Revising Misconceptions Using Multiple Documents

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Abstract

In the "information age," readers encounter information about socio-scientific issues repeatedly from multiple documents and sources. In turn, this information found across multiple sources may reactivate and strengthen inaccurate prior knowledge or misconceptions. Much existing theoretical and empirical work has examined how readers represent and process multiple documents and sources. Likewise, existing work has also provided an understanding of the conditions that promote the revision of preexisting misconceptions (i.e., knowledge revision) during reading. However, currently lacking is an understanding of how knowledge revision unfolds when readers engage with multiple documents from different sources. To address this gap, I present a new theoretical account that integrates key representational and processing aspects from existing accounts of multiple-document comprehension and sourcing to expand our current understanding of knowledge revision to account for multiple documents and sources (i.e., the Knowledge Revision Components Framework – Multiple Documents; KReC-MD). In a set of two experiments, I tested core hypotheses derived from KReC-MD regarding the influence of text structure, source credibility, and intertextual integration on knowledge revision. In Experiment 1, readers engaged with a set of three documents addressing misconceptions related to genetically modified organisms (GMOs) that varied in text structure (refutation vs. non-refutation) and source credibility (high vs. low). Readers demonstrated superior intertextual integration after engaging with refutation texts, as well as high-credibility sources. In turn, readers who engaged in more intertextual integration demonstrated superior knowledge revision outcomes. In addition to examining knowledge revision outcomes, it was also critical to examine the processes that readers

engage in moment-by-moment during reading. Thus, in Experiment 2, I used a typed think-aloud methodology to examine the integration, sourcing, and knowledge revision processes readers engaged in during reading of refutation texts from either high- or low-credibility sources. Readers engaged in more source evaluations in the low-credibility condition, yet they demonstrated superior intertextual integration and knowledge revision in the high-credibility condition. Thus, readers may have engaged in more evaluation of low-credibility sources as a means of subsequently rejecting information from those sources. These results are discussed in light of existing research regarding multiple-document comprehension and sourcing, and critically, are used to refine the initial proposal of KReC-MD and inform future work.

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Chapter 1: Introduction and Approach

We live in an 'Information Age' that provides readers with access to unprecedented amounts of information easily and at any time in an online information ecosystem. Due to the lack of editorial control and gatekeeping in this emerging ecosystem, learners will inevitably encounter various forms of inaccurate information (Kendeou, Harsch, Butterfuss, Kim, & Aubele, 2020; Wardle & Derakhshan, 2017). Moreover, because the current information ecosystem includes multiple representations and perspectives regarding a host of socio-scientific issues (e.g., vaccination, climate change, genetically modified organisms), readers are likely to encounter inaccurate information repeatedly and from different sources. One critical consequence of this exposure is that readers' inaccurate prior knowledge and misconceptions may become even more difficult and complex to correct and revise (Kendeou & O'Brien, 2014; Shtulman & Valcarcel, 2012). To make matters worse, existing literature in education, psychology, and communication sciences points to an incomplete understanding of the complex processes involved in correcting or revising misconceived knowledge (Chan, Jones, Jamieson, & Albarracín, 2017; Cook, Ecker, & Lewandowky, 2015; Kendeou, McCrudden, & Robinson, 2019; Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012; Rapp & Braasch, 2014). Given this complexity, it is critical to gain a deeper understanding of how readers effectively learn in an information ecosystem increasingly characterized by multitudes of inaccurate information. To help account for this complexity, the overarching aim of the current dissertation is to provide an initial theoretical account and empirical investigation of a key phenomenon with respect to

learning in the information age—how readers may revise misconceptions when they confront multiple documents from multiple sources.

The predominant medium through which inaccurate information and misconceptions are propagated is written text and documents (e.g., Rapp, 2016); thus, researchers have also leveraged texts in order to *revise* readers' misconceptions (Kim, Butterfuss, Aubele, & Kendeou, 2019). In particular, one method that has shown promise for facilitating revision of misconceptions is the refutation text (e.g., Sinatra & Broughton, 2011). Refutation texts provide an explicit refutation of the reader's misconception and an interconnected, causal explanation of the correct idea (Hynd, 2001) to facilitate *knowledge revision*, defined as the reduction in activation of readers' misconceptions (Kendeou & O'Brien, 2014). The revision processes that unfold as learners engage with refutation texts have been outlined and empirically examined in the context of the Knowledge Revision Components framework (KReC; Kendeou & O'Brien, 2014; Kendeou, Butterfuss, Kim & Van Boekel, 2019).

Although the KReC framework provides an account of knowledge revision processes, this account only applies to contexts in which a reader engages with a single document (i.e., refutation text) from a single source. However, in online environments, readers often confront *multiple* documents from *multiple* sources. At least two decades of research have informed our understanding of how readers represent, process, and use multiple documents (e.g., List & Alexander, 2019; Perfetti, Rouet, & Britt, 1999), as well as how readers process conflicting information across multiple documents (i.e., Braasch & Bråten, 2017; Stadtler & Bromme, 2014). Thus, on the one hand, the theoretical landscape currently provides an understanding of the processes involved in knowledge

revision during reading of a single document. On the other hand, there are models and frameworks that have been developed to account for multiple-document comprehension. What is currently missing from the theoretical and empirical landscape is an understanding of how readers revise misconceived knowledge in multiple-document contexts.

To address this gap, I use the three-pronged approach (Magliano & Graesser, 1991). The three-pronged approach is a systematic examination of discourse processes that requires linking theory to converging sources of empirical evidence in order to make claims about the processes under examination (Graesser, Swamer, & Hu, 1997; Magliano, Baggett, Johnson, & Graesser, 1993). The three-pronged approach was proposed by Magliano and Graesser to coordinate the use of text comprehension theories, verbal protocols, and behavioral measures and has been used for decades to study phenomena (e.g., inference generation) in discourse processing (e.g., Leon & Perez, 2001; Magliano et al., 1993; Magliano, Larson, Higgs, & Loschky, 2016; Sundermeier, van den Broek, & Zwaan, 2005). The first prong requires the use of a guiding theory to inform experimentation and generation of hypotheses. The second and third prongs aim to provide corroborating empirical evidence for the hypotheses generated in the first prong. For example, the second prong may consist of verbal protocols to gauge the processes readers engage in during comprehension, and the third prong may consist of reading time evidence to corroborate those processes.

In the context of this dissertation, the first prong consists of an initial conceptualization of KReC-MD, based on a targeted review and synthesis of existing models and frameworks of single-document comprehension, multiple-document

comprehension, and sourcing during reading, followed by a series of hypotheses drawn from KReC-MD (Chapters 2 and 3). The second prong consists of an experiment that examines the influence of key factors hypothesized to influence knowledge revision outcomes in the context of KReC-MD (Chapter 4). Finally, the third prong consists of an experiment that gauges the moment-by-moment processes, proposed by KReC-MD that take place as readers engage with multiple documents (Chapter 5). This is accompanied by a general discussion of the findings, further refinement of KReC-MD, and areas for future research.

Chapter 2: Literature Review

The aim of this chapter is to review and discuss prominent accounts of single-text comprehension (i.e., the Construction-Integration Model, Kintsch, 1988; the Resonance Model, Myers & O'Brien, 1998), multiple-text comprehension (i.e., the Documents Model Framework, Perfetti et al., 1999), and sourcing (i.e., the Discrepancy-Induced Source Comprehension, Braasch & Bråten, 2017; the Content-Source Integration Model, Stadtler & Bromme, 2014). For each account, the review includes key representational and processing aspects to inform discussion of how conflict is handled. Understanding how conflict is handled in the context of existing accounts of comprehension is critical to an initial conceptualization of how knowledge revision could unfold in the context of reading multiple documents.

Single Document Comprehension: Representation, Processing, and Conflict

Construction-Integration Model

The Construction-Integration (CI) model is often considered the best approximation of a true "theory" of text comprehension (McNamara & Magliano, 2009). The first phase of the model, *construction,* refers to the activation of information from the text and prior knowledge from the reader's long-term memory. This activation is "dumb" in that it operates on both information that is relevant to the current discourse situation and information that is irrelevant. The second phase of the model, *integration,* captures the spread of activation across the interconnected network of information. Information that has low activation as processing unfolds is unlikely to be maintained in the evolving mental representation of the text.

Representational Aspects. Both the construction and integration processes rely on prior knowledge (Kintsch, 1988) in the form of an associative network of interconnected nodes generated in the context of the reading task. A critical aspect of the CI model is the assumption that information in texts is represented at three levels. The first level is the surface code, which represents the actual words in a text. The second level is the textbase, which includes all of the information that was reactivated during the construction phase. Because initial activation and elaboration is sloppy, the textbase is an enriched, albeit incoherent and contradictory representation. The third level is the situation model, which captures the overall meaning of information in the text after its integration with prior knowledge.

Processing Aspects. The construction phase captures the process of encoding and reactivating information to construct a textbase. This process involves forming concepts from linguistic input, elaborating each of these concepts by reactivating related contents within the associative network, and inferring additional information. What has been constructed at this point is a set of concepts or propositions derived from the text, as well as a set of associates for each concept. The result is a network that consists of all the concepts and their elaborations that have been formed and inferences that were generated at both the local and global level.

The network that results from the construction process is not an accurate representation of a text because it was sloppily constructed and therefore contains inconsistencies. Fortunately, an iterative integration process increases activation of more heavily connected and relevant concepts, which comes at a cost of activation for concepts with fewer connections. The integration process is iterative in that readers construct a

new network during each processing cycle or sentence. If this integration process fails, then new concepts are added to the network and spreading activation continues. If the process continues to fail, then the reader may engage in problem-solving processes to attempt to restore coherence.

How is conflict handled*?* Within the context of the CI model, the sloppy activation processes that occur during the construction phase often result in a network that contains incoherent or conflicting information (Kintsch, 1988, 1998). However, as Kintsch (1998) noted, the price of this sloppy activation is relatively inconsequential. Because of the connectionist nature of the network, weakly connected information is unlikely to be maintained in the network during spreading activation and will thus fail to be incorporated into the situation model of the text. In essence, the CI model posits that relevant information accumulates activation at the expense of irrelevant or inconsistent information (see McNamara, 1997; McNamara & McDaniel, 2004). This assumes that the inconsistent information, due to relatively fewer interconnections with other information in the network, is not important for the macrostructure of the text. For example, McNamara (1997) used a CI simulation to show that greater activation of relevant prior knowledge was associated with greater suppression of the irrelevant meaning of ambiguous words during sentence comprehension.

It is critical to note that the "conflict" in investigations of the CI model may be somewhat distinct from the type of cognitive conflict that arises when readers encounter information that is inconsistent with their prior knowledge. Namely, the conflict in the context of the existing literature on CI is a byproduct of sloppy activation during reading of texts that contain lexical or semantic ambiguities but have a single "correct"

interpretation. Thus, the CI model does not explicitly account for how readers resolve conflict in discourse situations in which conflicting information serves a critical role in the text itself (i.e., two conflicting perspectives on an issue). Kintsch (1988) did note that the CI model was conceptualized with relatively weak and general representational and processing rules to evade the need to fine tune the model to ever-changing discourse contexts. This is a strength of the model, as these rules are flexible. In addition, Kintsch does leave the possibility that readers engage in top-down processes like reinstatement searches and problem-solving, which could be a reasonable response to the sort of conflict that occurs when readers encounter information that is inconsistent with prior knowledge.

The Resonance Model

Like the CI model, the resonance model (e.g., Myers & O'Brien, 1998) emphasizes the role of bottom-up, memory-based processes that occur during comprehension. The goal of the resonance model is to account for the reactivation of information during reading (Rizzella & O'Brien, 2002) that is critical to constructing a coherent situation model. The resonance model contends that knowledge reactivation and inferences can be elicited by coherence breaks. Knowledge reactivation occurs via passive resonance processes that operate on the basis of pattern-matching. Concepts derived from a sentence serve as a signal to memory (Myers & O'Brien, 1998). Concepts or propositions in the discourse representation and in prior knowledge *resonate* as a function of semantic and contextual overlap among concepts. Elements that resonate with the signal in turn signal other elements in memory. After activation builds, spreads, and

stabilizes, the most active elements enter working memory where they can influence subsequent processing.

Representational Aspects. The representational aspects of the resonance model are consistent with those of CI (Myers & O'Brien, 1998). The resonance model adopts a view that text representations consist of a retrieval structure (i.e., network) of propositions or concepts. However, Myers and O'Brien noted that a retrieval structure that consists of elements that are not linked, but instead resonate in response to each other, better captures a pattern-matching process.

Processing Aspects. According to the resonance model, elements in memory resonate in response to whatever elements are currently active. There are two fundamental processing features of the resonance process. The first is that resonance is continuous—a signal is always being sent to all of memory. Because working memory contents that constitute the signal are constantly changing, the long-term memory elements that resonate with the signal constantly change as well. Second, the resonance process is "dumb" in that information resonates with the signal and is reactivated regardless of whether it will facilitate comprehension or hinder it.

How is conflict handled? When resonance processes result in reactivation of information that disrupts comprehension, there are several possibilities for how readers may proceed. Readers may 'refocus' on working memory contents and send new signals to memory; readers may engage in problem-solving; or readers may simply read the next clause or sentence (Myers & O'Brien, 1998) depending on their standards of coherence (van den Broek, Risden, Husebye-Hartman, 1995). Critically, when readers refocus or engage in problem-solving, processing—and thus reading time—tends to slow (e.g.,

Albrecht & Myers, 1995; Albrecht & O'Brien, 1993; O'Brien, Plewes, & Albrecht, 1990). Likewise, Myers and O'Brien (1998) posited that there is a second process that continually evaluates the contents of working memory. This second process may register failure when, for example, concepts in working memory contradict each other. In such cases, readers may "refocus" on current working memory contents and send new signals to memory. They may also engage in problem-solving processes to re-establish coherence. Engagement in these processes is also reflected in slower reading times (e.g. Albrecht & O'Brien, 1993).

It is important to note that the ways in which readers handle conflict according to the resonance model are largely consistent with the ways in which readers do so according to the CI model. However, the CI model provides a richer account of how activation of irrelevant information is reduced during reading. This is because the resonance model is predominantly an account of how readers reactivate information during reading—it is not a model of comprehension, per se.

Multiple-Document Comprehension: Representation, Processing, and Conflict

Models of text comprehension, like the ones reviewed above, have deepened our understanding of the cognitive processes that occur as reading comprehension unfolds, but there are several relevant reading contexts that these accounts neglect. Specifically, as Perfetti et al. (1999) noted, these accounts do not capture contexts in which multiple representations of the same situation are presented across multiple documents. Such contexts are increasingly critical given the demands that information consumers face today.

Many of the hypotheses regarding multiple-documents comprehension have come from work on engagement with document sets about historical controversies (e.g., Wineburg, 1991). Results from this work have shown that readers' representations of multiple documents may include key information about the document itself (i.e., the type of document, primary vs. secondary source), the author's identity, and any other information that can be used to connect a piece of information to its source (e.g., Rouet, Britt, Mason, & Perfetti, 1996). Indeed, reading multiple documents compounds the complexity inherent in text comprehension because multiple documents introduce variation in factors like overlap among semantic content and credibility of sources (Braasch, McCabe, & Daniel, 2016). This added complexity has prompted researchers to propose theoretical accounts of multiple-document comprehension, the earliest and perhaps most prominent of which is the Documents Model Framework (DMF; Perfetti et al., 1999).

Several theoretical accounts of multiple-document comprehension have been developed since the DMF. Namely, the Multiple-Document Task-based Relevance Assessment and Content Extraction (MD-TRACE; Rouet & Britt, 2011) outlines a general sequence of processes that readers may perform when engaging with multiple texts for the purposes of completing an overarching reading task. The Reading as Problem Solving model (RESOLV; Rouet, Britt, & Durik, 2017) focuses on readers' management of goals and experience of their physical, social, and communicative context prior to engagement with multiple documents. The Cognitive Affective Engagement Model of multiple source use (CAEM; List & Alexander, 2017) focuses on how readers' level of affective engagement and text evaluation skills (i.e., their default stance)

influence several important multiple-text behaviors like text selection and information access. The Integrated Framework of Multiple Text use (IF-MT; List & Alexander, 2019) builds on these earlier models to conceptualize students' multiple text use as unfolding over the course of three stages: preparation, execution, and production.

These accounts have progressed our understanding of how readers engage with and integrate multiple documents and sources. Moreover, these accounts share in common many of the core processing aspects from the Documents Model Framework, particularly regarding the means by which readers negotiate conflict during reading of multiple documents. Given that the core processes by which readers contend with conflict are relatively consistent across accounts of multiple text comprehension, I focus on the DMF.

Documents Model Framework

There are several proposed ways in which a reader can represent information accessed through engagement with multiple documents (Britt, Perfetti, Sandak, & Rouet, 1999). First, readers may construct separate representations of each document that have no connections among them. Second, readers may construct a "Mush Model" in which information that is common among the various texts is integrated without regard to source information. Third, readers could construct a "Tag-All" model in which all information from every text is tagged with its respective source, but this would come at a very high cognitive load (Britt et al., 1999). The final possibility is the Documents Model, which accounts for how skilled readers form mental representations of multiple documents and the sources communicating the information.

Representational aspects. The documents model presents two core components. The first is the *intertext model*, which captures the relations among documents and among a document and elements of the situation described in the document set. The second is the *situations model*, which represents situations described in the texts broadly (i.e., both real situations and hypothetical ones). When the situations model and the intertext model are interconnected, an integrated *documents model* is represented.

The intertext model consists of a node for each document and links between documents and the situation(s) described. Consistent with the CI model, each node contains slots for source, rhetorical goals, and content. Slots will be filled if the sources are discriminable, cognitive demands are reasonable, and knowledge of the source and the reading situation is sufficient. Source nodes may include a range of source information, like author identification variables (e.g., author's name, credentials, motivation), setting information variables (e.g., setting, time), and document form variables (e.g., language style, document type). Document nodes also contain variables related to the document's rhetorical goals (e.g., intent of document, intended audience), which are typically not stated and must be inferred from prior knowledge. Additional elements of the intertext model are intertext predicates. Intertext predicates represent the relations among documents (e.g., "agrees with X/opposes X") and between a document and a situation model event.

The second core component of a documents model is the situations model. A situations model represents the reader's mental representation of some real or hypothetical world presented by the texts. However, multiple texts may present multiple situations or multiple perspectives on the same situation. The need for a documents

model becomes more obvious if a reader engages with multiple texts about the same situation. If each text were presented in isolation, then a simple causal-temporal network would suffice as a mental representation. However, when texts present conflicting causes for the same situation, event, or topic, the reader must resolve the contradiction. The simplest way to do so would be to build separate causal-temporal networks for each text. However, this would defeat the purpose of engaging with multiple texts (i.e., to acquire a coherent understanding of some situation) and would likely result in a relatively impoverished mental representation.

Processing Aspects. Perfetti et al. (1999) acknowledged that the DMF is primarily a representational framework, which leaves the processing assumptions relatively underspecified. However, the authors adopt and expand on the situation model (e.g., Kintsch, 1988) in the form of a situations model as a product of reading comprehension. In doing so, the authors also adopt, at least implicitly, the processing assumptions of the CI model. Thus, information from *multiple* documents sloppily reactivates information from other documents, previously read information from within a document, and information from prior knowledge to construct an interconnected network. However, in addition to the nodes and links described by the CI model, the DMF also proposes new nodes and links. Specifically, the DMF proposes document nodes and intertext links that can connect sources to other sources (i.e., source-source links) and sources to situations described in the documents (i.e., source-content links). Then, during integration, activation spreads throughout this network, and concepts that have many connections are maintained and those that have fewer are eliminated.

How is conflict handled? Given that the DMF borrows its processing assumptions primarily from the CI model, it can be assumed that conflicting information is handled in much the same way as proposed by the CI model. Essentially, information that has fewer connections within the network will not be maintained across processing cycles, and thus falls out of the reader's mental representation (Kintsch, 1988). However, the discussions of conflicting information in the context of the CI model have dealt with conflicting information such as reactivating multiple antecedents for an anaphor, which is a consequence of the sloppy activation processes during the construction phase. As previously discussed, the type of conflicting information that is most relevant to multiple texts is different. The conflicting information in multiple texts may present opposing perspectives on or accounts of the same issue. Something more than spreading activation during the integration phase may be necessary to resolve an inconsistency such as opposing perspectives. As mentioned, Kintsch (1988) has proposed that readers may engage in some type of problem-solving process in such instances, but this process is not described in detail. Likewise, the DMF also lacks detailed discussion about the processes that occur as readers attempt to resolve this type of conflict.

Sourcing in Multiple-Document Contexts

The development of models like the DMF shows progress in our understanding of how readers engage with multiple documents. This is especially important given that the relaxed publishing parameters brought about by the information age have shifted the responsibility of gatekeeping from professional editors to the readers (Bråten, Braasch, Strømsø, & Ferguson, 2015). As such, readers must be able to discern for themselves whether they can trust or believe an information source. Thus, it is crucial to understand

readers' sourcing processes in the service of multiple-documents comprehension. Sourcing refers to a range of activities involved in establishing relations between text contents and the sources of those contents (Saux et al., 2017). Importantly, sourcing has been shown to be particularly relevant when documents include sources that provide conflicting information (Braasch et al., 2012). The following sections provide more detail about recent accounts of how readers use source information during reading of multiple documents.

Discrepancy-Induced Source Comprehension Model

The D-ISC model (Braasch & Bråten, 2017) is a process-oriented account that draws from prominent accounts of single-text comprehension, such as the CI and Resonance models. D-ISC provides an account of how readers engage with controversial, conflicting, or inconsistent messages originating from different sources. The goal of the model is to account for how readers establish global coherence when engaging with discrepancies, either within a text or across multiple texts or documents. When readers cannot be sure about which source is correct, they will experience difficulty constructing a coherent mental representation of the situation. D-ISC is predicated on the idea that readers will strategically direct their attentional resources towards constructing a representation that emphasizes source information as a way to organize an otherwise incoherent mental representation.

Representational Aspects. D-ISC primarily adopts the representational framework of the DMF (Perfetti et al., 1999). A core claim of D-ISC is that readers use source information to structure their long-term memory representation of discrepant information. Increased attention to source information produces stronger source-content

links that can subsequently be retrieved. Because readers may construct a representation that includes strong source-content links, each source and its respective information are discriminable in long-term memory. Existing research has provided evidence for D-ISC's assumptions when discrepancies exist within a single text, across multiple texts, and between the text and the reader (e.g., Barzilai & Eshet-Alkalai, 2015; Braasch et al., 2016; Maier & Richter, 2013).

Processing Aspects. D-ISC assumes that readers process texts via the same processes proposed by prominent models of comprehension (Kintsch, 1998; Myers & O'Brien, 1998). What is unique about D-ISC is its emphasis on discrepancies. According to D-ISC, discrepancies compel readers to use source information as an organizational framework in order to restore coherence. Thus, discrepancy can be attributed to different sources, which lessens the burden on the reader to resolve the discrepancy. Moreover, reactivating source information related to discrepant claims may aid the reader's ability to evaluate the relative trustworthiness of those claims and the evidence provided by those sources. In turn, this reactivation and integration produces memory representations of discrepant information in terms of the respective sources.

Braasch and Bråten (2017) reviewed empirical findings to support their conceptualization of D-ISC. Among the important processing aspects of the model, the authors proposed that discrepancies within or between documents increase the time readers spend processing information sources and lead to better memory representation of source information after reading. These findings may be a function of deeper encoding of source-content links during reading. Conversely, when information within or across texts is consistent, readers may encode source-content links rather shallowly and demonstrate

impoverished memory traces, which reduces the readers' ability to recall and discriminate among information sources during retrieval (e.g., Braasch et al., 2016). Additionally, when information is consistent, readers may process texts in ways that prioritize semantic content integration, which may come at a cost to processing and representing source information (Braasch et al., 2016).

D-ISC draws upon the idea of passive co-activation as a first phase in processing in order to encode discrepancies during reading, as decoding the discrepancy is a necessary precondition for D-ISC to unfold. When source information is associated with the conflicting claims, D-ISC proposes that passive activation processes, adopted from the Resonance Model (Myers & O'Brien, 1998), lead to co-activation of the discrepant claims in working memory. If this co-activation leads to cognitive conflict, then a second, more effortful processing phase can occur. During this second phase, readers may strategically attend to and evaluate source information associated with the conflicting claims. Drawing from constructionist accounts of reading (e.g., Graesser, Singer, & Trabasso, 1994), readers may engage in an active search of prior knowledge to assess potential reasons for the conflict.

How is conflict handled? The means by which readers handle conflict is the crux of D-ISC. To summarize, when readers encounter a conflict or discrepancy, they shift to more strategic processing. This strategic processing is aimed toward encoding source information and evaluating the trustworthiness of the claims from those sources. This increased attention to sources and the information presented from each source encourages the construction of document nodes and strengthens source-content links in the reader's mental representation of the texts. Consequently, these source-content links can be used

as a means to organize the mental representation of the conflicting information, which is helpful given that readers typically encounter problems when they use semantic content alone to resolve conflicts (e.g., Chinn & Brewer, 1998; Hakala & O'Brien, 1995).

Content-Source Integration Model

The Content-Source Integration (CSI) model (Stadtler & Bromme, 2014) is another account of how readers use source information during reading. The CSI model also draws from existing accounts of single- and multiple-text comprehension (e.g., Kintsch, 1988; Perfetti et al., 1999) to describe the cognitive processes readers engage in when they encounter conflicting information about a particular issue. The model articulates several stages of processing conflicting information, including conflict detection, conflict regulation, and conflict resolution.

Representational Aspects. Like D-ISC, CSI borrows its representational assumptions from existing accounts of reading comprehension (e.g., Kintsch, 1988; Perfetti et al., 1999). Instead of proposing additional representational aspects, CSI posits several core processes that readers engage in when they encounter conflicting information in multiple documents. Moreover, the processing assumptions of CSI and the means by which conflict is handled are difficult to separate. Thus, underlying processing assumptions are reviewed only briefly, with a more in-depth discussion provided in the review of how CSI handles conflict.

Processing Aspects. CSI assumes that readers reactivate prior knowledge and detect inconsistencies during reading via passive resonance processes (Myers & O'Brien, 1998) or spreading activation processes (Kintsch, 1998). CSI also claims that a precondition for conflict detection is coactivation of conflicting propositions in working

memory. Coactivation allows for the conflicting propositions to become integrated into the same network, wherein an inhibitory link may be established between the conflicting propositions (Kintsch, 1988). As a result, the reader encodes the conflict and processing slows.

How is conflict handled? CSI posits three core processes that can occur when readers encounter conflicting information while reading multiple documents. The first processing phase, *conflict detection*, brings an awareness that two or more propositions are incoherent (Stadtler & Bromme, 2014). This would incite the reader, depending on his or her level of domain expertise, to actively check for information consistency (i.e., corroboration, Wineburg, 1991). Reading goals exert their influence in two main ways—by determining a reader's standard of coherence (van den Broek, Bohn-Gettler, Kendeou, Carlson, & White, 2011) and by determining the relevance of information. In terms of standards of coherence, proficient readers modify their processing in accordance with their standard of coherence (van den Broek et al., 2011). When detecting a conflict necessitates activation of distant information, a standard of coherence may be required that involves forming coherence across multiple documents. In terms of relevance, reading goals place constraints on what information is relevant (McCrudden & Schraw, 2007), which is important given that readers generally elaborate relevant information more than irrelevant information, which facilitates retrieval of that information (Stadtler & Bromme, 2014).

The second phase according to CSI is *conflict regulation*, which involves restoring coherence after conflict detection. Readers can ignore the conflict, reconcile the conflict, or accept the conflict as a consequence of different sources. Ignoring the conflict

is the simplest means of restoring coherence but may result in an impoverished mental model. Reconciling or choosing between conflicting propositions is likely to occur when the conflict is relevant to the reader's goals and when explanations are available to the reader. Finally, readers may accept a conflict as due to different sources. This is done when readers cannot ignore or reconcile a conflict. In this case, readers interpret the coherence disruption as a function of different perspectives rather than a genuine coherence break (Strømsø, Bråten, Britt, & Ferguson, 2013).

The third phase is *conflict resolution*. Resolving a conflict requires the reader to develop a personal stance toward the conflict via validity judgments as a result of firsthand and/or secondhand evaluations of truth value. Firsthand evaluations involve assessing the validity of claims based on prior knowledge and occur automatically so long as readers possess relevant prior knowledge (Richter, Schroeder, & Wohrmann, 2009). Secondhand evaluations involve evaluating the validity of claims based on source information. This evaluation occurs primarily when firsthand evaluations fail. When engaging in secondhand evaluations, readers may focus on two source features—benevolence (i.e., intention to provide valid information) and expertise (i.e., competence to provide accurate and relevant information) of the source.

Knowledge Revision: When Text(s) Conflict with Prior Knowledge

The aim of the preceding sections was to provide an understanding of how reading comprehension unfolds in general and under conditions of conflict. However, none of the models reviewed thus far account for how readers *revise* their incorrect prior knowledge during reading. As I discuss next, Kendeou and O'Brien (2014) developed the Knowledge Revision Components Framework (KReC) to describe the processes that

occur as readers engage with single documents that refute and explain misconceptions (i.e., refutation texts).

The Knowledge Revision Components Framework (KReC)

KReC describes a specific set of assumptions and conditions that must be met for knowledge revision to occur. The crux of KReC is the competing-activation mechanism, in which the reactivated misconception and the newly encoded correct information compete for limited activation. Knowledge revision is successful when the activation of the correct information overcomes activation of the misconception. Each of KReC's principles is briefly reviewed below and discussed more comprehensively when I propose modifications and expansions of each of KReC's principles, based on the work reviewed thus far, so that they may account for the added complexity of engaging with multiple documents.

Representational Aspects. Like other discourse frameworks reviewed here, a core assumption of KReC is that knowledge is organized in a network of interconnected nodes (Kendeou & O'Brien, 2014). Nodes consist of concepts or propositions, and links represent the relations among these concepts (e.g., Kintsch, 1988; Myers & O'Brien, 1998). Incoming information serves to passively reactivate previously read information and prior knowledge from memory. Reactivated contents, as well as newly encoded information, can then become integrated into one network. Moreover, as readers encode more information related to a particular concept, the structural richness surrounding that concept is assumed to increase (Kendeou & O'Brien, 2014), which enables that concept to dominate the network.

Processing Aspects. KReC consists of five principles that account for knowledge revision processes as readers engage with a refutation text. The first two principles consist of core assumptions (*encoding* and *passive activation*), and the next two principles (*coactivation, integration*) describe conditions that must be in place for the mechanism of knowledge revision (*competing activation*) to occur. The *encoding* principle assumes that information that has been encoded and stored in long-term memory cannot simply be erased or replaced (e.g. Gillund & Shiffrin, 1984; Hintzman, 1986; Kintsch, 1988; Ratcliff & McKoon, 1988) and therefore has some potential to be subsequently reactivated. The *passive-activation* principle assumes that information in long-term memory can be reactivated via passive processes (Myers & O'Brien, 1998; O'Brien & Myers, 1999). Specifically, incoming information serves as a signal to all of long-term memory, and long-term memory contents that resonate with that signal as a function of featural overlap become reactivated. Importantly, this reactivation can unfold regardless of whether memory contents facilitate or interfere with comprehension processes.

The remaining three principles of KReC specify the conditions and mechanism that serve to reduce the activation of misconceptions. *Coactivation* is necessary for knowledge revision because both the new information and misconception from prior knowledge must be simultaneously activated (Kendeou, Muis, & Fulton, 2011; Kendeou & van den Broek, 2007; van den Broek & Kendeou, 2008). Next, the *integration* principle contends that revision can only occur after the newly encoded information becomes integrated with the misconception (e.g., Kendeou & O'Brien, 2014; Kendeou, Walsh, Smith, & O'Brien, 2014). Integration enables the mechanism of the revision

process, *competing activation*, to unfold. As the amount of newly encoded information increases, it will begin to dominate the integrated network and draw activation to itself and simultaneously draw activation away from the misconception. If sufficient activation is drawn away from the misconception, any disruption it imposes can be reduced or eliminated (see also McNamara & McDaniel, 2004).

How is conflict handled? At the core of the KReC framework is the competing activation mechanism. After the newly encoded information becomes integrated with the misconception from the reader's prior knowledge, these two ideas in memory are bound into one memory representation. This means that activating one idea is expected to passively reactivate the other idea, regardless of whether it is correct or relevant. When the text provides an interconnected explanation that supports the correct idea, these interconnections increase the richness of the nodes surrounding the correct idea. In doing so, the correct idea draws increased activation to itself, and because activation is a fixed cognitive resource, activation is simultaneously drawn away from the misconception, thereby reducing interference induced by the conflict between the misconception and correct idea (Kendeou & O'Brien, 2014).

Competing activation may not always be sufficient for knowledge revision to occur, especially in cases when there is no refutation or explanation of the reader's misconception. In such cases, recent work has shown that inhibition of prepotent responses may assist readers in suppressing interference from co-activated, conflicting ideas (Butterfuss & Kendeou, 2020), which in-turn may enable readers to engage in problem-solving or metacognitive processes aimed at resolving the conflict in the absence of a refutation and explanation of the misconception (Kendeou et al., 2019).

Conclusion

The work reviewed above provides an understanding of how readers process and represent multiple documents. It also provides an understanding, albeit incomplete, of how readers negotiate information that conflicts with their prior knowledge in the context of text comprehension (i.e., KReC). However, we do not have a theoretical account of how readers revise their inaccurate prior knowledge or misconceptions in the context of multiple-document comprehension. Such an account must integrate aspects from the extant literature reviewed thus far. Specifically, processing and representational aspects (i.e., the idea of the multiple-documents (MD) representation) could be drawn upon to modify or extent KReC's principles in order to account for knowledge revision when readers engage with multiple documents. In the next chapter, I present an initial proposal of KReC-MD.

Chapter 3: The Knowledge Revision Components Framework – Multiple Documents (KReC-MD)

The aim of the current chapter is to propose an initial conceptualization of KReC-MD. To do so, I draw from the work reviewed in the previous chapter to propose how KReC's principles may be modified or extended in order to account for knowledge revision when readers engage with multiple documents. Although not a formalized account, this initial proposal of KReC-MD enables predictions for future empirical investigations and further development and refinement of the framework.

The Encoding Principle

The encoding principle captures the assumption that information that has been encoded into long-term memory leaves a permanent trace that cannot simply be erased or overwritten, although it is susceptible to interference or decay (e.g., Gillund & Shiffrin, 1984). Because information in long-term memory cannot be erased, it has potential to be reactivated. This can happen even when the information interferes with comprehension and even when the reader knows the information is incorrect.

In KReC-MD, readers encode information from different sources and, in some cases, *about* different sources. Consistent with D-ISC's proposal that readers devote greater attention to source information when they encounter a discrepancy during reading (Braasch & Bråten, 2017), in KReC-MD, readers may be likely to encode source information given that they encounter a discrepancy in the text (or are explicitly instructed to attend to source information; Van Boekel et al., 2017). Thus, in extending the encoding principle to account for multiple documents, readers are expected encode source information during reading of refutation texts because of the discrepancy inherent

in the refutation of the reader's misconception. The more explicit the discrepancy, the stronger the encoding of source information, which has been shown to increase memory for sources after reading as well (Saux et al., 2017) and influence conflict resolution after reading in opinion essays (Kobayashi, 2014).

The Passive Activation Principle

KReC adopted passive activation processes from global models of memory to account for how inactive information becomes reactivated (e.g., Gillund & Schiffrin, 1984). These resonance processes are passive and unrestricted, and thus any information that is related to current working memory contents may become reactivated.

In KReC-MD, passive activation is expected to function in much the same way as it does in single-document contexts. One key difference, however, is that with multiple documents, readers may integrate source nodes (Perfetti et al., 1999) into the network of information through which activation spreads. Because source information and document information that comprise the nodes are represented, this information is subject to passive activation in the same way as semantic content from texts and prior knowledge. Information that is common among authors of multiple documents is strengthened, and thus may have a lower threshold for passive activation than information that only occurs in one document within a document set. However, because content integration across texts can hurt source memory (e.g., Braasch et al., 2016), it may be more difficult to attribute shared information to any one source in the documents model due to weaker intertext links.

The Co-Activation Principle

The co-activation principle does not change substantially between KReC and KReC-MD. Co-activation of the misconception from prior knowledge and the newly encoded correct information from the texts is the result of the passive activation processes described above. Co-activation is necessary for knowledge revision because it is the sole way in which new information comes into contact with the misconception. In the case of KReC-MD, however, readers may have multiple accounts of a situation from multiple documents activated simultaneously. Once this occurs, the two (or more) concepts can become integrated into a single network. Additionally, co-activation of information from two (or more) documents or sources may be necessary for intertextual integration to occur (in the form of intertext links).

The Integration Principle

Unlike the preceding principles, the integration principle changes markedly between KReC and KReC-MD. In both single-document and multiple-document contexts, if the correct idea and the misconception do not become integrated into the same network, revision cannot occur given that spreading activation occurs throughout this integrated network. The nature of this network changes for KReC-MD to account for the representational complexities of multiple documents. Specifically, integration now spans across multiple documents, resulting in an intertext model, a situations model, and, if these two models become interconnected, a documents model. So, this network is expected to include source-source links and source-content links, as is assumed in the DMF.

It is important to note that certain kinds of tasks have been shown to enhance integration of information across multiple documents. Namely, tasks that encourage readers to develop a personal opinion and interpretation of information found in multiple documents (e.g., argumentative or persuasive essay-writing tasks) have been shown to facilitate stronger integration than tasks require merely retelling or summarizing information (e.g., List, Du, Wang, & Lee, 2019; Wiley & Voss, 1999).

The Competing-Activation Principle

The most important distinction between KReC and KReC-MD lies in how competing activation unfolds. According to KReC, as the amount of newly encoded correct information increases, it will start to dominate the network into which it was integrated. As the correct information begins to dominate the network, that portion of the network will begin drawing increased activation to itself, and as a consequence, away from the misconception. As activation is drawn away from the misconception, the interference associated with that misconception is reduced accordingly.

The added complexity of engaging with multiple documents from multiple sources requires KReC-MD to specify additional conditions to account for competing activation. Namely, KReC simply claims that readers encode correct information as they read an explanation in a refutation text. However, with multiple documents, instead of an explanation from a single source supporting a single correct idea, there may be multiple explanations that address several individual misconceptions, which together address a *global* misconception. This global misconception represents a deeper misconception that underlies the individual misconceptions addressed in the documents, and as such, encountering refutations and/or explanations of the individual misconceptions is expected

to reactivate this global misconception to some extent. Likewise, the explanations provided in the course of addressing the individual misconceptions are also expected to yield a *global* correct idea, which represents that antithesis of the global misconception. The global correct idea and the global misconception will compete for activation, and whichever idea has a richer network of supporting information is expected to attain the greatest activation during competing activation. Thus, competing activation unfolds in a network that contains multiple representations that include information about the documents and sources themselves, the individual misconceptions and corresponding correct information, as well as the global misconception and global correct idea.

How does KReC-MD account for the added complexity of multiple representations? First, KReC-MD adopts the framework of an intertext model and situations model, which combine to form a complete documents model, from the DMF (Perfetti et al., 1999). Particularly, each document the reader engages with is represented as a "document node" that may be connected to other nodes via intertext links that specify relations among documents (e.g., *supports, conflicts, etc.*). Document nodes can contain source information, which includes the source's credibility and intent. Importantly, these document nodes are also linked with the situation(s) described across the documents. In the case of knowledge revision, the situations model will consist of both newly encoded information related to the individual misconceptions addressed in the texts, as well as the global correct idea and the global misconception reactivated from prior knowledge.

Within this integrated Documents Model, several factors are hypothesized to play a role in determining the outcome of competing activation. These factors include: (1) the

number of links or connections between the intertext model and the situations model (i.e., the correct idea and the misconception); (2) the *type* of connections among documents and concepts; and (3) source credibility (i.e., the willingness of a source to provide accurate, reliable information; Pornpitakpan, 2004) of the information sources within the documents. Next, I propose the ways in which each of these factors may influence competing activation in KReC-MD.

Number of connections. The *number* of connections between elements in the intertext model and elements in the situations model is expected to influence knowledge revision outcomes. The number of connections between the intertext model and the situations model should correspond to the number of documents that support the global correct idea versus the global misconception—whichever idea is more richly linked to the intertext model may receive increased activation and consequently form a stronger memory representation. This is much like how, in single-document knowledge revision, the rich connections inherent in the explanation provided in a refutation text support activation of the correct idea at the expense of the misconception. With KReC-MD, though, the rich connections may come from multiple documents as well.

Type of Connections. There are several types of connections hypothesized by the DMF. Particularly, documents in the intertext model may be linked to concepts in the situations model via intertext links. Documents may also be linked to other documents in a document set (source-source links). For example, if a document explicitly refers to another document, readers may represent a link between those two documents. This is important because these documents may mutually bolster the activation of their

respective information. This increased activation, in turn, supports the idea in the situations model to which it is linked—either the global misconception or correct idea.

One important question is whether links between documents in the intertext model can influence revision regardless of whether the two documents conflict with or corroborate each other. This is particularly critical given that readers are likely to encounter documents that conflict with each other when they seek information on the internet related to their misconceptions. In such situations, existing work suggests readers may shift their attention to the sources of the documents as a means restoring coherence. Specifically, readers may be likely to affirm information from high-credibility sources and/or negate information from the lower-credibility sources (Kobayashi, 2014; Sparks & Rapp, 2011). In other words, information from sources that the reader deems highly credible may garner relatively higher activation and may therefore be more readily integrated into readers' intertext model and situations model, than information from low-credibility sources.

Source Credibility. Source credibility has been shown to influence the extent to which readers use source information when they encounter a discrepancy (Braasch et al., 2012). Whether readers attend to, encode, and use source information may be a function of task demands (e.g., Van Boekel et al., 2017). As mentioned, to encode and use source information, readers typically must be explicitly instructed to attend to source information (Van Boekel et al., 2017) or encounter a discrepancy between texts, within a text, or between texts and prior knowledge (e.g., Braasch et al., 2012). Indeed, Sparks and Rapp (2011) found that readers slowed down when encoding information from low-credibility sources, but only when they were not instructed to attend to source

information. When the task demanded source attention, results indicated the opposite pattern—readers were slower when encoding information from high-credibility sources, perhaps as a function of focusing more on statements from high-credible sources.

Additionally, within the context of refutation texts, Van Boekel et al. (2017) examined the role of source credibility of the characters that provided refutations and explanations (i.e., embedded sources; Bråten, Stadtler, & Salmerón, 2018). The results indicated that source credibility influenced knowledge revision such that participants experienced more interference in the low-credibility condition and demonstrated worse revision after reading. Taken together, these findings suggest that information from low-credibility sources may receive relatively less activation and may be less readily integrated compared to information from high-credibility sources. Thus, information from low-credibility sources may have a relatively difficult time overcoming the misconception during competing activation. In turn, this would suggest that knowledge revision is more likely to unfold successfully when the global correct idea is supported by information from high-credibility sources.

KReC-MD: Examples and Illustrations

In what follows, I walk through two scenarios of knowledge revision in which a reader engages with a set of three refutation texts that address a global misconception (i.e., *genetically modified organisms (GMOs) are harmful*). Within this set of refutation texts, each text addresses a specific misconception that may feed into that global misconception: (1) *Most crops humans consume are GMOs;* (2) *GMOs accumulate in animal products like meat, eggs, and milk;* and (3) *GMOs are reducing honeybee populations.* In one scenario, the texts all come from high-credibility sources in the

domain of GMOs (e.g., Food & Drug Administration, US Department of Agriculture, Organic Farmers Association). In a second scenario, the texts come from relatively low-credibility sources in the domain of GMOs (e.g., Fox News, Huffington Post, Buzzfeed News). Given that the goal of these scenarios is to outline the core KReC-MD processes that occur *during* reading of multiple refutation texts, I assume that the reader has chosen to engage with the set of documents and that they have been assigned a reading task that has been shown to facilitate understanding and integration of information in multiple documents (e.g., an argumentative writing task or research report for policy makers; e.g., List et al., 2019; Wiley & Voss, 1999).

In the first scenario, the reader *encodes* the refutation and explanation in each refutation text, with each text *passively reactivating* to some extent the global misconception that *GMOs are harmful.* Once this *co-activation* occurs, content from each of the refutation texts becomes *integrated* with the global misconception into a single network. Because each text contains an explicit discrepancy via a refutation, readers may be likely to shift attention to source information, and consequently, source-source and source-content links may also be integrated into this network. Moreover, if a document reactivates information from previous text, there could be links between documents. Thus, the result of these processes is a network of documents (i.e., an intertext model) and newly encoded information from the texts and reactivated memory contents (i.e., a situations model), which are linked to form documents model (see Figure 1 for an illustration). Because each refutation text contributes unique information in support of the global correct idea, there should be a relatively strong link between the intertext model and the global correct idea in the situations model (*that GMOs are safe*), assuming the

reader integrates the information from the documents. Moreover, the global misconception (*GMOs are harmful*) is related to each specific misconception addressed in the refutation texts. Thus, readers may also integrate a link between the misconception and the intertext model.

Because each source is high-credibility in this scenario, information from these sources receives a high-credibility "tag" that serve to increase their activation. By contrast, information with a low-credibility "tag" would garner relatively less activation. In turn, this increased activation for information from high-credibility sources supports the activation of the idea with which it is linked (e.g., in this case, the correct idea).

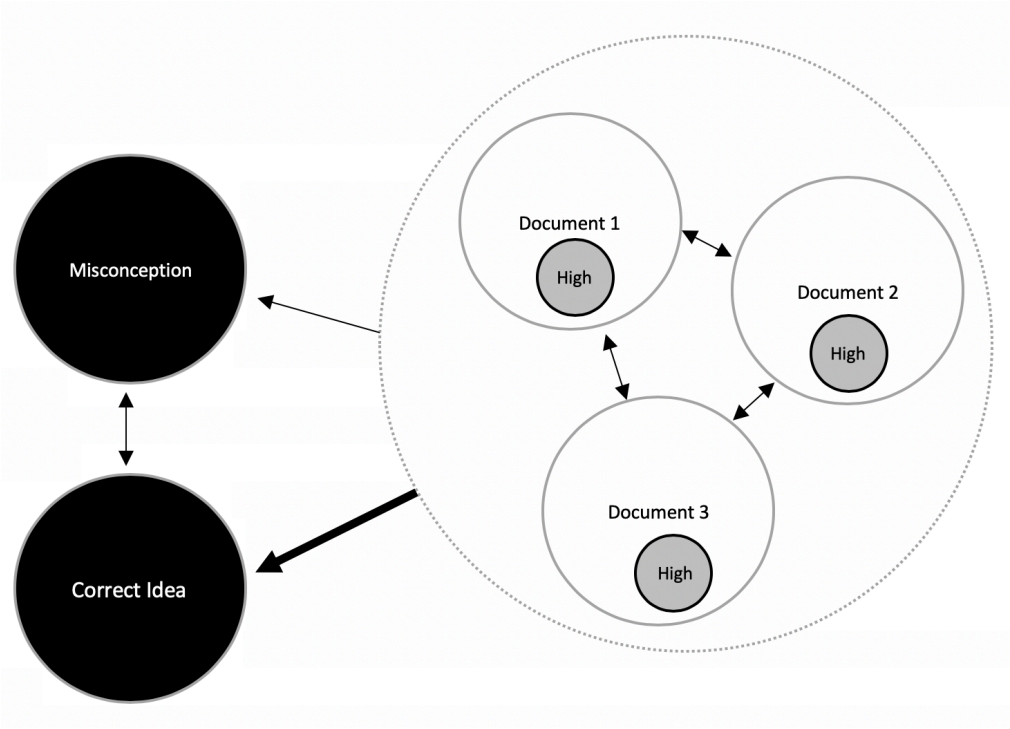

Figure 1. KReC-MD Documents Model in Scenario 1: High-Credibility Sources
Black circles represent concepts in the Situations Model. The large dotted circle represents the intertext model, and smaller white circles represent the documents. Gray circles

represent source credibility tags. Double-headed arrows represent source-source links. Single-headed arrows represent intertext links.

In this scenario, the outcome of competing activation may be fairly straightforward given the qualities of the documents within the set of refutation texts. Namely, there are three explanations that support the global correct idea that GMOs are safe, whereas none of the texts supports the global misconception that GMOs are harmful. Thus, there is a stronger connection between the integrated contents of the refutation texts (i.e., intertext model) and the global correct idea in the situations model. Moreover, information from each document is heightened in activation because of a high source-credibility tag, and the documents are interrelated via their semantic overlap. Thus, it is clear that the global correct idea should garner a relatively high level of activation at the expense of the activation of the global misconception (as indicated by the relatively bold connection between the intertext model and the "Correct Idea" node in the situations model). Thus, knowledge revision of the global misconception that GMOs are harmful should be facilitated.

In a second scenario, a reader engages with a similar document set, but the three sources are relatively low in credibility. In this case, the same sequence of processes unfolds much like it does in the first scenario, at least until the competing activation mechanism. Namely, the information in the texts are tagged as low-credibility, which introduces a few new possibilities: (1) the low-credibility sources garner relatively little activation—compared to instances in which documents are tagged with high-credibility—and thus have attenuated links to the idea they support (Van Boekel et al., 2017); (2) the low-credibility of the sources could lead readers to reject or negate the

information from those sources (Stadtler & Bromme, 2014): (3) it is also possible that the reader could reject the information and actually affirm the *opposite*, resulting in increased activation of the misconception (e.g., Sparks & Rapp, 2011). The first possibility may be more likely if the reader does not integrate strong source-source links during reading, whereas the last two possibilities may be more likely if the reader deeply integrates source-source links. Consistent with D-ISC and the CSI model, the strength with which the reader represents source-source links may depend on awareness of the explicit discrepancy inherent in the refutation (Braasch & Bråten, 2017; Stadtler & Bromme, 2014). In this illustration, I propose the most straightforward possibility—that the reader forms rather weak source-source links and discounts the information from the low-credibility texts. Figure 2 illustrates how this reader's documents model may have been constructed during reading of the refutation texts.

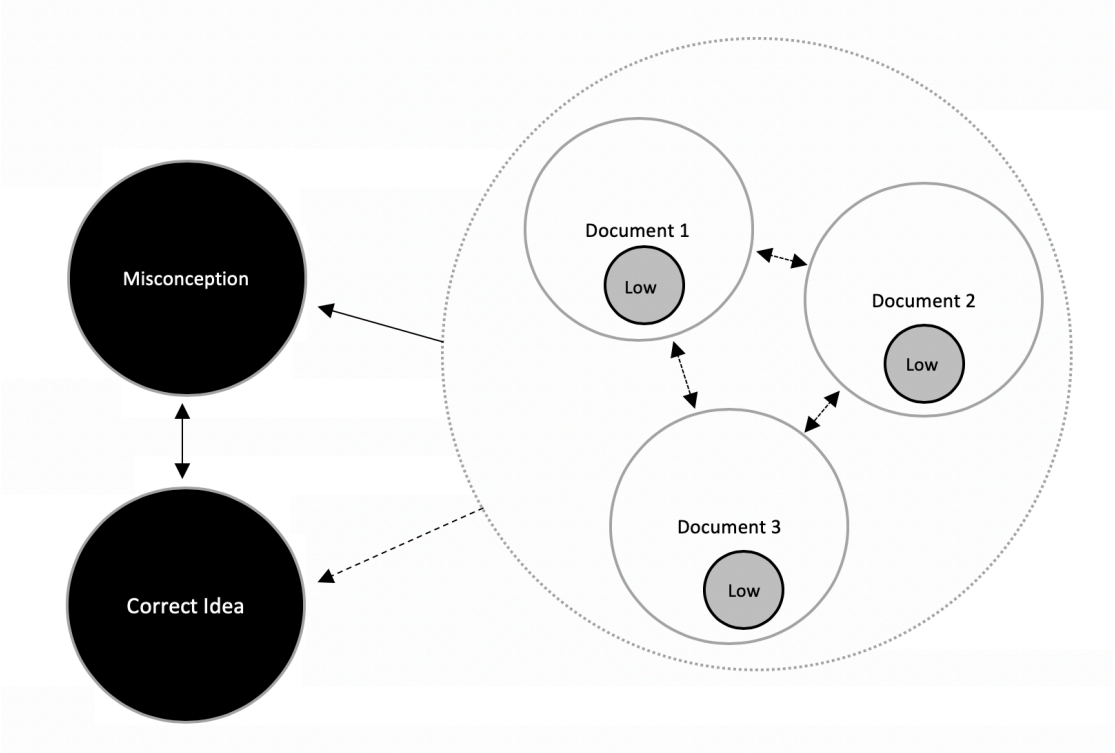

Figure 2. KReC-MD Documents Model in Scenario 2: Low-Credibility Sources.

Black circles represent concepts in the Situations Model. The large dotted circle represents the intertext model, and the smaller white circles represent the documents. Gray circles represent source credibility tags. Double-headed arrows represent source-source links. Single-headed arrows represent intertext links.

In scenario 2, the outcome of competing activation is less straightforward. Although the documents refute and explain specific misconceptions that relate to the global misconception that GMOs are harmful, the low-credibility sources may lead the reader to integrate source-source links rather shallowly (represented by dashed links between documents) and thus discount their respective content, as proposed by the CSI model (Stadtler & Bromme, 2014). This leaves none of the three sources to substantially impact the activation of the global misconception, given that readers tend to affirm information from high-credibility sources (e.g., Kobayashi, 2014). In other words, the connection between the intertext model and global correct idea in the situations model is attenuated because the information from those sources was discounted and therefore weakly integrated (represented by the dashed line between the intertext model and the global correct idea node in the situations model).

Given that the links among sources are relatively weak and the information from the documents is discounted, little activation would be garnered for the global correct idea. According to competing activation, this means that relatively little activation would be drawn away from the global misconception. Taken together, the result may be that lasting knowledge revision is unlikely.

Conclusion

This initial conceptualization of KReC-MD draws directly from existing work regarding knowledge revision, single- and multiple-document comprehension, and sourcing. Importantly, the proposed amendments to KReC's principles garner predictions for future experimental work to address. In turn, this empirical evidence will allow for a richer and more formal description of KReC-MD's principles. An account of knowledge revision in the context of multiple documents is critical given that readers are consistently confronted with multiple documents and sources. This is especially true in online environments, where the amount of inaccurate information that reactivates consequential misconceptions is an increasing threat to our intellectual survival (Kendeou et al., 2020).

Future empirical work should use diverse methodologies to examine how various text-level and reader-level factors could influence knowledge revision processes and outcomes in multiple-document contexts according to KReC-MD. As such, Experiment 1 (Chapter 4) examines the influence of text structure (refutation vs. non-refutation) and source credibility (low vs. high) on knowledge revision *outcomes*. To evaluate the *processes* that occur during reading of multiple documents, Experiment 2 (Chapter 5) examines the influence of source credibility (low vs. high) on the integration processes, sourcing processes, and knowledge revision processes that readers engage in as they read multiple documents. The implications of the findings from these two experiments for existing research, as well as how the findings specify and refine KReC-MD, are discussed in the General Discussion (Chapter 6).

In all, much work, both theoretical and empirical, is needed to develop a comprehensive, detailed account of knowledge revision during multiple-document

comprehension. Still, the first steps and initial proposal in this chapter may prove useful as the early groundwork necessary for this work to unfold.

Chapter 4: Experiment 1

The overarching aim of Experiment 1 was to examine the extent to which source credibility and text structure influence knowledge revision outcomes when readers engage with multiple documents, as conceptualized in KReC-MD. Moreover, because engaging with multiple documents offers the possibility of integrating information across documents and constructing an integrated multiple-documents representation (MD representation, Perfetti et al., 1999), Experiment 1 also examined the extent to which intertextual integration influenced knowledge revision outcomes. To address this overarching aim, I propose three core research questions.

The first research question is *to what extent do source credibility and text structure influence intertextual integration*? According to KReC-MD, source credibility and text structure are expected to influence integration in a few ways. With respect to source credibility, readers may affirm information from high-credibility sources and discount information from low-credibility sources. With respect to text structure, it is possible that the refutations may increase cognitive conflict, which in turn may promote greater intertextual integration as a means of resolving the conflict. Refutations may also increase attention to source information, which may promote greater integration of source information—and information from those sources—into readers' MD representations. Thus, it follows that high-credibility sources and refutation texts should foster superior intertextual integration (Hypothesis 1).

The second research question is *to what extent do source credibility and text structure influence knowledge revision outcomes?* With respect to source credibility, KReC-MD predicts that readers will more often affirm and integrate information from

high-credibility sources. Consequently, this information may receive relatively higher levels of activation than information from low-credibility sources. Therefore, correct information from high-credibility sources should overcome activation of the reader's misconception more easily than information from low-credibility sources during competing activation and should therefore facilitate better knowledge revision. Thus, I expect that the high-credibility text condition will foster superior knowledge revision, perhaps especially when those texts contain refutations (Hypothesis 2).

At the core of KReC-MD is the prediction that intertextual integration influences knowledge revision outcomes. Thus, along with KReC-MD's predictions for how source credibility and text structure would influence both intertextual integration and knowledge revision, it is critical to examine how intertextual integration influences knowledge revision outcomes. The third research question is *to what extent does intertextual integration influence knowledge revision outcomes?* Readers who engage in more intertextual integration and/or construct more highly integrated MD representations are likely to have a richer, interconnected network of correct information, which may more readily overcome the activation of pre-existing misconceptions, as well as the global misconception. Thus, I expect that readers who engage in more intertextual integration will demonstrate better knowledge revision than readers who engage in less integration (Hypothesis 3).

Method

Participants

One-hundred seventy-four undergraduate students (109 female, M_{age} = 19.6 years, SD_{age} = 1.7 years) completed the study for extra credit. This sample size was based on an

a-priori power analysis, which indicated a target sample size of n = 160 to detect a small-to-medium effect (η_p^2 = .10). The sample was 68% White, 19% Asian, 9% Black, and 5% other/not specified. All participants were fluent English speakers. Participants were recruited from undergraduate psychology and educational psychology courses and completed the study for extra credit. Data from n = 14 participants were excluded from analyses because their average time spent on each document indicated a reading rate of greater than 16.6 words per second, which is the upper limit of reading speed for superior readers (Brozo & Johns, 1986). Additionally, data from n = 3 participants were excluded because they failed to discriminate high- and low-credibility sources based on the Source Credibility Questionnaire (detailed below). Thus, the final sample size was n = 157 participants.

Pilot Study

A sample of n = 40 undergraduate students (15 male, 24 female, 1 non-binary; M_{age} = 19.9; SD_{age} = 4.1) participated in a pilot study to gauge misconception prevalence, as well as source familiarity and perceived source trustworthiness in the domain of GMOs. Participants completed true/false items to gauge misconception prevalence and rated the familiarity and trustworthiness of sources on a scale from 0 (Not at all familiar/trustworthy) to 100 (completely familiar/trustworthy). Overall, three of the misconceptions that had the highest prevalence (> 60% of participants believed the misconception) in the pilot study were included in the current materials (see Table 1).

Table 1.

Misconception Prevalence Based on Pilot Study.

Misconception	Prevalence

Genetic modification of food is a modern invention.	72%
There is evidence that GMO foods cause cancer.	29%
GMO crops contain toxic substances.	44%
GMO crops pose an increased risk to people who have allergies.	39%
Altered genes from GMO plants spread and damage conventional crops.	50%
*GMO crops contribute to the decline in honeybees.	63%
*Nearly all crops we consume today are GMOs.	96%
*If livestock eat genetically modified grain, there will be GMOs in meat, milk, and eggs	71%

* indicates a misconception included in the current study.

Moreover, the information sources that participants rated as highest in credibility (FDA, USDA, Organic Farmers Association) and lowest in credibility (Fox News, Huffington Post), but were also highly familiar, were included as the sources for the current study (see Table 2). Note that Buzzfeed News was included in the materials for the current study but was not included in the pilot study. Buzzfeed News was included because Snopes had low familiarity ratings. Thus, Buzzfeed News was included because it is a more popular news source and is also relatively low in credibility (Shen et al., 2018; Zhou & Xue, 2019), which is consistent with the other low-credibility sources identified in the pilot study.

Table 2.

Trustworthiness and Familiarity of Sources Based on Pilot Study.

Information Source/Organization	Trustworthiness	Familiarity
*US Food and Drug Administration (FDA)	88 (*SD* = 15.1)	68 (*SD* = 26.3)

Monsanto	52 (*SD* = 29.2)	16 (*SD* = 24.6)
*US Department of Agriculture (USDA)	89 (*SD* = 13.0)	63 (*SD* = 30.2)
*Organic Farmers Association	62 (*SD* = 25.3)	31 (*SD* = 23.6)
Organic Consumers Association	58 (*SD* = 24.2)	28 (*SD* = 23.8)
Non-GMO Project	47 (*SD* = 26.2)	38 (*SD* = 27.9)
National Public Radio	48 (*SD* = 24.1)	55 (*SD* = 28.9)
*Fox News	32 (*SD* = 23.9)	76 (*SD* = 28.3)
*Huffington Post	33 (*SD* = 21.2)	64 (*SD* = 32.7)
Snopes	27 (*SD* = 25.1)	21 (*SD* = 27.1)

Note. Ratings for both trustworthiness and familiarity ranged from 0 (not at all trustworthy/familiar – 100 (completely trustworthy/familiar).

* indicates sources included in the current materials

Materials

Pretest. The pretest consisted of 13 True/False/Not Sure statements regarding common misconceptions about GMOs. Five items were phrased in terms of the misconception, and seven were phrased in terms of the misconception in order to balance correct responses. Moreover, three of the items directly corresponded to the misconceptions addressed in the documents that participants read: (1) *most crops are GMOs*, (2) *GMOs end up in animal products*, (3) *GMO crops have contributed to declines in honeybee populations*. These misconceptions were highly prevalent in the current sample. Specifically, participants in the current sample endorsed these misconceptions at a rate of 90%, 86%, 89%, respectively. Additionally, one item, "GMOs could pose harm to humans," captured prevalence of a global misconception that *GMOs*

are harmful. The endorsement rate for the global misconception was 85%. The remaining nine items targeted information presented in the texts that was relevant to the topic of GMOs. The pretest scores had rather low internal consistency, Cronbach's $\alpha = .42$, which may reflect a lack of coherence in participants' prior knowledge (Gadgil, Nokes-Malach, & Chi, 2012).

Documents. The document sets consisted of three short expository texts (range: 166 – 186 words in length). Each text targeted a specific misconception about GMOs (i.e., *most crops are genetically modified, GMOs have contributed to the decline in honeybee populations,* and *GMOs end up in animal products*) that related to the global misconception that *GMOs are harmful.* This misconception was latent in that it was neither stated, refuted, nor explained in any of the documents.

Documents belonged to one of two source-credibility conditions (high vs. low) and two text-structure conditions (refutation vs non-refutation control). With regard to source credibility, documents in the high-credibility condition included information sources that the pilot study suggested have high credibility in the domain of GMOs (e.g., the Food and Drug Administration, Organic Farmers' Association, and the US Department of Agriculture); documents in the low-credibility condition included relatively low-credibility sources in the domain of GMOs (e.g., Huffington Post, Fox News, Buzzfeed News). To ensure that the current sample perceived the credibility of the sources as intended, participants completed the Source Credibility Questionnaire (detailed below).

In terms of text structure, all documents included a website heading and logo from the source that purportedly published the document at the top of the document (e.g, Food

& Drug Administration) to establish the information sources in an ecologically valid fashion (e.g., Kammerer, Kalbfell, & Gerjets, 2016). Documents included a general title that was relevant to the specific targeted misconception but did not state the misconception. In the refutation condition, an opening statement served to reactivate the reader's misconception (e.g., *It is commonly thought that GMO crops contribute to the decline of honeybee populations*), which was immediately refuted (e.g., *This idea is actually wrong*). In the non-refutation condition, instead of the statement of the misconception and refutation, there was a general statement about GMOs that did not mention or refute the misconception (e.g., *Some countries around the world have reported a 50% decline in honeybee populations*). In both the refutation and non-refutation conditions, readers next saw an explanation that supported the correct idea (range: 100 – 121 words in length). After the explanation of the correct idea, there was a statement that reiterated the source of the document (e.g., *Understanding the truth about GMOs is essential to becoming a wise consumer, so the US Department of Agriculture (USDA) is committed to providing consumers with only quality information.*) This statement was included in order to ensure that participants encoded the source of the information, as it is possible that some readers did not attend to the website heading. See Appendix A for documents in the refutation, high-credibility condition.

Intertextual Inference Verification Task. An Intertextual Inference Verification Task (IVT; see Appendix B) assessed the extent to which readers engaged in intertextual integration (Royer, Carlo, Dufresne, & Mestre, 1996) at a fine-grained level (Firetto, 2013). The IVT prompted participants to verify intertextual inferences that required connections among information units from different documents. Participants were told

that each of the sentences consisted of a statement that could "reasonably be inferred by combining information from at least two of the documents" they had just read, or of a statement that "could *not* reasonably be inferred by combining information from at least two of the documents." Intertextual inferences were generated on the basis of concept maps that represented potential valid and invalid inferences that readers could draw from the information in the three documents (See Appendix C). An example of an intertextual inference derived from the concept maps is "The FDA and the USDA agree that most soybeans and corn are genetically modified." The IVT consisted of 10 valid and 10 invalid inferences, which required "yes" and "no" responses, respectively. Participants' IVT scores consisted of the total number correct out of 20. Moreover, the IVT was designed to provide information about the integration of readers' multiple documents representations that is independent of their non-text-use related factors, such as writing-skills (List & Alexander, 2017). The IVT scores had acceptable reliability, Cronbach's α = .60.

Posttest and Delayed Posttest. The posttest included 13 True/False/Not Sure questions (see Appendix D). Like the pretest, three of the questions corresponded to the specific misconceptions addressed in the documents, and one question corresponded to the global misconception. These four questions were two-tiered. The first tier required participants to choose True/False/Not Sure and then explain their reasoning for each item. For the first tier, 1 point was awarded for correct responses, and 0 points were awarded for incorrect/not sure responses. The second tier required participants to provide an explanation their response to the first tier. Three points were awarded for an explanation that comprehensively captured the information available in the documents; 2 points were

awarded for an explanation that used information from the documents but was not comprehensive; 0 points were awarded for incorrect explanations. Thus, for these four questions, scores could range from 0 – 4. The remaining nine questions pertained to discrete facts presented in the documents (e.g., Some crops have insect-repellent proteins), and thus did not require explanation scores. Accounting for these nine discrete-fact items (1 point for correct, 0 points for incorrect/not sure), total scores on the posttest could range from 0 – 25 points. A trained research assistant scored participants' explanations, 20% of which were double scored. Interrater agreement was 90.2%. Internal consistency for the posttest scores was $\alpha = .62$.

For the delayed posttest, participants completed the same items after a 20-minute filler task (detailed in Procedure), but the items were presented in a randomized order. Internal consistency for delayed posttest scores was $\alpha = .67$.

Reading and Writing Task. A scenario-based reading and writing task required participants to imagine that they worked for a state representative who tasked them with writing a brief research report (e.g., List et al., 2019) about GMOs for a public forum (See Appendix E). Prior to engaging with the documents, participants were told that they must use the three provided documents to "create a clear overall picture of the team's stance on GMOs." The task did not provide a directional goal (i.e., explaining why GMOs are safe/harmful) so that readers' knowledge, rather than the task instructions, could determine their stance on GMOs. After participants engaged with all three documents, they receive a task reminder encouraging them to use all three documents, and that they should avoid both plagiarizing and simply compiling a list of facts about GMOs in their report.

The written reports were holistically coded for the type of MD representation they reflect, as per the DMF and recent work (List et al., 2019; Perfetti et al., 1999). Reports were coded as a *Mush Model* if they included information that was presented across documents in an integrated fashion but exhibited no sourcing. Reports were coded as a *Separate Representations Model with Citations* if they included citations and references to documents and/or sources but failed to integrate information across documents. A variant of this model is the *Separate Representations without Citations*, which means that information was presented sequentially by source of origin, but there were no *explicit* attributions to sources or integration across documents. Reports were coded as a *Documents Model* if they exhibited at least some degree of integration across documents by forming connections between at least two documents and referring to at least one of the three sources. Finally, reports were coded as a *Tag-All Model* if readers comprehensively connected all documents to one another via explicit sourcing. Reports were categorized by trained research assistants, 20% of which were double scored. Interrater agreement was 87%. Disagreements were resolved through discussion.

Additionally, written reports were coded for the frequency of integrative statements that connected information across two or more documents (e.g., compare/contrast, generalization and/or abstraction of main ideas), as well as frequency of sourcing (explicit and implicit). This coding was necessary to conduct a discriminant function analysis (detailed in Preliminary Analyses) to validate the coding of written reports into the MD types. Twenty percent of the codes were double scored. Interrater agreement was 94.1% for sourcing and 85.3% for integrative statements.

Source Credibility Questionnaire. To ensure that high- and low-credibility sources were perceived as intended, readers rated each of the six sources included in the documents on a scale from 0 (Not at all credible) to 100 (Completely credible).

Design

This study followed a 2 (source credibility: high vs. low) x 2 (text structure: refutation vs. non-refutation) between-subjects design. Crossing these factors yielded four sets of documents, with each set containing three documents. Participants were randomly assigned to one of the four sets. The first dependent variable—integration of participants' multiple documents representation—consisted of two distinct indicators: 1) IVT scores, which gauged the extent to which readers integrated specific, fine-grained connections among documents and sources, and 2) the type of MD representation evident in readers' written reports, which gauged holistic integration based on the presence or absence of content integration and/or source integration. The second dependent variable—knowledge revision—consisted of three indicators: (1) reduction in misconception prevalence, which was assessed by summing readers' responses (T/F/Not Sure) on the 13 pretest items. Specifically, readers' responses were awarded 1 point if they were correct and 0 points if they were incorrect/not sure. Pretest items did not require explanations; (2) readers' understanding of the correct information, which was evaluated by their total scores on the 13 posttest and 13 delayed posttest items. Specifically, total scores were calculated by summing the T/F/Not Sure responses with explanation accuracy scores on the three items corresponding to the targeted individual misconceptions and the item corresponding to the global misconception. Thus, total scores reflected their overall understanding of the critical information; and (3) revision of

the global misconception that GMOs are harmful, which was evaluated by accuracy of readers' T/F/Not Sure response to the global misconception item on the posttest and delayed posttest. Thus, the outcome for revision of the global misconception was dichotomous (correct response/incorrect response).

Procedure

Data were collected in small-group sessions held in a quiet room. Participants completed the study on their personal computers. An experimenter sent the link to the Qualtrics survey via email to participants at the beginning of each administration session. Participants first completed a brief demographics questionnaire and pretest to gauge prior knowledge. Second, participants received the reading and writing task, and then engaged with a set of three documents. Third, participants received a task reminder, and then completed their written report, during which time they could navigate the documents. Fourth, access to the documents was removed, and participants completed the IVT. Fifth, participants completed the knowledge posttest. Sixth, participants completed a 20-minute filler task that required them to read twelve short texts (each approximately 250 words in length) and rate their emotional response to each text. Seventh participants completed the delayed posttest. Eighth, participants completed the Source Credibility Questionnaire. Finally, participants were debriefed and thanked for their participation. Participants took approximately 45 minutes to complete the experiment.

Results

Preliminary Analyses

Source Credibility Questionnaire. To ensure that high-credibility and low-credibility sources were perceived as such, I conducted an independent-samples *t*-test was

conducted on readers' responses to the Source Credibility Questionnaire. Indeed, the results showed that themean credibility rating for the three high-credibility sources (M = 82.9, SD = 13.1) was significantly higher than the mean credibility rating for low-credibility sources (M = 54.7, SD = 15.2), $t(156) = 23.43$, $p < .001$, Cohen's d = 2.1. As mentioned, n = 3 participants failed to distinguish high-credibility sources from low-credibility sources. In other words, their mean credibility rating for low-credibility sources was actually *higher* than the mean credibility rating for the high-credibility sources; thus, data from these participants were omitted, as examining the influence of credibility requires that readers can distinguish high- from low-credibility sources in a normative fashion.

Coding of Written Reports. To validate the coding of written reports according to the type of MD representation they reflected drawing on the DMF (Perfetti et al., 1999), I conducted a discriminant function analysis (List et al., 2019). The type of MD representations included (1) Separate Representations Model without Citations, (2) Separate Representations Model with Citations, (3) Mush Model, (4) Documents Model, or (5) Tag-All Model. A Separate Representations Model without Citations was evident in 19% (n = 29) of written reports. A Separate Representations Model with Citations was evident in 6% (n = 9) of reports. A Mush Model was evident in 40% (n = 63) of reports. A Documents Model was evident in 12% (n = 18) of reports. Finally, a Tag-All Model was evident in 24% (n = 38) of reports.

With respect to the discriminant function analysis, I entered the two criteria that were used for categorizing participants' reports: overall frequency of sourcing in participants' reports and overall frequency of integrative statements. The results found

two significant discriminant functions. The first function (sourcing) explained 94.1% (canonical $R^2 = .90$) of the variance in type of MD representation, while the second (integrative statements) explained 5.9% of the variance (canonical $R^2 = .46$) in categorizations. In combination, these discriminant functions significantly differed across students whose reports reflected different MD representations [Function 1: Wilk's $\Lambda = .15$, $\chi^2(8) = 289.31$, $p < .001$]. Even when the first function is excluded, the second function is still significant, [Function 2: Wilk's $\Lambda = .79$, $\chi^2(3) = 36.05$, $p < .001$]. Sourcing loaded onto the first function ($r = .986$), and the total number of integrative statements loaded onto the second function ($r = .981$). Because the cross-loadings for these predictors were small (rs < .20), there is evidence that both sourcing and integrative statements independently contributed to the categorizations of the reports. As can be seen in Figure 3, the first function discriminated participants' reports according to their use of sourcing (i.e., discriminating mush models and separate representation models without citations from separate representations models with citations, documents models, and tag-all models). The second function discriminated participants' reports according to the frequency of integrative statements, with tag-all models, documents models, and mush models discriminated from separate representations models with and without citations.

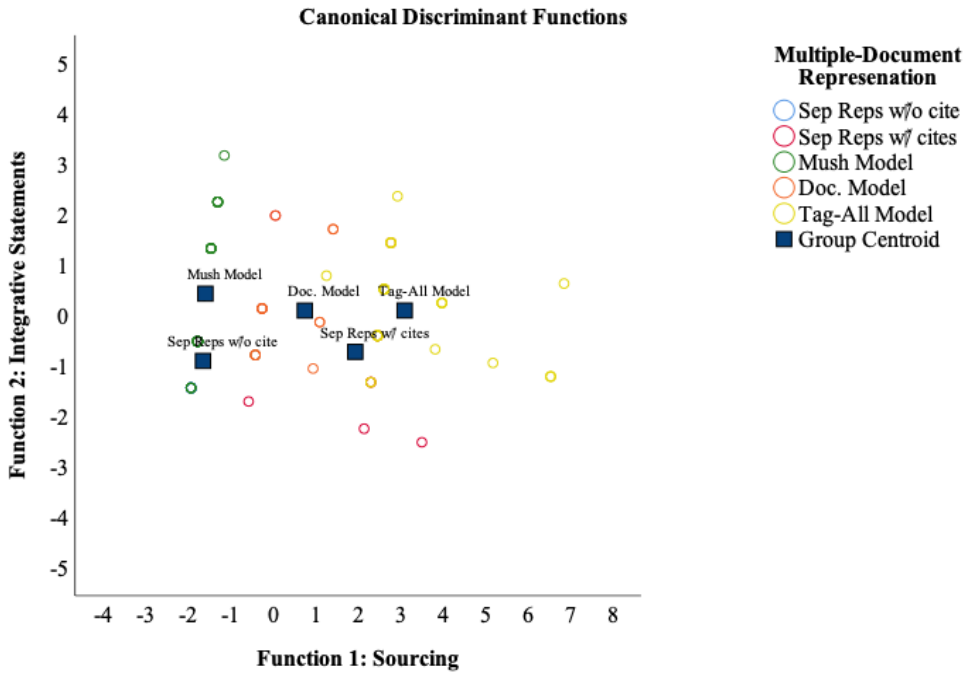

Figure 3. Classification results from the discriminant function analysis.

Question 1: To what extent do source credibility and text structure influence intertextual integration?

IVT Scores. To evaluate the extent to which source credibility and text structure influenced the integration of readers' multiple documents representations, as measured by intertextual IVT scores, I conducted a univariate ANOVA with text structure (refutation vs. non-refutation) and source credibility (high vs. low) as between-subjects factors and sum scores on the intertextual IVT as the dependent variable. The results showed a main effect of source credibility, $F(1, 153) = 4.51$, $p = .035$, $\eta_p^2 = .029$, such that IVT scores were higher for readers in the high-credibility condition ($M = 13.54$, $SE = .34$) than for those in the low-credibility condition ($M = 12.51$, $SE = .35$). Moreover, there was a main effect of text structure, $F(1, 153) = 4.03$, $p = .046$, $\eta_p^2 = .026$, such that IVT scores were higher for readers in the refutation condition ($M = 13.51$, $SE = .35$) than for those in the

non-refutation condition (M = 12.53, SE = .34). The credibility x text structure interaction did not approach significance (F = .36, p = .55).

MD Representation. To evaluate the extent to which source credibility and text structure influenced holistic integration, as evaluated by the type of readers' MD representation, I conducted separate chi-square tests to examine the associations among the source credibility and text structure and the type of MD representation that readers constructed. Results indicated that there was no significant association between source credibility and type of MD representation, $\chi^2(4) = 7.38$, p = .117. Likewise, there was no significant association between text structure and type of MD representation, $\chi^2(4) = 6.61$, p = .158. Thus, source credibility and text structure did not appear to influence integration at a holistic level according to the type of MD representation readers constructed.

Question 2: To what extent do source credibility and text structure influence knowledge revision outcomes?

Misconception Prevalence. To evaluate the extent to which source credibility and text structure influenced misconception prevalence, I conducted a mixed ANOVA with text structure (refutation vs. non-refutation) and source credibility (high vs. low) as between-subjects factors, time (pretest vs. posttest vs. delayed posttest) as a within-subjects factor, and misconception prevalence (based on T/F/Not Sure scores at each time point) as the dependent variable. Because the assumption of sphericity was violated, $\chi^2(2) = 135.4$, $p < .001$, the degrees of freedom were corrected using the Greenhouse-Geisser estimates of sphericity ($\varepsilon = 0.63$). Results showed a main effect of time, $F(1.256, 191) = 604.81$, $p < .001$, $\eta_p^2 = .799$ (See Figure 4). Pairwise comparisons indicated that

misconception prevalence was higher at pretest (M = 8.6, SE = .15) than at posttest (M = 2.7, SE = .17) and delayed posttest (M = 2.9, SE = .19), ps < .001. Prevalence did not differ between posttest and delayed posttest. There was also a main effect of source credibility, $F(1, 152) = 5.70$, $p = .018$, $\eta_p^2 = .036$, such that misconception prevalence was higher overall among readers in the low-credibility condition (M = 5.0, SE = .18) than readers in the high-credibility condition (M = 4.4, SE = .17).

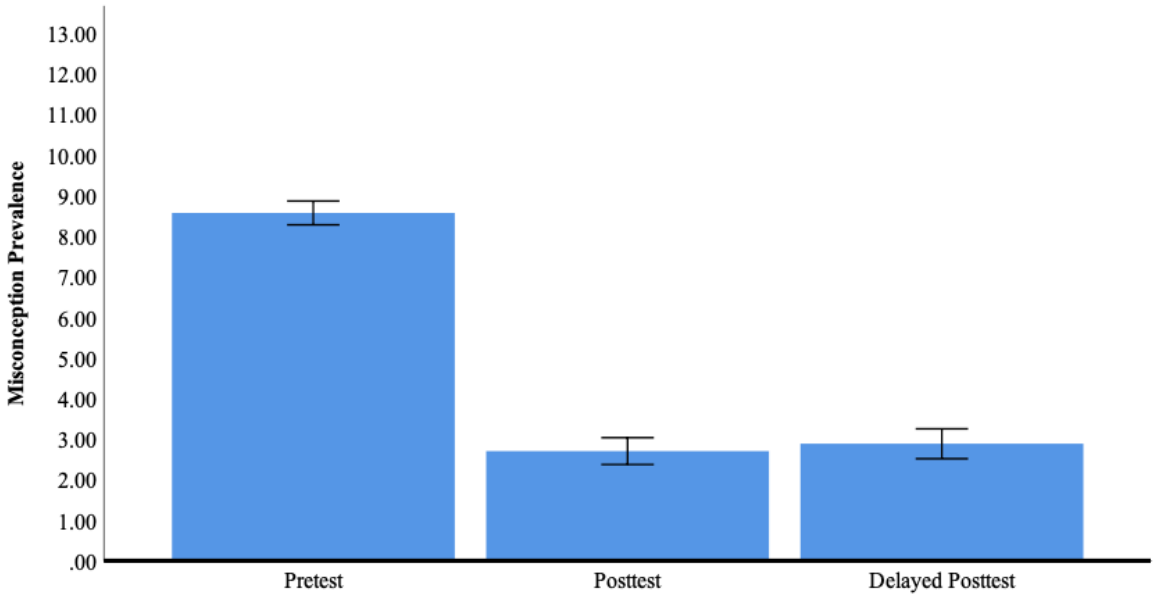

Figure 4. Mean misconception prevalence at pretest, posttest, and delayed posttest.

Understanding of the Correct Information. To evaluate the extent to which source credibility and text structure influenced readers' understanding of the correct information in the documents, I conducted a mixed ANOVA with text structure (refutation vs. non-refutation) and source credibility (high vs. low) as between-subjects factors, time (posttest vs. delayed posttest) as a within-subjects factor, and total scores (True/False/Not Sure + explanations) on the posttest and delayed posttest as the

dependent variable (note that pretest scores were not included because readers did not provide explanations on the pretest). Results showed a main effect of time, $F(1, 153) = 49.81$, $p < .001$, $\eta_p^2 = .25$, such that scores were higher at posttest ($M = 14.9$, $SE = .34$) than at delayed posttest ($M = 13.4$, $SE = .35$). There was also a main effect of source credibility, $F(1, 153) = 5.45$, $p = .021$, $\eta_p^2 = .034$, such that total scores were higher overall for readers in the high-credibility condition ($M = 15.0$, $SE = .45$) than for readers in the low-credibility condition ($M = 13.4$, $SE = .48$).

Global Misconception. To examine the extent to which source credibility and/or text structure influenced revision of the global misconception at posttest and delayed posttest, I conducted four separate chi-square tests. The first chi-square test included source credibility (high vs. low) and T/F/Not Sure responses on the global misconception posttest item. The results showed that there was no association between source credibility and revision of global misconception at posttest, $\chi^2(1) = .043$, $p = .84$. The second chi-square test included source credibility and responses on the global misconception delayed posttest item. The results showed that there was also no association between source credibility and responses on the global-misconception item at delayed posttest, $\chi^2(1) = 1.64$, $p = .20$. The third chi-square test included text structure (refutation vs. non-refutation) and responses to the global misconception posttest item. The results showed that there was no association between text structure and revision of the global misconception at posttest, $\chi^2(1) = .17$, $p = .68$. Finally, the fourth chi-square test included text structure and responses on the global misconception delayed posttest item. The results showed there was also no association between text structure and responses on the global-misconception item at delayed posttest, $\chi^2(1) = .37$, $p = .54$. Thus, it appears that

text structure and source credibility were not associated with readers' responses to the global-misconception item.

Question 3: To what extent does intertextual integration influence knowledge revision outcomes?

Misconception Prevalence. To evaluate the extent to which fine-grained intertextual integration (i.e., IVT scores) influenced knowledge revision, as indicated by the reduction in misconception prevalence from pretest to posttest to delayed posttest, I conducted a repeated-measures ANOVA with time (pretest vs. posttest vs. delayed posttest) as a within-subjects factor, IVT scores as a continuous predictor, and misconception prevalence (sum T/F scores at each time point) as the dependent variable. Because the assumption of sphericity was violated, $\chi^2(2) = 129.9$, $p < .001$, the degrees of freedom were corrected using the Greenhouse-Geisser estimates of sphericity ($\varepsilon = 0.64$). Results, showed a main effect of time, $F(1.3, 196) = 5.14$, $p = .017$, $\eta_p^2 = .032$, such that misconception prevalence was higher at pretest ($M = 8.6$, $SE = .15$) than at posttest ($M = 2.7$, $SE = .15$) and delayed posttest ($M = 2.9$, $SE = .16$), ps $< .001$. Prevalence did not differ between posttest and delayed posttest. Results also showed a main effect of IVT score, $F(1, 151) = 52.08$, $p < .001$, $\eta_p^2 = .253$, such that readers who had higher IVT scores tended to show a greater reduction in misconception prevalence than readers who had lower IVT scores. These main effects were qualified by a time x IVT interaction, $F(1.3, 196) = 17.01$, $p < .001$, $\eta_p^2 = .099$ (see Figure 5), such that IVT score did not play a substantial role at pretest, but at both Posttest and delayed Posttest, participants with higher IVT scores tended to show a greater reduction in misconception prevalence.

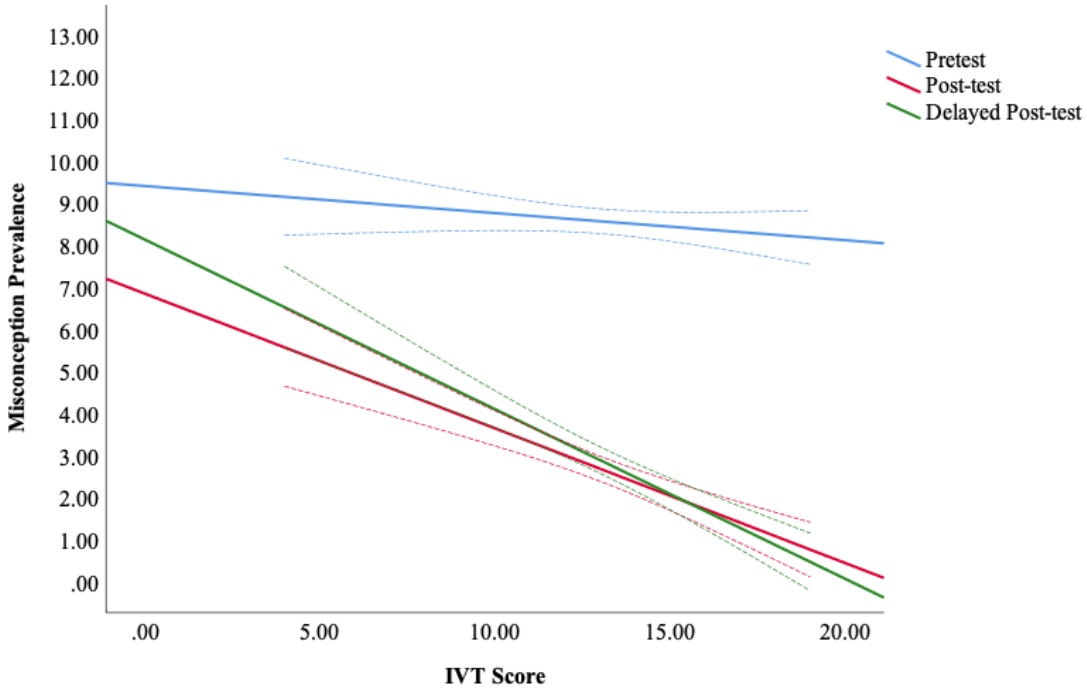

Figure 5. Effect of intertextual integration on misconception prevalence at pretest, posttest, and delayed posttest.

To evaluate the extent to which holistic intertextual integration (i.e., type of MD representation) influenced knowledge revision as indicated by the reduction in misconception prevalence from pretest to posttest to delayed posttest, I conducted a mixed ANOVA with type of MD representation (i.e., Separate Representations Model without Citations, Separate Representations with Citations, Mush Model, Documents Model, and Tag-All Model) as a between-subjects factor, time (pretest, posttest, and delayed posttest) as a within-subjects factor, and misconception prevalence as the dependent variable. Results showed a main effect of time, $F(1.3, 304) = 333.80$, $p < .001$, $\eta_p^2 = .687$, such that misconception prevalence was higher at pretest ($M = 7.5$, $SE = .17$) than at posttest ($M = 2.5$, $SE = .21$) and delayed posttest ($M = 2.7$, $SE = .23$), ps $< .001$.

Prevalence at posttest did not differ from prevalence at delayed Posttest ($p > .40$). No effects were observed regarding type of MD representation.

Understanding of the Correct Information. To evaluate the extent to which fine-grained intertextual integration (i.e., IVT scores) influenced participants' understanding of the correct information, I conducted a repeated-measures ANOVA with IVT scores as a continuous predictor, time (posttest vs. delayed posttest) as a within-subjects factor, and total score (True/False/Not Sure + Explanation) on the posttest and delayed posttest as the dependent variable. Results showed a main effect of time, $F(1, 155) = 5.36$, $p = .022$, $\eta_p^2 = .033$, such that total scores were higher at posttest ($M = 14.9$, $SE = .31$) than at delayed posttest ($M = 13.5$, $SE = .30$). There was also a main effect of IVT score, $F(1, 152) = 58.39$, $p < .001$, $\eta_p^2 = .274$, such that total scores were higher overall for readers who engaged in more intertextual integration.

To evaluate the extent to which holistic intertextual integration (i.e., type of MD representation) influenced understanding of the correct information, I conducted a mixed ANOVA with type of MD representation (i.e., Separate Representations Model without Citations, Separate Representations with Citations, Mush Model, Documents Model, and Tag-All Model) as a between-subjects factor, time (posttest vs. delayed posttest) as a within-subjects factor, and total score on the posttest and delayed posttest as the dependent variable. The results reveal a main effect of time, $F(1, 152) = 44.35$, $p < .001$, $\eta_p^2 = .226$, such that scores were higher at Posttest ($M = 15.5$, $SE = .41$) than at delayed Posttest ($M = 13.8$, $SE = .42$). There was also a main effect of MD representation, $F(4, 152) = 3.40$, $p = .011$, $\eta_p^2 = .082$ (see Figure 6). Pairwise comparisons indicated that readers who constructed Separate Representations Models with Citations ($M = 16.6$, $SE =$

1.3), Mush Models (M = 14.2, SE = .51), Documents Models (M = 15.6, SE = .94), or Tag-All Models (M = 14.6, SE = .65) demonstrated better overall understanding of the correct information than readers who constructed Separate Representations Models without Citations (M = 12.1, SE = .75) ps < .020.

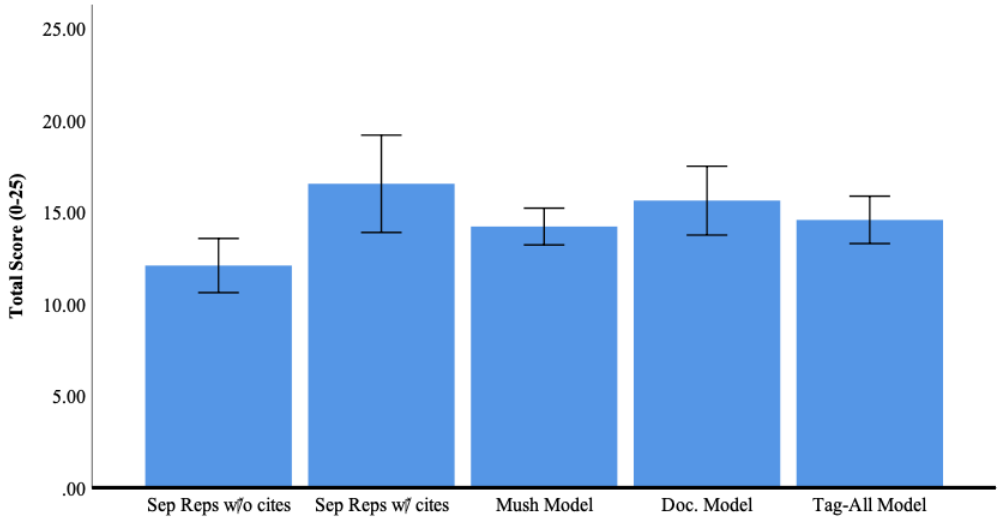

Figure 6. Mean total scores (understanding of the correct information) across types of multiple-documents representations.

Global Misconception. To examine the relation between holistic intertextual integration (i.e., type of MD representation) and revision of the global misconception that GMOs are harmful, I conducted two separate chi-square tests with the type of readers' MD representations and T/F/Not Sure scores on the global misconception item at posttest and delayed posttest, respectively. For these analyses, readers' MD representations were collapsed into two categories: 1) those that feature at least some intertextual integration (i.e., Mush Model, Documents Model, Tag-All Model) and 2) those that feature no intertextual integration (e.g., Separate Representations Model without Citations, Separate

Representations Model with Citations; List et al., 2019). At posttest, the results showed a significant association between response on the global misconception item on the posttest and intertextual integration, as gauged by type of MD representation, $\chi^2(1) = 5.17$, $p = .023$, Cramer's $V = .181$ (see Figure 7, left panel). Thus, of readers who engaged in at least some integration, 58% ($n = 69$) responded correctly to the global misconception, and 42% ($n = 50$) responded incorrectly. Of readers who engaged in no integration, 37% ($n = 14$) responded correctly to the global misconception and 63% ($n = 24$) responded incorrectly. At delayed posttest, results also show a significant association between response on the global misconception item on the Posttest and type of MD representation, $\chi^2(1) = 5.62$, $p = .018$, Cramer's $V = .189$ (see Figure 7, right panel). At delayed Posttest, of readers who integrated, 64% ($n = 76$) correctly responded to the global misconception item and 36% ($n = 43$) responded incorrectly. Of readers who engaged in no integration, 42% ($n = 16$) responded correctly to the global misconception and 58% ($n = 22$) responded incorrectly.

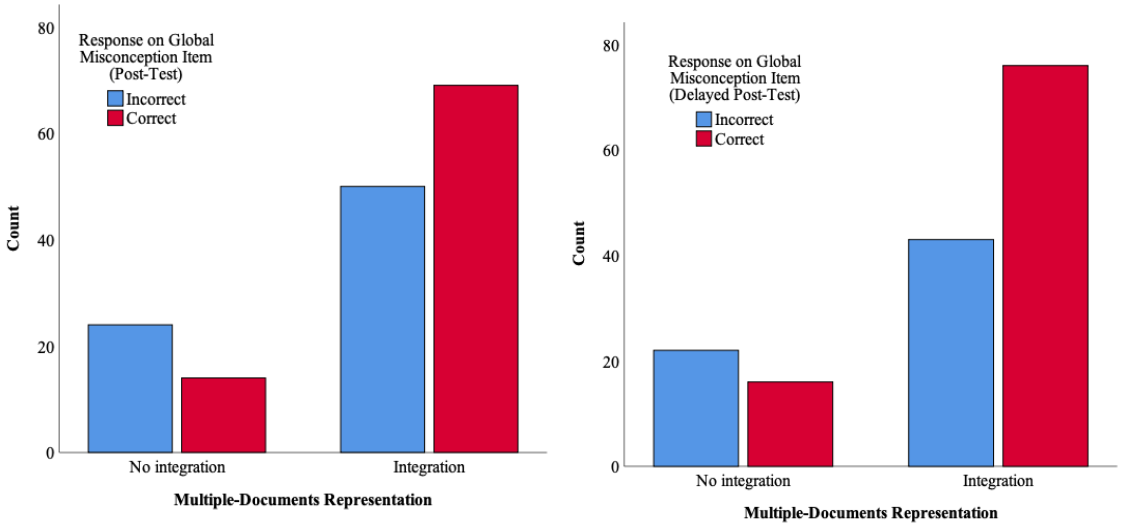

Figure 7. Response frequencies for the global misconception item clustered by multiple-documents representation on the posttest (left) and delayed posttest (right).

To examine the relation between revision of the individual misconceptions targeted in the documents and revision of the global misconception, I conducted a chi-square test with the number of individual misconceptions that readers revised (0, 1, 2, or 3 misconceptions) and response to the global misconception item (T/F/Not Sure) on the posttest, along with *p*-values for Fisher's exact tests (two-sided) for each comparison. The results showed a significant association between the number of misconceptions revised and revision of the global misconception at posttest, $\chi^2(3) = 11.42$, $p = .010$, Cramer's $V = .270$ (see Figure 8, left panel). Of readers who responded correctly to all three specific misconceptions items, 63% ($n = 59$) responded correctly to the global misconception item, and 47% ($n = 35$) responded incorrectly ($p = .003$). Of readers who responded correctly to two of the specific misconception items, 45% ($n = 18$) responded to the global misconception item correctly and 55% ($n = 22$) responded incorrectly ($p = .28$). Of readers who correctly responded to only one of the specific misconception items, 30% ($n = 3$) responded to the global misconception item correctly and 70% ($n = 7$) responded incorrectly ($p = .19$). Finally, of participants who did not correctly respond to any of the specific misconception items, 23% ($n = 3$) responded correctly to the global misconception item and 77% ($n = 10$) responded incorrectly ($p = .04$)

Likewise, the results show a significant association between revision of specific misconceptions and revision of the global misconception at delayed posttest, $\chi^2(3) = 23.49$, $p < .001$, Cramer's $V = .39$ (See Figure 8, right panel). Of readers who correctly responded to all three specific misconception items, 77% ($n = 62$) responded to the global misconception item correctly and 24% ($n = 19$) responded incorrectly ($p < .001$). Of readers who correctly responded to two of the specific misconception items, 43% ($n =$

24) responded to the global misconception item correctly and 57% (n = 32) responded incorrectly (p = .004). Of readers who correctly responded one of the specific misconception items, 27% (n = 4) responded to the global misconception item correctly and 73% (n = 11) responded incorrectly (p = .012). Finally, of participants who did not revise any of the specific misconceptions, 40% (n = 2) responded correctly to the global misconception item and 60% (n = 3) responded incorrectly (p = .65).

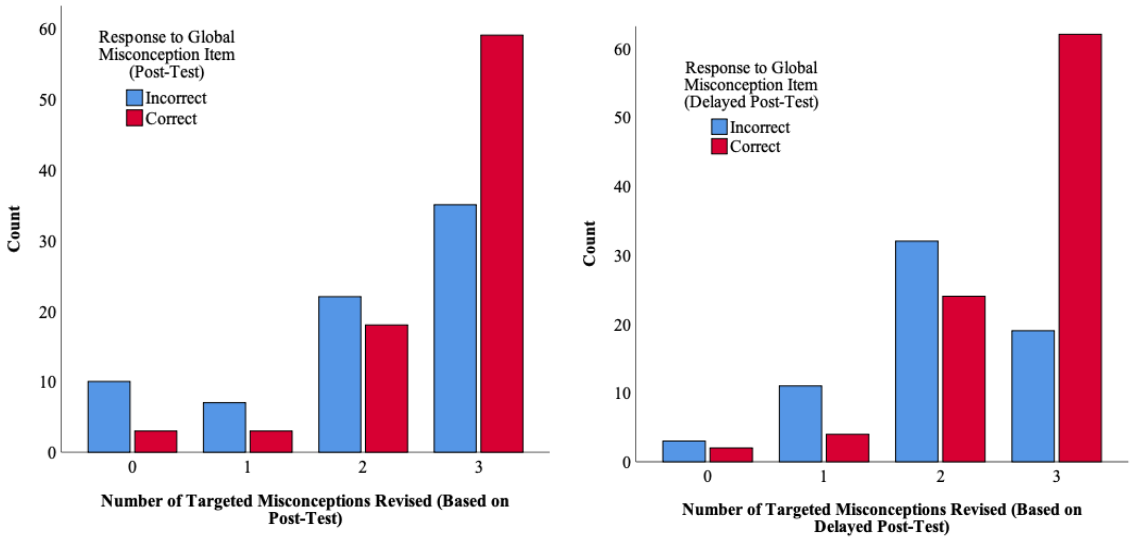

Figure 8. Response frequencies for the global misconception item clustered by multiple-documents representation on the posttest (left) and delayed posttest (right).

Discussion

The overarching aim of the current experiment was to examine the extent to which source credibility and text structure influenced knowledge revision outcomes when readers engaged with multiple documents. By doing so, the present experiment offers the first empirical investigation into some of the core hypotheses derived from KReC-MD. This is a critical contribution to the literature, as effective learning in the "information age" necessitates that readers negotiate information from multiple documents and

multiple sources (Stadtler & Bromme, 2014; Thomm & Bromme 2016) that may serve to reactivate or strengthen existing misconceptions. The current results provide a number of insights that can be used to specify further and refine KReC-MD.

First, the current study examined the extent to which source credibility and text structure influenced intertextual integration. There were two distinct indicators of integration: (1) scores on the inference verification task (IVT), which gauged the extent to which readers integrated specific, fine-grained connections among documents (Firetto, 2013; Royer et al., 1996), and (2) the type of MD representation that readers constructed, which gauged readers' engagement in holistic integration based on whether they drew basic connections across documents. The results indicated that the high-credibility sources fostered greater intertextual integration than low-credibility sources. Moreover, the refutation text condition fostered greater integration than the non-refutation text condition. However, these results were found only for intertextual integration at the fine-grained level. There was no association between source credibility or text structure and the type of MD representation readers constructed. Still, because the IVT is a finer-grained indicator of intertextual integration, these results are consistent with the hypothesis that high-credibility sources and refutation texts foster superior integration (Hypothesis 1).

Second, the current study examined the extent to which source credibility and text structure influenced knowledge revision outcomes. There were three indicators of knowledge revision: (1) reduction in misconception prevalence from pretest to posttest/delayed posttest, (2) understanding of the correct information, and (3) accuracy on the global misconception item at posttest and delayed posttest. The results indicated

that high-credibility sources reduced misconception prevalence and increased understanding of the correct information more than low-credibility sources did. These results overall support the hypothesis that knowledge revision would be optimal when readers engage with information from high-credibility sources (Hypothesis 2). However, refutation texts did not lead to better knowledge revision than non-refutation texts, but it is important to note that all documents included explanations of the correct ideas.

Third, the current study examined the extent to which intertextual integration influenced knowledge revision outcomes. The results suggest that greater intertextual integration at the fine-grained level (as gauged by IVT scores) reduced misconception prevalence and increased understanding of the correct information. Moreover, the results suggest that revising the individual misconceptions targeted in the documents may foster revision of the global misconception, as the current results showed that correctly responding to all three posttest and delayed posttest items that corresponded to the individual misconceptions targeted in the documents was associated with correct responses to the global misconception item. Taken together, these results suggest that integrating correct information across documents strengthens the reader's network of correct information. In turn, this richer network of correct information outcompetes the global misconception during competing activation, thereby fostering knowledge revision, consistent with Hypothesis 3.

With respect to KReC-MD, the current results permit further specification of the integration principle and competing activation mechanism. Specifically, high-credibility sources may have served as a cue to increase the integration of information that readers encountered from those sources into their situations model. In turn, as KReC-MD

proposed, this increased integration may have amounted to greater activation of the global correct idea. Thus, during *competing activation*, the global correct idea drew sufficient activation to itself and, simultaneously, away from the global misconception.

Likewise, the current findings suggest that refutations are another text-level factor that influences integration. Readers in the refutation condition tended to demonstrate better intertextual integration and understanding of the correct information. Encountering refutations may have increased cognitive conflict (Kendeou et al., 2019), which in turn may have signaled readers to increase the extent to which they integrated information across documents as a means of resolving the conflict. This increased integration may have resulted in better understanding of the correct idea. However, because refutations but did not also lead to a reduction in misconception prevalence, it could be the case that increased integration and understanding of the correct information may not always manifest as reduced misconception prevalence. This may be because both integration and understanding of textual information are incremental and exist on a continuum, whereas endorsement of misconceptions may be dichotomous based in part on a threshold of activation.

Another core contribution of KReC-MD is the idea that intertextual integration may facilitate revision of a global misconception. Indeed, the current results suggest that at least some intertextual integration at the holistic level (i.e., type of MD representation) was necessary for increasing the likelihood of revising the global misconception. In terms of KReC-MD, this finding corroborates the idea that integration of correct information promotes knowledge revision, even of a global misconception that was not stated in documents.

The current study has several limitations. One limitation is that the current experiment could not provide any information about the online knowledge revision processes that readers may exhibit as they engage with multiple documents, but it is these moment-by-moment processes that determine the success or failure of knowledge revision. Thus, to gain a more comprehensive understanding of how knowledge revision unfolds in the context of multiple documents, it is critical for the subsequent experiment (Experiment 2) to also consider online processes that readers engage in during reading (Kendeou et al., 2019). Additional limitations, such as the use of written reports to gauge holistic integration, are discussed in the General Discussion (Chapter 6).

Overall, the current work provides initial empirical evidence for some of KReC-MD's core hypotheses and assumptions. However, given the diversity of documents that permeate our information ecosystem (Kendeou et al., 2019), there is much work to be done in order to establish a more comprehensive understanding of the text-level and reader-level conditions that influence knowledge revision with multiple documents. As mentioned, a critical next step is to seek evidence for the online processes that readers engage in during reading of multiple documents. Given that the current study highlights the critical role of source credibility in this context, future work should examine online processes that occur as readers engage with documents from sources that vary in credibility using think-aloud methodology (Ericsson & Simon, 1993), while also replicating the novel findings from the current experiment.

Chapter 5: Experiment 2

The overarching aim of Experiment 2 was to examine the extent to which source credibility influenced the processes that occur during readers' engagement with multiple refutation texts. We focus on refutation texts (as opposed to non-refutation texts) in the current experiment because refutation texts have been shown to facilitate knowledge revision (Kendeou et al., 2014), and it is critical to provide readers with the textual conditions that induce revision as a necessary precondition to examine the online processes that occur during knowledge revision. To gauge these online processes, the current experiment used typed think-aloud methodology (Ericsson & Simon, 1993), which prompted readers to type their thoughts after each section of text (see Appendix F). These think-aloud protocols were coded for processes hypothesized to influence knowledge revision in the context of KReC-MD. These processes included (1) integrative processes that connect information across two or more documents (e.g., compare/contrast, generalization and/or abstraction of main ideas; e.g., List et al., 2019); (2) sourcing processes that serve to link sources to content or to evaluate source credibility (i.e., frequency of explicit, implicit sourcing, and source evaluations; e.g, Thomm & Bromme, 2016); and (3) knowledge revision processes involved with detecting inconsistencies and establishing coherence during reading of refutation texts (i.e., paraphrase, elaborations, bridging inferences, cognitive conflict, monitoring comprehension, questioning, and associations; e.g., Kendeou et al., 2019). A secondary aim was to replicate the findings regarding source credibility observed in Experiment 1.

To address the overarching aim, the first research question asks *to what extent does source credibility influence the moment-by-moment processes theorized in KReC-*

MD? To examine the moment-by-moment process, I used think-aloud methodology (e.g., Ericsson & Simon, 1993). Because administration of Experiment 2 was virtual, participants typed their thoughts using a constructed-response format. Existing work has found negligible differences between the processes evident in verbal think-aloud protocols versus typed think-aloud protocols. Particularly, for adult readers, there were negligible differences in reading strategies and generation of inferences targeted in the Reading Strategy Assessment Tool (RSAT) when readers typed their thoughts versus when they verbalized them during reading of science-related texts (Muñoz, Magliano, Sheridan, & McNamara, 2006).

As proposed by KReC-MD, the credibility of a source may serve as a cue to either endorse or reject information. Thus, information from high-credibility sources may be more readily integrated into readers' multiple document representation than information from low-credibility sources (Braasch & Bråten, 2017; Stadtler & Bromme, 2014). With respect to integrative processes, I hypothesize that readers in the high-credibility condition will demonstrate more integrative processes than participants in the low-credibility condition (Hypothesis 1).

With respect to sourcing processes, encountering discrepancies during reading (i.e., refutations that contradict prior knowledge) may increase attention to and encoding of source information (e.g., Braasch & Bråten, 2017). When that source information indicates high credibility, information from that source may be more highly activated and more readily integrated than information from low-credibility sources. Thus, I hypothesize a greater level of sourcing and source evaluation in the high-credibility source condition as a function of increased source attention (Hypothesis 2).

With respect to knowledge revision processes, I hypothesize that readers will report a higher degree of cognitive conflict in the low-credibility condition as a function of relatively lower activation of correct information from low-credibility sources (Hypothesis 3). Additionally, because information from high-credibility sources should be higher in activation than information from low-credibility sources and should induce less cognitive conflict, I hypothesize that readers will report more comprehension monitoring in the low-credibility condition in their efforts to re-establish coherence (Hypothesis 4).

As mentioned, the secondary aim of this experiment was to replicate the key findings from Experiment 1 regarding the influence of source credibility on intertextual integration and knowledge revision, as well as the role of intertextual integration on knowledge revision. With respect to this aim, I pose several replicative research questions and hypotheses.

The second research question asks *to what extent does source credibility influence intertextual integration.* Because information from high-credibility sources should be higher in activation and more readily integrated, I hypothesize that readers in the high-credibility condition will engage in more intertextual integration (Hypothesis 5).

The third research question asks *to what extent to does source credibility influence knowledge revision outcomes?* As in Experiment 1, I hypothesize that readers will demonstrate superior knowledge revision in the high-credibility condition (Hypothesis 6) as a function of a more integrated network in support of the correct idea fostered by high-credibility sources compared to low-credibility sources (e.g., Van Boekel et al., 2017). The fourth research question asks *to what extent does intertextual*

integration influence knowledge revision outcomes? As in Experiment 1, I hypothesize that readers who engage in a greater degree of intertextual integration will demonstrate superior knowledge revision outcomes (Hypothesis 7).

Method

Participants

One-hundred and twelve undergraduate students (74 female, M_{age} = 20.0 years, SD_{age} = 2.8 years) completed the experiment for extra credit. This sample size was based on an a-priori power analysis, which indicated a minimum sample size of n = 100 to detect a small-to-medium effect (η_p^2 = .10) with .90 power. The sample was 62% White, 21% Asian, 12% Black, and 2% other. All participants were fluent English speakers. Participants were recruited from undergraduate psychology and educational psychology courses and completed the study for extra credit. Data from n = 9 participants were excluded from analyses because of high frequency of missing data (e.g., a participant failed to respond to an entire measure). Thus, the final sample size was n = 103 participants.

Materials

Pretest. The same pretest used in Experiment 1 was used in the current experiment. The prevalence of the targeted misconceptions for the current sample was lower than it was in Experiment 1. Specifically, the endorsement rates of the three misconceptions: (1) *most crops are GMOs*, (2) *GMOs end up in animal products*, and (3) that *GMOs contribute to declines in honeybee populations*—were 70%, 59%, 38%, respectively. The endorsement rate for the global misconceptions that *GMOs are harmful* was 62%. The pretest had rather poor internal consistency, Cronbach's α = .47. As in

Experiment 1, the variability in prevalence and low internal consistency of pretest items can cautiously be interpreted as evidence of erroneous and fragmented prior knowledge about GMOs that may correspond to flawed mental models (e.g., Gadgil et al., 2012).

Documents. The same document sets from Experiment 1 were used in the current experiment, with one exception—*all* texts included a refutation of the misconception. Thus, document sets consisted of three short refutation texts (range: 166 – 186 words in length; see Appendix). Each text targeted a specific misconception about GMOs (i.e., *most crops are genetically modified, GMOs have contributed to the decline in honeybee populations,* and *GMOs end up in animal products*) that related to the global misconception that *GMOs are harmful.*

Documents appeared in one of two source-credibility conditions (high-credibility, low-credibility). With regard to source credibility, documents in the high-credibility condition included information sources have high credibility in the domain of GMOs (e.g., the Food and Drug Administration, Organic Farmers' Association, and the US Department of Agriculture); documents in the low-credibility condition included relatively low-credibility sources in the domain of GMOs (e.g., Huffington Post, Fox News, Buzzfeed). To ensure that the current sample perceived the credibility of the sources as intended, participants completed a Source Credibility Questionnaire (described below).

To facilitate the typed think-alouds, participants read instructions for the reading and writing task (detailed below) that informed them that they would have opportunities to type their thoughts into text boxes, and that they were free to type as much as they needed to in order to communicate their thoughts (see Appendix F). Before each

constructed-response text box, participants were prompted with the question, "What are you thinking right now?" Such general prompts are appropriate because they enable tracking of readers' cognitive processes without unduly influencing comprehension performance overall (e.g., Afflerbach & Cho, 2009; Ericsson & Simon, 1993; Fletcher, 1986). In the current experiment, five constructed-response boxes were interspersed into each document and roughly corresponded to each section of text: (1) after the statement of the misconception, (2) after refutation of the misconception, (3) after first half of the explanation of the correct idea, (4) after second half of the explanation, (5) after the conclusion. These response boxes were placed at these points because each section of text has a specific purpose.

Think-Aloud Protocols. Typed think-aloud protocols were coded for evidence of: (1) integration processes (i.e., frequency of compare/contrast, generalization and/or abstraction of main ideas), (2) sourcing processes (i.e., implicit sourcing, explicit sourcing, source evaluations), and (3) knowledge revision processes (i.e., paraphrase, elaborations, bridging inferences, cognitive conflict, monitoring comprehension, questioning, and associations). See Table 3 for examples of typed think-aloud responses. Regarding integration processes, it is important to note that there were insufficient instances of integration coded in the think-aloud protocols to include in analyses (i.e., only $n = 7$ readers engaged in any integration processes).

Table 3.

Example Typed Think-Aloud Responses

Knowledge Revision Processes	
Code	Sample Responses

Paraphrase	"Only a limited number of crops that are genetically modified."
Elaborations	"I am thinking that a lot of people tend to overreact about GMOs…"
Bridging Inference	"Most of our crops are just grown regularly."
Cognitive Conflict	"Everything seems opposite from what I've been told."
Monitoring	"This all makes sense!"
Questions	"What are the reasons for the decline in honeybees?"
Associations	"I really liked Bill O'Reilly growing up."
	Sourcing Processes
Code	Sample Responses
Explicit Sourcing	"Fox News was able to reinforce my initial thoughts on that majority of the crops we consume aren't GMOs."
Implicit Sourcing	"This answers the question brought up by the last article much more directly."
Source Evaluation	"Buzzfeed is not that reliable."

Sourcing Processes. Think-aloud protocols were coded for sourcing processes (proportion of implicit sourcing, explicit sourcing, and source evaluations; Strømsø, Bråten, Britt, & Ferguson, 2013). Explicit sourcing was evident when readers referred to specific sources by name (i.e., According to the FDA…" Implicit sourcing was evident when readers referred to specific sources but did not include the specific name of the source (i.e., "According to the second source…" and source evaluation was evident when readers reported judgments of the trustworthiness or credibility of particular sources (i.e.,

"USDA is a credible website so that makes sense…"). The proportion of each sourcing process served as the outcome. Twenty percent of the responses were double scored for inter-rater reliability, which was found to be 86.7% for sourcing processes overall.

Knowledge Revision Processes. Think-aloud protocols were also coded for knowledge revision processes (see Table 3). The categories of processes were adapted from those used by Kendeou et al. (2019) and Kendeou and van den Broek (2007), and included the following: *associations* (i.e., comments providing information activated from prior knowledge but not helpful for building coherence); *elaborations* (i.e., comments explaining the current text based on previous text and background knowledge); *bridging inferences* (i.e., comments accurately explaining the current text based on previous text); *paraphrases* (i.e., comments that capture the gist meaning of the current text); *cognitive conflict* (i.e., comments that express conflict between individuals' prior knowledge and the information in the current text); *monitoring comprehension* (i.e., comments that reflect individuals' understanding or lack thereof). The proportion of each of these processes served as the outcome. Twenty percent of the responses were double scored for interrater reliability, which was found to be 87.2%.

Intertextual Inference Verification Task. The same intertextual inference verification task (IVT) used in Experiment 1 was used in the current experiment. The IVT prompted participants to verify intertextual inferences that required connections among information units from different documents. The internal consistency of the IVT scores was $\alpha = .52$.

Posttest and Delayed Posttest. The same posttest used in Experiment 1 was used in the current experiment. A trained research assistant scored participants' explanations,

20% of which were double scored by a second research assistant. Interrater agreement was 85.3%. Internal consistency for the posttest scores was $\alpha = .57$.

For the delayed posttest, participants completed the same items after a 20-minute filler task (detailed in the Procedure), but the items were presented in a randomized order. Interrater agreement on 20% of responses was 96.7% for the delayed posttest. Internal consistency delayed posttest scores was $\alpha = .64$.

Reading and Writing Task. The same scenario-based reading and writing task used in Experiment 1 was used in the current experiment. The reports were also scored using the same holistic scoring scheme used in Experiment 1 (List et al., 2019; Perfetti et al., 1999). Reports represented a *Mush Model* if they included information that was presented across documents in an integrated fashion but exhibited no sourcing. Reports were coded as representing a *Separate Representations Model with Citations* if they included citations and references to documents but failed to integrate information across documents. A variant of this model is the *Separate Representations Model without Citations*, which means that information was presented sequentially by source of origin, but there were no attributions to sources or integration across documents. Reports were coded as a *Documents Model* if they exhibited at least some degree of integration across documents by forming connections between at least two documents and referring to at least one of the three sources. Finally, reports were coded as a *Tag-All Model* if readers comprehensively connected all documents to one another via explicit source attributions. Reports were categorized by trained research assistants, 20% of which were double scored. Interrater agreement was 86.4%.

Source Credibility Questionnaire. To ensure that high- and low-credibility sources were perceived as intended, readers rated each of the six sources included in the documents on a scale from 0 (Not at all credible) to 100 (Completely credible).

Design

This experiment followed a single-factor (source credibility: high vs. low) between-subjects design. Participants were randomly assigned to either the high-credibility or low-credibility condition. The three online dependent variables—knowledge revision processes, sourcing processes, and integrative processes—were gauged by coding of the typed think-aloud protocols. Proportions of each process served as the outcomes. The second dependent variable—integration of participants' multiple documents representation—consisted of two distinct indicators: (1) IVT scores, which gauged the extent to which readers integrated specific, fine-grained connections among documents and sources, and (2) the type of MD representation, which gauged holistic integration based on the presence or absence of content integration and/or source integration. The third dependent variable—knowledge revision—consisted of three indicators: (1) reduction in misconception prevalence, which was assessed by the sum of readers' T/F/Not Sure responses on all 13 pretest items. Specifically, readers' responses were awarded 1 point if they were correct and 0 points if they were incorrect/not sure; (2) readers' understanding of the correct information, which was evaluated by their total scores on the posttest and delayed posttest. To create the total scores, readers' scores for the T/F/Not Sure responses on all 13 items were summed with explanation accuracy scores on the three items corresponding to the individual misconceptions targeted in the documents, as well as the item targeting the global misconception (pretest scores were

not included as they did not require explanations). Thus, total scores reflected their overall understanding of the critical information; (3) revision of the global misconception that GMOs are harmful, which was evaluated by accuracy of readers' T/F/Not Sure response to the global misconception item on the posttest and delayed posttest. Thus, the outcome for revision of the global misconception was dichotomous (correct response/incorrect response).

Procedure

Administration took place in small-group sessions. Participants used their personal computers to complete the study. During the session, participants first completed a brief demographics questionnaire and pretest to gauge prior knowledge. Second, participants received the reading and writing task, and then engaged with a set of three documents and typed their thoughts. Third, participants received a task reminder, and then completed their typed report, during which time they could navigate the documents. Fourth, access to the documents was removed, and participants completed the IVT. Fifth, participants completed the knowledge posttest. Sixth, participants completed a 20-minute filler task that required them to read twelve short texts (each approximately 250 words in length) and rate their emotional response to each text. Seventh, participants completed the delayed posttest. Eighth, participants completed the source credibility questionnaire. Finally, participants were debriefed and thanked for their participation. Participants took approximately 50 minutes to complete the experiment. It is important to note that due to the COVID-19 pandemic, the administration method changed from in-person to remote virtual administration. An experimenter proctored the virtual administration sessions via Zoom.

Results

Preliminary Analyses

Source Credibility Questionnaire. As a manipulation check to ensure that high- and low-credibility sources were perceived as intended, I conducted a paired-samples *t*-test on the Source Credibility Questionnaire items. Results showed that the mean credibility rating for the high-credibility sources ($M = 80.6$, $SD = 15.7$) was significantly higher than that for the low-credibility sources ($M = 37.8$, $SD = 18.4$), $t(102) = 21.74$, $p < .001$, Cohen's $d = 2.14$.

Administration Method. Due to the COVID-19 pandemic, the administration method changed from in-person to remote virtual administration. Thus, it was important to ensure equivalence between those participants who completed the experiment in-person ($n = 41$) and those who did so remotely ($n = 62$). In doing so, the analysis focused on relevant variables, including prior knowledge (i.e. pretest sum scores) and document engagement as indicated by log-data. First, an independent-samples *t*-test showed that the two groups did not differ in prior knowledge, $t(101) = .17$, $p = .87$. Second, the two groups did not differ in the time they spend engaging with documents and typing think-aloud responses, as indicated by time-log data, $t(101) = 1.16$, $p = .25$. Finally, the two groups did not differ in their navigation of documents, according to the frequency of clicks per page, $t(101) = .11$, $p = .91$.

Question 1: To what extent does source credibility influence the moment-by-moment processes theorized in KReC-MD?

Integrative Processes. Because there was an insufficient frequency of integrative processes evident in readers' typed think-aloud protocols (i.e., only $n = 7$ readers engaged

in any online integrative processes), the influence of integrative processes could not be evaluated. This lack of online integration processes is in line with existing work that has also shown a paucity of integration processes in readers' think-aloud responses (i.e., List et al., 2019).

Sourcing Processes. To examine the extent to which source credibility influenced the proportion of each of the sourcing processes (i.e., explicit sourcing, implicit sourcing, and source evaluation) evident in readers' typed think-aloud protocols, I conducted separate univariate ANOVAs with source credibility as the between-subjects factor and the proportion of each sourcing process (i.e., explicit sourcing, implicit sourcing, and source evaluation) as the respective dependent variables. With respect to explicit sourcing, readers in the high-credibility condition (M = .18, SE = .03) did not differ from readers in the low-credibility condition (M = .18, SE = .03), $F(1, 101) = .001$, $p = .97$. Likewise, with respect to implicit sourcing, readers in the high-credibility condition (M = .33, SE = .03) did not differ from readers in the low-credibility condition (M = .33, SE = .03), $F(1, 101) = .032$, $p = .86$. Finally, with respect to source evaluations, readers in the low-credibility condition (M = .48, SE = .02) demonstrated significantly more source evaluations than readers in the high-credibility condition (M = .37, SE = .02), $F(1, 101) = 10.96$, $p = .001$, $\eta_p^2 = .098$.

Knowledge Revision Processes. To examine the extent to which source credibility influenced each knowledge revision process (i.e., paraphrase, elaborations, bridging inferences, cognitive conflict, monitoring comprehension, questioning, and associations) evident in readers' typed think-aloud protocols, I conducted separate univariate ANOVAs with source credibility as the between-subjects factor and each

knowledge revision process (i.e., paraphrasing, elaborations, bridging inferences, cognitive conflict, monitoring comprehension, questioning, and associations; see Table 3 for example responses in each category) as the respective dependent variables.

Source credibility did not influence paraphrasing, $F(1, 101) = .00$, $p = .98$; elaborations, $F(1, 101) = 1.37$, $p = .24$; bridging inferences, $F(1, 101) = 1.86$, $p = .18$; monitoring comprehension, $F(1, 101) = .38$, $p = .54$; cognitive conflict, $F(1, 101) = 2.37$, $p = .13$; associations, $F(1, 101) = .35$, $p = .56$; or questioning, $F(1, 101) = .047$, $p = .83$. See Table 4 for descriptive statistics for each process in both the high- and low-credibility conditions.

Table 4.

Descriptive Statistics for Think-Aloud Responses (Mean Proportion) in Each Condition

	Condition			
	Low-Credibility		High-Credibility	
Processes	*M*	*SD*	*M*	*SD*
Associations	.05	.08	.05	.11
Bridging Inferences	.03	.06	.01	.04
Elaborations	.12	.16	.09	.14
Monitoring Comprehension	.48	.24	.45	.26
Cognitive Conflict	.07	.13	.03	.08
Paraphrase/Summary	.15	.23	.15	.25

Question 2: To what extent does source credibility influence intertextual integration?

IVT Scores. To examine the extent to which source credibility influenced fine-grained intertextual integration, as measured by the IVT, I conducted a univariate ANOVA with source credibility (high vs. low) as a between-subjects factor and IVT scores as the dependent variable. Results showed that readers in the high-credibility

condition (M = 13.61, SD = 2.63) did not perform differently than readers in the low-credibility condition (M = 13.21, SD = 2.98), $F(1, 101) = .51$, $p = .47$. Considering the mean scores in each condition relative to the highest possible score (20), overall it appears that participants engaged in a decent level of intertextual integration.

MD Type. To examine the source credibility influenced the integration of readers' mental representations, as manifest in the type of MD representation evident in the reports, I conducted a chi-square test with source credibility (high vs. low) and MD representations (integration vs. no integration). MD representations were categorized as featuring intertextual integration if they were coded as Tag-All Models (n = 43, 42%), Documents Models (n = 3, 3%), or Mush Models (n = 27, 26%); MD representations were categorized as featuring *no* intertextual integration if they were coded as Separate Representations Models without Citations (n = 20, 19%) or Separate Representations Models with Citations (n = 10, 10%). Results showed that there was an association between source credibility and intertextual integration, $\chi^2(1) = 4.43$, $p = .035$, Cramer's V = .21 (see Figure 9), such that readers in the high-credibility condition more often constructed MD-representations that featured integration. Specifically, in the high-credibility condition—n = 41 readers engaged in intertextual integration, whereas n = 10 did not. In the low-credibility condition, n = 32 readers engaged in integration, whereas n = 20 readers did not.

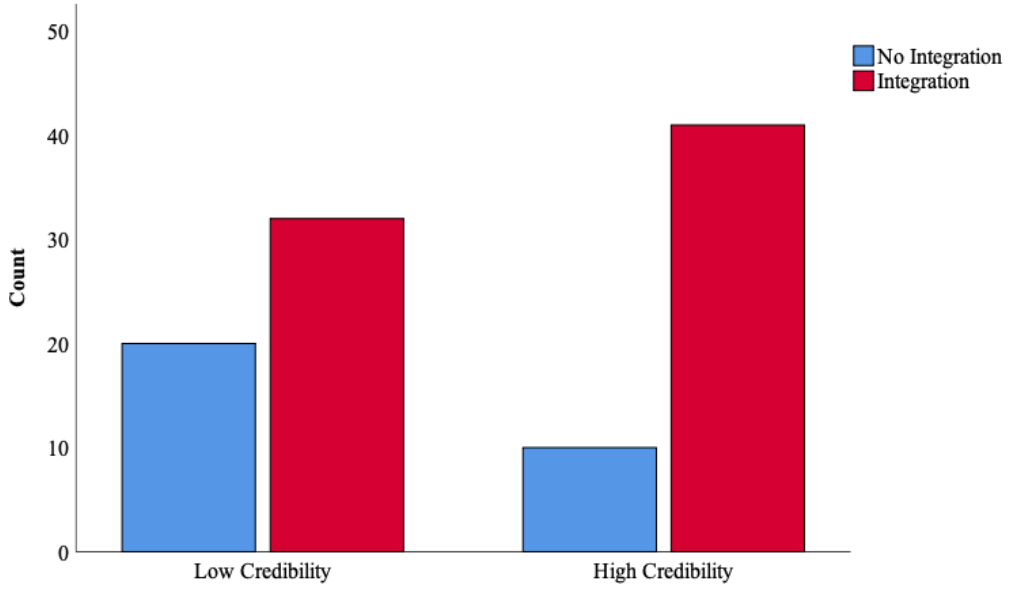

Figure 9. Frequencies of MD representations that feature integration (or not) in the high- and low-source credibility conditions.

Question 3: To what extent to does source credibility influence knowledge revision outcomes?

Misconception Prevalence. To examine the extent to which source credibility influenced misconception prevalence, I conducted a mixed ANOVA with source credibility (high vs. low) as a between-subjects factor, time (pretest vs. posttest vs. delayed posttest) as a within-subjects factor, and misconception prevalence—as indicated by participants' summed responses to the True/False/Not Sure component of each item on the pretest posttest, and delayed posttest—as the dependent variable. Because of a violation of the sphericity assumption, $\chi^2(2) = 92.41$, $p < .001$, the degrees of freedom were corrected using the Greenhouse-Geisser estimates of sphericity ($\varepsilon = 0.62$). The results showed a main effect of time, $F(1.2, 126.0) = 164.41$, $p < .001$, $\eta_p^2 = .62$ (see Figure 10), such that misconception prevalence was higher at pretest ($M = 4.04$, $SE = .19$)

than at posttest (M = 1.08, SE = .14) and delayed posttest (M = 1.18, SE = .15), $p < .001$. Prevalence did not differ between posttest and delayed posttest (p = .28). There was also a main effect of source credibility, $F(1, 101) = 4.73$, p = .032, η_p^2 = .045, such that prevalence was lower overall in the high-credibility condition (M = 1.84, SE = .17) than in the low-credibility condition (M = 2.37, SE = .17).

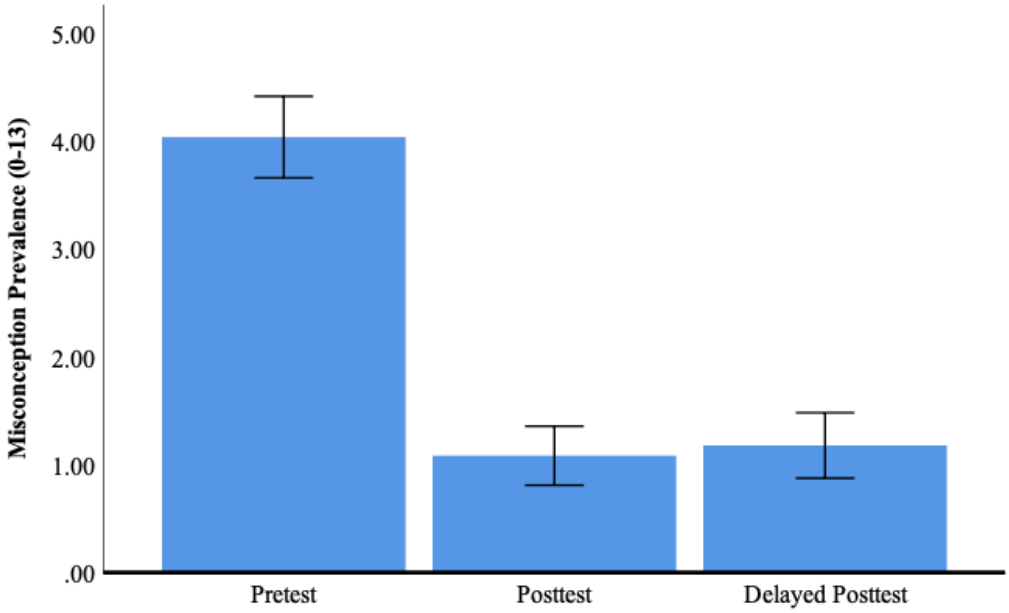

Figure 10. Mean misconception prevalence at pretest, posttest, and delayed posttest.

Understanding of the Correct Information. To examine the extent to which source credibility influenced readers' understanding of the correct idea, I conducted a mixed ANOVA with source credibility (high vs. low) as a between-subjects factor, time (posttest vs. delayed posttest) as a within-subjects factor, and total scores (True/False/Not Sure + explanation) on the posttest and delayed posttest as the dependent variable. There was a main effect of time, $F(1, 101) = 23.19$, $p < .001$, η_p^2 = .19, such that scores were

higher at posttest (M = 17.15, SE = .35) than at delayed posttest (M = 15.80, SE = .33). There was also a main effect of source credibility, $F(1, 101) = 11.39$, $p = .001$, $\eta_p^2 = .10$, such that understanding of the correct information was higher overall in the high-credibility condition (M = 17.53, SE = .45) than in the low-credibility condition (M = 15.41, SE = .44).

Global Misconception. To examine the extent to which source credibility influenced revision of the global misconception (i.e., GMOs are harmful), I conducted a chi-square tests with source credibility (high vs. low) and participants' responses (T/F/Not Sure) to the global misconception item on the posttest and delayed posttest, respectively. There was no association between source credibility and responses to the global misconception on the posttest, $\chi^2(1) = 0.38$, $p = .54$. However, there was a significant association between source credibility and response to the global misconception item on the *delayed* posttest, $\chi^2(1) = 4.05$, $p = .044$, Cramer's $V = .20$ (see Figure 11). In the low-credibility condition, n = 17 readers held the misconception, whereas n = 35 did not. In the high-credibility condition, n = 8 readers held the misconception, whereas n = 43 did not. Thus, participants in the high-credibility condition were more likely to provide correct responses to the global misconception delayed posttest item than those in the low-credibility condition.

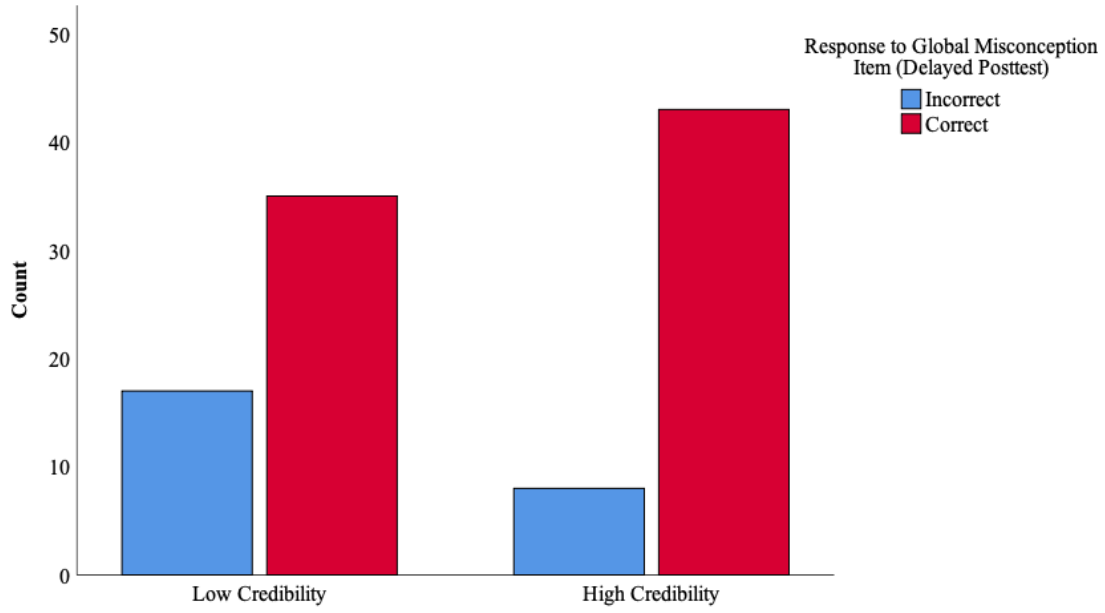

Figure 11. Response frequencies to the global misconception delayed posttest item.

Question 4: To what extent does intertextual integration influence knowledge revision outcomes?

Misconception Prevalence. To examine the extent to which fine-grained intertextual integration (i.e., IVT scores) influenced misconception prevalence, I conducted a repeated-measures ANOVA with time (pretest vs. posttest vs. delayed posttest) as a within-subjects factor, IVT scores as a continuous predictor variable, and misconception prevalence as the dependent variable. Because of a violation of the sphericity assumption, $\chi^2(2) = 86.58$, $p < .001$, the degrees of freedom were corrected using the Greenhouse-Geisser estimates of sphericity ($\varepsilon = 0.63$). The results showed a main effect of integration (IVT score), $F(1, 101) = 12.28$, $p = .001$, $\eta_p^2 = .11$. This main effect was qualified by a time x integration interaction, $F(1.3, 127.9) = 5.17$, $p = .017$, $\eta_p^2 = .049$ (see Figure 12). IVT scores did not influence pretest performance, but during

posttest and delayed posttest, readers who had higher IVT scores tended to have lower misconception prevalence.

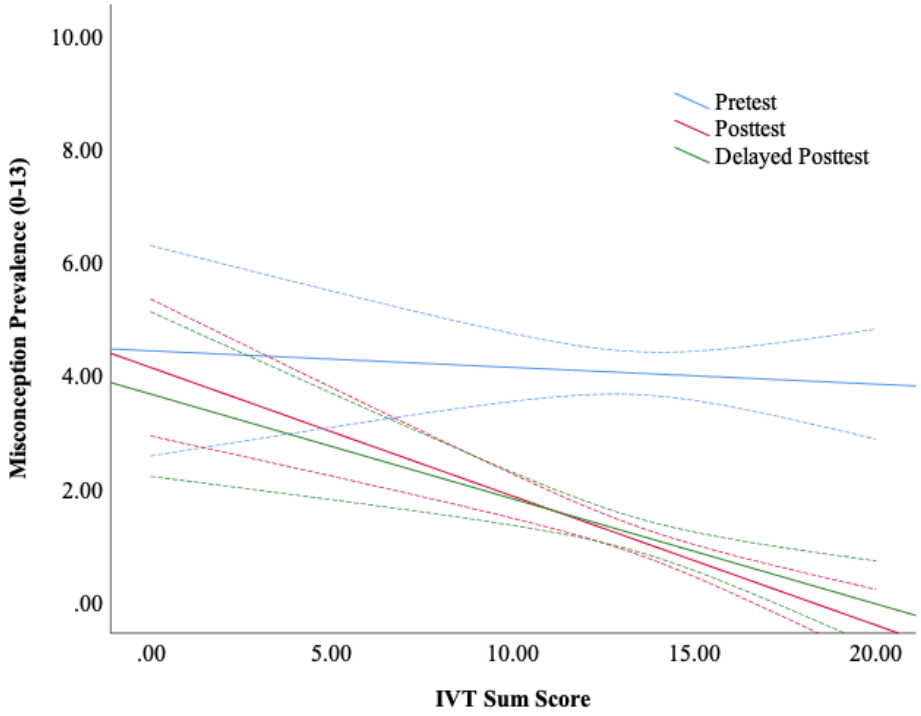

Figure 12. Effect of intertextual integration on misconception prevalence at pretest, posttest, and delayed posttest.

To evaluate the extent to which the holistic integration (i.e., type of MD representation) influenced misconception prevalence, I conducted a mixed ANOVA with type of MD representation (Separate Representations without Citations, Separate Representations with Citations, Mush Model, Documents Model, and Tag-All Model) as a between-subjects factor, time (pretest, posttest, and delayed posttest) as a within-subjects factor, and misconception prevalence as the dependent variable. Because of a violation of the sphericity assumption, $\chi^2(2) = 91.59$, $p < .001$, the degrees of freedom were corrected using the Greenhouse-Geisser estimates of sphericity ($\varepsilon = 0.63$). There

was a main effect of time, $F(1.3, 126.3) = 163.82$, $p < .001$, $\eta_p^2 = .619$, such that misconception prevalence was higher at pretest ($M = 4.03$, $SE = .19$) than at posttest ($M = 1.08$, $SE = .14$) and delayed posttest ($M = 1.16$, $SE = .16$), ps <.001. Prevalence did not differ between the posttest and delayed posttest ($p = .34$). No effects were observed regarding the type of MD representation.

Understanding of the Correct Information. To examine the extent to which fine-grained intertextual integration (i.e., IVT scores) influenced readers' understanding of the correct idea, I conducted a repeated-measures ANOVA with time (posttest vs. delayed posttest) as a repeated-measures ANOVA, IVT scores as a continuous predictor variable, and total scores (True/False/Not Sure + explanation) as the dependent variable. There was a main effect of integration (IVT score), $F(1, 101) = 14.94$, $p < .001$, $\eta_p^2 = .129$, such that higher IVT scores were associated with better understanding. This main effect was qualified by a time x integration interaction, $F(1, 101) = 6.29$, $p = .014$ $\eta_p^2 = .059$ (see Figure 13). At posttest, participants who had higher IVT scores tended to have higher total scores; the same was true at delayed posttest, albeit to a lesser extent.

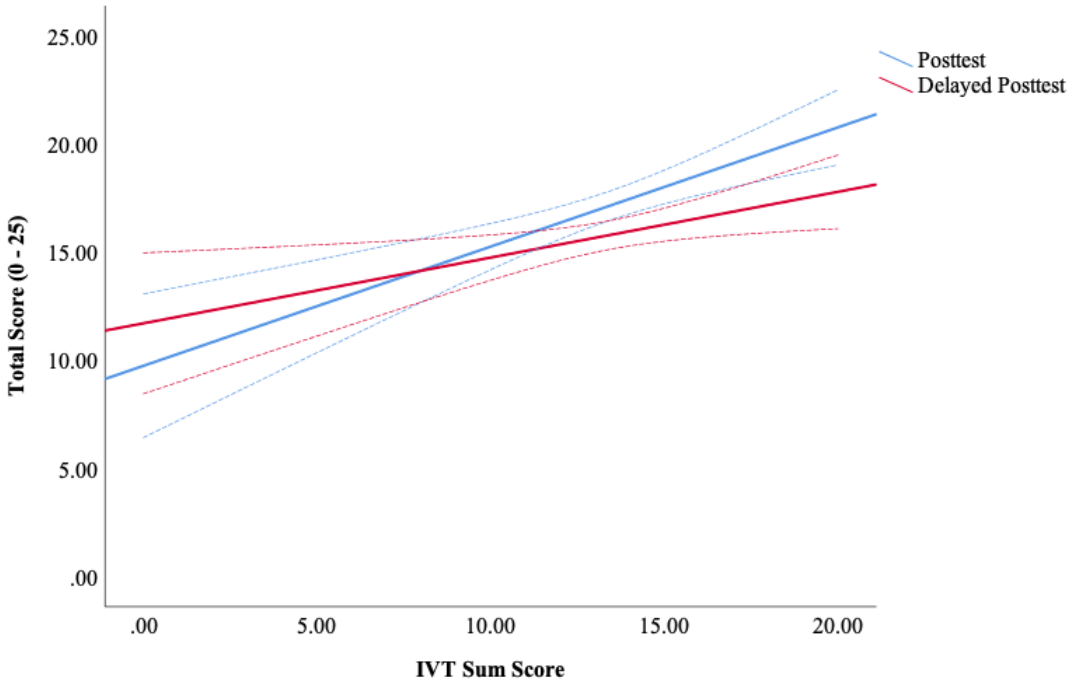

Figure 13. Effect of intertextual integration on understanding of the correct information at posttest and delayed posttest.

To evaluate the extent to which the holistic intertextual integration (i.e., type of readers' MD representation) influenced understanding of the correct information in the texts, I conducted a mixed ANOVA with type of MD representation (Separate Representations without Citations, Separate Representations with Citations, Mush Model, Documents Model, and Tag-All Model) as a between-subjects factor, time (posttest vs. delayed posttest) as a within-subjects factor, and total score on the posttest and delayed posttest as the dependent variable. The results revealed a main effect of time, $F(1, 98) = 8.70$, $p = .004$, $\eta_p^2 = .086$, such that scores were higher at posttest ($M = 16.68$, $SE = .56$) than at delayed posttest ($M = 15.41$, $SE = .52$). No effects were observed regarding the type of MD representation.

Global Misconception. To examine the relation between holistic intertextual integration (i.e., type of MD representations) and revision of the global misconception that GMOs are harmful, I conducted two separate chi-square tests with type of readers' MD representations and scores on the global misconception item at posttest and delayed posttest, respectively. For these analyses, readers' MD representations were collapsed into two categories: (1) those that feature at least some intertextual integration (i.e., Mush Model, Documents Model, Tag-All Model) and (2) those that feature no intertextual integration (e.g., Separate Representations Model without Citations, Separate Representations Model with Citations; List et al., 2019). At posttest, there was no association between intertextual integration, as gauged by type of MD representation, and response to the global misconception item, $\chi^2(1) = .18$, $p = .43$. Likewise, at delayed posttest, there was no association between integration and response to the global misconception item, $\chi^2(1) = .01$, $p = .57$.

Finally, to examine the relation betwen revision of the individual misconceptions influenced revision and the global misconception, I conducted a chi-square test with the number of specific misconceptions targeted in the text that readers revised (0, 1, 2, or 3 misconceptions) and accuracy (accurate, inaccurate) on the global misconception item on the posttest (based on T/F/Not Sure responses), along with *p*-values for Fisher's Exact Tests (two-sided) for each comparison. The results showed a significant association between the number of misconceptions revised and revision of the global misconception at posttest, $\chi^2(3) = 9.78$, $p = .021$, Cramer's $V = .31$ (see Figure 14, left panel). Of readers who responded correctly to all three specific misconceptions items, 80% ($n = 61$) responded correctly to the global misconception item, and 20% ($n = 15$) responded

incorrectly (p = .02). Of readers who responded correctly to two of the specific misconception items, 61% (n = 11) responded to the global misconception item correctly and 39% (n = 7) responded incorrectly (p = .24). Of readers who correctly responded to only one of the specific misconception items, 57% (n = 4) responded correctly to the global misconception item and 43% (n = 7) responded incorrectly (p = .38). Finally, of participants who did not correctly respond to any of the specific misconception items, 100% (n = 2) responded incorrectly.

At delayed posttest, the results showed that there was again a significant association between the number of misconceptions revised and revision of the global misconception at posttest, $\chi^2(3) = 19.30$, $p < .001$, Cramer's $V = .43$ (see Figure 14, right panel). Of readers who responded correctly to all three specific misconceptions items, 84% (n = 65) responded correctly to the global misconception item, and 16% (n = 12) responded incorrectly, (p = .001). Of readers who responded correctly to two of the specific misconception items, 63% (n = 12) responded to the global misconception item correctly and 37% (n = 7) responded incorrectly (p = .23). Of readers who correctly responded to only one of the specific misconception items, 17% (n = 1) responded to the global misconception item correctly and 83% (n = 5) responded incorrectly (p = .003). Finally, of participants who did not correctly respond to any of the specific misconception items, 100% (n = 1) responded incorrectly.

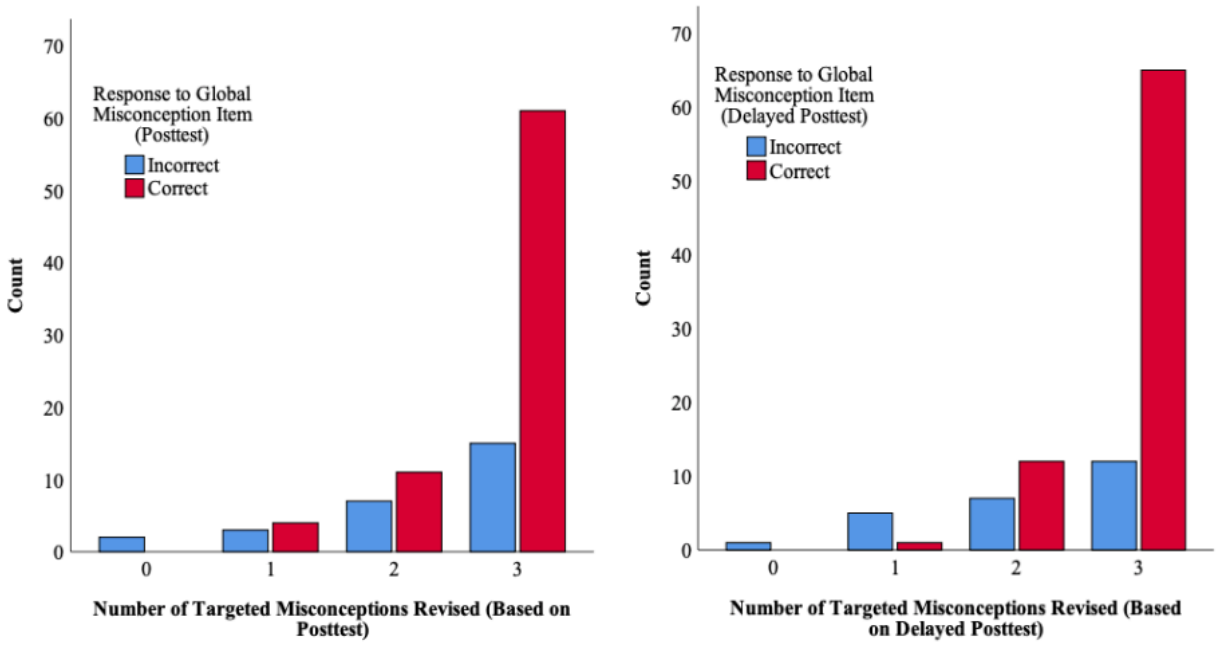

Figure 14. Response frequencies for the global misconception item clustered by responses to targeted misconception items on the posttest (left) and delayed posttest (right).

Discussion

There were two primary aims to the current experiment. For the first aim, this experiment examined the extent to which source credibility and intertextual integration influenced online integration, sourcing, and knowledge revision *processes* that occurred as readers engaged with multiple documents (i.e., refutation texts). This experiment included refutation texts (as opposed to non-refutation texts) because refutations facilitate knowledge revision (Kendeou et al., 2014), which then allowed for examination of the processes that occur during knowledge revision. This first aim provided an initial investigation into the processes that take place during engagement with multiple refutation texts, as hypothesized by KReC-MD. For the second aim, this experiment examined the extent to which source credibility and intertexual integration influenced knowledge revision outcomes after reading, as well as how intertextual integration

influenced knowledge revision outcomes. This experiment provided further empirical investigation into the core assumptions and predictions outlined by KReC-MD, as well as replication of the effects regarding the influence of source credibility on knowledge revision outcomes observed in Experiment 1. Overall, the current experiment provides a number of insights that can be used to specify and refine future iterations of KReC-MD.

First, the current experiment examined the extent to which source credibility influenced online sourcing, integration, and knowledge revision processes during reading of multiple refutation texts, as gauged by typed think-aloud protocols. With respect to integration processes, there were insufficient instances evident in readers' think-aloud protocols to examine the extent to which integration was influenced by source credibility—thus, the hypothesis that readers in the high-credibility condition would demonstrate more integrative processes than participants in the low-credibility condition (Hypothesis 1) could not be evaluated.

With respect to sourcing processes, the results suggested that readers in the low-credibility condition engaged in more source evaluations than did readers in the high-credibility condition. This is counter to the hypothesis that readers would engage in more source evaluation in the *high*-credibility source condition (Hypothesis 2). It could be the case that the increased source evaluations in the low-credibility condition were a function of evaluating the specific claims from those sources. These evaluations may have precluded the integration of the information from low-credibility sources.

With respect to knowledge revision processes (i.e., paraphrases, elaborations, bridging inferences, cognitive conflict, monitoring comprehension, questioning, and associations), the results suggest that source credibility did not influence the extent to

which readers reported these processes in their typed think-aloud protocols. This is counter to the hypothesis that there would be a higher degree of cognitive conflict in the low-credibility condition as a function of relatively lower activation of correct information from low-credibility sources (Hypothesis 3) and also with the hypothesis that readers would report more comprehension monitoring in the low-credibility condition in their efforts to re-establish coherence (Hypothesis 4). One potential explanation for the failure of source credibility to influence knowledge revision processes during reading is that source credibility may not have significantly influenced the frequency with which participants engaged in knowledge revision processes, which may be especially important given that a key factor that has been shown in past work to influence frequency of knowledge revision processes, namely text structure (i.e., refutation vs non-refutation; Kendeou et al., 2019; Kendeou & Van den Broek, 2007), was held constant in the current experiment, as all texts included refutations of readers' misconceptions.

Second, the current experiment examined the extent to which source credibility and intertextual integration influenced knowledge revision outcomes. As in Experiment 1, there were two distinct indicators of integration: 1) scores on the inference verification task (IVT), which gauged the extent to which readers integrated specific, fine-grained connections among documents, and 2) the type of MD representation that readers constructed, which gauged readers' engagement in holistic integration based on whether they drew basic connections across documents. The current results suggest that source credibility did not influence the extent to which readers engaged in intertextual integration at the fine-grained level. This is counter to the hypothesis that readers in the high-credibility condition would engage in more intertextual integration (Hypothesis 5).

However, when considering the more holistic integration gauged by the type of MD representation manifest in the reports, the current results suggest that readers in the high-credibility condition more often constructed MD representations that featured at least some intertextual integration (i.e., Mush Model, Documents Model, Tag-All Model) compared to no intertextual integration (i.e., Separate Representations Model without Citations, Separate Representations Model with Citations; List et al., 2019; Perfetti et al., 1999). Thus, overall, Hypothesis 5 was supported to some extent by the findings regarding the holistic integration (i.e., MD representation) but not fine-grained integration (IVT scores).

With respect to the influence of source credibility on knowledge revision outcomes, the results suggest that participants in the high-credibility condition demonstrated reduced misconception prevalence and better understanding of the correct information (i.e., better knowledge revision). Thus, these results replicated the effects observed in Experiment 1. Additionally, the current findings are consistent with the hypothesis that readers would demonstrate superior knowledge revision in the high-credibility condition (Hypothesis 6) as a function of a more integrated network in support of the correct idea fostered by high-credibility sources.

With respect to the influence of intertextual integration on knowledge revision outcomes, the results indicated that readers who engaged in greater intertextual integration—as gauged by higher IVT scores—demonstrated a larger reduction in misconception prevalence from pretest to posttest and delayed posttest, as well as better understanding of the correct information. However, the same was not true for the more holistic indicator of integration (the type of MD representation). The current results also

indicated that revising the individual misconceptions targeted in the documents was associated with a higher frequency of correct responses to the global misconception item. Taken together, these results are generally consistent with the hypothesis that readers who engage in a greater degree of intertextual integration will demonstrate superior knowledge revision outcomes (Hypothesis 7).

Overall, the current results regarding the influence of source credibility on intertextual integration and knowledge revision replicated several key findings from Experiment 1. In particular, both experiments suggest that readers who engage in more intertexual integration tend to demonstrate better knowledge revision outcomes. In turn, this provides further support for KReC-MD's core hypothesis that a richer, more integrated network supports the activation of the idea to which it is most heavily linked (i.e., the global correct idea). In the context of the current experiments, the network supported the correct information; thus, the activation of the global correct idea overcame the activation of readers' global misconceptions.

There are several limitations to the current experiment that must be considered. One potential limitation concerns the typed think-aloud methodology itself. To engage in the think-aloud, readers typed their thoughts into constructed-response boxes that were placed after each section of the text. Although existing work has shown negligible differences in the reading strategies and generation of inferences when think-aloud responses were verbalized versus when they were typed (Muñoz et al., 2006), this is the first experiment that used typed think-alouds rather than traditional verbal think-alouds to capture the influence of source credibility on integration processes, sourcing processes, and knowledge revision processes. Thus, it could be the case that typing out the responses

influenced the sensitivity of the think-aloud methodology to capture the influence of source credibility on the online integration processes or knowledge revision processes that readers engaged in during reading.

An additional limitation regards the categories of responses readers provided for the typed think-alouds. Think-aloud protocols were coded for both *cognitive conflict* and *questions* as separate processes. However, cognitive conflict may feasibly take the form of a question. Thus, in some cases, instances of cognitive conflict and questions may have been confounded. Additional limitations that are shared with Experiment 1 are discussed in the General Discussion (Chapter 6).

Overall, the current experiment, in conjunction with Experiment 1, offers evidence for KReC-MD's hypotheses regarding factors (i.e., source credibility and intertexual integration) that influence the outcome of the integration and competing activation principles. In turn, this initial evidence can expand on existing literatures regarding sourcing and multiple-document comprehension and can also be used to refine and specify KReC-MD to increase its explanatory power.

Chapter 6: General Discussion

Overview of the Study

The overarching aim of this dissertation was to articulate an initial proposal of the Knowledge Revision Components Framework-Multiple Documents (KReC-MD) and experimentally test some of its core hypotheses in order to provide an understanding of how knowledge revision unfolds in multiple-document contexts. The proposal of KReC-MD, which was informed by a review of the extant literature, and the two subsequent experiments followed the structure of the three-pronged approach (Magliano & Graesser, 1993).

For the first prong, I reviewed prominent accounts of single-document comprehension, multiple-document comprehension, and sourcing during reading, with a focus on how readers cope with conflicting information. This review served as the basis for proposing KReC-MD, a companion account to the Knowledge Revision Components Framework (KReC; Kendeou & O'Brien, 2014), that attempts to understand how knowledge revision unfolds in multiple-document contexts. For the second prong, I conducted an experiment to test some of the core hypotheses from KReC-MD with respect to knowledge revision *outcomes* after readers engaged with multiple documents that varied in source credibility and text structure (Experiment 1). Specifically, I evaluated the extent to which source credibility and text structure influenced intertextual integration and knowledge revision outcomes. For the third prong, I conducted a second experiment to examine the online processes that occurred as readers engaged with multiple refutation texts that varied in source credibility (Experiment 2). Specifically, I evaluated the extent to which source credibility influenced the online processes (i.e.,

integration processes, sourcing processes, and knowledge revision processes) that readers engaged in during reading, as well as the influence of source credibility on intertextual integration and knowledge revision outcomes.

Taken together, the results from these prongs provide an initial understanding of how knowledge revision unfolds when readers engage with multiple refutation documents that conflict with preexisting beliefs. The understanding derived from the current results is critical given that readers must constantly engage with multiple documents and sources that vary in structure, accuracy, and credibility (Britt & Rouet, 2020; Bråten, 2008; Cho & Afflerbach, 2015).

Review of the Results

KReC-MD hypothesized that several text-level and reader-level factors may influence how knowledge revision unfolds when readers engage with multiple documents. In particular, *text structure* and *source credibility* were hypothesized to influence the integration of readers' multiple-documents (MD) representation. In turn, readers who engaged in more *intertextual integration* were hypothesized to demonstrate better knowledge revision. These hypotheses garnered several research questions that were examined across the two experiments.

The first research question asked *to what extent does text structure (refutation vs. non-refutation) influence intertextual integration?* Experiment 1 showed that readers engaged in more integration of fine-grained connections (as indicated by IVT scores) when they read refutation texts compared to non-refutation texts. This finding suggests that the discrepancy introduced by the direct refutation of prior knowledge induced cognitive conflict. Consistent with this idea, Experiment 2 showed that readers reported

cognitive conflict to some extent during reading of refutation texts, regardless of source credibility. In turn, the cognitive conflict readers experienced may have encouraged more integration as a means of resolving the inconsistency between their reactivated misconceptions and the correct information.

The second research question asked *to what extent does source credibility (high vs. low) influence intertextual integration?* Experiment 1 showed that readers demonstrated better integration of fine-grained intertextual connections in the high-credibility condition, and Experiment 2 showed that readers demonstrated more integration at a holistic level in the high-credibility condition. Taken together, these findings suggest that information from highly credible sources may be more readily integrated into readers' MD representations, thereby resulting in a richer network of accurate information that supports the correct idea.

The third research question asked *to what extent does source credibility (high vs. low) influence knowledge revision outcomes?* Experiments 1 and 2 both showed that readers in the high-credibility condition demonstrated better knowledge revision outcomes (i.e., greater reduction in misconception prevalence and better understanding of the correct information) than readers in the low-credibility condition. Taken together, these finding suggests that information from high-credibility sources resulted in a more integrated network of correct information that overcame readers' misconceptions.

The fourth research question asked *to what extent does intertextual integration influence knowledge revision?* Experiments 1 and 2 both showed that readers who engaged in more integration of fine-grained connections (as gauged by IVT scores) demonstrated better knowledge revision outcomes (i.e., reduced misconception

prevalence and better understanding of correct ideas) than those who engaged in less integration. Experiment 1 also showed that readers who constructed MD representations that featured at least a minimal level of integration (i.e., Mush Models, Documents Models, Tag-All Models; Perfetti et al., 1999) were more likely to provide correct responses to the global misconception item than readers who constructed MD representations that featured no intertextual integration (i.e., Separate Representations Models without Citations, Separate Representations Models with Citations). With respect to revision of the global misconception, Experiments 1 and 2 both showed that readers who revised more of the individual misconceptions targeted in the documents tended to be more likely to correctly respond to the global misconception item at posttest and delayed posttest. Thus, these findings offer further support for the idea that greater intertextual integration of correct information fosters revision of the global misconception.

A final research question asked *to what extent does source credibility influence the online processes readers engage in during reading of multiple refutation texts.* Experiment 2 showed that readers did not tend to report integrative processes in their typed think-aloud protocols, which is consistent with existing work (i.e., List et al., 2019). Moreover, source credibility did not influence the frequency by which readers engaged in any of the targeted knowledge revision processes. However, readers in the low-credibility condition engaged in significantly more source evaluations than readers in the high-credibility condition. It could be the case that readers engaged in relatively more source evaluations in the low-credibility condition because of the need to evaluate the

trustworthiness of claims from low-credibility sources (e.g., Braasch & Bråten, 2017; Kobayashi, 2014).

In sum, the current results suggest that readers tend to integrate correct information more readily from high-credibility sources and refutation texts into their MD representations. In turn, MD representations that feature a higher degree of integration—at both a fine-grained level and more holistic level—fostered better knowledge revision outcomes for both the individual misconceptions and the global misconception. Importantly, these findings help advance and have implications for the existing literatures regarding multiple-document comprehension and sourcing.

Implications for Multiple-Document Comprehension

In the context of the Documents Model Framework (DMF, Perfetti et al., 1999), readers' MD representations consist of (1) an intertext model, which captures information about the documents and sources, as well as the connections that readers draw between sources; and (2) a situations model, which captures the reader's mental representation of the situation(s) described in the documents. When the intertext model and the situations model are connected via source-content links, meaning that readers can map elements (i.e., nodes) of information in the situations model to sources within the intertext model, readers have constructed a *Documents Model*. When readers can *comprehensively* map each node in the situations model to a specific source in their intertext model, readers are likely to have constructed a *Tag-All Model*. The current findings suggest that high-credibility sources and refutations may independently facilitate the interconnectedness of readers' MD representations. The results also suggest that intertextual integration, at both the holistic and fine-grained levels, may increase readers' understanding of information

found in multiple refutation texts. Thus, taking these results together, the MD representations as conceptualized in the context of the DMF may be optimized when readers engage with texts that include refutations and information from high-credibility sources.

Regarding the different types of MD representations, readers could construct representations that represent little or no integration (i.e., Separate Representations Model with Citations, Separate Representations Model without Citations), integration of content (i.e., Mush Model) or integration of both sources and content (i.e., Documents Model, Tag All Model). In the current experiments, the types of MD representations, as manifest in their written reports, were coded using the rubric by List et al. (2019), who categorized the MD representations of college-aged readers after they engaged with a set of six conflicting documents. Readers in that study most often constructed a Documents Model (34%), followed by Separate Representations Model with Citations (29%), Mush Model (19%), Separate Representations Model without Citations (13%), and Tag-All model (<1%). By contrast, in Experiment 1 of the current work, most readers constructed a Mush Model (40%), followed by Tag-All Model (24%), Separate Representations Model without Citations (19%), Documents Model (12%), and Separate Representations Model with Citations (6%). In Experiment 2, most readers constructed a Tag-All Model (42%), followed by Mush Model (26%), Separate Representations Model without Citations (19%), Separate Representations Model with Citations (10%) and Documents Model (3%). The variability in the type of MD representations that readers constructed across these investigations could be explained, in part, by differences in the document sets with which readers engaged. Particularly, List et al. used document sets that included six

expository documents (word counts: 222 – 274 words), and some of the documents conflicted with other documents in the set, but not necessarily with readers' prior knowledge. In the current set of experiments, however, I used document sets that included only three expository documents (word counts: 166 – 186 words), all of which contradicted GMO-related misconceptions. Thus, the current results, in conjunction with those observed in List et al., suggest that readers may construct MD representations with a highly integrated structure (i.e., Documents Model, Tag-All Model) with greater ease when document sets have fewer texts, shorter texts, and texts that are corroboratory rather than conflicting. These findings highlight that the extent to which readers successfully construct Documents Models from reading multiple documents is driven heavily by the affordances of the documents themselves.

Implications for the Role of Sourcing

The current results expand on existing work regarding sourcing in the context of knowledge revision. Namely, Van Boekel et al. (2017) used refutation texts that included high- or low-credibility embedded sources and gauged knowledge revision processes (gauged by reading times of target sentences that reactivated readers' misconceptions) and outcomes (posttest scores), albeit in the context of single documents. Namely, Van Boekel et al. (2017) found that readers demonstrated worse knowledge revision (slower reading times and lower posttest scores) after engaging with refutation texts from low- than high- credibility sources, which is consistent with the findings of the current experiments. Additionally, the slowdown in reading times in the low-credibility condition observed by Van Boekel et al. may have been due in part to increased source evaluations, consistent with the think-aloud results of Experiment 2. Importantly, in Van Boekel et al.,

the effect of source credibility emerged only after readers were provided with direct instructions that alerted them that the credibility of the sources would vary and that they should pay attention to sources. Indeed, other studies have shown similar task effects in which the influence of source credibility on comprehension did not emerge until participants were explicitly told that they should attend to source credibility (e.g., Sparks & Rapp, 2011). However, the current set of experiments observed differential effects of source credibility on knowledge revision outcomes and sourcing processes without any explicit pre-reading instructions to attend to source credibility. Although there was no pre-reading instruction, the reading and writing task used in the current experiments may have fostered source attention. Specifically, readers' task was to use the three documents to write a brief research report. The readers were instructed to avoid plagiarizing—which served as implicit instruction to attribute information to sources in their written reports—but this instruction was provided *after* readers had first encountered the documents. Although readers could revisit documents during their writing, one potential implication of the current experiments is that even after initial encoding, instructions to use source information may make readers' mental representation of sources constructed during encoding more salient and accessible.

The current results also expand on existing work regarding the role of discrepancies in sourcing in the context of reading comprehension (Braasch & Bråten, 2017; Braasch, Rouet, Vibert, & Britt, 2012). Braasch et al. found that readers processed information more deeply, recalled information more readily, and recalled sources with better accuracy when presented with news stories that presented causally discrepant, rather than consistent, explanations for an event. This Discrepancy-Induced Source

Comprehension (D-ISC) assumption contends that encountering conflicting information or textual discrepancies across documents prompts readers to attend more strategically to sources and evaluate information from those sources. This results in the integration of more source–content links in the reader's MD representation (Braasch & Bråten, 2017). The current work extends D-ISC in two ways. First, the current work showed that after readers engaged with documents in that included *refutations,* they engaged in more intertextual integration. This result suggests that discrepancies between the reader's *prior knowledge* and information in the documents also may facilitate increased integration of source-content links. Second, the current work showed that encountering refutations (i.e., discrepancies) may have increased source attention (i.e., explicit sourcing, implicit sourcing, and source evaluations) to *low-credibility* sources. This increased attention to low-credibility sources may have been necessary to evaluate the trustworthiness of claims. Thus, in the context of D-ISC, readers may be especially likely to increase integration of source-content links when the sources are low in credibility as a function of increased evaluation—and potentially rejection—of claims.

In addition to these implications for existing literature, it is critical to articulate what the current findings mean in terms of KReC-MD's principles, as the current results also represent the first empirical examinations of KReC-MD.

Implications for KReC-MD

The results of the current set of experiments have implications primarily for KReC-MD's integration principle and competing-activation mechanism, which together serve as the crux of knowledge revision. The integration principle and competing-activation mechanism share a direct relation in that the outcome of competing activation

is a function of the integrated network readers construct from their reactivated prior knowledge and newly encoded textual information.

Integration Principle. According to KReC-MD's integration principle, integration follows from the co-activation of prior knowledge and newly encoded information. This integration results in the construction of a network through which spreading activation occurs (Kintsch, 1988; Myers & O'Brien, 1998) during competing activation. Because readers engage with multiple documents, the reader's network must take the form of a multiple-documents (MD) representation. Indeed, one of the novel aspects of KReC-MD is the integration of the MD representations from the DMF (Perfetti et al., 1999) with the principles of KReC that guide knowledge revision. Consistent with KReC-MD's hypothesis, the current experiments suggest that source credibility is a key factor that influences the integration principle. Specifically, readers in the high-credibility condition engaged in more fine-grained integration and were more likely to construct MD representations that featured integration at a holistic level. Moreover, readers engaged in more evaluation of low-credibility sources, perhaps as a function of evaluating the specific claims from those sources. This evaluation may have precluded the integration of the information from low-credibility sources.

Another text-level factor that influenced KReC-MD's integration principle is the refutation text structure, such that readers demonstrated more integration when they encountered refutations. One potential reason for this finding is that readers may have experienced more cognitive conflict in the refutation text condition (e.g., Kendeou et al., 2019), which may have increased the extent to which they engaged in intertextual integration as a means of restoring coherence. Although it would be tempting to draw this

conclusion, the think-aloud results from the current work cannot corroborate this explanation. This is because Experiment 2, which included the think-aloud methodology, used only refutation texts, so it is unknown whether more cognitive conflict was experienced during reading of refutation texts, as there was no non-refutation condition to provide a comparison.

To take the findings regarding source credibility and text structure into account, KReC-MD's integration principle can now specify that high source credibility is one text-level factor that fosters the integration of fine-grained intertextual connections, as well as more structurally integrated MD representations. Moreover, direct refutations of readers' prior knowledge may also foster the integration of fine-grained intertextual connections. However, low source credibility fosters hesitance, increased evaluation, decreased endorsement, as well as decreased integration of information into the MD representation. Thus, in the context of KReC-MD's integration principle, readers may strategically evaluate the sources of claims they encode that conflict with prior knowledge. In turn, these source evaluations may provide the means by which readers reject information from low-credibility sources. This is consistent with existing work that suggests that readers shift to more strategic, evaluative processing after encountering information that contradicts their prior knowledge (e.g., Braasch & Bråten, 2017; Richter & Maier, 2017).

The current findings also showed that revision of individual misconceptions targeted in the documents may also foster revision of the global misconception and, therefore, endorsement of the global correct idea. In the context of the reader's MD representation, the global misconception node is accompanied by a network of additional nodes that correspond to the individual misconceptions. Likewise, the global correct idea

node is accompanied by a network of nodes that correspond to the individual correct ideas. As readers revise the specific misconceptions and integrate the correct information, they increase the richness of the network associated with the global correct idea. To put this in the context of the current experiments, a reader could have held the individual misconceptions that (1) most crops are GMOs, (2) GMOs end up in animal products, and (3) that GMOs have contributed to declines in honeybee populations. Considered together, these individual misconceptions support the global misconception that *GMOs are harmful*. However, if a reader revised these individual misconceptions, then the reader's network of newly encoded correct information could have included the information that (1) few crops are GMOs, (2) GMOs do not end up in animal products, and (3) that GMOs are unrelated to declining honeybee populations. Integrating these individual correct ideas increases the richness of the network supporting the global correct idea that *GMOs are safe*.

To account for the findings regarding integration of the individual correct ideas, KReC-MD's integration principle now specifies that that the global misconception and global correct idea each include respective networks of information. The network accompanying the global misconception consists of individual misconceptions, whereas the network accompanying the global correct idea consists of individual correct ideas. Failure to integrate correct information from the documents fosters the integration of the network supporting the global misconception. However, success in integrating the correct information fosters the integration of the network supporting the global correct idea. The differential integration of these two contradicting ideas sets the stage for the competing activation mechanism of KReC-MD to successful unfold.

Competing Activation Mechanism. According to KReC-MD's competing activation mechanism, the network of newly encoded correct information, which includes the global correct idea, competes for activation with the global misconception. Critically, if this network of information supporting the global correct idea is richly integrated with newly revised correct ideas from the documents, then the activation of the global correct idea should easily overcome activation of the global misconception. However, the current results show that failure to revise even one of the individual misconceptions may hinder revision of the global misconception. This may be because any individual misconception that the reader endorses could strengthen the activation of the global misconception, which in turn raises the threshold of activation required for the global correct idea to outcompete the global misconception.

Although the evidence from this set of experiments suggests that competing activation unfolded fairly smoothly in the current experiments—particularly when readers engaged in high levels of intertextual integration of correct information from high-credibility sources—competing activation would likely become more complicated if readers engaged with contradictory documents (i.e., some documents support the reader's misconceptions and others support the correct idea). In such instances, the activation of the global correct idea may correspond to (1) the number of documents that serve to successfully revise individual misconceptions, and (2) the extent to which the reader integrates the newly encoded correct information into the network supporting the global correct idea. If some documents strengthen the activation of the global misconception, then the likelihood of the global correct idea attaining sufficient activation to overcome the global misconception would decrease. In turn, this may result in failure to revise the

global misconception or in transient revision of the global misconception as a function of a relatively weak network of correct information.

Overall, KReC-MD's competing activation mechanism now specifies that revision of the individual misconceptions is a necessary precondition for revision of the global misconception. This is because increasing the network of newly encoded correct information increases the activation of the global correct idea, which serves as the basis of winning the competition for activation over the global misconception. However, failure to revise individual misconceptions and/or integrate the correct information may result in either relatively weak revision of the global misconception or failure to revise the global misconception altogether.

Limitations

The results of the current set of experiments must be interpreted cautiously in light of some limitations. One limitation shared by both experiments is that holistic integration (i.e., type of MD representation) was gauged via readers' written reports. However, limitations in readers' writing skill may have constrained the extent to which intertextual integration manifested in their written reports (Graham & Perin, 2007). That said, the think-aloud results indicated that readers tended to not engage in intertextual integration, so it could be the case that readers' intertextual integration was limited overall.

Additionally, as List et al. (2019) noted, using written reports to gauge integration may have been limiting because readers' understanding of what constitutes a quality written response may have underemphasized intertextual integration. This is because readers are often taught particular writing conventions that do not necessarily encourage

intertextual integration in their writing (e.g., the five-paragraph essay format; Campbell & Latimer, 2012). For example, a reader could have produced a report that was highly organized, included sourcing, and drew upon evidence from the documents. Although this report could be considered an effective written product, if it did not feature explicit statements that connected information across documents, it would have been devoid of intertextual integration and coded as a Separate Representations Model with Citations. To remedy this limitation, in addition to limitations in writing skill, future work should include additional methods to gauge the holistic integration of readers' MD representations, such as oral questioning and post-reading interviews (e.g., Wolfe & Goldman, 2005), which may bypass constraints on the expression of integration due to limitations of writing.

Another limitation shared by both experiments is that the documents readers engaged with provided exclusively correct information that conflicted with their misconceptions. It was necessary in the current experiments to use documents that contradicted readers' misconceptions in order to promote revision of these individual misconceptions, which was a precondition for examining revision of the global misconception. This is consistent with Strømsø's (2017) call for systematic investigations into reading situations in which multiple documents provide overlapping, complementary, and corroboratory information. One reason such investigation is necessary is because the current information ecosystem confronts readers with multiple documents that may either strengthen preexisting beliefs or contradict them. For example, in 'filter bubbles' and 'echo chambers,' readers encounter multiple documents from multiple sources that converge on a singular idea (Del Vicario et al., 2016), often in line

with their preexisting beliefs (Borgesius et al., 2016; Pariser, 2011). In turn, this insulates those preexisting beliefs and prevents readers from encountering alternative ideas (Del Vicario et al., 2016). As a consequence of repeatedly encountering information that exclusively affirms preexisting beliefs, readers may shift towards more extreme viewpoints on socio-scientific issues (Zollo et, al., 2017). However, because of these belief-insulating effects of filter bubbles and echo chambers, readers are advised to actively seek information outside of their preferred information sources (Borgesius et al., 2016), which would ideally result in a more balanced exposure to information that reinforces preexisting beliefs and information that challenges those beliefs. Thus, because readers should access a combination of documents that support their prior knowledge and alternative ideas, future work must use documents sets that include inter-document contradictions. Doing so would also provide a better understanding of how KReC-MD's integration principle and competing activation mechanism unfold when some documents support the global misconception and others support the global correct idea, which the current work could not provide.

Another limitation in the current experiments was the low internal consistencies of several measures. Namely, in both Experiments 1 and 2, the knowledge pretest scores demonstrated low internal consistency (i.e., Cronbach's $\alpha < .50$). This has been observed in previous work and may reflect incoherence and fragmentation in readers' prior knowledge, as well as misconceptions in readers' mental models (e.g., Gadgil et al., 2012). To better capture prior knowledge, future work should gauge the confidence in responses for each item in addition to categorical True/False/Not Sure options (e.g., van Loon, Dunlosky, Van Gog, Van Merriënboer, & De Bruin, 2015). Doing so would

provide an index of not only the presence or absence of misconceptions, but also the strength of the beliefs. Taking strength of the beliefs into account may help improve reliability of prior knowledge measures. Additionally, for Experiment 2, the IVT demonstrated questionable reliability (i.e., Cronbach's $\alpha < .60$). Indeed, existing research has reported similarly low internal consistencies for intertextual IVTs (Bråten & Strømsø, 2010; Firetto, 2013; Hagen, Braasch, & Bråten, 2014). However, these reliabilities may still be considered within the acceptable range for measures developed for research purposes (Nunnally, 1978).

Future Research

Future empirical and theoretical work related to KReC-MD must address several important questions that the current work did not. A critical next step is to examine how knowledge revision unfolds when readers engage with multiple documents that conflict with one another. Examining the role of inter-document conflict is critical because of its potential influence on the integration of readers' MD representations and competing activation mechanism. Moreover, future work could examine document consistency in relation to source credibility—how would revision unfold when high-credibility sources support readers' misconceptions and low-credibility sources support the correct idea, for example? How would it unfold when multiple documents provide repeated exposure to the same correct idea, but the sources vary in credibility? Such reading situations are complex to examine and understand, yet they remain critical because they correspond to situations that individuals are likely to encounter in social media environments.

Indeed, understanding better how factors like multiple-document consistency influence knowledge revision could open the door to investigating KReC-MD's

principles in more authentic contexts, such as social media. Social media contexts are particularly critical because they confront readers with different types of documents (e.g., new stories, opinion pieces) and various media (e.g., text, video, infographics) from primary sources (i.e., new sources) and secondary sources (i.e., other social media users) that vary in familiarity and credibility. A better understanding of knowledge revision given the complexities of social media could have implications for developing approaches to overcome the belief-insulating effects of filter bubbles and echo chambers (i.e., amplified communication and repetition of beliefs or ideas inside a closed system, Flaxman, Goel, & Rao, 2016).

Overall, the current proposal of KReC-MD and initial experimental investigations offer only a first step in understanding the conditions that determine how knowledge revision unfolds when readers engage with multiple documents, but much more work is necessary before a more comprehensive understanding can be articulated and carried into additional contexts.

Conclusion

This dissertation proposed an initial iteration of KReC-MD and experimentally examined how two factors—text structure and source credibility—influenced intertextual integration and knowledge revision processes and outcomes. To summarize, the results suggest that refutation texts and high-credibility sources independently foster intertextual integration, which in turn yields better knowledge revision outcomes. These findings provide evidence that source credibility is a key factor that influences KReC-MD's integration principle. The findings also provide evidence that the integration of readers' MD representation influences KReC-MD's competing activation mechanism, such that a

more integrated network of accurate information more easily overcomes activation of the global misconception, thereby resulting in superior knowledge revision.

This preliminary understanding of knowledge revision in multiple-document contexts is critical, as readers increasingly seek information in online environments and social media platforms (Gottfried & Shearer, 2016). These environments force readers to confront multiple perspectives from multiple sources that vary in credibility and intent, as well as multiple documents that vary in structure and coherence. Consequently, readers will encounter information that varies in accuracy and therefore may reactivate and reaffirm consequential misconceptions, while at the same time potentially underrepresenting correct information. This overexposure to inaccurate information and inconsistent exposure to correct information pose a significant threat to our 'intellectual survival' (Kendeou et al., 2020).

Given that information—both accurate and inaccurate—is ambient within our information ecosystem, intellectual survival has never been more complicated, as it involves simultaneously negotiating the onslaught of misinformation while seeking quality information that may conflict with preexisting misconceptions. Thus, theoretical accounts like KReC-MD are as are important as ever. Future work in this context must continue to examine the conditions that foster revision of consequential misconceptions in authentic multiple-document contexts while using ecologically valid, naturalistic materials. Doing so has the potential to contribute a deeper understanding of the complex relations among the reader, the documents, and the context that occur when readers bring their inaccurate knowledge into their interactions with a complex ecosystem of information.

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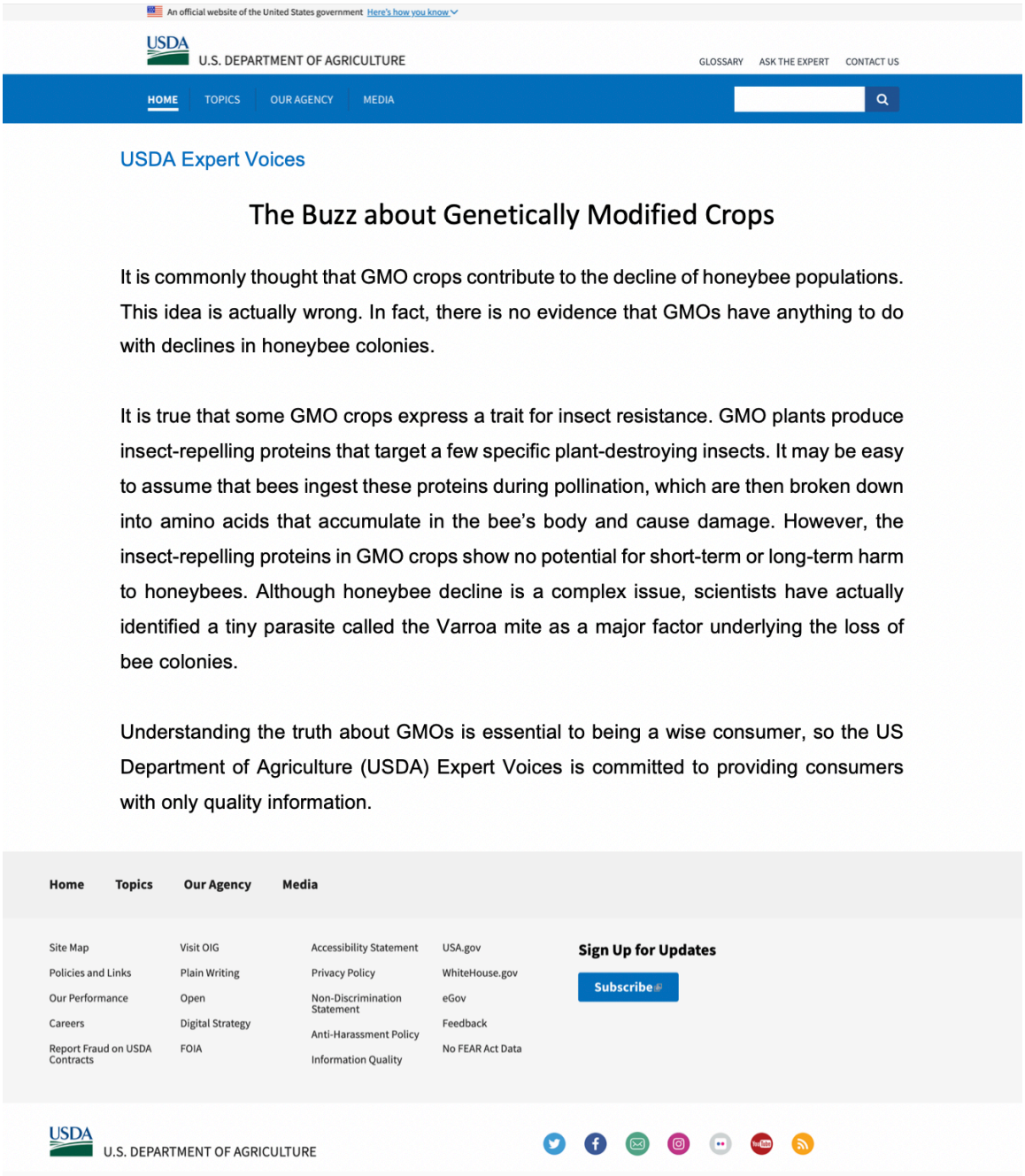
Appendix A: Example Documents



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The Buzz about Genetically Modified Crops

It is commonly thought that GMO crops contribute to the decline of honeybee populations. This idea is actually wrong. In fact, there is no evidence that GMOs have anything to do with declines in honeybee colonies.

It is true that some GMO crops express a trait for insect resistance. GMO plants produce insect-repelling proteins that target a few specific plant-destroying insects. It may be easy to assume that bees ingest these proteins during pollination, which are then broken down into amino acids that accumulate in the bee's body and cause damage. However, the insect-repelling proteins in GMO crops show no potential for short-term or long-term harm to honeybees. Although honeybee decline is a complex issue, scientists have actually identified a tiny parasite called the Varroa mite as a major factor underlying the loss of bee colonies.

Understanding the truth about GMOs is essential to being a wise consumer, so the US Department of Agriculture (USDA) Expert Voices is committed to providing consumers with only quality information.

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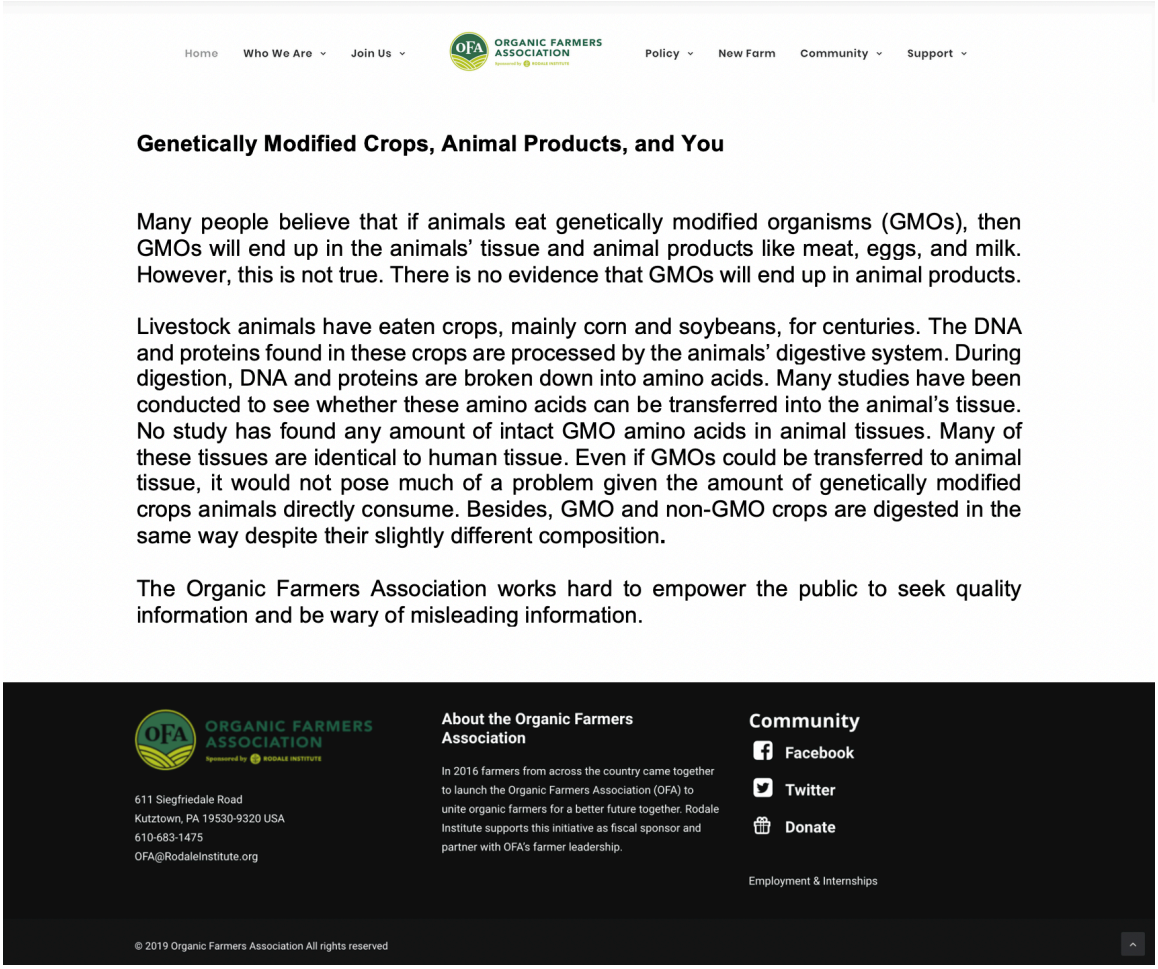
Appendix A: Example Documents



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Genetically Modified Crops, Animal Products, and You

Many people believe that if animals eat genetically modified organisms (GMOs), then GMOs will end up in the animals' tissue and animal products like meat, eggs, and milk. However, this is not true. There is no evidence that GMOs will end up in animal products.

Livestock animals have eaten crops, mainly corn and soybeans, for centuries. The DNA and proteins found in these crops are processed by the animals' digestive system. During digestion, DNA and proteins are broken down into amino acids. Many studies have been conducted to see whether these amino acids can be transferred into the animal's tissue. No study has found any amount of intact GMO amino acids in animal tissues. Many of these tissues are identical to human tissue. Even if GMOs could be transferred to animal tissue, it would not pose much of a problem given the amount of genetically modified crops animals directly consume. Besides, GMO and non-GMO crops are digested in the same way despite their slightly different composition.

The Organic Farmers Association works hard to empower the public to seek quality information and be wary of misleading information.

ORGANIC FARMERS ASSOCIATION

611 Siegfriedale Road
Kutztown, PA 19530-9320 USA
610-683-1475
OFA@RodaleInstitute.org

About the Organic Farmers Association

In 2016 farmers from across the country came together to launch the Organic Farmers Association (OFA) to unite organic farmers for a better future together. Rodale Institute supports this initiative as fiscal sponsor and partner with OFA's farmer leadership.

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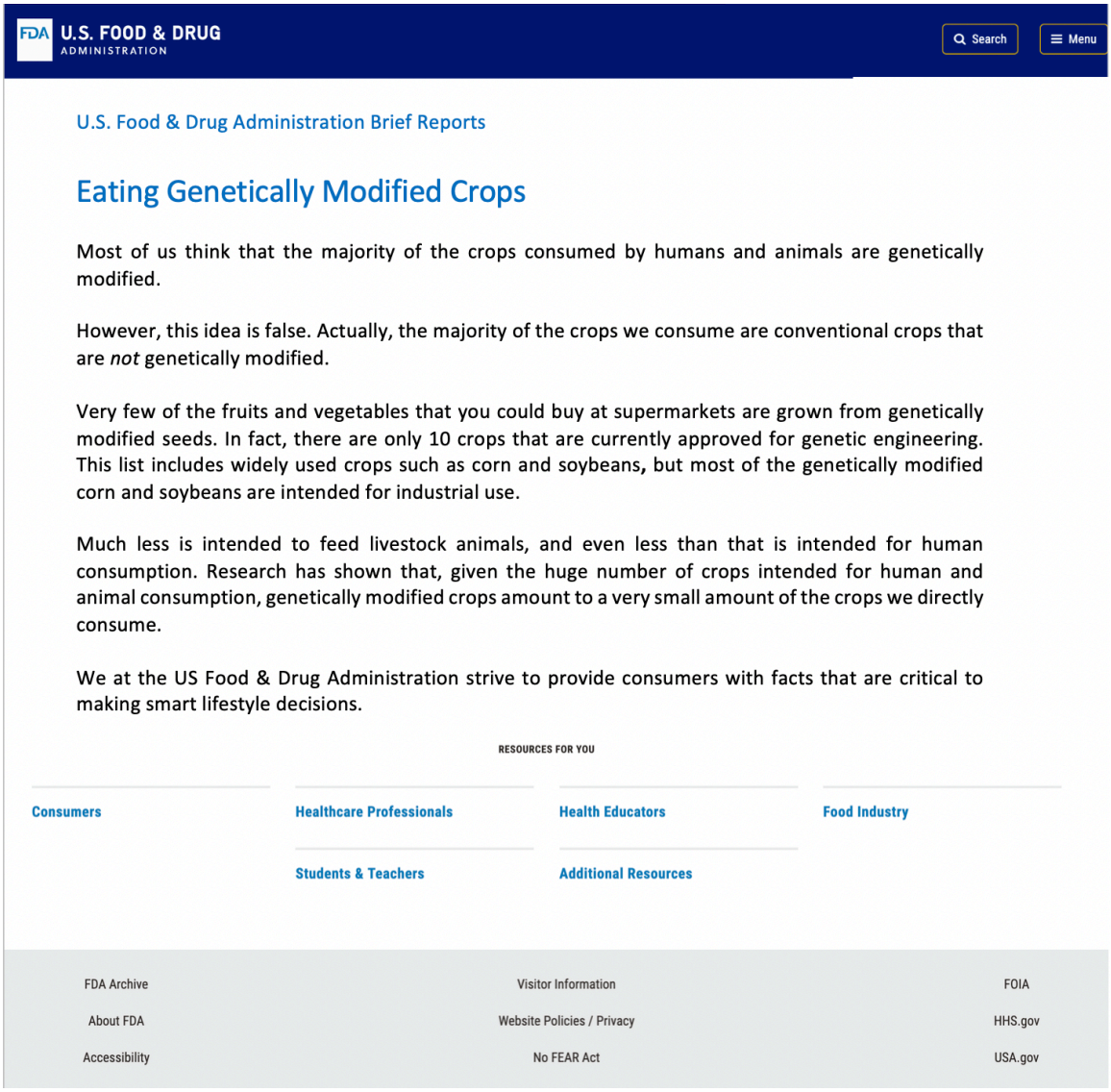
Appendix A: Example Documents



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U.S. Food & Drug Administration Brief Reports

Eating Genetically Modified Crops

Most of us think that the majority of the crops consumed by humans and animals are genetically modified.

However, this idea is false. Actually, the majority of the crops we consume are conventional crops that are *not* genetically modified.

Very few of the fruits and vegetables that you could buy at supermarkets are grown from genetically modified seeds. In fact, there are only 10 crops that are currently approved for genetic engineering. This list includes widely used crops such as corn and soybeans, but most of the genetically modified corn and soybeans are intended for industrial use.

Much less is intended to feed livestock animals, and even less than that is intended for human consumption. Research has shown that, given the huge number of crops intended for human and animal consumption, genetically modified crops amount to a very small amount of the crops we directly consume.

We at the US Food & Drug Administration strive to provide consumers with facts that are critical to making smart lifestyle decisions.

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Appendix B: Intertextual Inference Verification Task

	Statement	Response
1.	Most livestock animals digest relatively few GMO proteins.	T
2.	GMOs do not end up in animal tissue because most crops are not GMOs.	T
3.	Due to the amount of GMOs in animal feed, we indirectly consume GMOs from meat, milk, and eggs.	F
4.	Although GMOs are everywhere, they do not end up in the animal products we eat.	F
5.	The FDA and the Organic Farmer's Association agree that animals do ingest some GMO crops.	T
6.	Because GMOs are relatively uncommon, bees do not consume very many GMO proteins during pollination	T
7.	GMOs are not responsible for honeybee declines because most plants that bees pollinate are non-GMOs.	T
8.	Most of the plants we eat contain insect-repelling proteins.	F
9.	Most of the produce we buy in stores was not pollinated by bees because the plants have specific proteins that repel bees.	F
10.	The FDA and the USDA agree that soybeans and corn are both genetically modified.	T
11.	The insect-repelling proteins in GMO crops cannot end up in bee's bodily tissues.	T
12.	A bee that consumes only non-GMO crops would not be healthier than a bee consuming GMO crops because both crops are digested the same way.	T
13.	Varroa mites harm the bees' health because the mites consume GMO crops and transfer toxic proteins to the bees.	F
14.	The insect-repelling proteins in GMO crops repel bees because they cannot be broken down into amino acids.	F
15.	The Organic Farmer's Association and the USDA disagree about whether GMOs end up in animal tissue.	F
16.	If you buy honey from a beekeeper, it could not contain GMO amino acids because the bees that made the honey pollinated mostly conventional crops.	T
17.	GMOs cannot be harmful to humans because GMOs are not abundant enough to harm bees, which have many tissues that are similar to human tissue.	T
18.	Most crops are GMOs because they produce proteins that attract pollinators like honeybees.	F
19.	The amount of GMOs in a bee's tissues depends on whether it pollinated GMO plants.	F
20.	The USDA, FDA, and Organic Farmer's Association all suggest that we don't have enough evidence to know if GMOs are harmful.	F

Appendix C: Concept Maps

Note. Concepts in the cloud shapes represent target inferences.

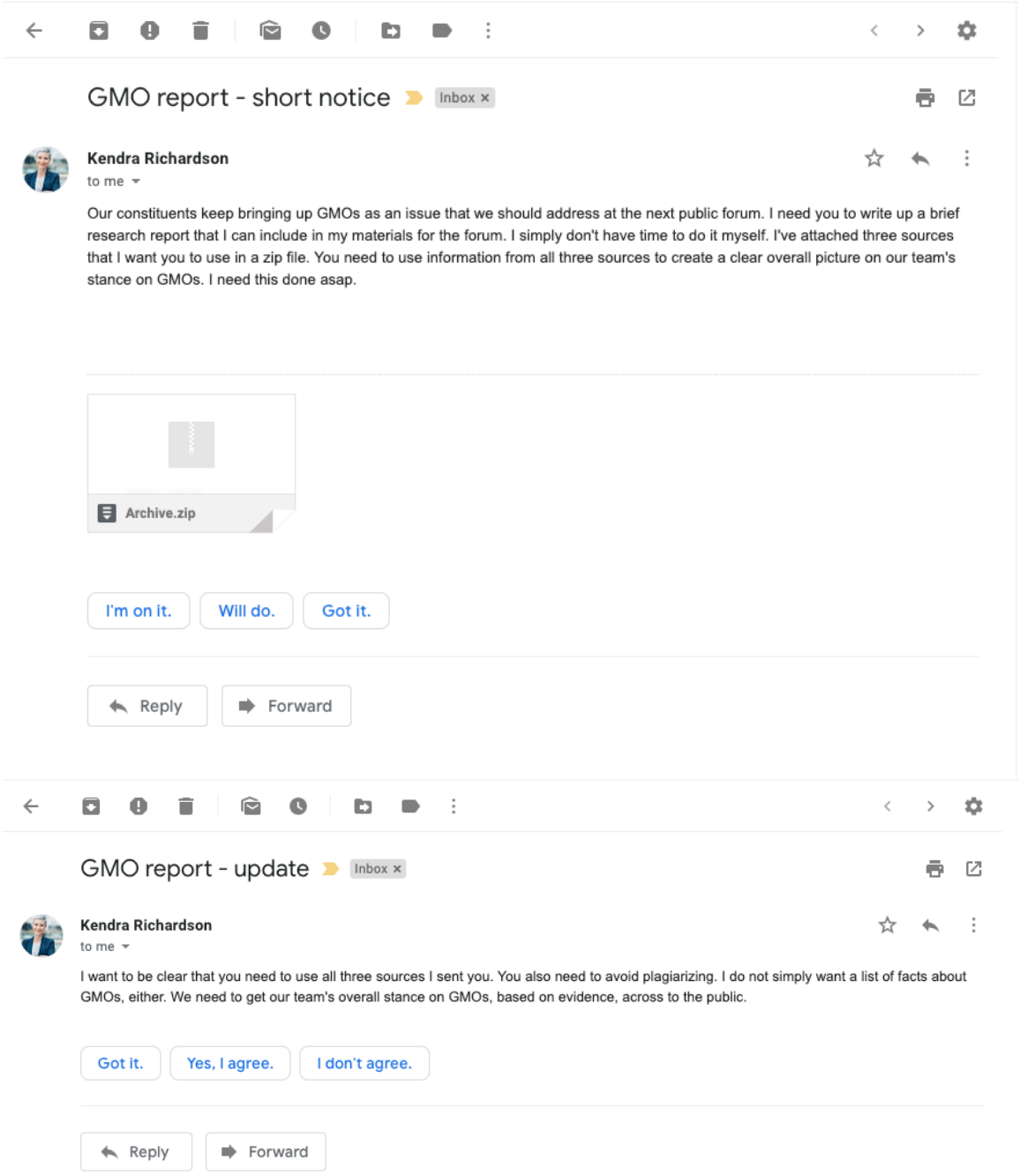
Appendix D: Prior Knowledge Pretest

	Posttest Item	Response
*1	The majority of food crops are genetically modified	F
2	Only 10 crops are approved for genetic modification	T
3	The FDA stands for Food & Drug Administration	F
4	Most of the genetically modified corn and soybeans are not intended for human consumption.	T
*5	GMOs end up in animal tissue	F
6	Livestock animals have eaten corn for centuries.	T
7	During digestion, proteins are broken down into amino acids	T
8	GMO and non-GMO crops are digested the same way.	T
*9	GMO crops have contributed to the decline in honeybee populations	F
10	Some crops have insect-repelling properties	T
11	The causes of honeybee decline are actually simple.	F
12	Bees encounter plant proteins during pollination.	T
**13	GMOs could pose harm to humans	F

* indicates an item for which the explanation was scored.

** indicates the global misconception item

Appendix E: Reading and Writing Task



Appendix F: Typed Think-Aloud Task