8-6-2020

The Role of Prior Knowledge in Multiple Text Comprehension: A Meta-Analysis

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THE ROLE OF PRIOR KNOWLEDGE IN MULTIPLE TEXT COMPREHENSION: A META-ANALYSIS

by

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A Thesis

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Master of Science

Major: Psychology

The University of Memphis

August 2020

Abstract

In an effort to build upon research focusing on multiple-text comprehension, a meta-analysis was conducted with 24 studies to evaluate the relationships between prior knowledge and various aspects of comprehending, evaluating, attending to sources, and using multiple texts. Amongst the 63 effect sizes analyzed, prior knowledge – overall – was found to be a significant guiding contributor to various aspects of comprehension.Whereas prior knowledge was a strong predictor for understanding semantic information and in integrating information across multiple texts, when considering evaluation and attention to sources, prior knowledge yielded a moderate effect. When considering various moderating factors involving different divisions of the type of dependent measures used across studies, no moderation occurred. This suggests a level of robustness in how constructs are being measured. Implications of results and opportunities for future directions are discussed.

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Introduction

Among many of the difficult cognitive skills in which individuals engage within their daily experiences, comprehension may be one of the most complex. Arguably, it is a requisite for understanding all information with which one comes into contact. Comprehension is necessary for successful functionality as well as for any "higher-level cognitive activities, including learning, reasoning, problem solving, and decision making." (McNamara & Magliano, 2009, p. 298). Several different models of text comprehension have been offered to advance the understanding of the cognitive processes in which readers engage when they are attempting to comprehend texts (Perfetti, Rouet, & Britt, 1999, Kintsch, 1988, O'Brien & Albrecht, 1992, Rouet & Britt, 2011). To validate the different cognitive processes in which readers presumably engage, researchers have developed and used various kinds of measures such as the ability to evaluate and integrate information within single texts, in integrating information across texts, and in attending to, evaluating, and using any available source information that may help to understand trustworthiness, to name but a few (Bråten, Ferguson, Strømsø, & Anmarkrud, 2013; Bråten, Ferguson, Strømsø, & Anmarkrud, 2014, Bråten, Stadtler, & Salmerón, 2018). Dating back a few decades, a multitude of research has put emphasis on both single-text comprehension (i.e. Albrecht & Myers, 1995; Kintsch, 1988; van Den Broek, 1995) and more recently, multiple-text comprehension models (i.e. Braasch & Bråten, 2017; Rouet & Britt, 2011), particularly in describing the key processes mentioned above. Whether a researcher is theorizing a model for a single text or multiple texts, they create and implement assessments to gather evidence to support inferences about the nature of the mental representation of the individual, including the makeup of ideas therein, relationships between concepts as indicators of both local and global coherence, and so forth. Specifically, in order to comprehend information, one must be able to understand

the words being read, the sentences those words construct, and the association between multiple sentences being read along with the ideas being presented. These processes are represented and organized in one's mental model of the situation, event, or phenomenon (McNamara & Magliano, 2009).

Several models have systematically explained cognitive processes believed to underlie more versus less successful comprehension and in those models included prior knowledge as a part of their theoretical framework. It is evident that prior knowledge does play a role in guiding a reader's comprehension (Ahmed et al., 2016; Bransford & Johnson, 1972; Lipson, 1982). Conversely though, when methodologically examining comprehension, models have only peripherally mentioned prior knowledge as a factor to be considered. Despite this inattention to the construct, analyses have included prior knowledge as a measure when examining different multiple text comprehension variables, however, this is typically in the form of a non-focal covariate. This meta-analytic review pointedly investigates the role that prior knowledge plays in different facets of comprehension across a number of available studies, which focus on understandings of each unique text, evaluating and integrating information available across multiple texts in complex comprehension contexts. As such, the underlying goal is to empirically validate assumptions about mental representations of multiple texts specifically described in the previous literature using a more comprehensive and expansive analytic approach, and – in particular – the strength with which prior knowledge predicts performance on the different facets of multiple-text reading comprehension.

Single-Text Comprehension Models

The most prominent model of text comprehension is that of the Construction-Integration (CI) model (Kintsch, 1988). Based off of the original theory of discourse comprehension (Dijk &

Kintsch, 1983), the CI model was foundational for all subsequent text comprehension models. Fundamentally, Kintsch (1988) proposed that discourse comprehension reflects construction and integration of the combined "raw" (basic, individual) words and semantics to the individual's prior knowledge already represented in their mental model, or that becomes a part of the mental model evolving over cycles during reading. Kintsch (1988) identifies the importance of recency in the individual's working memory. That is, the foundation of his model involves the construction of the semantics and activation of neighboring information from long term memory to what is being read, based off of any relevant information (Kintsch, 1988).

The first feature of the CI model is construction. "Construction refers to the activation of the information in the text and related knowledge" (McNamara & Magliano, 2009, p. 308). Construction, as it relates to this model, is an ongoing "retrieval-based" rhythm. As individuals read, propositions (ideas, statements, concepts) are continuously entering working memory; at the same time, prior knowledge is entering working memory as well. This is what begins the first formation of the reader's mental representation, a propositional text-base (Kintsch, 1988). This structure eventually grows to be a whole lot of text-bases as more and more information comes in because, noteworthy to Kintsch's model, prior knowledge does not necessarily have to be relevant to the immediate text in order to enter into working memory. In fact, it would be described as "an automatic memory retrieval process" (Kintsch 1988; McNamara & Magliano, 2009), meaning any level of overlap would qualify for reentrance into working memory. This results in a somewhat incoherent, "sloppy" output—consistent and inconsistent, relevant and irrelevant, necessary and unnecessary propositions are all activated, regardless of contextual relationship (Braasch & Bråten, 2017; Kintsch, 1988). However, this incohesive state transforms

into a coherent representation by account of the connecting integration element of Kintsch's model.

Integration refers to the settlement of activation across the mental representation (McNamara & Magliano, 2009). Integration helps resolve the issue of incoherence by eliminating the undesired components. Elimination is one of the two simultaneous processes by which the stability and development of a coherent representation of the text is reached; the other process is retention of linked information. Elimination is the result of loss of activation due to lack of association between prior knowledge and immediate concepts. Stronger activation, therefore, is the result of greater association between prior knowledge and immediate concepts, which leads to retention of information. Together, the outcome of the reader's mental representation produces a strong and secure coherent representation of the text. This framework expounds upon previous comprehension research because it emphasizes the importance of including prior knowledge relevant to what is presently being read in the mental representation. Thus, prior knowledge is descriptively one of the pertinent building blocks of single-text comprehension in the CI model.

Above and beyond Kintsch's (1988) model which poses the precise construction of sentences and connections of those sentences to each other, O'Brien and Albrecht (1992) developed a more advanced, "bottom-up" framework that focuses on the activation processes involved in the individual's mental representation, referred to as the Resonance Model. This model parses out what information is and is not vital to bring into working memory from long term memory. These decisions are passive and automatic and based on the possibility of potential connection to future incoming information, as individuals are actively reading (Myers & O'Brien, 1998; O'Brien & Albrecht, 1992). When a proposition is read, if there is information

stored in and accessible from the reader's prior knowledge, it will resonate strongly with the current proposition. Thus, the Resonance Model would suggest that the reader would reactivate that information based on feature overlap. Feature overlap primarily concerns contextual similarities which would afford opportunities to make a connection between prior knowledge and the proposition(s) currently residing in working memory (Albrecht & Myers, 1995). Although the activation and reactivation components of the Resonance model are passive actions, it has proved to be a beneficial contribution alongside the CI model. The Resonance model brings to light the factors that influence the processes involved in bringing prior information back into working memory, differentiating it from the construction process of the CI model. This influential factor was not pertinent in the CI model, which instead described reactivation of prior knowledge as a "context-free retrieval" process (Kintsch, 1988). Together with Kintsch's model, both the CI model and the Resonance models have been foundational in addressing the structural processes involved in reading comprehension.

Building upon the Construct-Integration model and related to parts of the Resonance framework is yet another singe-text comprehension model, the Landscape model. Proposed by van Den Broek (1995), the Landscape model, often compared to the Construction-Integration model because of computational similarities, posits that ideas and concepts connected to the text fluctuate or "shift landscapes" in their activation during reading. That is, at any point while reading, an individual may automatically bring into their working memory information connected to the focal sentence, information from prior reading sequences, or background information from prior knowledge in order to maintain coherence (Perfetti, et al., 1999). It is the source of automatic activation and the amount of automatic activation that the Landscape model posits in comprehension (McNamara & Magliano, 2009). Specifically, activation is driven by

two mechanisms: cohort activation and coherence-based retrieval (van Den Broek, 1995). Cohort activation maps together all concepts related to the current concept in working memory, forming a "cohort," or textual interconnections with the goal that the reader will be supported in making inferences. Furthermore, coherence-based retrieval deals with the amount of automatic activation of the reader, which is dependent upon individual differences of the reader's goals (McNamara & Magliano, 2009). If the goals of the reader are shallower, the amount of activation is lower, compared to if the goals of the reader are more in depth, the amount of activation is higher (van Den Broek, 1995).

Research has made significant gains in describing and modeling the cognitive processes that occur during single text comprehension. Within each of these descriptions and models, prior knowledge has been a contributing factor. But when considering the processes of comprehension, it is more often the case that individuals interact with multiple texts – relative to single texts – in everyday reading contexts. Based on this realization, researchers have sought to build upon single-text comprehension models, extending mechanisms to account for situations where readers are attempting to comprehend multiple texts (Braasch & Bråten, 2017; Rouet & Britt, 2011).

Multiple-Text Comprehension Models

Above and beyond being able to make connections across information within a single text, researchers became interested in how individuals create mental representations as they comprehend and integrate information across multiple texts. Theoretical models of multiple-text comprehension suggest that individuals must be able to combine and connect ideas that are conveyed across several texts in order to successfully understand what is being read, including ideas that are consistent, complementary, or discrepant with one another (Braasch & Bråten,

2017). However, to what mechanisms can this integration be attributed? Furthermore, to what extent does prior knowledge play a role in integrating information across texts in order to achieve higher levels of comprehension? Researchers have more recently offered theoretical models and frameworks to describe potential processes that might underlie these kinds of reading experiences.

The Documents Model Framework (DMF; Britt, Perfetti, Sandak, & Rouet, 1999, Britt & Rouet, 2012) and the Discrepancy-Induced Source Comprehension model (D-ISC model; Braasch & Bråten, 2017) are two prominent models that address different facets of multiple text comprehension. Each describes the cognitive processes in which readers engage when interacting with multiple texts to learn and comprehend the material, in order to complete a given task, or resolve a conflict. By way of these models, researchers investigate multiple-text comprehension in terms of different types of assessments designed to reflect the conceptual make-up and coherence of readers' understandings of each unique text, the degree to which they have represented accurate concepts from different texts, and the degree of their source evaluation and representation, to name but a few (Barzilai & Ka'adan, 2017; Bråten & Strømsø, 2011; Bråten, et al., 2013). It is noteworthy that within each of these frameworks, prior knowledge is described as playing a central role in these various aspects of comprehending multiple texts, with varying degrees of specificity.

Informed by the CI model of single-text comprehension (Kintsch, 1988), the DMF (Britt et al., 1999, Britt & Rouet, 2012), addresses multiple-text comprehension; it proposes that learning from more than one text requires two additional representations above and beyond those specified in the CI model—the intertext model and the integrated mental model. The first representation proposed by the DMF is the intertext model. The intertext model represents the

reader's comprehensive understanding of each individual document broken down into the features of that document. These features of the documents are defined by Britt et al. (1999) as document nodes. Document nodes can consist of both content information and source information. Content information directly relates to what the reader knows about the ideas of subject matter being read, while the source information consists of metadata information such as the text's author, the publisher, the article's type of publication. This information can be both objective (ie. name of journal that the article is published in, author's name) and subjective (evaluative) information (ie. the reader's biased views of author or publisher, etc.). What the reader evaluates from the given text is dependent on any and all prior knowledge the reader may bring to bear as they are processing information about the topic, situation, or phenomenon. Thus, the accuracy and completeness of the reader's intertext model varies from person to person because it is heavily influenced by how knowledgeable they may be on the topic of the texts. If an individual accesses and reactivates a large amount of prior knowledge, it can be assumed that the intertext model will, as a result, be more complete than if the individual has little or no prior knowledge to consider.

Through intertext relations, as readers are taking in information from multiple texts and constructing document nodes, these document nodes may be linked to one another. These links may be from source to source (S-S links) or source to content (S-C links). While some of these connections may be explicitly provided by the writer in the text (i.e. "In the opinion of," "according to"), most will be inferred by the reader as information is being processed. A lot of these S-S and S-C links are often guided by the amount of prior source information and prior content information the individual is able to reactivate. The more prior knowledge the reader has, the more opportunities they have to facilitate the creation of links, thus resulting in a stronger

mental representation. The converse may also be true: A lack of prior knowledge could afford less opportunities to make those connections within and across the texts, resulting in a weaker mental model.

The second representational layer stemming from the DMF is the integrated mental model (Britt & Rouet, 2012). The integrated mental model is intended to connect all given semantic information across texts for the purposes of forming a mental representation of a specific situation, event, or phenomena. When constructing an integrated mental model, the compilation of content likely requires a good deal of engagement and reading skill (Barzilai & Strømsø, 2018). While some content may overlap across texts, there may also be unique, stand-alone information that was only presented in a single text. Additionally, there may be a number of contradictory claims across texts that will make up some of the information compilation (Saux et al., 2016). An important component of the integrated mental model is understanding the nature of the reader's assigned task (ie. supporting a side of an argumentative assignment, resolving a conflict, etc.). Based upon the given task, the student must then begin to organize all of the information accordingly. For instance, if the task is structured as an argumentative paper on competing claims, the individual must acquire the necessary evidence, counterarguments, and supporting facts to compose a successful argument. Due to the intensity of the reader's end goal, they must continuously organize, create, and sustain their mental model. It is a process of continuously evaluating each claim and piece of information relevant to the task. As information present in the individual's current mental model overlaps and connections are made amongst the semantic content, it is expected that reactivation of prior knowledge will occur. This will help stabilize the organization and consolidation process. It is anticipated that prior knowledge will become part of and help coordinate and strengthen connections within the mental model. The

outcome of these processes is ultimately a complete intertext and integrated mental model as well as successful completion of the reader's task (Britt & Rouet, 2012).

Another multiple-text comprehension model is the D-ISC model, theorized by Braasch and Bråten (2017), which argues that discrepancy is an impetus for sourcing when attempting to resolve conflict among multiple texts. Essentially, as a reader develops a mental model of what they are reading and encounters conflicting information, the D-ISC model suggests readers might have difficulty constructing a mental model that is coherent. Thus, in order to reach coherence, the reader's attention will shift to formulating a mental representation that incorporates sources. This is an organizational mechanism that helps establish resolution for the reader. Similar to mechanisms described in the CI and Resonance models presented above, prior knowledge becomes passively and automatically activated in this process. When information is read, prior knowledge relevant to that same information will enter into working memory that might or might not be discrepant to what is read. Ultimately, this prior knowledge will be a factor in stimulating readers to elaborate on the information for the purposes of resolving the conflict (Braasch & Bråten, 2017).

As with the single-text comprehension models, activation of prior topic and domain knowledge is recognized in multiple-text models as being important for not only comprehending the semantic information present in textual materials, but also relating the information sources to their respective pieces of relevant content. Whereas prior knowledge appears to play a central role for several aspects of multiple-text comprehension, empirical studies have not primarily treated it as a variable of interest. Rather, it has been treated as a peripheral variable for which researchers should control. That is, a host of studies examining different performance outcomes that presumably reflect different aspects of multiple-text comprehension have included prior

knowledge or domain knowledge as a covariate, in essence controlling for prior knowledge (see Braasch & Bråten, 2014; Bråten et al., 2014; Florit et al., 2020; List & Stephens, 2017). It may be the case that researchers expected prior knowledge to have a strong effect on the outcome variable and thus controlled for it in order to focus on their specific variables of interest. Arguably though, more extensive consideration should be taken to focus specifically on the influence prior knowledge has across different kinds of reading outcomes. As such, the current paper argues that the role of prior knowledge should be considered a primary variable of interest as it allows researchers to investigate in what ways and the degree to which prior knowledge guides comprehension of semantic information found within multiple texts, and in representing any source information that may have been available. It is proposed that when consolidating a group of prior studies, prior knowledge will be shown to serve a primary role in comprehending information within texts and across texts, as well as with sourcing, which should be evident in its predictiveness of variables reflective of these constructs.

Current Study

In considering the expected level of influence prior knowledge plays in guiding reading comprehension, comprehension was intentionally separated into these three distinct categories: semantic information, multiple-text integration, and sourcing. Grouping comprehension performance within these three categories allows us to evaluate and compare the level of influence prior knowledge plays in each, and may allow us to see the overall differences in the strength of prior knowledge in relation to each category. Therefore, we take a meta-analytical approach to investigate the following research questions:

- To what degree does prior knowledge predict how much readers will mentally represent semantic information within single texts?

- To what degree does prior knowledge serve as a guiding mechanism in multiple text comprehension when readers must integrate and connect ideas across multiple texts?
- To what degree does prior knowledge influence sourcing?

Within theoretical models of reading comprehension, prior knowledge (alternatively referred to as background, topic, and domain knowledge) has been recognized as a part of the retrieval process in successfully achieving comprehension (Britt et al., 1999, Braasch & Bråten, 2017, Kintsch, 1988, Rouet & Britt, 2011, van Den Broek, 1995). Specifically, it is empirically validated by way of several discourse comprehension models for single texts that while individuals are constructing mental representations of what they are reading, prior knowledge plays a key role in developing that representation to be coherent and complete (Kintsch, 1988; McNamara & Magliano, 2009; Myers & O'Brien, 1998). It has been shown in multiple-text integration research that in one's mental representation, prior knowledge is an instrumental element as readers must consolidate information, resolve conflict across several texts, or support a side of an argument task (Britt & Rouet, 20012; Kurby et al., 2005). Finally, when readers must rely on sources as way of conflict resolution, prior knowledge aids in evaluating those sources (Braasch & Bråten, 2017; Rouet & Britt, 2011). Beyond theoretically recognizing prior knowledge as a framework element of successfully developing a reader's mental representation of the text, we want to empirically validate the strength with which prior knowledge directly predicts performance on the three aforementioned facets of multiple-text reading comprehension, through meta-analysis.

The Role of Prior Knowledge in Semantic Information

According to several variations of single text comprehension frameworks (Albrecht & Myers, 1995; Kintsch, 1988; Perfetti, et al., 1999; van Den Broek, 1995), the amount of prior

knowledge that is reactivated into a reader's working memory determines the strength of coherence and completeness of their mental representation. The more successful connections that are made between focal information and prior knowledge, the stronger the mental representation (McNamara & Magliano, 2009; van Den Broek, 1995). If it is the case that prior knowledge is that meaningful in reaching cohesion, the strength of relationship needs to be assessed much more in-depth than treating it as a potentially confounding variable for which to be controlled in analyses.

The Role of Prior Knowledge in Multiple Text Integration

Furthermore, in multiple-text integration experimentation, researchers are interested in how readers not only understand single ideas or concepts but also how they make inferences across passages as information is taken in from multiple texts. They want to see the product of the situation models that have been theorized—models that have added mental representations in order to connect information across texts (Britt et al., 1999, Britt & Rouet, 2012). As a means to assess how readers are evaluating, combining, and representing information as they read, researchers analyze multiple-text integration using measures such as justification of texts, coding essay responses, and inference verification tasks (Bråten et. al, 2014; Bråten, & Strømsø, 2010, Strømsø, Bråten, & Britt, 2010), to name but a few. In measuring these variables, researchers can analyze whether or not a textbase or situation model is present as readers are reading to comprehend information. Often, researchers want to rule out prior knowledge as predictor of comprehension. As a result of this, prior knowledge is almost always controlled for in the first block using linear regression techniques or in an analysis of covariance. Because prior knowledge is treated as a controlled variable, it cannot be assessed in terms of how it directly relates to multiple-text integration. This is problematic—going back to theoretical models

detailing the cognitive processes of comprehension, prior knowledge is relative in every one of them; arguably, it is necessary for successful cohesion in the research literature, we want to know the specificity of that relationship.

The Role of Prior Knowledge in Sourcing

Research in terms of students sourcing has not amounted to a large quantity. Current comprehension models provide little in way of understanding the how source information is mentally and cognitively processed. Furthermore, the extent to which prior knowledge aids in students comprehending source information is sparse. Braasch and Bråten's D-ISC model (2017) has considerably given light to what might stimulate readers to rely on source information to resolve discrepancies in the text but have not elaborated on the explicit role prior knowledge may contribute. Analyzing the extent to which prior knowledge guides sourcing would be beneficial. For instance, in regard to the D-ISC model, if researchers were able to directly gage how much of an effect prior knowledge was being asserted to sourcing, they might be able to indicate whether or not readers are even recognizing contradictions, in order to resolve and successfully comprehend material. This is just one example of why understanding the strength in which prior knowledge guides sourcing is important.

Ultimately, while researchers have individually represented and acknowledged the presence of prior knowledge in their experimentation, no literature has quantitively synthesized the separate individual papers and combined this aspect across studies to validate its importance in the literature across these three types of comprehension. The current research aims to address this limitation. In alignment with the theory that has been presented, as well as the three main research questions, the following meta-analytic predictions are presented:

1. It is predicted that when mentally representing semantic information in single texts (e.g., inclusion of accurate concepts in essays, accurate recognition of sentences read), prior knowledge will yield a large effect, thus suggesting an important role in the representation of content.
2. It is predicted that prior knowledge should yield a moderate effect when investigating its role in integrating information across texts (e.g., accurately verifying inferences one could make across the materials).
3. It is predicted that when representing sourcing information, prior knowledge will result in a smaller effect size. This is because as readers evaluate information within and across texts, while they may attempt to rely on prior knowledge in sourcing, it is done so poorly.

Moderators

Two moderators of interest were identified to examine whether the relationship of prior knowledge to comprehension was dependent on the value of a third variable. Concerning semantic information, we analyzed whether assessing a single idea or an inference within a text would serve as a moderator. Secondly, in regard to sourcing, we analyzed whether direct reference of sources in open-ended responses versus trustworthiness of sourcing would result as a moderator.

Method

Literature Search Parameters

In order to identify studies of multiple text comprehension and the role prior knowledge plays in guiding comprehension, the first step was to conduct a broad search of the literature to gather a large set of manuscripts from which the finalized group of works would be identified as

eligible based off of required criteria. To do this, a systematic search of five distinct databases (Web of Science, PsycINFO, PsycARTICLES, Google, and Google Scholar) was conducted using every combination of those variable names or roots of those variable names (*multiple text comprehension, multiple source comprehension, multiple documents comprehension, multiple documents litera* (the * represents the allowance of any ending to the preceding phrase or lettering), multi-source literacy, multi-source comprehension, prior knowledge, topic knowledge, background information, pre-existing knowledge, background knowledge, general world knowledge, prior subject matter knowledge,* and *topic specific knowledge*). To maximize search results, both hyphenated and non-hyphenated terms were included (e.g., *multiple text* and *multiple-text*).

Studies Reviewed

The following eligibility criteria's aim was to strengthen the precision of analyzing the role of prior knowledge in multiple text comprehension. Studies were required to meet the following inclusion criteria in order to be incorporated in this review. First, measures reported in studies must have reflected post-reading "products" of reading (mental representations that readers have taken away from their reading experience, rather than what was processed while they were reading). For this reason, only studies that measure comprehension using multiple choice measures, Likert ratings of evaluation of texts, recognition assessments, forced choice response (ie. yes/no), rankings, and open-ended constructive response measures (ie. essay or short answer formatted responses) were included. Studies that measured "online" comprehension using measures such as eye-tracking, think-aloud measures, or post-reading interviews asking questions about strategies employed during reading were excluded as they reflect mental processes of comprehension that occurred during reading. The second criterion, due to the

specificity of the research question, was that studies must have looked at comprehension in the form of correlational data, any type of regression analysis, or analysis of covariance. Thirdly, there was no specific inclusion criteria for participant characteristics. Because of the research question being addressed, characteristics such as the participant's age, language, sex, and any additional demographics were not a concern in impacting the main analyses. Finally, as meta-analysis requires the extraction of effect sizes, it was necessary for all studies that were included to have reported sufficient statistics to estimate effect sizes. For this reason, four studies that reported results of multivariate analysis of variance and analysis of covariance that failed to produce the needed statistical information were ultimately excluded.

In total, 280 studies were initially found and confirmed as relevant to multiple-text comprehension. However, after screening for eligibility criteria, the majority did not meet the necessary requirements. After the first review of abstracts, article titles, and overall comparison of study to criteria, 44 studies were kept. Of those 44 studies, reference sections were reviewed, authors were contacted, and unpublished studies were sought out to search for any additional eligible studies. Ultimately after complete and thorough inspection of full text, 23 studies were accumulated which met all inclusion criteria. Figure 1 shows the description of the process to select studies for meta-analysis.

These studies were coded for type of analyses conducted (ie. Regression, Correlation, ANOVA), means of measuring both prior knowledge and comprehension; comprehension was divided into subcategories of semantic information, multiple text integration, and sourcing. These subdivisions allowed for more distinct exploration of the relationship between prior knowledge and various facets of text comprehension. Additionally, studies were coded for how

many participants were in each study sample, population breakdown by gender, and topic of content used in each study used to measure comprehension.

Study Characteristics

The dates of the 23 studies ranged from 2007 to 2020. All of the studies were peer-reviewed publications in various journals; no dissertations or unpublished work were discovered that were relevant to this topic. The average sample size across the 23 studies was 130 participants (*SD* = 71.53. One study was conducted using elementary students (4%), one study consisted of a sample of middle school students (4%), eight studies' participants were high schoolers (35%), participants of twelve studies were undergraduate students (52%), and the remaining study was conducted with graduate students (4%). Across all the studies, 65% on average, were female (*SD* = 12.93). The topic of materials that individuals read ranged from science topics (48%) to controversial health issues (39%) to topics of social studies (13%).

Analyses

In order to compare and analyze the role of prior knowledge in multiple text comprehension, a standardized value was needed. For this study, because two continuous variables are our variables of interest, the Pearson *r* correlation coefficient was sufficient to use (Borenstein et al., 2009; Field & Gillett, 2010; Rosenthal & DiMatteo, 2001). The meta-analysis was conducted using Fisher *z*-values, transformed from the correlation coefficients, so that the estimates were normally distributed and unbiased (Field & Gillett, 2010; Rosenthal & DiMatteo, 2001). Additionally, in order for clear interpretation and standard preocedure, Fisher *z*-values were converted back to *r* for reporting, alongside confidence intervals, in this manuscript (see Borenstein et al., 2009).

In order to avoid invalid standard tests of statistical significance and weighing studies according to the number out outcome measures they reported, a modified version of meta-analysis was used in which studies were individually treated as the subjects (see Smith et al., 1980 for more detail). That is, a simplified version was conducted in which each study was used as the basic unit for the analysis. Of the 23 studies, a total of 63 effect sizes were extracted and analyzed. Eighteen effect sizes reflected measures of semantic information, 25 reflected measures of multiple-text integration, and 20 reflected measures of sourcing. Not all studies included correlation tables in which the correlation coefficient could be extracted. Only 3% of the study's statistics did not report the needed correlation coefficients, they did however provide *F* statistics. Because this alternative information as provided, the necessary effect size *r* was computed using a transformation formula (see Rosenthal & DiMatteo, 2001 for more detail).

Results

We will first consider the main effects found in the meta-analysis for each subcategory of multiple text comprehension, in relation to prior knowledge: semantic information, multiple text integration, and sourcing, respectively. The relationship between prior knowledge and semantic information ($r = 0.89$, $p < 0.001$, CI 95% [0.303, 0.515]), and between prior knowledge and multiple text integration ($r = 0.82$, $p < 0.001$ CI 95% [0.189, 0.344]), were both large in magnitude, while also statistically differing from zero. These effects imply that prior knowledge does indeed play an important role in the reader's mental representation of content. The relationship between prior knowledge and sourcing ($r = 0.54$, $p < 0.05$ CI 95% [0.018, 0.129]) was moderate in magnitude and also statistically different from zero. Conclusions can be made that prior knowledge does not serve as a strong guidance in sourcing. This smaller effect also verifies the presumption that often while students attempt to engage sourcing when trying to

comprehend information within and across texts, they do so poorly. These results align with the original hypotheses.

In examining the variability of the dependent measures used to reflect the main constructs, individual, supplementary exploratory analyses were conducted to seek further interpretations of the relationship between prior knowledge and comprehension. First, when considering semantic information, we were interested in whether or not assessing a single idea versus connecting ideas within a single text to form an inference would serve as a significant moderator; as such, a moderation analysis was conducted. We are interested in this investigation because the measurements reflective of a single idea suggest a novice ability to understand the basic, surface level of a text (Britt & Rouet, 2012; Kintsch, 1988). Correspondingly, by way of the single text comprehension models (Kintsch, 1988; Perfetti et al., 1999; van Den Broek, 1995), a deeper level of processing must be undergone in order to make an inference within a text, above and beyond merely attending to or remembering a single idea. Six overall effect sizes (33%) reflected single idea assessment while 12 effect sizes (67%) conveyed assessment of connections of ideas within a single text. Results were non-significant ($p = 0.424$), signifying that the strong effect of prior knowledge on semantic information was not influenced by whether or not readers were assessing a single idea or making an inference within the text.

A second exploratory analysis was conducted dividing sourcing into two categories: explicitly mentioning or incorporating sources as means for justification and overall trustworthiness of text based off of source. Said in another way, measures reflecting sources mentioned in open essay response or multiple-choice assessments matching a claim to its reference were grouped into one moderating category, as this reflects having to directly use and mention sources as a justification to an explanation. Likewise, measures in which individuals had

to rate their trustworthiness of a source, based off of what they read or rate whether or not it was necessary to cross-check information across sources were grouped into the second moderating category. Eleven of the 20 effect sizes (55%) totaled the first group, while the remaining 9 (45%) totaled the second group. Results for this moderation approached but did not reach statistical significance ($p = .077$). Although a speculative conclusion due to the lack of significance, the moderation analysis does suggest that prior knowledge may play a greater role in mentioning and referencing sources directly as justifications, rather than trustworthiness of a source. Nevertheless, this suggests that it may not matter whether readers are remembering sources to reinforce claims or judging if sources are even important to support a claim, individuals are generating sources into their mental models to similar extents.

In order to address publication bias, that is selective publication of only statistically significant results, a couple different methods were applied. While we were not able to locate any unpublished data to include in our meta-analysis, we applied three separate methods, using CMA (Comprehensive Meta-Analysis software) to address potential issues. First the Fail-Safe N approach (Rosenthal, 1979) was implemented, which indicated that 123 studies per observed study would be needed in order to reach statistically non-significant results. Put another way, 7746 "null" studies would need to be located in order for the combined p-value to exceed 0.05. Next, we applied the Funnel Plot method (Sterne et al., 2001), displayed in Figure 2. While there is a dispersion of points across the horizontal axis, there does seem to be some asymmetry alluding to publication bias. Finally, we used the Trim-and-Fill method proposed by Duval & Tweedie (2000a) under the random-effects model. Looking for studies to the left of the mean, no studies were trimmed meaning there is no reduction to the magnitude. Looking for studies to the right of the mean, six studies were trimmed, resulting in a slight increase in magnitude. Overall

though, the point estimate and 95% Confidence Interval for the combined studies is 0.238 (0.189, 0.286); using trim and fill, these values are unchanged. Overall, results indicate that the overall effect is not likely to be affected by any unpublished results.

Discussion

This meta-analysis aimed to further understand the role of prior knowledge in multiple text comprehension. Previous research has authenticated comprehension using a variety of assessments, all evaluating varying degrees of comprehension complexity (Braasch et al., 2014; Bråten et al., 2013; Bråten et al., 2014, Bråten et al., 2018). To our knowledge, no extensive research has been conducted to combine individual papers to examine the extent to which prior knowledge contributes to different aspects of multiple text comprehension. As mentioned in each of the comprehension models that researchers have theorized, different components of cognitive processing are activated based off of what information needs to be consolidated. Additionally, the motives to why prior knowledge is reactivated differentiates based off of the context and ultimate task of the reader. For this reason, we looked at the role of prior knowledge in separately predicting three specific categories of reading comprehension: semantic information, multiple-text integration, and sourcing. The results are consistent with the hypotheses that when mentally representing semantic information, prior knowledge would yield a moderate to strong effect, when representing multiple text integration, prior knowledge would yield a moderate to strong effect and when mentally representing source information, prior knowledge would yield a smaller effect. These observations have allowed advancements in the field of comprehension, especially the role in which prior knowledge plays.

The Role of Prior Knowledge in Semantic Information

Findings have given more insight to the amount of prior knowledge individuals bring into their mental representations in order to comprehend what has been read. Interestingly enough, according to the current results, analyses have comparatively indicated that as readers are required to integrate complex pieces of information across texts and at times, also consider source information, the degree to which prior knowledge contributes lessens. That is, we can infer that when individuals read and process information from single texts, they will activate larger amounts of prior knowledge than if they were sourcing or integrating information across more than one text. For example, Ozuru, Dempsey, and McNamara (2009) discovered that prior knowledge had a positive relationship with single-text comprehension above and beyond individual's reading skill, and that rapid activation was necessary for overall comprehension.

Within the confines of this meta-analysis, semantic information was largely measured by way of Sentence Verification Tasks (SVT) or Intra-text Inference Verification Tasks (IntraIVT). Sentence Verification Tasks can be defined as assessments in which participants are presented with original phrases, paraphrased segments, and distractor phrases, and asked to identify whether or not the same meaning was presented in what was read (Royer et al., 1996). Intra-text Inference Verification Tasks, in a similar way measures whether or not readers are able to make deeper level inferences by presenting the reader with sentences constructed from combining ideas across different sentences within the same text. Construct Validity has been verified by Royer et al. (1996) for both of these assessments and have been credibly used by many other researchers (Bråten & Strømsø, 2010; Wiley & Voss, 1999, to name a few). With respects to single-text comprehension models, the resulting strong effect of prior knowledge with semantic information aligns with the theories presented in the models. That is, students successfully

verified both sentences and inferences made within the text via the assessments, conclusively supporting the notion that prior knowledge helped guide a reader's comprehension.

Supplemental forms of measuring semantic comprehension included open ended essay responses and multiple-choice assessments asking participants to determine main ideas and inferences made within the text. According to Kintsch's (1988) integration element of the CI Model as well as O'Brien and Albrecht's (1992) Resonance Model, individuals were overlapping prior knowledge with focal information, making the activation stronger, leading to an overall complete mental model. As a result, readers were both able to comprehend the text and then include inferences in their essays generated from memory, as well as accurately verify main ideas and inferences that could be drawn from those texts. These results demonstrate that prior knowledge does indeed have a strong effect on comprehending semantic information. The patterns across studies suggest that prior knowledge may have been strongly activated.

Across administration of SVTs, IntraIVTs, multiple choice assessment, and open-ended essay responses, two groupings of semantic information measurement were classified in order to conduct a moderation analysis: assessing a single idea and making inferences within a single text. While both groupings are valid indications of single text comprehension (Royer et al., 1996), exploratory analyses were conducted to examine whether this would influence the effect prior knowledge has on comprehension. As results were non-significant, this indicates that in alignment to single text comprehension frameworks (Kintsch, 1988, McNamara & Magliano, 2009), readers are reactivating prior knowledge both to comprehend single sentences as well as connecting the meaning of multiple sentences within the same text, to the same extent.

The Role of Prior Knowledge in Multiple-Text Integration

When looking at the role prior knowledge plays in multiple-text integration, we observe that there is a slightly weaker relationship here than with the relationship between prior knowledge and semantic information. The majority of these studies evaluated prior knowledge in the form of a multiple-choice assessment. Additionally, studies evaluated multiple-text integration in the form of the following comprehension measurements: Inter-textual Inference Verification Tasks (InterIVT), open-ended essay structure, and multiple choice assessments. Essentially, the objective was to determine whether or not readers made accurate inferences across multiple texts. Because of the increase in content being read, detail involved, information being received, and the need to consolidate information across materials, naturally, more cognitive effort is required. Above and beyond simply constructing a mental representation that preserves the surface level of the content, multiple-text interpretation involves elaboration that exceeds the explicit information at the textbase level (Britt et al., 1999). The agreement with prior multiple-text research and our current outcomes further validates the strong guidance of prior knowledge in multiple-text integration. In respect to the Documents Model Framework (Britt et al., 1999), intertext relations are successfully forming links between document nodes in readers' mental representations, whether this be between content material, source material, or source to content material. It can also be inferred that readers are reactivating prior knowledge in order to facilitate these links. Furthermore, prior knowledge has seemingly enabled readers to accurately organize, evaluate, and conceptualize the appropriate information needed to form a coherent mental representation and as a result, reach complete understanding of the given text. (Britt et al., 1999, Britt & Rouet, 2012). Based off of our results, the overall effect identified between prior knowledge and multiple-text integration suggests that reader's prior knowledge of

topics contributes to their generation of more complete intertext models, leading them to more fully comprehend what it is they are reading. In comparison to comprehension of semantic information, the slightly weaker relationship to prior knowledge could be due to the higher level of mental representation connecting texts and the concern to consolidate that information, rather than the immediate need to activate prior knowledge and bring it back into working memory. Moreover, this initial finding could be used to guide future research endeavors.

The Role of Prior Knowledge in Sourcing

Finally, when looking at prior knowledge as a guiding mechanism for sourcing, we see that there is a much less impactful relationship compared to how prior knowledge guides semantic information and multiple-text integration, albeit the effect was still significant. This is consistent with descriptive and inferential studies within source related research. Looking at the literature, it is evident that students often do not engage in sourcing while trying to comprehend information within and across texts; the current work implies they do not consistently rely on prior knowledge to guide sourcing when it does occur (Bråten et al., 2016; Stang-Lund et al., 2017). Reflecting on the current findings and in revisiting the DMF (Britt & Rouet, 2012), it appears that source specific document nodes are not being strongly connected to content nodes in readers' mental representations. This also means that generally, students are most likely not activating prior knowledge relative to source information in order to make those connections (Britt et al., 1999, Britt & Rouet, 2012). As reflected in results from Bråten et al.'s study (2009), trustworthiness of sourcing was not significantly reflected in comprehension because of the inadequate amount of prior knowledge readers had relative to the source information. Moreover, as informed by the D-ISC model (Braasch & Bråten, 2017), readers' attention will shift to developing a mental model that incorporates sources primarily when a discrepancy arises which

must be resolved. In alignment with theories and studies of previous researchers such as Braasch and Bråten (2017), Britt et al. (1999), and Saux et al. (2016), it might be noteworthy to consider that often, when students do strategically focus on sources in their mental representations, it is because studies have intentionally manipulated the material to be contradictory so as a result, students would shift attention to sourcing. Thus, if the task is not pointedly aimed at some form of conflict resolution, students might not necessitate the need to reactivate prior knowledge in order to evaluate sourcing. Current findings corroborate with this supposition as every study in which sourcing was measured, content formatted to be conflicting information. While the results of this study have justified that the effect of prior knowledge guiding sourcing is not a strong one, the full reason why may not be fully clear, but research is slowly advancing to expose it.

In addition to this, the results of the exploratory moderation analysis on sourcing were nonsignificant. This further implies that whether a reader is explicitly referencing a source as a means of justification or rating whether or not source information is even necessary to support a claim, prior knowledge does not vary in its influential effect. It should be noted though, that the result of the moderation analyses was trending in the direction of having a significant effect, and thus future research should pursue this exploration as additional studies are conducted.

Limitations

While meta-analyses have continued to expand and advance research findings across numerous domains of study, like any study, must be interpreted in the context of limitiations in the methodology. In summarizing and taking into consideration implications of the current study, future research opportunities are presented, in light of a few limitations. First, to address the demographics, the majority of samples consisted of high school to graduate level students and, thus, they were likely proficient readers. Prior research has indicated that ability to comprehend,

as well as the amount of prior knowledge one has is influenced by age (Hannon & Daneman, 2009; Meyer et al., 2012). In view of the fact that the current study was low in age variability, there is room for expansion across additional grade levels such as elementary students or adults outside of the context of universities. This would also allow the ability to better generalize to the greater population. Additionally, the range of assessing comprehension did not have many restrictions beyond having to reflect post reading "products" of reading. Because of these loose parameters, the diversity of measurements was so much so that a viable moderation analysis was unable to be conducted to further investigate the role of prior knowledge in multiple-text comprehension. Stricter boundaries might result with better opportunity for moderator analyses.

Conclusion

Conclusively, meta-analytic results have validated the role prior knowledge plays in guiding the mechanisms involved in developing coherent mental representations of text comprehension. Based off of the results that have been found in this meta-analysis, one can see there are implications that could be researched in future experimentation to continue to advance the literature of comprehension research. Specifically, for one example, it would be of value to further investigate the relationship between prior knowledge and sourcing, as it produced the smallest effect—why is it the case that readers do not use prior knowledge more closely to evaluate sources when reading to understand? Replication of studies with new contexts and different tasks could clarify and further probe this unresolved question. Overall, while this meta-analysis does not account for many unanswered questions concerning prior knowledge and its role in reading comprehension, it did methodologically validate foundational models of comprehension. In dissecting mechanisms of mental representations and zeroing in on how and when prior knowledge is reactivated into working memory, we were able to advance the

literature and quantitatively consolidate previous studies. It has also opened the door for further research to be conducted to understand the role prior knowledge plays in the cognitive processing that is undergone as readers strive towards comprehension.

References

References marked with an asterisk indicate studies included in the meta-analysis.

Ahmed, Y., Francis, D.J., York, M., Fletcher, J.M., Barnes, M., Kulesz, P. (2016). Validation of theDirect and Inferential Mediation (Dime) Model of Reading Comprehension in Grades 7 through 12. *Contemporary Education Psychology*: 44-45, 68-82.

Albrecht, J. E., & Myers, J. L. (1995). Role of context in accessing distant information during reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*(6), 1459–1468.

*Anmarkrud, Ø., & Bråten, I. (2009). Motivation for reading comprehension. *Learning and Individual Differences*, *19*(2), 252–256.

*Barzilai, S., & Eshet-Alkalai, Y. (2015). The role of epistemic perspectives in comprehension of multiple author viewpoints. *Learning and Instruction*, *36*, 86–103.

*Barzilai, S., & Ka'adan, I. (2017). Learning to integrate divergent information sources: The interplay of epistemic cognition and epistemic metacognition. *Metacognition and Learning*, *12*(2), 193–232.

Barzilai, S., & Strømsø, H. I. (2018). Individual differences in multiple document comprehension. In J. L. G. Braasch, I. Bråten & M. T. McCrudden (Eds.), *Handbook of Multiple Source Use.* New York, NY: Routledge, 99-116.

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to meta-Analysis.* (pp. 41-43) Chicester: Wiley.

Braasch, J. L. G., & Bråten, I. (2017). The discrepancy-induced source comprehension (D-ISC) model: Basic assumptions and preliminary evidence. *Educational Psychologist*, *52*(3), 167–181.

*Braasch, J. L. G., Bråten, I., Strømsø, H. I., & Anmarkrud, Ø. (2014). Incremental theories of intelligence predict multiple document comprehension. *Learning and Individual Differences*, *31*, 11–20.

Bransford, J.D., & Johnson, M.K. (1972). Contextual Prerequisites for Understanding: Some Investigations of Comprehension and Recall. *Journal of Verbal Learning and Verbal Behavior, 11*, 717-726.

*Bråten, I., Anmarkrud, Ø., Brandmo, C., & Strømsø, H. I. (2014). Developing and testing a model of direct and indirect relationships between individual differences, processing, and multiple-text comprehension. *Learning and Instruction*, *30*, 9–24.

*Bråten, I., Ferguson, L. E., Anmarkrud, Ø., & Strømsø, H. I. (2013). Prediction of learning and comprehension when adolescents read multiple texts: The roles of word-level processing, strategic approach, and reading motivation. *Reading and Writing: An Interdisciplinary Journal*, *26*(3), 321–348.

*Bråten, I., Ferguson, L. E., Strømsø, H. I., & Anmarkrud, Ø. (2013). Justification beliefs and multiple-documents comprehension. *European Journal of Psychology of Education*, *28*(3), 879–902.

*Bråten, I., Ferguson, L. E., Strømsø, H. I., & Anmarkrud, Ø. (2014). Students working with multiple conflicting documents on a scientific issue: Relations between epistemic cognition while reading and sourcing and argumentation in essays. *British Journal of Educational Psychology*, *84*(1), 58–85.

*Bråten, I., Salmerón, L., & Strømsø, H. I. (2016). Who said that? Investigating the Plausibility-Induced Source Focusing assumption with Norwegian undergraduate readers. *Contemporary Educational Psychology*, *46*, 253–262.

Bråten, I., Stadtler, M., & Salmerón, L. (2018). The role of sourcing in discourse comprehension. In M. F. Schober, D. N. Rapp, & M. A. Britt (Eds.), *The Routledge handbook of discourse processes., 2nd ed.* (pp. 141–166). New York, NY: Routledge/Taylor & Francis Group.

*Bråten, I., & Strømsø, H. I. (2010). When law students read multiple documents about global warming: Examining the role of topic-specific beliefs about the nature of knowledge and knowing. *Instructional Science*, *38*(6), 635-657.

*Bråten, I., & Strømsø, H. I. (2011). Measuring strategic processing when students read multiple texts. *Metacognition and Learning*, *6*(2), 111–130.

*Bråten, I., Strømsø, H. I., & Britt, M. A. (2009). Trust matters: Examining the role of source evaluation in students' construction of meaning within and across multiple texts. *Reading Research Quarterly*, *44*(1), 6–28.

Britt, M. A., Goldman, S. R., & Rouet, J. (2013). *Reading - from words to multiple texts*. New York: Routledge.

Britt, M. A., Perfetti, C. A., Sandak, R., & Rouet, J.-F. (1999). Content integration and source separation in learning from multiple texts. In S. R. Goldman, A. C. Graesser, & P. van den Broek (Eds.), *Narrative comprehension, causality, and coherence: Essays in honor of Tom Trabasso.* (pp. 209–233). Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Britt, M. A., & Rouet, J.-F. (2012). Learning with multiple documents: Component skills and their acquisition. In J. R. Kirby & M. J. Lawson (Eds.), *Enhancing the quality of learning: Dispositions, instruction, and learning processes.* (pp. 276–314). New York, NY: Cambridge University Press.

*Coiro, J. (2011). Predicting reading comprehension on the internet: Contributions of offline reading skills, online reading skills, and prior knowledge. *Journal of Literacy Research*, *43*(4), 352–392.

Dijk, T. A., & Kintsch, W. (1983). *Strategies of discourse comprehension*. New York: Academic Press.

Duval, S. & Tweedie, R. (2000a). A nonparametric 'trim and fill' method of accounting for publication bias in meta-analysis. *Journal of American Statistical Association,* 95*,* 89-98.

Field, A. P., & Gillett, R. (2010). How to do a meta-analysis. *British Journal of Mathematical and Statistical Psychology*, *63*(3), 665–694.

*Florit, E., De Carli, P., Giunti, G., & Mason, L. (2020). Advanced theory of mind uniquely contributes to children's multiple-text comprehension. *Journal of Experimental Child Psychology*, *189*.

*Hagen, Å. M., Braasch, J. L. G., & Bråten, I. (2014). Relationships between spontaneous note-taking, self-reported strategies and comprehension when reading multiple texts in different task conditions. *Journal of Research in Reading*, *37*(Suppl 1), S141–S157.

Hannon, B., & Daneman, M. (2009). Age-related changes in reading comprehension: An individual-differences perspective. *Experimental Aging Research*, *35*(4), 432–456

Kintsch, W. (1988). The role of knowledge in discourse comprehension: A construction-integration model. *Psychological Review*, *95*(2), 163–182.

Kurby, C. A., Britt, M. A., & Magliano, J. P. (2005). The role of top-down and bottom-up processes in between-text integration. *Reading Psychology*, *26*(4–5), 335–362.

*Le Bigot, L., & Rouet, J.-F. (2007). The impact of presentation format, task assignment, and prior knowledge on students' comprehension of multiple online documents. *Journal of Literacy Research*, *39*(4), 445–470.

Lipson, M.Y. (1982). Learning New Information from Text: The Role of Prior Knowledge and Reading Ability. *Journal of Reading Behavior*, *14*, 243-261.

*List, A., Alexander, P. A., & Stephens, L. A. (2017). Trust but verify: Examining the association between students' sourcing behaviors and ratings of text trustworthiness. *Discourse Processes*, *54*(2), 83–104.

McNamara, D. S., & Magliano, J. (2009). Toward a comprehensive model of comprehension. In B. H. Ross (Ed.), *The psychology of learning and motivation., Vol. 51.* (Vol. 51, pp. 297–384). San Diego, CA: Elsevier Academic Press.

Meyer, B. J., Ray, M. N., & Middlemiss, W. (2012). Children's Use of Comparative Text Signals: The Relationship between Age and Comprehension Ability. *Discours,* (10).

Myers, J. L., & O'Brien, E. J. (1998). Accessing the discourse representation during reading. *Discourse Processes*, *26*, 131-157.

O'Brien, E. J., & Albrecht, J. E. (1992). Comprehension strategies in the development of a mental model. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 18,777-784.

Ozuru, Y., Dempsey, K., & McNamara, D. S. (2009). Prior knowledge, reading skill, and text cohesion in the comprehension of science texts. *Learning and Instruction*, *19*(3), 228–242.

Perfetti, C. A., Rouet, J-F., & Britt, M. A. (1999). Towards a theory of documents representation. In H. van Oostendorp & S. R. Goldman (Eds.) *The Construction of Mental Representations During Reading* (*pp. 99-122*). Mahwah, NJ: Lawrence Erlbaum Associates.

Rosenthal, R. (1979). The File drawer problem and tolerance for null results. *Psychological Bulletin, 86,* 638-641.

Rosenthal, R., & DiMatteo, M. R. (2001). Meta-analysis: Recent developments in quantitative methods for literature reviews. *Annual Review of Psychology*, *52*, 59–82.

Rouet, J.-F., & Britt, M. A. (2011). Relevance processes in multiple document comprehension. In M. T. McCrudden, J. P. Magliano, & G. Schraw (Eds.), *Text relevance and learning from text.* (pp. 19–52). Charlotte, NC: IAP Information Age Publishing.

Royer, J. M., Carlo, M. S., Dufresne, R., & Mestre, J. (1996). The assessment of levels of domain expertise while reading. *Cognition and Instruction*, *14*(3), 373–408.

*Salmerón, L., Gil, L., & Bråten, I. (2018). Effects of reading real versus print-out versions of multiple documents on students' sourcing and integrated understanding. *Contemporary Educational Psychology*, *52*, 25–35.

Saux, G., Britt, A., Bigot, L. L., Vibert, N., Burin, D., & Rouet, J. (2016). Conflicting but close: Readers' integration of information sources as a function of their disagreement. *Memory & Cognition, 45*(1), 151-167.

Smith, M. L., Glass, G. V., & Miller, T. I. (1980). The benefits of psycho- therapy. Baltimore: Johns Hopkins University Press.

Spiro, R. J., Feltovich, P. J., Jacobson, M. J., & Coulson, R. L. (1991). Cognitive flexibility, constructivism, and hypertext: random access instruction for advanced knowledge acquisition in ill-structured domains. Educational Technology, 31(5), 24–33.

*Stang Lund, E., Bråten, I., Brante, E. W., & Strømsø, H. I. (2017). Memory for textual conflicts predicts sourcing when adolescents read multiple expository texts. *Reading Psychology*, *38*(4), 417–437.

*Strømsø, H. I., & Bråten, I. (2009). Beliefs about knowledge and knowing and multiple-text comprehension among upper secondary students. *Educational Psychology*, *29*(4), 425–445.

*Strømsø, H. I., Bråten, I., & Britt, M. A. (2010). Reading multiple texts about climate change: The relationship between memory for sources and text comprehension. *Learning and Instruction*, *20*(3), 192-204.

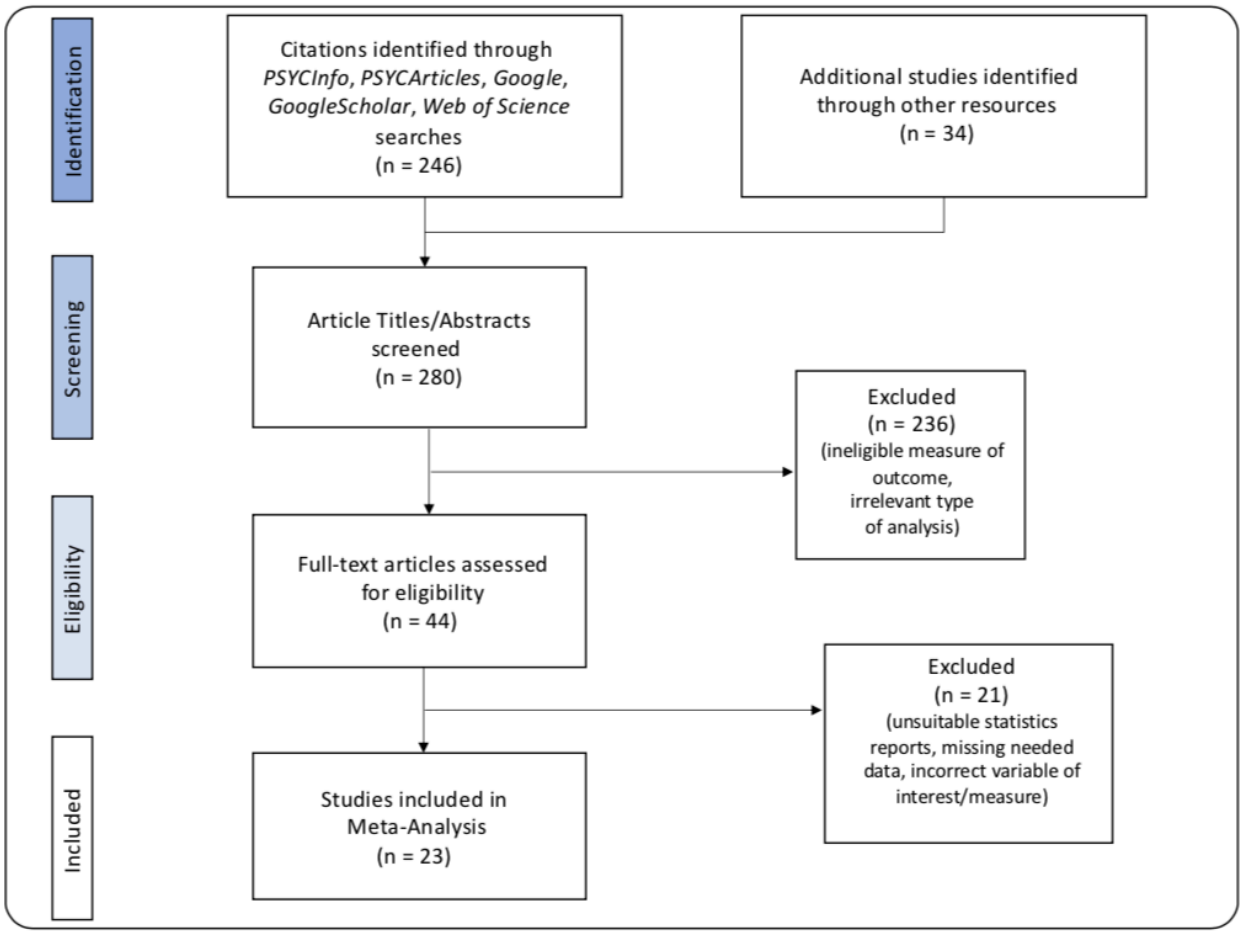
*Strømsø, H. I., Bråten, I., & Samuelstuen, M. S. (2008). Dimensions of topic-specific epistemological beliefs as predictors of multiple text understanding. *Learning and Instruction*, *18*(6), 513–527.

van Den Broek, P. (1995). A "landscape" model of reading comprehension: Inferential processes and the construction of a stable memory representation. *Canadian Psychology/Psychologie Canadienne*, *36*(1), 53–54.

Wiley, J., & Voss, J.F. (1999). Constructing arguments from multiple sources: Tasks that promote understanding and not just memory for text. *Journal of Educational Psychology, 91,* 301–311.

Figure 1

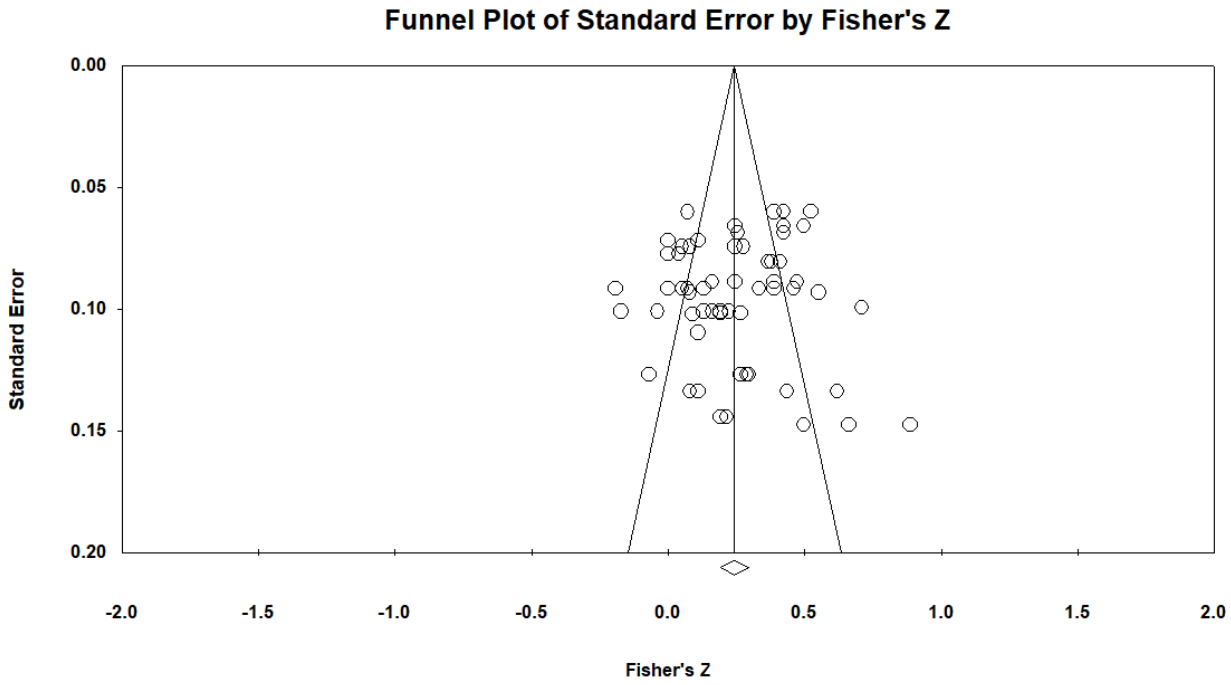
PRISMA Flow Diagram



Note. Flow chart of studies identified and evaluated during the selection process.

Figure 2

Funnel Plot



Note. Each dot represents an individual study.

Appendix

Study characterstics from the current meta-analysis.

	Participants		Measurement of Construct			
Study	Sample	Classification	Prior knowledge	Comprehension	Category of Comprehension	ES *r*
Anmarkrud et al., 2009 (n=104)	Norwegian	High school	MC Assessment	MC Assessment	Semantic Information	0.61
Barzilai et al. 2015 (n=170)	Israeli	Undergraduate	MC Assessment	Author Viewpoint	Sourcing	
				Open-ended, integration	MTI	0.00
				Open-ended, justification	MTI	0.00
Barzilai et al. 2017 (n= 99)	Arab	High school	Open-ended Assessment	Open-ended, integration performance	MTI	0.09
Braasch et al. 2014 (n= 59)	Norwegian	Undergraduate	Open-ended Assessment	Essay task	MTI	0.55
				InterIVT	MTI	0.08
				Rank-Order Discrimination	MTI	0.11
				Trustworthiness Assessment	MTI	0.41
Bråten & Anmarkrud et al. 2014 (n=279)	Norwegian	Undergraduate	MC Assessment	Justification by multiple source assessment	Sourcing	0.07
				Multiple-Text Strategy Inventory	MTI	0.37
Bråten et al. 2009 (n= 122)	Norwegian	Undergraduate	MC Assessment	SVT	Semantic Information	0.32
				IntraIVT	Semantic Information	0.43
				Trustworthiness Likert scale, author	Sourcing	0.07
				Trustworthiness Likert scale, publisher	Sourcing	0.07
				Trustworthiness Likert scale, document	Sourcing	0.13
				Trustworthiness Likert scale, content	Sourcing	0.00

Note. n = Sample size; MC Assessment = Multiple Choice Assessment; SVT = Sentence Verification Task; IntraIVT = Intratextual Inference Verification Task; InterIVT = Intertextual Inference Verification Task; MTI = Multiple Text Integration

Appendix (continued)

	Participants		Measurement of Construct			
Study	Sample	Classification	Prior knowledge	Comprehension	Category of Comprehension	ES *r*
Bråten et al. 2009 (n= 122)	Norwegian	Undergraduate	MC Assessment	Trustworthiness Likert scale, own opinion	Sourcing	0.05
				Trustworthiness Likert scale, date	Sourcing	-0.19
				InterIVT	MTI	0.37
				SVT	Semantic Information	0.58
				InterIVT	Semantic Information	0.71
				InterIVT	MTI	0.46
				IntraIVT	Semantic Information	0.40
				InterIVT	MTI	0.25
				Open-ended Assessment	MTI	0.28
Bråten et al. 2010 (n= 49)	Norwegian	Graduate	MC Assessment	Open-ended Assessment	Sourcing	0.21
				S-C link recognition	Sourcing	0.19
				Open-ended	Sourcing	0.08
Bråten et al. 2011 (n=216)	Norwegian	Undergraduate	MC Assessment	Justification Likert Scale, multiple sources	Sourcing	0.07
				Open-ended Assessment	MTI	0.26
Bråten et al. 2013 (n=65)	Norwegian	Undergraduate	MC Assessment	Open-ended Assessment	MTI	0.50
Bråten et al. 2014 (n= 51)	Norwegian	Undergraduate	Open-ended Assessment	Open-ended Assessment	Sourcing	0.21
				S-C link recognition	Sourcing	0.19
Bråten et al. 2016 (n= 71)	Norwegian	Undergraduate	Likert Scale	Open-ended	Sourcing	0.08
Bråten & Ferguson, et al. 2013 (n= 65)	Norwegian	High School	MC Assessment	Justification Likert Scale, multiple sources	Sourcing	0.07
				Open-ended Assessment	MTI	0.26
Coiro, 2011 (n=118)	North-eastern	Middle School	Open-ended Assessment	Open-ended Assessment	MTI	0.50

Note. n = Sample size; MC Assessment = Multiple Choice Assessment; SVT = Sentence Verification Task; IntraIVT = Intratextual Inference Verification Task; InterIVT = Intertextual Inference Verification Task; MTI = Multiple Text Integration

Appendix (continued)

	Participants		Measurement of Construct			
Study	Sample	Classification	Prior knowledge	Comprehension	Category of Comprehension	ES *r*
Florit et al. 2020 (n=184)	Italian	Elementary	MC Assessment	MC Assessment	Semantic Information	0.24
				MC Assessment	Semantic Information	0.27
				MC Assessment	MTI	0.05
				MC Assessment	MTI	0.08
Hagen et al. 2014 (n= 130)	Norwegian	Undergraduate	MC Assessment	Essay, Intertext Elaboration	Semantic Information	0.24
				SVT	Semantic Information	0.24
				IntraIVT	Semantic Information	0.37
Hagen et al. 2014 (n= 130)				Essay, Intertext Elaboration	MTI	0.16
				InterIVT	MTI	0.44
Le Bigot et al. 2007 (n= 65)	French	Undergraduate	Open-ended Assessment	Post-test Assessment	MTI	0.29
List et al. 2017 (n= 197)	Mid-Atlantic	Undergraduate	Term Identification Task	Source Trustworthiness	Sourcing	0.07
				Inclusion of sources in essay	Sourcing	0.11
Salmerón et al. 2018 (n= 101)	Spanish	Undergraduate	MC Assessment	Essay task	Semantic Information	-0.04
				IntraIVT	Semantic Information	0.19
				Open ended essay, gen. document mentioned	Sourcing	-0.17

Note. n = Sample size; MC Assessment = Multiple Choice Assessment; SVT = Sentence Verification Task; IntraIVT = Intratextual Inference Verification Task; InterIVT = Intertextual Inference Verification Task; MTI = Multiple Text Integration

Appendix (continued)

	Participants		Measurement of Construct			
Study	Sample	Classification	Prior knowledge	Comprehension	Category of Comprehension	ES *r*
Salmerón et al. 2018 (n= 101)	Spain	Undergraduate	MC Assessment	Open ended essay, specific document mentioned	Sourcing	0.13
				Open ended essay, embedded sources	Sourcing	0.16
				Open ended essay, source memory	Sourcing	0.22
				InterIVT	MTI	-0.04
Schoor et al. 2019 (n= 100)	-	Undergraduate	Open-ended Assessment	Post-test	MTI	0.26
				Open-ended Assessment	MTI	0.19
Stang-Lund et al. 2017 (n=86)	Norwegian	High School	MC Assessment	Source Identification Task	Sourcing	0.11
Strømsø et al. 2008 (n= 157)	Norwegian	Undergraduate	MC Assessment	SVT	Semantic Information	0.36
				IntraIVT	Semantic Information	0.39
				InterIVT	MTI	0.35
Strømsø et al. 2009 (n= 282)	Norwegian	High School	MC Assessment	SVT	Semantic Information	0.48
				IntraIVT	Semantic Information	0.48
				InterIVT	MTI	0.40
Strømsø et al. 2010 (n= 233)	Norwegian	High School	MC Assessment	IntraIVT	Semantic Information	0.46
				S-C Task	Sourcing	0.24
				InterIVT	MTI	0.40

Note. n = Sample size; MC Assessment = Multiple Choice Assessment; SVT = Sentence Verification Task; IntraIVT = Intratext Inference Verification Task; InterIVT = Intertext Inference Verification Task; MTI = Multiple Text Integration