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Comprehending Multiple Controversial Texts about Childhood Vaccinations: Topic Beliefs and Integration Instructions

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ABSTRACT

This study examined the extent to which prior beliefs and reading instructions impacted elements of a reader's mental representation of multiple texts. College students' beliefs about childhood vaccinations were assessed before reading two anti-vaccine and two pro-vaccine texts. Participants in the experimental condition read for the purpose of integrating across the texts, while those in the control condition read for comprehension. Participants completed a vocabulary assessment then post-reading essays, which were scored for the quality of argumentation and organization. Results indicated that those who were instructed to integrate, held accurate beliefs about vaccines, and demonstrated higher vocabulary knowledge tended to write more organized essays. Participants with inaccurate beliefs about vaccines produced essays that were more incoherent and polarized, even when asked to integrate texts. Although prompting readers to integrate might generally contribute to a more organized mental representation, a more robust intervention may be needed when misconceptions are present.

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The influx of information online has made multiple text comprehension an everyday activity. Readers often consult various perspectives to gain an understanding of a topic or event, or to make an informed decision.

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The ubiquity of this task makes it no less challenging, as readers must consolidate what they have read into a mental model that is reflective of the overlapping and inconsistent information found in each of the texts. This is further complicated by the strength and accuracy of a reader's prior beliefs, which may interfere with their ability to create a comprehensive mental model (Lord, Ross, & Lepper, 1979; McCrudden & Barnes, 2016; Richter & Maier, 2017). The current study was designed to empirically address the challenge of creating a comprehensive mental model representative of multiple controversial texts, with varying levels of consistent or conflicting prior beliefs present. Broadly, we examined the extent to which the use of reading instructions to integrate while reading influences participants' mental representations of texts. As such, several relevant literatures are reviewed. The first two sections of the paper present relevant theoretical models and frameworks of multiple text comprehension, with empirical support for their main assumptions. After, two additional sections address the specific role that prior topic beliefs play in text comprehension.

Multiple Text Comprehension

Generally speaking, text comprehension models assume that readers incrementally construct a mental representation over successive cycles of processing (Gernsbacher, 1997; Myers & O'Brien, 1998; Van den Broek, Young, Tzeng, & Linderholm, 1999; Kintsch, 1988). One of the most popular theories of *single* text comprehension is the Kintsch's construction-integration (C-I) model (Kintsch, 1988). In the theorized construction phase, linguistic information is used to create propositions that are stored in the form of lexical nodes within an associative network that also reflects connections to prior knowledge that has become activated during comprehension. In the integration phase, activated concepts that have or gain associations with many other concepts in the network will stabilize as part of the reader's final mental representation. By contrast, if inappropriate, irrelevant, and redundant propositions have become activated during comprehension, they ideally will decay or will be actively inhibited until they are eliminated from the representation. Thus, successful comprehension would result in a coherent mental representation of the text reflecting contributions from both the text and prior knowledge.

The Documents Model Framework (DMF) furthers this understanding of comprehension in terms of how readers process information presented in *multiple* texts (Britt & Rouet, 2012). Like the C-I model asserts for single text comprehension, integration is also a key component of the DMF. Integration processes for multiple text comprehension can include bottom-up automatic or top-down strategic processing, and typically

involves identifying reading goals, problem-solving, evaluating, and synthesizing that information to create an organized product (Barzilai, Zohar, & Mor-Hagani, 2018; Brand-Gruwel, Wopereis, & Walraven, 2009; Leu et al., 2007; Rouet & Britt, 2011). The result of these processes is the creation of an integrated mental model containing information relating to the content of the texts, such as the main arguments and supports specific to each text, consistent or inconsistent ideas across multiple texts, and ideas pertaining to the situation of the text (Britt & Rouet, 2012; Bråten, Braasch, & Salmerón, 2020).

Since texts contain varying levels of expertise and bias, Britt and Rouet (2012) propose that readers will create an intertext model in addition to the integrated mental model. The intertext model is a mental representation which houses source information, such as genre, origin, date, intent, audience, and author of a text. These source features are stored in the form of document nodes, from which the reader can make connections to document nodes of other texts, and to the claims of texts stored in the integrated mental model through what Britt & Rouet refer to as intertext links. This final ideal representation consisting of an integrated mental model and an intertext model presumably allows for a more organized and coherent representation of multiple texts (Britt & Rouet, 2012).

Integration

In support of the DMF's intertext model, the benefit of identifying source information and using this to aid in the interpretation of texts has been well documented (Strømsø, Bråten, Britt, & Ferguson, 2013). Source awareness is associated with deep comprehension, the ability to differentiate between reliable and unreliable sources, and notably, *integration* (Strømsø, Bråten, & Britt, 2010; Strømsø et al., 2013; Wiley et al., 2009). That is, readers with better source evaluation skills are more likely to read reliable sources strategically and integrate that information into a coherent mental model. In turn, the tendency to integrate information is associated with higher learning outcomes (Wiley & Voss, 1999; Wolfe & Goldman, 2005).

While experts regularly engage in these strategies while reading, readers with less domain knowledge often need to be prompted (Rouet, Favart, Britt, & Perfetti, 1997). For example, Britt and Aglinskas (2002) found that students who had received an instructional intervention that focused on identifying source features produced more coherent, integrated essays relative to those who had not received the intervention. Other studies have demonstrated success in promoting integration by using cognitive and metacognitive prompts (González-Lamas, Cuevas, & Mateos,

2016), scaffolding integrative strategies and epistemic metastrategic knowledge (Barzilai & Ka'adan, 2017), and even using a video tutorial to model the process of synthesizing research to write a literature review (Darowski, Patson, & Helder, 2016).

Integration can also be shaped by the nature of the post-reading task. Writing essays from memory is a common measure of learning after reading multiple texts, and such tasks have been shown to be more effective in promoting integrative strategies than answering intertextual questions, for example (Barzilai et al., 2018; Cerdán & Vidal-Abarca, 2008). Most notably, post-reading argumentative writing tasks have been found to promote attention to source information, integration, and overall comprehension relative to descriptions or summaries (Naumann, Wechsung, & Krems, 2009; Wissinger & De La Paz, 2016; Wiley et al., 2009).

In sum, integration can be shaped by various contextual factors such as prompts and the nature of the post-reading task. Our objective was to examine the effects of reading task instructions that stem directly from conceptions of an integrated mental model described in the DMF. Specifically, we examined whether giving reading instructions to integrate aided students in the production of better argumentation and organization in essays written after reading multiple texts. Previously, the sophistication of a mental model has been studied in participants' essays by analyzing number of ideas recalled (Kendeou & Van Den Broek, 2005), the quality of inferences (Maier & Richter, 2013), the number of references to belief-consistent or inconsistent arguments found in texts (van Strien, Kammerer, Brand-Gruwel, & Boshuizen, 2016), or whether participants assumed an overall neutral versus biased stance (Kardash & Scholes, 1996; van Strien, Brand-Gruwel, & Boshuizen, 2014). Thus, evaluating the sophistication of argumentation and organization in reader-generated essays would give insight into the *structural* aspects of their mental representation of multiple texts, such as the quality of organization and argumentation.

Prior Beliefs

Beyond source evaluation and integration strategies, other research has specifically focused on the extent to which prior beliefs can guide comprehension of multiple texts. Some have suggested that people engage in two different types of processing while reading belief-consistent and inconsistent information (McCrudden & Barnes, 2016; Maier & Richter, 2013). Richter and Maier (2017) proposed a two-step model of belief validation, which describes the phenomenon of biased processing. This theoretical model is informed by research demonstrating that schematic

knowledge guides the encoding process as well as the validation of information (Maier & Richter, 2013). The first step is referred to as epistemic monitoring or non-strategic validation, whereby readers take the most efficient approach to comprehension by allocating cognitive resources on the arguments they deem to be most plausible. The result of readers' interactions with texts is a mental model that is biased toward belief-consistent information. Richter and Maier note key differences between what occurs within their model and what is traditionally known as confirmation bias, in that their model highlights text-belief consistency effects that occur passively and routinely during text comprehension.

If an inconsistency is identified during epistemic monitoring, the theory states that the reader might then enter the second step of the validation model: elaborative processing of belief-inconsistent information (Richter & Maier, 2017). This step is more conditional than the first as it requires more cognitive resources than routinized epistemic monitoring. However, if readers are motivated, have the necessary working memory resources, and have ideal epistemological beliefs (particularly that knowledge is uncertain), they may be more likely to resolve inconsistencies within this strategic processing phase. Accordingly, readers who engage in this step would employ strategies such as elaborations and bridging inferences to resolve inconsistencies between the texts and their preexisting beliefs. This elaborative processing may support the construction of an integrated mental model, which according to the DMF contains the main arguments, supports, and connections between texts (Britt & Rouet, 2012).

One seminal study examining the role of biases and beliefs in constructing mental models pertaining to controversial issues was by Lord et al. (1979). In this study, college students were shown studies both for and against capital punishment. Those participants, whether they were opposed to or in support of capital punishment, rated the studies that confirmed their beliefs more favorably in terms of how well the study was conducted and how convincing it was. Additionally, there was an increase in polarization resulting from this task such that the beliefs of both proponents and opponents were strengthened after reading texts with equally inconclusive or questionable information. This phenomenon of judging belief-consistent information and belief-inconsistent information differentially, sometimes referred to as myside bias, has been demonstrated in a long history of studies. For example, Kardash and Scholes (1996) found that those who had more extreme prior beliefs and held the epistemological belief that knowledge was certain tended to favor evidence that coincided with their opinions and produce more biased essays. McCrudden and Barnes (2016) also observed this phenomenon, noting that readers with higher levels of myside bias applied biased

evaluation standards to the arguments they read. Similarly, in two studies, van Strein et al. (2016) found that those with stronger prior beliefs spent less time assessing the conflicting evidence and took a more explicit, biased stance after reading, sometimes adding support for their stance that was not mentioned in readings (2014). Finally, Maier and Richter (2013) observed that some readers would make reference to ideas not found in the texts, suggesting that their prior beliefs can guide encoding and influence the quality of inferences. This inability to generate valid inferences interferes with the quality of recall, which ultimately influences the accuracy of their mental representation of the text (Kendeou & Van Den Broek, 2005).

Correcting these inaccurate beliefs or misconceptions is not easy. Even if the information is known to be inaccurate, it can still influence inferences and judgments. This phenomenon, referred to as the continued influence effect, has been studied in the context of misinformation (Johnson & Seifert, 1994). Once information is read, explained, elaborated, and stored in a mental representation, the familiarity and accessibility of that information is retained regardless of a later realization that it is inaccurate (Anderson, Lepper, & Ross, 1980; Ecker, Hogan, & Lewandowsky, 2017; Lewandowsky, Ecker, Schwarz, Seifert, & Cook, 2012). A notable example of this would be the 1998 Wakefield study connecting the MMR vaccine to autism. Despite being formally retracted and repeatedly debunked, this information continues to shape perceptions of vaccines (Ecker et al., 2017; Poland & Spier, 2010). Furthermore, some have noted there may be a motivational component to retaining inaccurate concepts (Ecker, Lewandowsky, Fenton, & Martin, 2014). Misconceptions based on retracted misinformation are more likely to be sustained if such information is congruent with prior beliefs and attitudes. As such, it is important to consider the effects of inaccurate beliefs on the construction of a well-supported and coherent mental model. In addition to analyzing the significance of integration instructions on argumentation and organization, the impact of accurate and inaccurate belief conditions will also be considered in our analyses.

Vocabulary Knowledge

Individual differences, such as vocabulary knowledge, can also influence text comprehension. Vocabulary knowledge, in particular, is a known predictor of reading and writing ability, and can be a proxy for other skills, such as world knowledge (Shanahan, 1988; Stotsky, 1983). For this reason, readers' vocabulary knowledge will also be considered in our analyses. Aside from its association with reading comprehension skill, vocabulary knowledge has also been connected to accurate

inferences (Cain, Oakhill, & Lemmon, 2004; Kintsch & Rawson, 2005). For example, one study demonstrated that those with higher vocabulary knowledge had an easier time drawing inferences, such that they had to look back at previous content less frequently than people with lower vocabulary knowledge (Calvo, 2004). According to Kintsch's C-I model, generating inferences is essential to developing a mental model of the text, which is filtered through, and integrated into, prior knowledge (Kintsch, 1988). Inferences are also important to multiple text comprehension, as these can support integration and allow for readers to reconcile information that contradicts their prior beliefs, resulting in a more accurate mental representation of a topic (Maier & Richter, 2013; Stadtler et al., 2014; Kurby, Britt, & Magliano, 2005). Since vocabulary knowledge is associated with generating inferences, and inferences help promote integration, the current research also examined how vocabulary knowledge might facilitate the construction of an integrated mental model about multiple texts.

Current Study

The literature summarized above describes how readers ideally represent multiple texts, and the roles that reading task instructions, prior beliefs, and vocabulary knowledge might play in guiding comprehension. While previous work has evaluated source-based references, quality of inferences, and mentions of belief consistent or inconsistent arguments from texts recalled in post-reading essays, no studies to date have directly examined how both preexisting beliefs and vocabulary might impact the *structural aspects of a reader's integrated mental model,* as described in the DMF.

We focus on unique and interactive effects between reading instructions, beliefs, and vocabulary knowledge in relation to the construction of a coherent, logical, and well-supported essay. Particularly, it is unclear how preexisting beliefs may influence the *quality of the argumentation* and *organization of ideas* within readers' understandings of multiple texts, as inferred from the essays that participants write. The current study also examined whether argumentation quality and organization of ideas depended upon whether participants read for the purpose of integration, or more generally for comprehension (see Table 1).

In the current study, college students were given controversial information: two pro-vaccine readings containing accurate information, and two anti-vaccine readings containing misinformation. One group was instructed to read for the purpose of integration, while the other was asked to read for general comprehension, before completing a vocabulary assessment and writing essays for memory. These essays were scored for both argumentation and organization.

Table 1. Reading instructions for the experimental condition (left) and control condition (right).

Integration condition instructions	Comprehension condition instructions
"When reading online, there is a variety of information available. *Some texts completely agree with one another, some may offer complimentary ideas, still others may directly contradict one another. While you are reading, please explain to yourself the ways the ideas across the texts relate to one another*. You will read on the topic of childhood vaccinations and write an essay describing the information you read. Please take your time when reading, you will be constructing your essay from memory."	"When reading online, there is a variety of information available. *Some texts are more familiar and easier to understand; and some texts are challenging and more unfamiliar. While you are reading, please explain the texts to yourself to ensure that you understand the concepts described in the texts*. You will read on the topic of childhood vaccinations and write an essay describing the information you read. Please take your time when reading, you will be constructing your essay from memory."

We tested the following hypotheses:

1. After reading multiple controversial texts, people with accurate prior beliefs will produce essays with higher quality argumentation and organization compared to people with inaccurate prior beliefs.
2. The effect of the reading condition will be such that people reading for the purpose of integration will produce essays with higher quality of argumentation and organization compared to people reading for general comprehension (the control condition).
3. We also expected an interaction between reading condition and prior beliefs for both outcomes. When reading for general comprehension, we expected that having accurate beliefs would be a positive predictor of argumentation and organization scores (albeit weaker than the when participants are tasked to think about relationships across texts); however, inaccurate beliefs would be a strong negative predictor of argumentation and organization scores, reflecting less coherent and one-sided essays. We also expected that reading for the purpose of integrating across the texts would enhance the positive relationship between accurate beliefs and argumentation and organization scores, and would weaken the negative relationship between inaccurate beliefs and argumentation and organization scores, that is, asking people to think about relationships between multiple texts would make it less likely that misconceptions would lead to less coherent and one-sided essays.

The controversial topic of childhood vaccinations was chosen for the reading task with the assumption that it should generalize to other controversial topics. It is important to note that the data for this study was collected in 2019, prior to the identification of the COVID-19 virus and subsequent pandemic, which reshaped the public's thought and discourse

surrounding the use of vaccines. However, this is not to say that the subject of vaccination would have been totally irrelevant to participants. In fact, 2019 was the year in which the greatest number of measles cases had been reported since 1992, despite being eliminated in the United States in 2000 (Patel et al., 2020). Outbreaks in 31 states were attributed to lower immunization rates and an increase in anti-vaccine misinformation (Patel et al., 2020; Selim, 2019). Although vaccines were not the everyday talking point they are at present, the topic was controversial and important given the current events at the time of the study.

Method

Participants

The participants include 121 students from a large urban university in the south. Of those, 81.8% identified as female and 18.2% identified as male. The average age was 19.17 ($SD = 3.81$), with 81.0% being in their first year of college, 9.9% in their second year, 6.6% in their third year, and 2.5% in their fourth or more. The ethnic composition was 52.1% Caucasian, 27.3% African American, 7.4% Hispanic/Latinx, 7.4% Asian American, 4.1% Native American/Alaska Native, Native Hawaiian/Pacific Islander, or Multi-race and 1.7% Middle Eastern. English was the first language for 89.3% of participants, and the remaining 10.7% of participants had spoken English for at least 10 years. During our analysis, two outliers were removed to better approximate normality, as their ratings for accurate belief statements were 3 standard deviations below the mean for accurate beliefs. It should be noted that, although this did not reduce skewness to a value less than the absolute value of 1 as is standard practice for outlier removal techniques, there were no additional Z scores that met the 3 standard deviation criterion for removal from the data set.

Materials

Childhood Vaccination Belief Inventory (CVBI)

The CBVI includes 13 items that measure whether participants' beliefs about vaccines are accurate or inaccurate. Of these items, five of them reflect accurate beliefs that vaccines are helpful (*Childhood vaccinations are effective in preventing diseases*), while the remaining 8 reflect the inaccurate beliefs that vaccines are harmful or unnecessary *(Vaccines do more harm than good*; *In modern times, most serious illnesses are already eradicated so vaccines are unnecessary*). After reading each statement, participants rated each item on a 10-point Likert scale ranging from 1 (completely disagree) to 10 (completely agree). Higher scores on the

vaccines are helpful scale represent pro-vaccination stance, while higher scores on the *harmful and unnecessary* scales represent an anti-vaccination stance. Reliability for the measures of beliefs that vaccines are helpful, harmful, and unnecessary (Cronbach's alphas of .89, .87, and .90 respectively) has been established in prior research, the values of which are quite good (Kessler, Braasch, & Kardash, 2021). Average ratings across harmful and unnecessary belief ratings were aggregated to create a single variable representing inaccurate beliefs, while the helpful belief rating was used as our accurate belief variable.

Reading purpose manipulation

Participants received either an Intertextual Integration Experimental Condition, or a Control Condition, for which they read for basic comprehension. The left column of Table 1 shows the reading instructions for the Intertextual Integration purpose, while the right shows the instructions for the Control Condition.

Texts

Participants were given four texts in randomized order adapted from authentic sources online, two contained accurate information about vaccines (vaccines are helpful) and two contained misconceptions about vaccines (vaccines are harmful or unnecessary). Texts had a mean word count of 325 (*Range* = 253–379, *SD* = 52.48) and source features ranging from more reliable to less reliable with an average Flesch-Kincaid Grade estimated at 13.13 (*Range* = 11.9–14.3, *SD* = 1.25). The content of the texts was authentic, and thus, inter-textual differences in structures and types of evidence remained. The two pro-vaccine articles attributed the elimination of serious diseases to successful vaccination campaigns, tending to reference data and specific findings from published research as evidence. Conversely, the anti-vaccine articles attributed the elimination of serious diseases to natural immunity and provided reasoning for their claims, although vague. For example, one claim from a pro-vaccine article is supported by the following piece of evidence: "Research published in the Journal of Pediatrics demonstrated that whooping cough outbreaks were far more likely to happen in areas with lower rates of vaccination, which ultimately resulted in 10 deaths." By contrast, one of the anti-vaccine articles offered the following evidence: "Research shows that vaccines are now unnecessary due to children developing stronger immune systems," without citing the source of this research or elaborating on the specifics of these findings.

Source information was provided at the top of each text as indicators of trustworthiness. For example, we wrote one of the texts containing

accurate information as a composite of several ideas found on the Internet. The text was purportedly written by an epidemiologist at the Institute for Health Research for *Scientific American* magazine. Details regarding the author's expertise and intentions were also provided as follows: "The mission of our magazine is to provide accurate and empirical evidence about current and past health topics. Regarding information on childhood vaccines, this magazine strives to provide information on how necessary vaccines are in terms of living a long, healthy life free from vaccine-preventable diseases. We work with doctors, nurses, researchers, and statisticians all over the world to provide trustworthy and true information for our readers." In contrast, we created one of the texts containing inaccurate information about vaccines, also as a composite of several inaccurate ideas found online, which stated the author was a Chief Editor at *Organic Lifestyle* magazine and included the following statement of intention: "We are dedicated to providing evidence-based natural medical information. Through both open access and paid access, *Organic Lifestyle* Magazine provides physicians, clinicians, researchers, and consumers a resource to determine the therapeutic value of vitamins, minerals, herbs, and foods."

Gates-MacGinitie vocabulary test

A 20-item version of the Gates-MacGinitie Vocabulary Test (4th ed.) was presented between the reading task and the writing task to serve as a distractor task, and to measure individual differences in general vocabulary knowledge (GMVT, MacGinitie, MacGinitie, Maria, & Dreyer, 2002). We opted to use a shortened version of the test, as opposed to the full version, to reduce the risk of participants becoming fatigued. Instructions were: "We would like you to complete a brief 5-minute vocabulary assessment. In the following questions, please choose the word that means nearly the same as the underlined word. If you are not sure of the answer, mark the one you think is right." For each item, a brief sentence appeared at the top of the screen with the key vocabulary word underlined (e.g., It should be amended). Five possible answer choices for each word were provided below (e.g., explained, praised, asked for, returned, and corrected). When participants selected what they thought was the accurate synonym response option (in the example case, corrected would be the appropriate response), they clicked next to advance to the next item. There was a 5-minute time limit for the test. Total correct out of 20 items was the measure of general vocabulary knowledge. Thus, higher scores on the GMVT signified higher vocabulary knowledge, while lower scores signified lower vocabulary knowledge. Please note that, because a condensed version of the full vocabulary measure was used, the norms

respective to grade-level are not interpretable. Instead, the scores are used as a continuous predictor variable.

Essay writing task

The following prompt was given for the essay: "Write an essay that explains the effects of vaccines on health and the extent to which childhood vaccinations should be required by the government. Think carefully about the prompt. In your essay, elaborate on the information in the texts rather than merely summarizing. Please be as detailed as you can in your explanation, whenever possible please provide sources for the information you include in your essay. When you use information from the texts to support your essay, be sure to put ideas in your own words (e.g., paraphrasing or summarizing the information). The essay gives you an opportunity to show how effectively you can develop and express ideas. You should, therefore, take care to develop your point of view, present your ideas logically and clearly, and use language precisely." There was no time limit given for the essays, however, the average writing time was around 15 minutes and 30 seconds with a range of around 29 minutes and 21 seconds.

Essay scoring

The essays were scored for the quality of argumentation and organization using an integrated essay scoring rubric (Crossley, Wan, Allen, & McNamara, 2021). Essays were awarded 1–4 points for each of these subscales. Two expert raters coded the essays for these characteristics, and others outside the scope of the current project. Inter-rater reliability was $\kappa > .70$.

The argumentation score was based on how the participant discussed sides of the argument and took a position, supported their position by providing claims, and supported those claims by providing evidence. The lowest score, a 1, signifies that the participant did not discuss the sides of the argument nor provided a position, provided no supporting claims and no supporting evidence. Thus, an essay that received a score of 1 would reflect that the person made little to no attempt at advancing an argument based on the texts. A score of 2 signifies that the participant discussed one or both side(s) of the argument but *did not* provide a position, discussed the side(s) by providing 1 or more relevant and accurate claim and one or more relevant and accurate piece of evidence. A score of 3 signifies the participant discussed both sides of the controversy and *implicitly* stated a position, then supported that position by providing 1–2 relevant and accurate claims as well as 1–2 relevant and accurate pieces of evidence. The highest score, a 4, signifies that the

participant discussed both sides of the controversy and *explicitly* stated a position, then supported this position by giving 3 relevant and accurate claims and 3 relevant and accurate pieces of evidence (Allen et al., in press).

Organization was based on the essay's logical structure, flow, and coherence. The lowest score, a 1, signifies the essay generally lacked a logical sequence of thought, appropriate organizational structure, cohesive elements, and was incoherent. A score of 2 signifies that the essay occasionally deviated from logical structure, was missing an introduction or conclusion, and contained some evidence of organization but lacked transitions and other cohesive elements. A score of 3 signifies that the essay showed evidence of logical structure but was missing an explicit introduction or conclusion as well as some transitions, but was still coherent based on cohesive elements that were included. The highest score, a 4, signifies that the essay followed a logical structure, included an introduction and conclusion, and was well-organized with a sense of flow throughout paragraphs as a result of cohesive elements (Crossley et al., 2021).

Demographic questionnaire

A demographic questionnaire was administered following the essay writing task. This 11-item questionnaire used multiple choice and fill-in-the-blank type questions to identify self-reported age, GPA, year in college, gender identity, racial/ethnic identity, and primary and secondary languages spoken.

Procedure

During the first session, to assess preexisting beliefs about childhood vaccinations, participants completed the CVBI, along with other tasks not part of the current study. During the second session, they were given the task instructions for the reading portion of the study. After completing the reading portion, they were given the Gates-MacGinitie (4th ed.) vocabulary test (MacGinitie et al., 2002) as a distractor task. Finally, participants were instructed to complete the essay portion, and finally to complete a demographic questionnaire. All participants provided consent, and IRB approved protocols were followed.

Results

Descriptive statistics for accurate vaccine beliefs, inaccurate vaccine beliefs, Gates-MacGinitie vocabulary knowledge scores (GMVT), argumentation scores and organization scores are provided in Table 2.

Table 2. Descriptive statistics.

Variable	M	Range	SD	Skewness
Vaccine beliefs: Accurate	8.72	5.20	1.39	−1.25
Vaccine beliefs: Inaccurate	2.49	6.88	1.31	.98
General Vocab. Knowledge	11.85	18.0	4.09	−.10
Argumentation	2.70	3.00	.60	−.09
Organization	2.40	3.00	.63	.51

Note. Scores for general vocabulary knowledge are from Gates-MacGinitie vocabulary test.

On average, participants generally agreed with accurate statements pertaining to the helpfulness of vaccines ($M = 8.71$, $SD = 1.39$, range = 5.20) and disagreed with the inaccurate statements that vaccines are harmful and unnecessary ($M = 2.49$, $SD = 1.31$, range = 6.88). A paired sample t-test comparing the scores reflecting the belief that vaccines are helpful with the scores reflecting the belief that vaccines are harmful and unnecessary resulted in a significant difference between the two means, $t(120) = 25.86$, $p < .001$. The standard deviations suggest there was some degree of inter-participant variability; however, the sample—in general—tended to endorse accurate beliefs.

For vocabulary knowledge, the average score was 11.85 ($SD = 4.09$, range = 18) out of 20. The mean reflects that people answered approximately 59% of the questions correctly, with nearly the full range of scores represented. An independent samples t-test identified that the vocabulary scores of the control and experimental groups did not significantly differ, $t(119) = -.61$, $p = .54$. The average argumentation and organization scores were, respectively, 2.70 ($SD = 0.60$) and 2.40 ($SD = 0.63$), and all possible scores occurred for both types of essay evaluations. The means can be interpreted as indicating that participants typically addressed both sides of the controversy, provided at least one accurate claim or piece of evidence, and attempted to employ a coherent structure, although imperfectly.

The results of the bivariate correlations are shown in Table 3. It is first important to note that, while accurate and inaccurate beliefs are not collinear, there does appear to be a strong significant negative correlation between the two ($r = -.68$). Thus, the more people endorsed accurate beliefs, the less likely they were to endorse misconceptions. For vaccine beliefs and argumentation scores, there was a positive correlation between accurate vaccine beliefs and argumentation scores that did not reach an acceptable level of significance ($r = .13$). The relationship between inaccurate vaccine beliefs and argumentation was also non-significant ($r = -.06$), as were the correlations with each belief type and organization scores.

Table 3. Descriptive statistics and bivariate correlations for all participants.

Variable	1	2	3	4	5
1. Vaccine beliefs: Accurate	–				
2. Vaccine beliefs: Inaccurate	−.68**	–			
3. General vocabulary knowledge	.28**	–	.20*		
4. Argumentation	.13	−.06	.24**	–	
5. Organization	.03	−.02	.30**	.66**	–

Note.
*$p < .05$
**$p < .01$. Scores for general vocabulary knowledge are from Gates-MacGinitie vocabulary test

For the vocabulary knowledge scores, there was a significant *positive* correlation with accurate vaccine beliefs (r = .28), and a significant *negative* correlation with inaccurate vaccine beliefs ($r = -.20$). Moreover, performance on the vocabulary test was also significantly and positively correlated with both measures of essay quality including degree of argumentation (r = .24), and organization scores (r = .30). Thus, those with higher levels of general vocabulary knowledge tended to agree with accurate vaccine beliefs statements, disagree with the misconception-based statements, and produce essays with stronger arguments and organizational structure. Finally, as one might expect, there was a significant correlation between argumentation and organization scores (r = .66), meaning that those who put forth a better argument by taking a stance and including relevant supports did so in a way that was more organized and coherent.

Multiple Linear Regression Analyses

To address research questions concerning the predictability of prior accurate and inaccurate topic beliefs, general vocabulary knowledge, reading purpose (integration, general comprehension), and their interactions, two hierarchical multiple regression analyses with argumentation and organization scores serving as outcomes were conducted. In each analysis, participants' two prior topic beliefs and vocabulary knowledge were entered into the equation in step one. In step two, reading purpose condition was entered, and in the third step, three interaction terms were entered: accurate topic beliefs x reading purpose, inaccurate topic beliefs x reading purpose, and vocabulary knowledge x reading purpose. The results for organization scores are shown in Table 4.

The model in step one explained a statistically significant amount of variance, R^2 = .08, $F(3, 117) = 3.23$, $p < .05$, with only general vocabulary knowledge serving as a unique positive predictor of essay organization score (β = .28, $p < .01$). The coefficient indicates that for every 1 unit increase in the vocabulary, post-reading essay organization scores

Table 4. Results of multiple linear regression for accurate and inaccurate topic beliefs and reading purpose predicting level of organization in essays.

	B	*SE*	β	*t*	*p*
Model 1					
Accurate topic beliefs	−.04	.06	−.08	−.68	.50
Inaccurate topic beliefs	−.03	.05	−.07 −.56 .58		
Vocabulary knowledge	.04	.02	.28 2.97 .00**		
Model 2					
Accurate beliefs	−.04	.06	−.08	−.65	.51
Inaccurate beliefs	−.03	.05	−.07	−.62	.54
Vocabulary knowledge	.05	.02	.28	3.0	.00**
Reading Purpose	−.12	.12	−.09	−1.02	.31
Model 3					
Accurate beliefs	−.14	.08	−.30	−1.85	.07
Inaccurate beliefs	−.14	.07	−.32	−2.00	.05
Vocabulary knowledge	.04	.02	.27	2.10	.04*
Reading Purpose	2.89	1.20	2.17	2.40	.02*
Accurate beliefs x Reading purpose	.24	.11	1.64 2.11	.04*	
Inaccurate beliefs x Reading purpose	.25	.11	.59 2.33	.02*	
Vocabulary x Reading purpose	.00	.03	.02	.07	.95

Note.
*$p < .05$
**$p < .01$. Scores for vocabulary knowledge are from Gates-MacGinitie vocabulary test

increased by .28. The addition of reading purpose in step two, however, did not explain a statistically significant change in the amount of variance explained, $R^2_{change} = .01$, F_{change} (1, 116) = 1.04, $p = .31$. In inspecting the unique predictors, only general vocabulary knowledge served as a positive predictor of essay organization score (β = .28, $p < .01$), with identical beta weights to model one[1]. Although the addition of the three interaction terms in step three did not reach a statistically significant change level in amount of variance explained, $R^2_{change} = .05$, F_{change} (1, 113) = 2.03, $p = .11$, there were several unique and interactive predictors that reached acceptable levels of statistical significance. As before, general vocabulary knowledge was a positive predictor of essay organization score (β = .27, $t = 2.10$, $p < .05$). However, so too were inaccurate vaccine beliefs (β = −.32, $t = -2.00$, $p < .05$) and text condition (β = 2.17, $t = 2.40$, $p < .05$). The direction of the effects suggests that the more people endorsed inaccurate beliefs before reading, the more poorly organized were their post-reading essays. In addition, those reading for the purpose of integrating information were more likely to produce well-organized essays relative to those who read for general comprehension. These main effects, however, are qualified by two interactions.

Specifically, the accurate topic beliefs x reading purpose interaction term was significant (β = 1.64, $t = 2.11$, $p < .05$). A follow-up test of the significance of the difference between the two slopes did not reach an

acceptable level to determine that the slopes of two lines significantly differed from each other, $t = 0.63$, $p = .053$. Following recommendations by Cohen, Cohen, West, and Aiken (2003), simple slope follow-up analyses were also conducted, which allows for estimating effects indicative of the continuous predictor on essay score separately in the group that read to integrate across texts and the group that read to comprehend the texts. The simple slopes analyses signified that both slopes differed from 0. Accurate beliefs had a positive effect on essay organization scores for participants who read to integrate the texts ($B = 2.49$, $SE_B = 0.49$, $p < .001$). The same pattern was present for participants who read to comprehend the texts ($B = 1.99$, $SE_B = 0.62$, $p < .01$); however, the slope for integration readers was slightly steeper.

In addition, the inaccurate topic beliefs x reading purpose interaction term was significant ($\beta = 0.59$, $t = 2.33$, $p < .05$). A follow-up test of the significance of the difference between the two slopes did not determine that the slopes of two lines significantly differed from each other, although the trend was there, $t = 1.77$, $p = .079$. Simple slopes analyses signified that both slopes, however, differed from 0. The slopes reflected that inaccurate beliefs had a negative effect on essay organization scores for participants who read to integrate the texts ($B = 2.80$, $SE_B = 0.16$, $p < .001$), as they did for participants who read for general comprehension ($B = 2.36$, $SE_B = 0.19$, $p < .001$), with a slightly steeper line for participants reading to integrate across texts. All other effects did not achieve acceptable levels of significance, $ps > .06$.

A second hierarchical multiple regression analysis was conducted using argumentation scores as the outcome, the results of which are shown in Table 5. The model in step one approached but did not reach an acceptable level of statistical significance, $R^2 = .06$, $F(3, 117) = 2.48$, $p = .065$, with only general vocabulary knowledge serving as positive predictor of essay argumentation score ($\beta = .21$, $p < .05$), indicating that the stronger participants' vocabulary knowledge, the better the argumentation in their post-reading essays. Neither the addition of reading purpose in step two, nor the interaction terms in step three accounted for any statistical or substantial increases in explaining additional variance ($R^2_{changes} < .02$, $F_{changes}(1, 113) < 1.04$, $ps > .50$)[2]. Whereas only general vocabulary knowledge remained as a positive predictor of essay argumentation score in step two ($\beta = .21$, $p < .05$), it became non-significant in step three.

Discussion

The current study contributes to our understanding of the ways in which reading instructions to integrate and prior beliefs potentially influence

Table 5. Results of multiple linear regression for accurate and inaccurate topic beliefs and reading purpose predicting level of argumentation in essays.

	B	*SE*	β	*t*	*p*
Model 1					
Accurate topic beliefs	.02	.05	.04	.35	.72
Inaccurate topic beliefs	−.02	.05	−.05	−.43	.67
Vocabulary knowledge	.03	.01	.20	2.17	.03*
Model 2					
Accurate beliefs	.02	.05	.05	.37	.71
Inaccurate beliefs	−.02	.05	−.06	−.47	.64
Vocabulary knowledge	.03	.01	.21	2.17	.03*
Reading Purpose	−.07	.11	−.06	−.66	.51
Model 3					
Accurate beliefs	−.04	.07	−.08	−.48	.64
Inaccurate beliefs	−.08	.07	−.20	−1.23	.22
Vocabulary knowledge	.03	.02	.18	1.37	.17
Reading purpose	1.59	1.13	1.31	1.41	.16
Accurate beliefs x Reading purpose	.13	.11	.93	1.16	.25
Inaccurate beliefs x Reading purpose	.14	.10	.35	1.32	.19
Vocabulary x Reading purpose	.01	.03	.08	.26	.79

Note.
*$p < .05$
**$p < .01$. Scores for general vocabulary knowledge are from Gates-MacGinitie vocabulary test

the comprehension of multiple texts about vaccines as evidenced in essays written as a post-reading task. As expected, those who received instructions to integrate texts produced more organized essays than those reading for general comprehension. This was also the case for those with accurate prior beliefs and higher vocabulary knowledge. Inaccurate prior beliefs appeared to be detrimental for knowledge organization, with particular unexpected detriments when readers were tasked to explain the relationships between ideas offered by the different texts. However, none of the individual differences and contextual factors in the regression models appeared to influence argumentation quality within participants' essays.

To elaborate on the influence of reading task instructions, the findings suggested that those who received instructions to integrate information across controversial texts about childhood vaccines produced more organized essays than those who simply read for general comprehension. This finding supports previous research demonstrating that a relatively subtle instructional support can promote integration, as evidenced through intertextual connections and the use of cohesive devices (Barzilai & Ka'adan, 2017; González-Lamas et al., 2016; Darowski et al., 2016; Maier & Richter, 2014), with the qualification that we controlled for vocabulary knowledge and beliefs.

Additionally, this finding implies that giving a reading prompt to integrate can influence the more structural elements of a reader's mental

representation of multiple texts, perhaps resulting in a more balanced integrated mental model according to the DMF (Britt & Rouet, 2012). Contrary to our expectations, tasking readers to integrate ideas across texts did not seem to improve argumentation scores. This may have been because a score of 3 or 4 on the rubric for argumentation would have required readers to state a position, whereas the reading instructions to integrate asked participants to "explain to yourself the ways the ideas across the texts relate to one another." This distinction could explain why participants who received the integration instructions could have written more coherent, well-organized essays, describing the connections they made between both sides of the issue, while not implying or stating that they had chosen a particular position in order to receive a higher augmentation score. An alternative interpretation is that the general instructions to explain relationships across texts may not have been sufficient for readers to know on what they should focus their attention. Future work could employ a more involved instructional approach that provides declarative knowledge and feedback regarding the best practices for texts' comparing claims and supporting evidence and with prior understandings, as others have done (Barzilai & Ka'adan, 2017; Maier & Richter, 2014), which may in turn increase argumentation scores in the essays.

Regarding prior topic beliefs, as expected, those who endorsed accurate statements about the helpfulness of vaccines were far more likely to disagree with the statements asserting that childhood vaccines are harmful or unnecessary. This replicates previous findings by Kessler et al. (2021), who reported a strong negative correlation between preexisting beliefs that vaccines are helpful, and preexisting misconceptions about vaccines. The negative correlation, thus, conversely suggests that those who endorsed the misconceptions about vaccines were less likely to agree with the accurate statements. This implies that the participants generally did not simultaneously hold strong accurate and inaccurate beliefs about vaccines, but rather one or the other.

Regarding the influence of accurate and inaccurate these beliefs on essay organization and argumentation scores, those who agreed with the accurate statements about vaccines tended to write more organized essays than those who endorsed inaccurate statements about vaccines. This was the case for those who read for comprehension and those who read for integration, although the slope was steeper for the read-to-integrate across texts condition. This suggests that the integration instruction had a slightly more positive influence on essay organization for those who already endorsed accurate beliefs. In light of Richter and Maier (2017) two-step theoretical model of belief validation, this may mean that those reading in the control group could have been operating within either

the epistemic monitoring or the elaborative processing stages, but that those who received the instructions to integrate across texts may have utilized their prior beliefs to engage in more strategic, elaborative processing, resulting in a more cohesive and coherent mental model.

But once again, this was not the case for the argumentation scores, which were non-significant. Because participants in both reading conditions were asked to, at some level, understand and describe the information from the texts, participants may have been less concerned with explaining and defending a certain position as they were with providing a broader description of what they had read. In effect, participants may have interpreted the instructions in alignment with summary writing conditions in prior research, rather than reading-to-write arguments. This is worth mentioning, as several studies have demonstrated that tasking adult readers to write summaries from multiple texts lead to essays of lower quality than did writing arguments. For example, Wiley and Voss (1999) observed that writing arguments produced more integrated essays than those writing summaries or explanations. This effect was also noted by Stadtler et al. (2014), as they found that those reading with the goal of writing an argument produced more balanced essays when compared with the more one-sided essays of those with the reading goal of writing a summary.

Additionally, the results for the inaccurate beliefs and reading condition interaction were not as expected. Asking readers to integrate ideas across the texts they encountered did not reduce the impact that their misconceptions had on essay organization. In fact, those reading for general comprehension had a slightly more gradual slope relative to people reading to integrate. This suggests that tasking people to read to make connections across accurate and inaccurate texts may *increase* deleterious effects that misconception endorsement prior to reading had on essay organization after reading, although we make no strong claims about this. Of course, it was expected that inaccurate prior beliefs would have a negative impact on essay organization, as prior research has demonstrated that misconceptions can impact inferences, judgments, and recall (Ecker et al., 2014; Johnson & Seifert, 1994; Kendeou & Van Den Broek, 2005). It was not anticipated that essay organization, particularly the use of cohesive devices to establish connections between ideas, would be worse for those reading for the purpose of integration. The results suggest that misconception endorsement interfered with these participants' abilities to draw connections between ideas as instructed, resulting in less coherent, and more polarized essays.

Finally, those who generally had more vocabulary knowledge tended to believe that childhood vaccines are helpful, and were less likely to believe that vaccines are unnecessary or harmful. Furthermore, those

who displayed higher levels of general vocabulary knowledge also tended to write better-organized essays, although vocabulary knowledge did not significantly impact argumentation. Although speculative, higher vocabulary may have reflected a richer network of general world knowledge, resulting in a greater potential for elaborations and inferences to be made, allowing the reader to create a more organized mental representation (Kintsch, 1988). However, the benefit of having higher vocabulary may have less of an influence on argumentation quality, since it may not necessarily relate to a participant's ability to choose and defend a certain position.

Limitations and Future Directions

There are a few limitations to the current work which offer interesting avenues for future research. First, the only measure used in the current study to identify participants' beliefs about childhood vaccines was the CVBI. Understanding more about the context in which these beliefs were formed, the situations in which they become operational, and how they can evolve over time could help guide future research into interventions or reading instructions that might be more effective. Prior work has shown that misconceptions are particularly difficult to correct, especially if they have been sustained for some time, and if there is enough motivation to retain them based on related prior beliefs or social capital (Ecker et al., 2014; Ecker et al., 2017; Reich, 2018). Thus, knowing which factors might contribute to the formation of inaccurate beliefs would be insightful, as would knowing the degree to which they function differently across different reading contexts (e.g., reading for enjoyment vs. reading to complete an assignment). Additionally, the current study did not utilize any measures indicating whether or not there was a shift in beliefs following the reading or essay tasks. As such, it could be helpful for future research to employ longitudinal designs in order to identify shifts from accurate to inaccurate beliefs, or vice versa, to gain insight into what individual and contextual factors might promote those shifts, in addition to different organizations of mental representations, as demonstrated here.

Additional information regarding the context around prior beliefs might also be helpful for understanding why the integration instructions did not mitigate the negative effects of inaccurate prior beliefs. Although speculative, it was as if being asked to draw connections between texts caused the participants with inaccurate beliefs to "double-down" on their misconceptions, however the data do not allow us to pinpoint what may have contributed to this. As such, employing think-aloud methodologies could offer insight into the processes in which people in different conditions engaged *during*

reading, as well as how these processes might have been encouraged or discouraged by individual differences. Using think-aloud methodologies might also uncover how arguments develop over the course of reading. Given the lack of significant results related to our argumentation measure, this could provide insight into why some readers' performance may have been impeded, and how individualized prompts and feedback can be tailored in the future to help improve argumentation in essays. This would be particularly useful, as the underwhelming results for argumentation may have been due to a misalignment between our intended nature when designing the reading task and the criteria for higher argumentation scores that were employed in the current work (Allen et al., 2021). Specifically, participants were not directed to choose and defend a position, but instead to describe what they had read. Because prior research has demonstrated that reading with the goal of writing an argumentative essay results in more balanced and integrated essays (Stadtler et al., 2014; Wiley & Voss, 1999), it may be beneficial to adapt the reading task accordingly.

A final limitation could be the difficulty of the reading materials, as vaccine information from health professionals is often difficult to read (Okuhara et al., 2022). These articles were appropriate for college students according to the Flesch-Kincaid formula (grade estimated at 13.13); however, because participants only completed a brief version of the Gates-MacGinitie Vocabulary Test, we could not derive grade level equivalencies from the participants' scores. Given the relationship between vocabulary knowledge and general reading skill demonstrated in previous work (Allen, Snow, Crossley, Jackson, & McNamara, 2014; Malatesha Joshi, 2005), as well as the strong correlation between the Gates-MacGinitie vocabulary and comprehension sections (MacGinitie et al., 2002), the effects related to our use of the vocabulary knowledge may be similar to effects related to general reading comprehension skill. Thus, it could be that those with higher vocabulary knowledge tended to have accurate beliefs about vaccines and write better-organized essays because they were more comfortable interpreting health-related ideas based on their higher reading skill and, perhaps, prior interaction with this type of information.

Conclusion

In conclusion, the current work demonstrated that there is an association between reading for integration, prior beliefs on the topic, and vocabulary knowledge in producing organized essays. Specifically, our results indicated that participants who read for the purpose of integrating ideas across texts, held accurate beliefs about the controversial topic, and had higher vocabulary knowledge generally wrote more organized essays. However, contrary to our expectations, participants who had inaccurate beliefs did

not respond as well to instructions to integrate ideas across texts; in fact, this reading purpose ultimately produced less coherent and more polarized essays than those with inaccurate beliefs in the control condition. Although the instructions to read for integration did not prove to be as beneficial for those with inaccurate beliefs as we had initially predicted, these results open the door to future research into a more robust and intensive intervention since misconceptions are notoriously difficult to correct. The current work also suggests that future interventions may benefit from pre-reading subject matter instruction relating to the controversial topic, as accurate health information in particular can be more difficult to read.

Notes

1. Condition was also not significant in analyses that did not control for individual differences, for both argumentation, $t(112.091) = .41$, $p = .69$, and for organization scores, $t(119) = 0.82$, $p = .41$.
2. Condition was also nonsignificant in t-tests for both argumentation, $t(112.091) = .41$, $p = .69$, and for organization scores, $t(119) = 0.82$, $p = .41$.

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