6 Sensitivity to Inaccurate Argumentation in Health News Articles: Potential Contributions of Readers' Topic and Epistemic Beliefs

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What are the health benefits of daily exercise? Would a vaccination reduce the likelihood that I get the flu this season? Are there health risks associated with cell phone use? In our day-to-day lives, we have frequent concerns about health topics that can drive us to seek out relevant, high-quality information. The development of the Internet has made it possible to rapidly and easily acquire a wealth of information about such health topics, affording opportunities to increase the depth and breadth of our understandings. However, the Internet brings about an unbridled access to information, where virtually anyone can publish without adherence to verification standards. Health articles on the Internet often present "arguments," in the sense that the text's author makes assertions about the world and provides support for his or her assertions. There are increasing concerns about the kinds of arguments individuals might come across when reading health information for which they have little prior knowledge upon which to draw (Adelhard & Obst, 1999; Andreassen & Strømsø, 2012; Cline & Haynes, 2001; Fox, 2006; Freeman & Spyridakis, 2004). As such, perhaps now more than ever, given the ubiquity and easy access of the Internet, readers must be able to carefully evaluate the accuracy of the arguments they read to differentiate those that seem tenable from those that are not.

At the same time, features of the information sources themselves can be informative regarding message quality and credibility. Readers could opt to critically scrutinize the sources proposing arguments to decide on credibility (e.g., Who wrote this argument? Where was it published? Do they have a particular agenda in distributing this argument?). Although a source may draw an inaccurate conclusion simply based on naïveté (e.g., imprecision in language use, low knowledge on the criteria one needs to establish causation), the source might also have a purposeful, calculated agenda in providing an incorrect proposal. For example, an author might argue that cell phone use causes brain tumors to seek solace for a loved one's recent affliction.

Examples like these highlight that readers should critically evaluate both the conclusions that authors draw (are they warranted based on the empirical evidence?), and the available source features (does the author seem knowledgeable?). If readers uncritically

accept faulty arguments they come across and change their behavior accordingly, there could be consequences for their health and well-being. In this chapter, we investigate the ways in which college students' preexisting beliefs relate to their memory for simple scientific arguments found in health news articles and the sources presenting them. What we intend to demonstrate is that readers will use their preexisting beliefs to help determine whether an author has made unwarranted conclusions given the available evidence, which will, in turn, relate to a reader's memory for inaccurate arguments and their information sources.

By way of an introduction to our specific research questions, we briefly review four separate but related research literatures. These include (1) argumentation, (2) the role of source information in text comprehension, (3) the relationships between reading texts on controversial scientific topics and topic-specific beliefs, and (4) the relationships between reading texts on controversial scientific topics and beliefs concerning the ways one can justify knowledge claims in science. The overarching goal in presenting these literatures is to provide clearer specifications of the ways that reader beliefs might relate to memory for popular press scientific reports, with a specific focus on belief–memory relationships when sources present inaccurate versus accurate arguments.

Argumentation

Argumentation concerns identifying and weighing positive and negative attributes of conflicting perspectives on a particular topic or issue, as well as considering relevant reasons and evidence for the different perspectives when making decisions (Kuhn & Crowell, 2011). Argumentation may refer to both the process of creating an argument and the resulting product, as well as to the process of considering arguments for the purpose of understanding a phenomenon (Nussbaum, Sinatra, & Poliquin, 2008). In its basic form, an argument consists of a main claim that takes a stance on a controversial issue (e.g., whether living close to power lines may increase the risk of contracting cancer), with at least one reason or piece of evidence provided as support for the claim (Toulmin, 1958). Claims can be supported by a mechanistic explanation that make it clear how the claim could be true (e.g., "Power lines create electromagnetic fields, and electromagnetic fields disturb normal cell development") or by *evidence* serving as proof that testifies to the accuracy of the claim (e.g., "People living in houses near electromagnetic fields have a higher incidence of developing cancer") (Kuhn, 2001).

While a reasonable explanation and evidential proof may both be used as legitimate support for a claim, research indicates that generating and understanding evidence may be more difficult than generating and understanding reasons for a claim (Glassner, Weinstock, & Neuman, 2005; Kuhn, 1991). Evidential support for a claim is particularly emphasized within the disciplinary epistemology of science (Kuhn, 1993) and is, thus, essential to consider when reading about science issues both in formal

and informal contexts. While formal conditions include the practices of scientists and students of science, informal experiences include everyday situations in which people have to make rational judgments about social-scientific issues, such as whether to restrict their cell phone use (Kuhn, 1991; Shtulman, 2013; Yang & Tsai, 2010). Science education researchers have also highlighted the challenges of processing popular reports of science, especially when they deal with controversial scientific issues (Linn & Eylon, 2006; Yang & Tsai, 2010). For example, Norris and colleagues (Norris, Phillips, & Korpan, 2003; Phillips & Norris, 1999) have shown that both high school and university students may read media reports about scientific topics uncritically, readily accepting the claims without thoroughly analyzing the degree to which the evidence provided supports the claim.

A less thorough analysis of arguments is especially problematic given that popular reports of science often contain claims that are poorly coordinated with the evidence provided. That is, readers seeking relevant health information may come across arguments that, at times, overstate findings—for example, providing weak evidence accompanied by a strong claim—perhaps to persuade the reader toward their stance. In other instances, popular media reports offer a more guarded approach, understating the findings by presenting strong evidence in support of a weak claim, possibly to take the sting out of a stance with which the journalist disagrees. Such lack of coordination between claim and evidence creates conditions for inaccurate argumentation, in contrast to the accurate argumentation that occurs when the strength of the claim and the type of evidence are aligned (Kuhn, 1991).

Source Information

At the core of most theories of text comprehension is a basic assumption that readers strive to maintain globally coherent representations of the information they read (for a review, see McNamara & Magliano, 2009). Inference generation serves as one—and perhaps the most frequently applied—way to maintain coherence during reading (Blanc, Kendeou, van den Broek, & Brouillet, 2008; Hakala & O'Brien, 1995; Graesser, Singer, & Trabasso, 1994; van den Broek, Lorch, Linderholm, & Gustafson, 2001; Wiley & Myers, 2003). However, some comprehension difficulties are simply unresolvable via inferential processing.

Several researchers have highlighted the functionality of the information sources themselves in (re)establishing coherence in both single and multiple document reading contexts (Braasch, Rouet, Vibert, & Britt, 2012; Britt & Rouet, 2012; Macedo-Rouet, Braasch, Britt, & Rouet, 2013; Strømsø, Bråten, Britt, & Ferguson, 2013). That is, rather than generating inferences to reduce comprehension difficulties at the level of the content information, readers may incorporate source–content links into their mental representations of what was read. Doing so helps to define contradictory information

as representing different perspectives rather than a break in coherence per se, thus serving as a means of reducing any unwanted confusion (Bråten, Britt, Strømsø, & Rouet, 2011; Perfetti, Rouet, & Britt, 1999). Several recent think-aloud studies have demonstrated that, indeed, spontaneous sourcing responses often emerge from experienced comprehension difficulties (Anmarkrud, Bråten, & Strømsø, in press; Goldman, Braasch, Wiley, Graesser, & Brodowinska, 2012; Strømsø et al., 2013), which were, in turn, related to more integrated understandings of multiple documents. In related single text comprehension research, Braasch et al. (2012) experimentally manipulated the presence or absence of contradictory claims between two authors. The findings showed that, when two sources contradicted one another in news reports, readers attended to and recalled them better than when the sources agreed. Much like with multiple documents, readers appeared to index the discrepant claims onto the respective sources as a way to structure their memory of the text, thereby resolving discrepancy-induced comprehension difficulties.

For the single and multiple text examples outlined above, the oppositional nature of the claims dictates that at least one must be inaccurate. That is, cell phone use cannot *be unrelated to* and at the same time *cause* brain tumors. In the current chapter, we extend these investigations to consider whether comprehension problems stemming from other kinds of textual inaccuracies also stimulate a greater attention to and memory for source feature information. In the same vein, readers might experience comprehension difficulties that raise their awareness of the need to more closely consider the available source information as a way to maintain a coherent mental representation of the text. It is a main assumption in the current work that students' memory for the content may differ when they read inaccurate arguments versus accurate arguments about controversial scientific topics. More specifically, student beliefs may play a larger role in the former condition.

As we clarify in the next two sections, we examined students' beliefs about the topic of the texts and their epistemic beliefs concerning the justification of knowledge claims in science. When encountering inaccurate arguments, stronger beliefs about the topic in question may make it important for readers to turn to source information for support. Furthermore, justification-for-knowing beliefs may become functional to a greater extent to compensate for the lack of convincing arguments.

Topic Beliefs

Topic beliefs reflect what individuals accept as or want to be true about a particular topic. They may, more or less consciously, prime or guide particular reading goals, processing activities, and the understandings that are ultimately derived from reading experiences (Bråten, Ferguson, Strømsø, & Anmarkrud, 2013; Murphy & Mason, 2006). Thus, when people read about controversial issues or topics, the strength of their topic beliefs prior to reading (e.g., how strongly they believe prior to reading that radiation

from cell phones causes brain tumors) may guide their processing and postreading text memory. In demonstratively seminal work by Lord, Ross, and Lepper (1979), people read and evaluated conflicting research evidence regarding the efficacy of capital punishment as a criminal deterrent. Participants who held strong initial beliefs on the topic, regardless of whether they believed capital punishment does or does not deter crime, evaluated evidence that supported their views as more convincing and substantiating than they did conflicting evidence. Reading conflicting evidence also actually strengthened their initial views on the topic. Kardash and Scholes (1996) investigated the degree to which people's preexisting beliefs about the HIV–AIDS relationship was reflected in the written conclusions that they produced after reading a text presenting arguments for different positions on the topic (HIV is the sole cause of AIDS vs. HIV does not cause AIDS). Results showed that the stronger the preexisting beliefs that students held about this topic, the more certain conclusions the students wrote from the inconclusive text favoring their own initial beliefs. In the same vein, Murphy and Alexander (2004) found that students reading single texts—each presenting arguments as well as counterarguments for a particular position—strengthened their own preexisting beliefs about the topic discussed in the text. Finally, Kahan et al. (2012) showed that people's perceptions of risks related to climate change were not dependent on their science literacy or their technical reasoning capacities (i.e., numeracy) but, rather, on their preexisting beliefs and values stemming from their cultural groups.

Thus, evidence indicates that readers frequently use their preexisting topic beliefs to interpret arguments in texts. They appear to place a greater value on belief-compatible arguments compared to belief-incompatible arguments, even when the argument materials are carefully designed to ensure similar believability, strength of evidence, and—of interest for the current work—appropriateness of the conclusions given the available evidence. Regarding this last point, the previous experiments all represent reading situations in which the arguments were "accurate," in the sense that none involved unwarranted claims given the available evidence. Moreover, very few studies included information about the sources presenting the arguments. As alluded to above, source feature information could be an additional cue that helps readers support their preexisting beliefs, especially when the arguments themselves are suboptimally supportive of those beliefs (i.e., inaccurate).

Justification Beliefs

Readers, of course, hold a number of different beliefs with different degrees of endorsements. Above, we posited a potential role concerning beliefs specific to the topic. Several studies suggest that more broadly operative beliefs, such as those stemming from readers' personal epistemologies, also prime or guide reading goals, processing activities, and the understandings that are ultimately derived from reading experiences (Bråten et al., 2011). Research efforts in personal epistemology have focused on individuals'

views and understandings of knowledge and the process of knowing (Hofer & Pintrich, 1997). Recently, Greene, Azevedo, and Torney-Purta (2008) posited that beliefs concerning justifications for knowing are the only beliefs that deserve to be labeled epistemic. They also suggested that justifications for knowing should be a primary research focus and that the construct should be further separated into more than one dimension. This is because individuals can justify knowledge claims using both internal and external sources. In their proposed model, they emphasized two dimensions: *justification based on personal opinion* (internal) and *justification by authority* (external). Justification by personal opinion reflects whether or not readers believe it is appropriate to evaluate knowledge claims in a domain based on personal views and opinions; justification by authority reflects whether or not it is appropriate to evaluate knowledge claims in a domain simply because authoritative sources—teachers, textbooks, and scientists—reported the information. In addition to those two dimensions, Ferguson and colleagues (Ferguson, Bråten, & Strømsø, 2012; Ferguson, Bråten, Strømsø, & Anmarkrud, 2013) recently identified a third dimension, *justification by multiple sources*. This dimension reflects whether or not it is appropriate to evaluate knowledge claims in a domain on the basis of cross-checking, comparing, and corroborating across several sources of information.

Researchers have begun to investigate relationships between preexisting justification-for-knowing beliefs concerning the domain of science and understandings derived from multiple conflicting documents about socioscientific issues. Investigating the three dimensions outlined above, Bråten and colleagues (Bråten, Ferguson, Strømsø, & Anmarkrud, 2013, in press; Bråten, Strømsø, & Samuelstuen, 2008) showed that beliefs in both justification by authority and justification by multiple sources positively predict performance on measures reflecting readers' generation of inferences within and across documents. Beliefs in personal justification were negatively related to the same performance measures.

Thus, evidence supports the assumption that readers use their justification-for-knowing beliefs when interpreting multiple conflicting claims presented across different documents. It is important to note that, in the above-described studies, postreading measures were all completed from memory. As such, performance may reflect the degree to which content information is integrated in readers' mental representations. In the current work, we investigated whether justification beliefs differentially relate to postreading memory performance when students read single texts presenting inaccurate or accurate arguments.

The Present Study

Informed by these theoretical and empirical literatures, we sought to address two research questions. First, to what extent do students' topic beliefs and justification

beliefs predict their memory for the *arguments* presented in the texts? We hypothesized that justification beliefs would be related to argument memory when reading inaccurate arguments, but not when reading accurate arguments, whereas topic beliefs would be unrelated to argument memory in both conditions. When arguments are accurate, the justification of claims, whether weak or strong, can be considered to be inherent in the texts. When the arguments are inaccurate, however, readers might rely more on their preexisting beliefs to help to evaluate the new knowledge claims. For readers who typically appeal to authoritative sources, inaccuracy-induced comprehension difficulties might result. Additional processing of the inaccurate arguments might ultimately result in better memory for them. Readers relying on their personal opinions, however, might dismiss inaccurate arguments outright. Given assumptions of shallow processing, one would expect poorer memory for these dismissive readers. Thus, we expected that beliefs in justification by authority would positively predict memory for inaccurate arguments while beliefs in personal justification would negatively predict them. Given that students did not read multiple conflicting texts on the same issue in the present study, we considered beliefs in justification by multiple sources less relevant in single text contexts and did not entertain any specific hypothesis regarding their relationship with argument or source memory.

We also addressed a second research question: To what extent are students' topic beliefs and justification beliefs related to their memory for *information sources* when reading inaccurate and accurate arguments concerning controversial issues? Given that readers appear to strengthen their preexisting beliefs when reading about controversial issues (Kardash & Scholes, 1996; Lord et al., 1979; Murphy & Alexander, 2004), two potential sources of support for those beliefs are source information (e.g., about the author) and the evidence presented in the texts. When the arguments are insufficient because they are not convincing (i.e., an inaccurate interpretation is made given the evidence), readers holding stronger beliefs about the topic may turn to source information (e.g., a reliable author, a well-respected publication venue) to bolster their initial beliefs whereas individuals reading accurate arguments may have less need for source information. This is because the argument, in and of itself, is sufficient to support their prior topic beliefs. Accordingly, we hypothesized that readers' topic beliefs would positively predict source memory for inaccurate but not accurate arguments whereas justification beliefs would be unrelated to source memory in both conditions.

Method

Participants

One-hundred thirty-three college undergraduate students (49% male, 51% female) with a mean age of 19.5 years (*SD* = 1.69) enrolled in an introductory psychology course at a large midwestern university participated for course credit.[1] Demographic

characteristics reflected a diverse sample of students: 58% Caucasian, 31% African American, 9% Hispanic, and 2% Asian American. Regarding science background, the mean number of high school science classes completed was 2.49 (*SD* = 0.65) and the mean number of college science classes completed or in progress was 0.69 (*SD* = 0.73). There were no significant differences across the argument accuracy manipulation on any of these variables.

Materials

Topic Beliefs Measure Topic beliefs were measured with a list of six health belief statements (sample items: *Radiation from cell phones may cause brain tumors*, *Sunrays may cause skin cancer*, *Electro-magnetic fields released from power lines may cause cancer*), two for each of the three health articles that participants read (see below). Instructions asked participants to rate the extent to which they agreed or disagreed with each statement on a 10-point Likert-type scale with anchors of *strongly disagree* (1) and *strongly agree* (10). Because all items concerned the degree of participants' beliefs that radiation may cause serious illness in humans, we used a composite score based on the average of all six items to assess participants' preexisting beliefs. The Cronbach's alpha reliability for scores on this six-item measure was 0.99.

Justification Beliefs Measures Participants' justification beliefs were measured with the Justification for Knowing Questionnaire (JFK-Q; Bråten et al., 2013; Ferguson et al., 2013). The JFK-Q contains 18 items focusing on three different points of reference: justification by authority (JA), justification by personal opinion (JPO), and justification by multiple sources (JMS). In the current study, all items were targeting the domain of natural science. JA items focus on the reliability of statements or claims based on scientific research and conveyed by teachers, textbooks, and scientists (sample item: *If a scientist says something is a fact, then I believe it*). Higher scores on these items indicate that students believe knowledge claims can be justified by appealing to an authoritative external source or evidence derived from scientific research. JPO items focus on the extent to which students consider it appropriate to evaluate knowledge claims in natural science based on personal views and opinions (sample item: *What is fact in natural science depends on one's personal views*). Higher scores on these items indicate that students believe knowledge claims can be justified by appealing to subjective, internal means of justification. Finally, JMS items focus on cross-checking and corroborating claims across several sources of information (sample item: *To detect incorrect claims in texts about natural science, it is important to check several information sources*). Higher scores on these items represent stronger beliefs in the importance or necessity of justifying knowledge claims in natural science by checking multiple external sources for consistency. Each item was rated on a 10-point Likert scale (anchored 1 = *disagree completely*, 10 = *agree completely*).

We factor-analyzed participants' scores on the JFK-Q using maximum likelihood exploratory factor analysis with oblique rotation. This analysis resulted in three factors with high loadings (> 0.45) and no overlap for any item. The three factors had eigenvalues of 3.35, 2.35, and 1.55, respectively, and explained 60.5% of the total sample variation. In accordance with the conceptualization underlying the JFK-Q, a first factor included five JA items, a second factor included two JPO items, and a third factor included four JMS items. We used three composite justification belief measures based on this factor analysis in subsequent statistical analyses. The reliability estimates (Cronbach's alpha) for the JA, JPO, and JMS scores were 0.87, 0.62, and 0.73, respectively.

Health Articles We developed three short health articles (approximately 200 words each) that all focused on radiation as a potential contributor to cancer. The articles discussed everyday contexts of cell phone usage, exposure to the sun's rays, and proximity to electromagnetic radiation released from power lines. We constructed four different versions of each article by manipulating claim strength and type of evidence (see table 6.1 for an example). Thus, in one version, a strong claim was combined with experimental evidence, which resulted in an accurate argument. In another version, a weak claim was combined with correlational evidence, also resulting in an accurate argument. The two versions containing inaccurate arguments involved mismatches between the strength of the claim and the type of evidence. In these conditions, a strong claim was combined with correlational evidence or a weak claim was combined with experimental evidence.

For all versions of each article, the title (e.g., "Cell Phones and Cancer") was followed by source information including the author's name, occupation, place of work or affiliation, the magazine venue that published the article, and the year of publication (e.g., "By Dr. Bradford Franks, Neurosurgeon at the University of Memphis, Tennessee. Published in Newsweek Magazine, Week 26, 2011"). A seven-to-eight-sentence research report with a standard structure followed. Three sentences introduced the topic, which were also held constant across the four versions. The remainder of table 6.1 demonstrates the manipulation of claim strength and type of evidence. Whereas strong claims used causal language with definitive qualifiers, weak claims used correlational language with probabilistic hedges. That is, claim strength was manipulated by varying the predicates (e.g., *causes* vs. *is linked to*) and the hedges (e.g., *clearly demonstrated* vs. *likely suggests*) together. Type of evidence was manipulated in the three sentences that followed the main claim. The first sentence reported on participant assignment (the experimental cases reported random assignment; the correlational cases reported preexisting groups). The second sentence included an interpretation statement of the method for participant assignment, as our sample had not had a course in research methods prior to participation in the experiment. The third sentence provided the results of the study. A final sentence of the article restated the main claim. The structure and manipulation of claim strength and type of evidence were the same for all three articles.

Table 6.1
Example stimulus demonstrating manipulation of claim strength (strong, weak) and type of evidence (causal, correlational)

Title: Cell Phones and Cancer **By Dr. Bradford Franks, Neurosurgeon at the University of Memphis, Tennessee.** **Published in Newsweek Magazine, Week 26, 2011**		
Introduction	The rise in technology has led to greater cell phone use, but that doesn't come without concerns about potential risks associated with using them. When a cell phone is being used, it creates a radiofrequency (RF) current that is used to stay connected with the network. The RF levels vary from phone to phone; many have high levels, while a smaller set of phones have low levels.	
	Strong Claim	**Weak Claim**
Claim statement	My research has **clearly demonstrated** that cell phone use **causes** brain tumors.	My research **likely suggests** that cell phone use **is linked to** brain tumors.
	Causal Evidence	**Correlational Evidence**
Participant assignment	In this study, I **randomly assigned 30 people to use** high RF-emitting phones, while 30 were given low RF-emitting phones to use.	In this study I **interviewed 60 patients with brain tumors**.
Interpretation statement	Random assignment is a gold standard for experiments, because **it rules out alternative explanations.**	This procedure **does not allow us to rule out alternative explanations.**
Result statement	The results showed that 90% of the people in the high RF-emitting phone group reported the presence of brain tumors after 5 years, while only 20% in the low RF-emitting phone group reported brain tumors.	The results showed that 90% of these cancer patients had been using high RF-emitting cell phones for the past 5 years.
	Strong Claim	**Weak Claim**
Claim restatement	**Clearly** my research **demonstrates** that cell phones cause brain tumors.	My research **likely suggests** that cell phone use **is linked to** brain tumors.

Argument Memory Measure After reading the set of articles, participants were prompted to recall each author's main claim and the details of the study described. To measure argument memory, we counted the number of arguments (claim–evidence pairs) that participants correctly recalled from the three articles. Verbatim or close synonyms of the wordings of the article were accepted. Claims were scored as strong if the response used a causal term (e.g., *causes*, *was due to*) and were scored as weak if the response used a predicate that indicated a correlational relationship (e.g., *related*, *is linked to*) or a probable hedge (e.g., *possibly*, *may*). To score evidence statements, participants had to mention something about how conditions were formed or how the study could be interpreted. A response was scored as experimental evidence if the participant

mentioned random assignment or the corresponding interpretive statement (e.g., rules out alternative explanations). A response was scored as correlational evidence if relevant participant assignment (e.g., interviewed, surveyed) or the limits on interpretation (e.g., does not allow ruling out alternative explanations) were mentioned.

Recalls were scored blind to reading condition; accuracy was then determined in relation to the particular version of the articles that were read. Thus, if either the claim strength or the type of evidence recalled did not match those presented in the versions of the articles that were read, argument memory was considered incorrect. Given that participants read three articles each, they could potentially recall three arguments. Two raters independently classified a 20% randomly selected sample of the argument recall protocols. A Cohen's Kappa reliability index of 0.88 was obtained. Disagreements were resolved in discussion, and one rater coded the remaining protocols.

Source Memory Measure Source memory was measured in terms of the number of source features that participants accurately recalled from each of the three articles. Because five source features were presented for each of three articles (i.e., author name, occupation, affiliation, magazine venue, and year of publication), scores on this measure could range from 0 to 15. Author names were considered correct if the student wrote down the author's first, last, or both names. For occupation, verbatim matches (e.g., neurosurgeon) or closely related words (e.g., neuroscientist) were considered correct. For affiliation, responses were considered correct if the student wrote down the city, state, or both. For magazine venue, verbatim matches or closely related titles were accepted, and for year of publication, only the exact year was coded as correct. Two raters independently classified a 20% randomly selected sample of the source recall protocols. A Cohen's Kappa reliability index of 0.90 was obtained. Disagreements were resolved by discussion, and one rater coded the remaining protocols.

Procedure

Participants were randomly assigned to one of four conditions. Two conditions presented health articles containing accurate arguments (i.e., strong claims using experimental evidence as support or weak claims using correlational evidence as support), and two conditions presented health articles containing inaccurate arguments (i.e., strong claims using correlational evidence as support or weak claims using experimental evidence as support). For our analysis, we collapsed the four conditions into two to create an argumentation accuracy variable (accurate vs. inaccurate arguments). Average word length (154.3 vs. 153.2), Flesch–Kincaid grade level (9.8 vs. 9.9), and Flesch reading ease values (57 vs. 56.8) were comparable for articles presented in the accurate and inaccurate argument conditions.

The group-administered experimental session lasted 60 minutes. Participants completed the topic and epistemic beliefs surveys for 10 minutes. Afterwards, they read

the three health articles in their argument condition for 20 minutes. Topic presentation order was counterbalanced; however, participants were instructed that they could read the articles in any order they wished. The instructions asked participants to "read carefully as if you were trying to make a decision about your own behavior. After you are done reading, you will be asked questions about what you read. So it is important that you try to remember what you read in these articles." When the participants had finished reading or time had expired, they performed a 5-minute filler task. Participants were then provided with the source memory test. For each article, participants were provided with the title and the five distinct source feature cues (i.e., author name, occupation, affiliation, magazine venue, and year of publication) and asked to identify as much information as they could for each text. They were allotted 5 minutes to complete this task. The argument memory task immediately followed; participants had 10 minutes to complete this task. For each article, participants were asked to recall the main conclusion and the details of the study. Finally, participants were allotted 10 minutes to complete a demographic and academic background survey.

Results

Table 6.2 presents descriptive statistics (means, standard deviations, and values of skewness and kurtosis) for all variables for all participants. First, we conducted a repeated-measures analysis of variance to check whether there were differences between participants' scores on the three justification beliefs measures. Using the Huynh–Feldt correction due to a violation of the sphericity assumption, results indicated that participants endorsed some of the means of justifying knowledge claims in science more than others, $F(1.89, 249.91) = 88.20$, $p = 0.000$, $\eta_p^2 = 0.40$. Follow-up paired-sample t tests with Bonferroni adjustment showed that participants agreed significantly more

Table 6.2
Descriptive statistics for all participants

	M	*SD*	Skewness	Kurtosis
Topic beliefs	6.58	1.33	–.41	1.89
Justification by authority	5.73	1.90	.05	–.69
Justification by personal opinion	5.04	1.93	.00	–.39
Justification by multiple sources	7.77	1.42	–.44	–.40
Source memory	1.19	1.78	2.04	4.69
Argument memory	.70	.90	1.13	.34

Note. The topic beliefs scale ranged from 0–10 with 10 as *strongly agree*. Justification scales ranged from 0–10 with 10 as *agree completely*. Source memory ranged from 0–15. Argument memory ranged from 0–3.

with the justification by multiple sources statements (M = 7.77, SD = 1.42) than the justification by authority (M = 5.73, SD = 1.90), $t(132) = 10.59$, $p = 0.000$, Cohen's d = 1.23, and the justification by personal opinion statements (M = 5.04, SD = 1.93), $t(132) = 13.26$, $p = 0.000$, Cohen's d = 1.63. Moreover, participants' scores on the measure of justification by authority were significantly higher than their scores on the measure of justification by personal opinion, $t(132) = 2.86$, $p = 0.005$, Cohen's d = 0.36. The participants in this study, thus, seemed to differ from lower- and upper-secondary-school students participating in other studies using the JFK-Q, who have previously been shown to endorse justification by authority most often, followed by justification by multiple sources and justification by personal opinion (Bråten et al., 2013; Strømsø, Bråten, Anmarkrud, & Ferguson, 2012).

There were no statistically significant differences between participants in the accurate and inaccurate argument conditions on any of the justification beliefs measures, $ts(131) < 1.30$, $ps > 0.20$, nor were there differences on the topic beliefs measure, $t(131) = 1.12$, $p = 0.26$. In fact, the only statistically significant difference between the two conditions was observed on the source memory measure, Mann–Whitney U, $Z = -2.87$, $p < 0.01$, $r = -0.25$, indicating that participants in the accurate argument condition tended to recall more source features than did participants in the inaccurate argument condition (see table 6.3 for descriptive information regarding each of the two conditions).

Because the descriptive statistics indicated that the score distribution for source memory was positively skewed, we corrected those scores toward normality by means of standard transformation techniques (Tabachnick & Fidell, 2007) before performing

Table 6.3
Descriptive statistics and Pearson correlations between topic beliefs, justification beliefs, and postreading memory for source features and arguments from health news articles

Variable	1	2	3	4	5	6	*M*	*SD*
1. Topic beliefs	—	–.02	–.06	.08	.23*	–.04	6.46	1.47
2. Authority	.12	—	–.03	.15	.02	.24*	5.81	1.81
3. Personal opinion	.18	–.05	—	–.06	–.15	–.22*	4.83	1.91
4. Multiple sources	.14	.06	.09	—	.20	–.03	7.69	1.36
5. Source memory	.13	.06	–.16	.12	—	–.02	0.79	1.47
6. Argument memory	–.04	.02	–.03	.16	.14	—	0.55	0.82
M	6.72	5.64	5.26	7.85	1.59	0.85		
SD	1.18	2.00	1.94	1.48	1.97	0.97		

Note. Accurate argument readers' correlations are below the diagonal; inaccurate argument readers' correlations are above the diagonal.
*$p < .05$, one-tailed.

correlational and multiple regression analyses to examine our two major research questions. Specifically, we improved the deviation from normality through log transformation, resulting in acceptable skewness (0.79) and kurtosis (–0.55) values for these participants. Please note that the log transformed source memory variable was used for the Pearson correlations computed separately for the two conditions, which are reported in table 6.3. The multiple regression analyses conducted for each condition (see below) also used the log transformed source memory variable. Given our specific directional hypotheses regarding relationships of student beliefs to argument memory and source memory, we conducted one-tailed tests (Levin, 1985; Tabachnick & Fidell, 2007).

Our first research question examined the extent to which students' topic beliefs and justification beliefs related to memory for the inaccurate versus accurate arguments presented in health news articles. We expected that justification beliefs would correlate with argument memory when reading inaccurate arguments, but not when reading accurate arguments, whereas topic beliefs would be unrelated to argument memory in both conditions. As can be seen in table 6.3, for participants reading articles presenting inaccurate arguments, preexisting beliefs about the topic did not correlate with memory for arguments (r = –0.04, *ns*). However, justification of knowledge claims by personal opinion was negatively correlated with memory for arguments, r = –0.22, p = 0.038. Moreover, justification of knowledge claims by appealing to authority showed a positive correlation with memory for inaccurate arguments, r = 0.24, p = 0.027. Justification by multiple sources showed no relationship with argument memory, r = –0.03, *ns*. As a point of contrast, when articles presented accurate arguments, neither the topic beliefs nor any of the justification-for-knowing indices related to memory for arguments embedded within the content of the health news articles. Thus, the more students considered it appropriate to evaluate knowledge claims in natural science based on their personal views and opinions, the more they disregarded inaccurate arguments in the texts (as evidenced by their poorer memory). On the other hand, the more students evaluated knowledge claims in natural science through appeals to authoritative external sources or evidence derived from scientific research, the better their memory for inaccurate arguments. Although process data was not collected in the current study, these memory products may reflect that students holding authority beliefs more "deeply" scrutinized arguments, especially when they involved conclusions that did not match the available evidence.

Our second research question examined the extent to which students' topic beliefs and justification beliefs related to memory for source information after reading inaccurate and accurate arguments. We expected that justification beliefs would correlate with argument memory when reading inaccurate arguments, but not when reading accurate arguments, whereas topic beliefs would be unrelated to argument memory in both conditions. As expected, for participants reading news articles presenting inaccurate

arguments, preexisting beliefs about the topic positively correlated with memory for source features ($r = 0.23$, $p = 0.031$). On the other hand, the same pattern was not present for participants reading news articles presenting accurate arguments: Topic beliefs did not correlate with source memory ($r = 0.13$, *ns*). Thus, the more students believed that environmental factors could lead to health risks associated with radiation, the better they remembered the articles' source features. This was only the case, however, when the content of the argumentation signaled that information sources were presenting unwarranted conclusions based on the supporting evidence (i.e., under- or overstating the findings). This was obtained, importantly, irrespective of the fact that source features were held constant across the text versions.

None of the justification beliefs, in general, related to memory for source features associated with inaccurate or accurate arguments.

Table 6.3 also signifies that, for participants reading either type of argument, there were no relationships between the two indices of memory performance (inaccurate: $r = –0.02$, *ns*; accurate: $r = 0.14$, *ns*). The ratings on topic beliefs and justification beliefs were also unrelated or only weakly related for participants in either reading condition. This suggests that the previously described significant relationships reflect isolable belief contributions to memory for sources and for inaccurate arguments.

To further examine this issue, we conducted two multiple regression analyses for each reading condition, one with argument memory as the dependent variable and another with source memory as the dependent variable. In each analysis, participants' topic beliefs and the three justification beliefs measures were entered simultaneously as predictors. When memory for inaccurate arguments was the dependent variable, the model explained 11% of the variance. For this measure, both justification by personal opinion, $\hat{a} = –0.22$, $p = 0.038$, and justification by authority, $\hat{a} = 0.24$, $p = 0.027$, emerged as unique predictors. The four predictors together explained 10% of the variance in source memory, but only topic beliefs emerged as a unique predictor, $\hat{a} = 0.21$, $p = 0.046$. For participants reading accurate arguments, however, only 3% and 7% of the variance in argument and source memory, respectively, were explained; no variables emerged as unique predictors.

Discussion

This chapter contributes uniquely to research on readers' contemplations of inaccurate information in texts. Whereas other chapters in this volume focus on the comprehension of and memory for factual inaccuracies, we focused on a subtler—yet frequently encountered—type of inaccuracy: inaccurate argumentation, which regularly appears in popular press scientific reports. When readers can interpret that a source has drawn an accurate conclusion given the empirical results, their preexisting beliefs do not predict memory for either the information sources or the arguments reports put forth.

Beliefs seem to become important when there is a conflict between the author's interpretation and the type of research study that was reported. That is to say, relationships between readers' beliefs and memory measures depended on the accuracy of the arguments that were read.

Readers might have considered accurate arguments, instances where the interpretations were logically derived from the available empirical evidence, as "internally justifiable." In this sense, readers may not have needed to activate and use their preexisting beliefs on the topic or the ways one can justify knowledge claims in science, more generally. In this sense, the text does all of the "heavy lifting." In cases in which the evidence does not logically support the interpretation, that is, when arguments are not "internally justifiable," readers appear to utilize their preexisting beliefs to support memory for different aspects of the articles.

For example, readers may not be able to use the textual evidence to strengthen their preexisting beliefs on the topic, which they often want to do, when a misinterpretation is present (Kardash & Scholes, 1996; Lord et al., 1979; Murphy & Alexander, 2004). Accordingly, readers might instead more "deeply" process source information (e.g., author credentials and affiliation). This increased attention to the source features of the articles may have, in turn, facilitated memory. Correlations provide initial support for such a characterization. Topic beliefs predicted memory for source features associated with inaccurate but not accurate arguments, irrespective of the fact that all readers received the same source features.

The findings also seem to support that claim–evidence misalignment might stimulate activation and the use of different justification-for-knowing beliefs in support of argument processing. On one hand, stronger beliefs that knowledge claims can be justified based on personal opinion seemed to make it more likely that readers disregarded inaccurate arguments, as evidenced by their relatively poorer memory compared to the accurate argument conditions. On the other hand, stronger beliefs that knowledge claims can be justified through appeals to authoritative sources appeared to relate to a deeper processing of the details of the study as well as the author's misinterpretation, perhaps reflecting an attention to the lack of "scientificness" (Thomm & Bromme, 2012). This increased attention may have, in turn, facilitated memory for the inaccurate arguments.

Thus, the recall measures—taken as evidence of the memory "products" of reading—indicated that college students activate preexisting beliefs to deal with the different facets of popular press science reports depending on the quality (in this case the accuracy) of the argumentation. It is unclear, however, *when* they made these decisions. Future work could track reading behaviors to examine whether readers with different topic-specific and justification belief profiles differentially attend to and process the news articles *during reading* (e.g., more rereading and reanalysis of the arguments, more scrutinizing of the source features). Such indices could confirm that the different

memory effects reflect that moment-by-moment changes in text processing occurred during reading. These reading time analyses could more directly pinpoint which specific text features stimulated a deeper processing of the articles, and for which types of readers.

Of course, our findings are potentially constrained not only by the undergraduate sample that participated but also by the particular text materials and tasks that were presented to them. Future work examining the role of reader beliefs in argument memory should probe the generalizability of our findings. Such extensions could include populations working with unwarranted conclusions for other controversial health topics (e.g., "causes" of childhood obesity). It would also be interesting to incorporate additional outcome measures that more closely mirror the use of previously read information in making future decisions (e.g., "Given what you read, would you change your child's diet? Why, and in what ways?"). Moreover, because the current analyses were correlational in nature, the findings do not warrant causal conclusions. Further experimental work is needed to more firmly establish causal relations between students' beliefs and aspects of their postreading memory for texts. For example, future work might experimentally induce different justification beliefs to more directly assess their impact on comprehension and decision making.

Finally, although readers should cautiously consider the quality of the arguments that they come across, especially since many, if not most, people use the Internet to inquire about topics of interest, such consideration appears to depend on the beliefs that are brought to bear during reading. Across a life span, a reader will no doubt make a number of important health decisions based primarily on independent research on a variety of issues (i.e., without consulting a medical professional directly). In practice, this means some of the texts the individual comes across will contain conclusions that are poorly coordinated with the evidence provided, both intentionally and unintentionally. A passive, uncritical acceptance of faulty arguments could merely result in someone's being ill-informed on the topic, but it is the more drastic consequences that are most concerning (e.g., a negative impact on a person's health and well-being). As such, future research in this area may have important implications for understanding why some people succumb to maladies based on knowledge-based decisions and others are more critical and seemingly savvy about which sources and arguments to trust when their health is on the line. Informing oneself to make health decisions is, at the very least, a pervasive activity that warrants concentrated research efforts.

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Note

1. The sample of students in the current work is a subset of students who also contributed data reported by Steffens et al. (in press), particularly in experiment 1. Accordingly, the participants used the same materials and followed the same procedure as reported there.

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