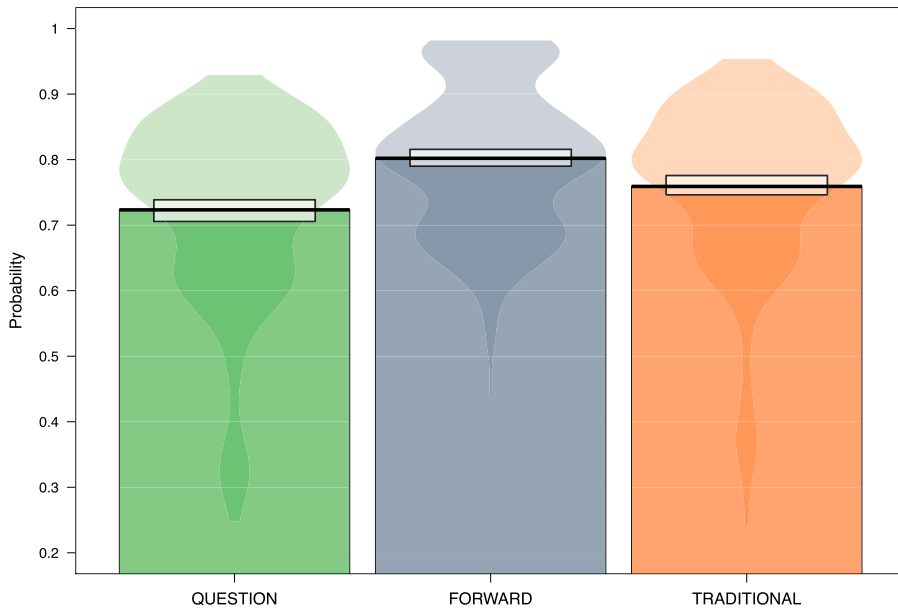


Figure 3. Predicted probability of categorizing the stories as real news (as opposed to fake news, satire, or other) based on the format of the headline averaged across other variables. Black bar represents the mean, and the white boxes are Bayesian highest density intervals.

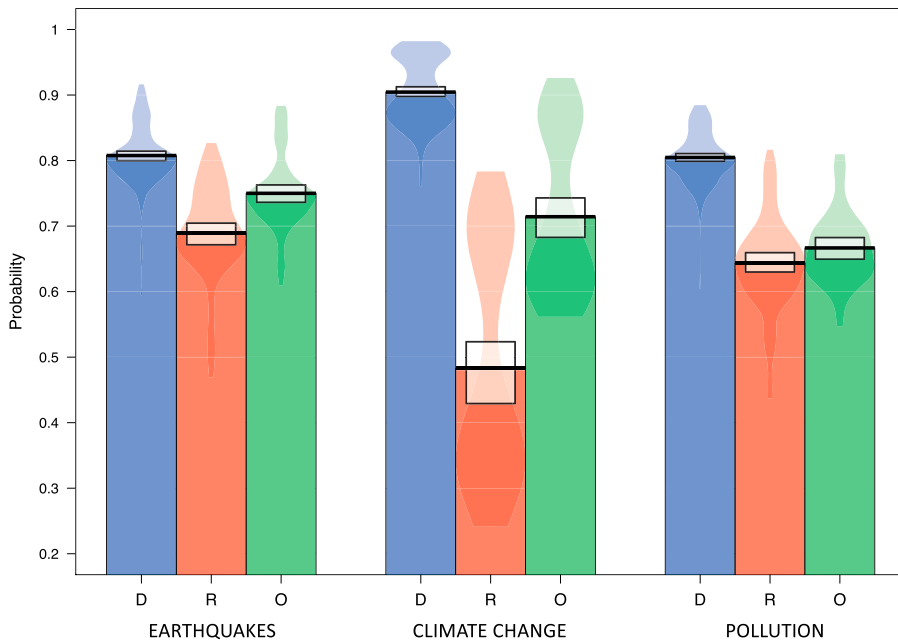


Figure 4. Interaction effect between story topic and political party affiliation. Democrats (D) were more likely than Republicans (R), generally, to categorize a story as real news. However, the difference was most drastic for the climate change story.

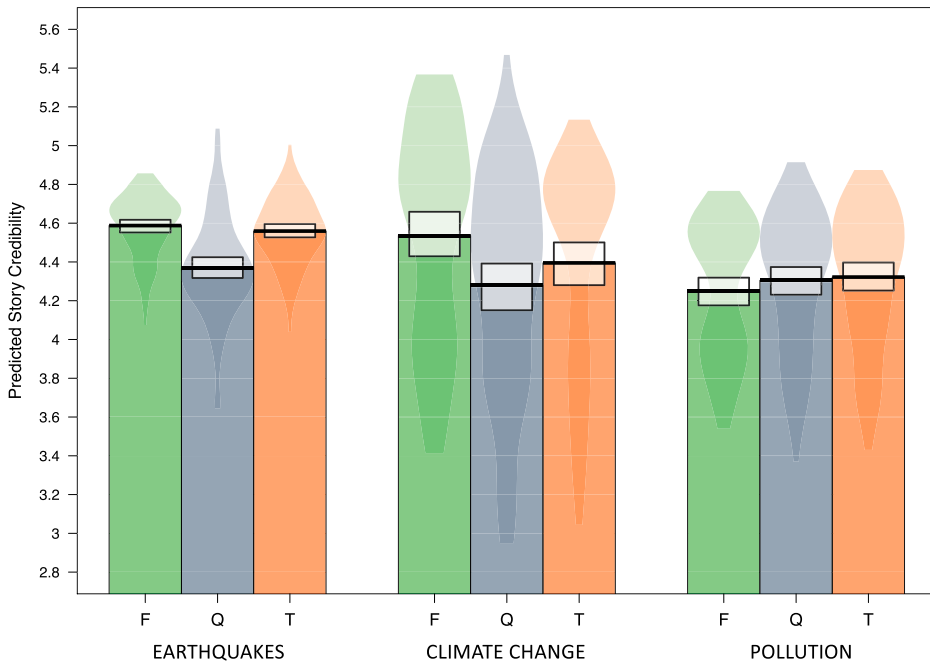


Figure 5. Story topic by headline format interaction. Whereas traditionally-formatted headlines are rated similarly as forward-referencing headlines for the earthquake and pollution stories, they are seen as slightly different (with forward-referencing headlines leading participants to expect a story to be more credible) for the climate change story.

credibility, we conducted a regression analysis (see Table 2). There was a significant effect of headline format, $F(2, 839) = 5.27, p = .005$, when controlling for other variables in the model (supporting Hypothesis 1b). There was also a headline format by story topic interaction, $F(4, 839) = 2.70, p = .030$. This effect appears to be primarily driven by participants rating stories with a forward-referencing headline as more credible than stories with a question-based headline. However, the difference between the forward-referencing headline and the traditionally-formatted headline was greater for the climate change story than this difference was for the earthquake story (see Figure 5).

Just as higher science curiosity predicts perceiving the headlines as more credible, higher science curiosity also predicts greater expectations for a story to be credible, regardless of the story topic and headline format, $F(1, 839) = 11.31, p = .001$ (supporting Hypothesis 4b). We also found a political party by story topic interaction (supporting Hypothesis 3b), $F(4, 839) = 9.27, p < .001$, in which the difference in expected story credibility between the climate change story and the other two stories was greater for Republicans than for Democrats: Republicans expected the climate change story to be less credible than the pollution and earthquake stories, whereas Democrats expected the climate change story to be more credible than the pollution and earthquake stories (see Figure 6).

Hypothetical Engagement with Story

Lastly, we asked whether headline format influences the extent to which participants anticipate engaging with a story. See Table 2. For this variable, we did not find any

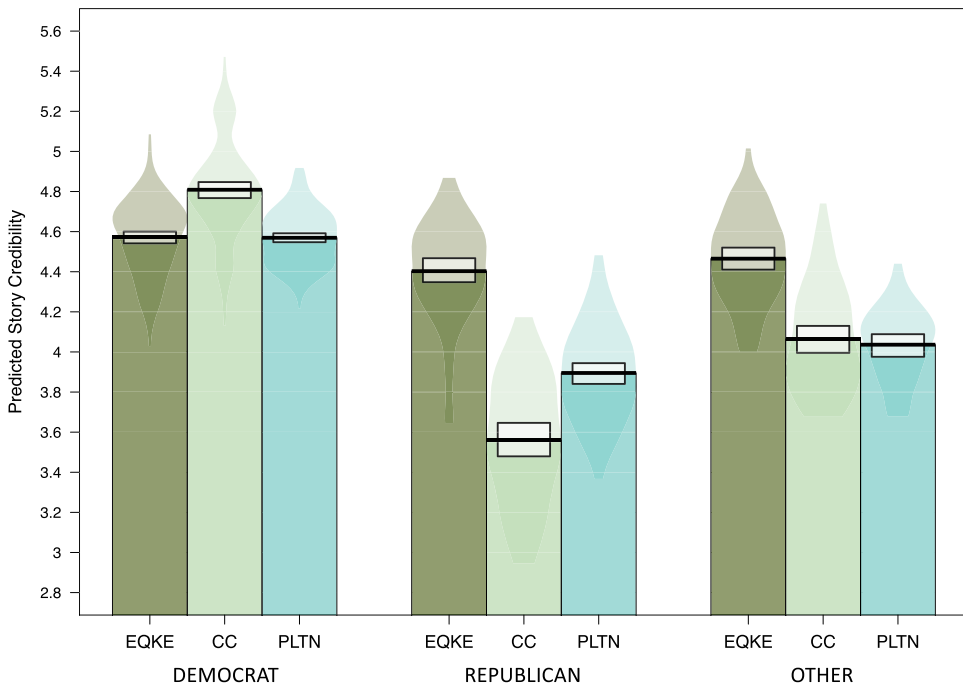


Figure 6. Story topic by political party affiliation interaction. This interaction effect is likely driven by the differences in views about climate change from the different political parties.

effects of headline format. Like with our behavioral measure (asking participants which story they preferred to read first), we found a strong effect of science curiosity, $F(1, 866) = 38.21, p < .001$ (supporting Hypothesis 4a). Participants with greater science curiosity had greater engagement scores ($b = 0.47$). In addition, people who identify as Black or African American had lower engagement scores ($M = -0.05, SD = 0.41$) than people who do not identify this way ($M = 0.17, SD = 0.36$), $F(1, 866) = 9.61, p = .002$.

Discussion

In our collaboration with science media professionals, we learned that they are very interested to know more about how to optimize headlines to increase audience engagement. These professionals, like those from many other media enterprises, frequently rely on market research techniques such as A/B testing (a method of releasing two versions of a headline simultaneously and comparing them on the engagement metrics reported by the various platforms used) to try to determine what headline strategies will most likely increase engagement with different populations, or which features of headlines might be off-putting to certain demographics (Moses 2014). Indeed, at least when it comes to social media, media consumers often make decisions about whether to click on stories based only on the headline (and sometimes an accompanying image). Therefore, it is surprising that more theoretically-based research on headline strategies, which could greatly inform journalism practice, is not present in the science and environmental communication literature.

One reason for this gap in the literature may be that researchers find little to no differences in engagement based on the headline formats used (e.g., Scacco and Muddiman 2016, 2019). In our experiment, we compared three headline formats (forward-referencing, question-based, and traditional) across three environmental story topics (earthquakes, air pollution, and climate change).

Key Findings

This study has several key findings.

On Engagement

First, headline format did not improve or reduce the probability of choosing to read the environmental article (over the other topics: entertainment, business, and sports). Instead, the probability of selecting the environmental article was influenced by readers' science curiosity, gender, generation, race, and political affiliation. Being female, white, and voting Democrat were associated with choosing the environmental article, as was being a part of the older group of participants (people who were older than millennials). Second, headline format similarly did not influence hypothetical engagement. Instead, hypothetical engagement was predicted by science curiosity, race, and voting Democrat versus Republican. Thus, we find no evidence that using click-bait (or curiosity) style headlines increases (or decreases) engagement.

On Credibility

Whereas headline format didn't appear to influence engagement, it did appear to influence perceptions of credibility. Our third key finding is that question-based headlines were perceived as being less credible than traditional, summary headlines. However question-based headlines did not appear to influence participants' expectations of the actual story's credibility. In contrast, forward-referencing headlines were not less credible than traditional, summary headlines, though they were associated with expectations that the story would be more credible. This is a surprising finding as we expected that the click-bait style headlines would lead to perceptions of lower credibility. It's important to note, however, that the differences in rating expectations of story credibility between the three headline types are extremely small. A simple effects test finds no significant difference between the groups ($M_{\text{Que}} = 4.32$ of 6, $SD = 0.95$; $M_{\text{FOR}} = 4.46$, $SD = 0.86$; $M_{\text{TRAD}} = 4.42$. $SD = 0.99$), $F(2, 874) = 1.77$, $p = .171$. These differences in credibility ratings exist only after having controlled for the effects of other individual differences variables and for the differences associated with the story topic. Supporting this finding, however, was the result from the story categorization question: participants were more likely to categorize a story as "real" news if it had a forward referencing headline compared to a traditional or question-based headline. Again, though, these differences were small. The predicted probability of categorizing the forward-referencing article as real news was .80 compared to .76 when it was a traditional, summary headline and .73 when it was a question-based one.

Limitations

As with most studies, ours has limitations. First of all, we used only one example headline for each topic and the pollution headline was unique in that it included a metaphor, calling pollution the “new tobacco.” As we stated in the results section, this specific metaphor may have been particularly off-putting. Future studies should seek to use multiple headline examples for each topic and aim to control for other conspicuous features of individual headlines, as much as is possible.

Second, we asked participants whether they would categorize the story as real news, fake news, satire, or other, with an option to specify. Although we provided participants with definitions for each of the terms we used, our provided options may have been too strict. In Nielsen and Graves (2017) report, the authors describe more categories such as poor journalism (superficial, inaccurate, sensationalist), propaganda (hyperpartisan content, extreme spin), advertising, and false news (for-profit fabrication, malicious hoaxes). In our study, of the 27 participants who chose “other” and specified how they would categorize the story, four said clickbait, five called it speculative, and five called it sensationalized or greatly exaggerated. Future research could either ask for open ended responses and code them or use a broader range of categories and keep them all in the analysis.

Lastly, to measure differences in engagement, we created an index using factor scores from an item response theory analysis. This latent variable of “engagement” which ranged from scores of -0.89 to $+3.59$, is more difficult to interpret and apply to real world situations than the number of likes, shares, and comments. Furthermore, use of the index obscures any potential effects based on specific metric (likes vs. shares vs. comments). Although our public media partners similarly create an index by combining different metrics to try to get a bigger picture of what editorial decisions appear to be “working,” analyzing data in this way may make the results feel less meaningful.

Differences from Prior Work

It is worth noting that our findings regarding the perceived credibility of forward-referencing headlines appear to differ from Scacco and Muddiman (2019). In their study, the authors measured whether participants felt the headline provided adequate information and whether the article would likely provide adequate information, asking whether the article was informative or uninformative and whether it was clear or confusing (using two semantic differential scale items). Linear regression models suggested that compared to the traditional, summary headline, the forward-referencing headline was expected to have less information adequacy (significant effect), but the article was not necessarily expected to have less information adequacy (marginal effect). In the report version of their study (Scacco and Muddiman 2016), however, Scacco and Muddiman found no differences between traditional headlines and forward-referencing headlines, though they did find negative outcomes for question-based headlines. As with our study, in the report, Scacco and Muddiman described using seven of the same semantic differential items that we used, asking participants whether they expect the article to be uncivil/civil, untrustworthy/trustworthy, partisan/nonpartisan, uninformative/informative, boring/entertaining, inappropriate/appropriate, and confusing/clear. It seems highly

likely that any differences between our study and Scacco and Muddiman (2019) can likely be accounted for by (a) the published manuscript's focus on items only measuring information adequacy and (b) the difference in topic (they focused on political issues such as immigration, the economy, and Congress, whereas we focused on three issues related to environmental news).

In contrast to the findings for credibility, we replicated the findings from prior work which found no significant difference in engagement between summary and forward-referencing headlines. However, whereas we did not find difference in engagement between question-based headlines and traditional summary headlines, Scacco and Muddiman did; and the effect of question-based headlines is significant both for the published manuscript (Scacco and Muddiman 2019) and for the online report (Scacco and Muddiman 2016). It is possible that differences between our study and Scacco and Muddiman (2019) can be explained by different methods of measuring engagement. In our study, we asked participants whether they would share the article, read the article, comment on the article, or ignore the article, and they could check all that apply. Then we combined these items using a 2PL item response theory analysis. In Scacco and Muddiman (2019), the authors asked six Likert-type items assessing how likely participants were to (a) like or favorite an article, share or tweet the article, leave a comment in the comments section, talk to someone about the article, or pay a small fee for the article. This broader conceptualization of engagement may capture differences our check list did not—at least for question-based headlines.

Although we did not find differences in engagement between the three headline formats that we used, it is good to remember that the absence of evidence is not always evidence of absence. It may be that the formats of headlines we tested do not vary the most critical features for influencing engagement with environmental news stories. Other features of headlines such as the formality of language, the tone, or the use of metaphor may be more influential (Bonyadi and Samuel 2013; Smith and Petty 1996) and are worthy of further investigation.

Conclusion

Even when little to no differences are found between headline formats, it is still important to continue to study and publish findings on this topic. These results (or lack thereof) might both inform future research choices and debunk journalistic practices that are based on what seems intuitively correct. Here is an example. Work which this research cited on science curiosity (e.g., Kahan et al. 2017; Landrum et al. 2016; Motta et al. 2019) has shined a light on the possible benefit of sparking curiosity among audiences (as opposed to highlighting conflict, for instance) for increasing interest and engagement. The most intuitive method for sparking curiosity may be to frame headlines as questions to highlight missing information (Loewenstein 1994). Studies with children, for example, find that asking pointed questions (as opposed to stating pertinent information) increases exploratory behavior (e.g., Yu et al. 2019). Applied to adults, we may intuit that asking leading questions would spark curiosity and increase engagement with news stories. Although science curiosity did predict engagement in our study, participants generally (and millennials in particular) perceived question-based headlines as less credible and were less likely to categorize these stories as real news than they were the other headline

types. Thus, the intuitive method of sparking curiosity via asking questions to increase engagement could result, instead, in loss of credibility, which is something that the news media, and environmental news in particular, cannot afford to lose.

Notes

1. Even as the purpose of headlines have shifted from summarizing to attention attracting over time, incorporating sensationalism in journalism is nothing new. The pejorative term “yellow journalism,” for example, first appeared in the late 1890s in response to William Randolph Hearst’s and Joseph Pulitzer’s use of sensationalism (Kaplan 2008).
2. Individuals who reported being between the ages of 20 and 23 ($n = 26$) were also included with the millennial sample.

Acknowledgements

We would like to thank our grant project collaborators, Sue Ellen McCann, Sevda Eris, and Dan Kahan for their help and support. We would also like to thank the science news team at KQED for their input on which headlines we used in this study.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the National Science Foundation under Grant DRL181099 awarded to S. E. McCann, S. Eris (KQED) and A. R. Landrum (Texas Tech).

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