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Content integration across multiple documents reduces memory for sources

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Abstract The current experiments systematically examined semantic content integration as a mechanism for explaining source inattention and forgetting when reading-to-remember multiple texts. For all 3 experiments, degree of semantic overlap was manipulated amongst messages provided by various information sources. In Experiment 1, readers' source recognition was significantly poorer when the sources presented semantically-congruent compared to semantically-distinct messages. Experiment 2 replicated the findings, despite half of the participants receiving a pre-reading warning. Experiment 3 extended the examination to include longer argument-based texts; readers additionally wrote a comprehensive essay on the topic. The results indicated longer reading times and better recall memory for the claims and evidence statements from semantically-congruent compared to semantically-distinct texts, while still reproducing the poorer source recognition effects of Experiments 1 and 2. We discuss implications for contemporary accounts of multiple text comprehension as well as directions for future research.

Keywords Text comprehension · Multiple sources · Semantic congruency

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The articles comprising this special issue make a compelling case that sourcing is a crucial component of the reading process given the current information age. People frequently seek out information for which they know very little, and have rapid access to a host of information sources including Internet articles and blogs, magazines, and newspapers, to name but a few. Many contend that such a context requires additional reading competencies (Alexander, 2012; Coiro & Dobler, 2007; Goldman, Braasch, Wiley, Graesser, & Brodowinska, 2012; Rouet, 2006). Important for the current special issue, successful comprehension requires that readers increase their vigilance about the nature of texts as socially constructed artifacts (written by a particular author, in support of a particular agenda, for a particular publication venue, at a particular point in time, and so forth; Beck, McKeown, Sandora, Kucan, & Worthy, 1996; Braasch, Bråten, Strømsø, Anmarkrud, & Ferguson, 2013; Britt, Rouet, & Braasch, 2013; Wineburg, 1994).

Presumably readers have amassed a great deal of practice conducting inquiries in the information age. Why, then, does the empirical evidence consistently suggest that source attention and memory are quite poor, even for skilled readers (Britt & Aglinskas, 2002; Sparks & Rapp, 2011; Walraven, Brand-Gruwel, & Boshuizen, 2009; Wiley et al., 2009)? An active and ever-expanding community of researchers has recognized a paucity in our understandings of the reasons source attention and memory are not—as of yet—optimized for most readers. In alignment with this focus, our contribution to this special issue investigates one new potential cause for suboptimal source attention and memory: *semantic content integration*. We define semantic content integration as readers' propensities to make connections across the semantic content found within multiple texts and incorporate these connections into their mental representation of what was read.

The complexities of the information age make it such that readers often engage with diverse sets of texts that vary along a number of dimensions including relevance to readers' goals, the degree of overlap amongst the semantic content, how complex and readable the information is, the credibility of the information sources, and likely many more. To address some of these reading complexities, Britt, Rouet, and colleagues (Britt, Perfetti, Sandak, & Rouet, 1999; Britt & Rouet, 2012; Perfetti, Rouet, & Britt, 1999; Rouet, 2006) proposed a theoretical account of multiple-text reading comprehension known as the Documents Model Framework (DMF). The DMF extends theories of single text reading comprehension, the most prominent of which is the Construction-Integration Model (Kintsch, 1988, 1998). According to Kintsch (1998), readers construct three levels of mental representations of a text: a surface, a textbase, and a situation model level. That is, when reading a single text, readers decode the words in the texts to form a surface level representation that preserves the exact words from the texts and their syntactic relations. The textbase level, however, concerns a proposition-based representation of the underlying meaning of the ideas conveyed by the text. Finally, the situation model reflects a representation that also includes additional inferences, elaborations,

and interpretations of the situation described within the text. Thus, the situation model level goes beyond what is explicitly stated in the text. The DMF extends characterizations put forth by the Construction–Integration Model to include two additional levels of representation specific to contexts where readers interact with multiple texts: the *integrated mental model* (previously referred to as the situations model) and the *intertext model*.

Britt and Rouet (2012) theorize that readers should create an integrated mental model about the situation or phenomena that represents connections made across semantic content found within multiple texts. This could include assertions unique to single texts, assertions upon which multiple texts' authors agree, and instances where texts' authors offer contradictory assertions. Accordingly, to successfully comprehend, readers should attend to and represent the relationships amongst the semantic content presented in the various documents they read (Goldman, 2004). Several think aloud studies have illustrated that readers' spontaneous attempts to self-explain relationships between concepts offered by multiple texts are related to their ultimate comprehension success (Anmarkrud, Bråten, & Strømsø, 2014; Goldman et al., 2012; Wolfe & Goldman, 2005). These processing patterns might reflect readers' moment-by-moment attempts to construct an integrated mental model, as specified in the DMF, which could ultimately help them successfully answer comprehension questions after reading.

The second additional layer of mental representation proposed by the DMF is the intertext model. Britt, Rouet, and colleagues theorize that readers should ideally include features of the information sources within their mental representations of the texts (e.g., authors, publications venues, intended audience, and so forth). Within the framework, the features of the information sources are represented as "document nodes." Moreover, "intertext links" are theorized as associations that readers can make to represent relationships between documents' nodes and their respective pieces of content information (e.g., "Author A says…"; "Author B says…"), and between multiple document nodes (e.g., "Author A disagrees with Author B"). Empirical research, however, appears to demonstrate that individuals often fail to encode characteristics of the information sources during reading, resulting in frequent inability to remember "who said what" (Britt & Aglinskas, 2002; Goldman et al., 2012; Rouet, Favart, Britt, & Perfetti, 1997; Sparks & Rapp, 2011; Wineburg, 1991). Very few examinations have empirically validated mechanisms underlying readers' attention to and memory for the characteristics of the information sources. Studies in this vein, however, could fruitfully inform on reasons why these encoding failures occur.

One recent line of research has demonstrated that readers do focus more on sources when clear contradictions are present across texts (see Braasch, Rouet, Vibert, & Britt, 2012, for an example). Contradictions can arise in natural reading contexts when multiple sources make assertions about a topic (Stadtler & Bromme, 2014). For example, a reader might come across a text written by the US Environmental Protection Agency (EPA) claiming that greenhouse gases act like a "blanket around Earth," trapping energy in the atmosphere and causing it to warm (EPA, 2015). The same reader might later come across a contradictory argument from a conservative website claiming that climate change is a liberal hoax that the

world is becoming dangerously warmer due to the emission of greenhouse gases (Conservapedia, 2015). Models of comprehension would assume that related information from previously-processed texts would re-enter working memory from long-term memory by way of a passive, automatic, and memory-based spreading of activation. This is similar in operation to associative or resonance processes specified in several models of text comprehension (Gerrig & O'Brien, 2005; Kendeou & O'Brien, 2014; Kintsch, 1988, 1998; Myers & O'Brien, 1998; O'Brien & Myers, 1999). In the case exemplified above, co-activation of the discrepancy in working memory might stimulate readers to experience cognitive conflict because they are unable to resolve it based on the semantic content alone (Kendeou & O'Brien, 2014).

To adequately represent the information, readers should instead establish coherence by making a rhetorical connection between the assertions (in this case, one assertion contradicts the other), and by linking each assertion to its respective information source (e.g., "The EPA says…"; "Conservapedia says…"), as is specified in the intertext model of the DMF (Britt & Rouet, 2012). Recent research by Braasch et al. (2012) and Rouet, Le Bigot, de Pereyra, and Britt (2016) examined whether contradictory claims—similar to the example above—instigate readers to structure their mental representation of texts such that the assertions are indexed to their respective information sources. In Braasch et al. (2012), eye movement data demonstrated greater source attention when readers were encoding stories providing contradictory compared to congruent claims about a topic. Furthermore, readers displayed greater accuracy in retrieving the information sources from contradictory compared to congruent stories they previously read. Rouet et al. 2016 and Barzilai and Eshet-Alkalai (2015) provide additional experimental evidence to support that discrepancies promote memory representations that account for source features. Thus, initial evidence suggests that source attention and memory increase when it is difficult for readers to resolve contradictory accounts based on elaborative or interpretive processing of the content alone.

However, the current work contends that readers should attend to and remember "who said what" not only when texts contain glaring contradictions. It might still be important for readers to mentally represent source-content links even when multiple information sources offer similarly-themed claims (e.g., "humankind has contributed to global warming"). In doing so, different pieces of evidence may be provided by each source to support the agreed-upon claim, which could vary on a number of dimensions including how convincing, well-articulated, and documented they are. That is, complementary pieces of evidence may vary in terms of the strength with which they support the claim. When this occurs, the reader could better comprehend the topic if his/her mental representation included "tags" of each piece of evidence used as support to the respective information sources involved (e.g., "a NASA representative provided piece of evidence A to support that humankind has contributed to global warming, whereas an oceanographer provided piece of evidence B"). Perhaps more importantly, source attention and memory could inform on credibility issues, even when there is agreement amongst the claims. For example, multiple information sources may agree that "global warming does not actually exist," providing various pieces of evidence to support this claim.

In this instance, agreement amongst the sources should not obviate a need to attend to and more critically evaluate the potential biases of the information sources agreeing on an inaccurate claim. Thus, the second example also demonstrates that readers could better understand the topic if they mentally represented linkages between the pieces of evidence provided and the various information sources involved (e.g., "a conservative political commentator provided piece of evidence A to support that global warming does not actually exist, whereas a blog entry provided piece of evidence B"). All told, there are often nuanced ways that different information sources use evidence to support their main claims. The two examples above illustrate that it can still be important to attend to, and remember, source information even in cases of agreement.

Nevertheless, when contradictions are *not* present or are difficult to detect, attention to and memory for information sources can be quite impoverished (Braasch et al., 2012; Goldman et al., 2012; Stadtler, Scharrer, Brummernhenrich, & Bromme, 2013). Since multiple information sources often make very similar assertions about a topic in natural reading contexts, offering comparable or related evidence as support, empirical research should further examine whether the *integration of congruent semantic content*—in and of itself—reduces attention to and memory for the information sources offering their respective arguments.

In returning to the DMF, congruence amongst the semantic content described across multiple texts will almost certainly impact the construction of the integrated mental model of the situation (Britt & Rouet, 2012; Kurby, Britt, & Magliano, 2005). Co-activation of congruent content information in working memory would afford opportunities for readers to make associations amongst the activated propositions via elaborations and interpretations (Kintsch, 1998; Kendeou & O'Brien, 2014). These processes would further strengthen representation at the level of the integrated mental model (Britt & Rouet, 2012). However, the current work contends that there may be a kind of "trade-off" between the construction of the integrated mental model and intertext model levels of text representation. That is, although a greater degree of content agreement should support readers' construction of an integrated mental model, this agreement may *disrupt the construction of the intertext model*. In a limited capacity working memory system, greater attention to semantic content coherence-building processes may reduce the resources available to allocate to other processes (Goldman, Varma, & Coté, 1996), such as those that would support the construction of the intertext model (e.g., linking document nodes to their semantic messages). Alternatively, agreement may obviate a need to attend to and remember the various information sources making similarly-themed arguments. In more colloquial terms, do I really need to remember "who said what" if everyone agrees? In either case, a shallow processing of the information sources during encoding should result in a poorer-quality memory trace. Poorer memory traces may reduce the degree to which readers can discriminate amongst the various information sources at retrieval (Johnson, Hashtroudi, & Lindsay, 1993).

The present set of experiments was designed to systematically examine whether the process of integrating congruent semantic content in mental model development serves as a potential reason that source-content links are mismanaged and, as a result, easily forgotten or confused. In three experiments, we investigated the effects

of *semantic content congruence* on readers' memory for information sources making assertions about a topic (the impact of social media on society). In all three experiments, sets of claims were manipulated such that information sources made *congruent* assertions (claims with different surface forms that otherwise preserve the same textbase meaning), or *distinct* assertions (claims with unrelated textbase meanings). We theorized that congruent assertions direct processing efforts towards content integration at the expense of processing and successfully remembering each claims' respective information source. As such, in Experiment 1, we tested whether poorer memory and more confusion occurred when the sources conveyed similar messages compared to instances where the same sources instead provided unique messages. If the findings align with the hypothesis, one could argue that the readers simply required a greater metacognitive awareness that it was important to differentiate amongst the information sources to better comprehend their relationships with the respective semantic content they provide. As such, Experiment 2 investigated whether a pre-reading "source interference" warning might increase the likelihood that readers attend to the information sources making the claims and, as a result, reduce or even eliminate the source memory detriments associated with semantically congruent texts. Thus, Experiment 2 was conducted to (a) replicate the findings of Experiment 1 with an additional sample, and (b) test the pervasiveness of the effect (i.e., does claim congruence cause source forgetting even when readers received a prior warning that this could occur?). Experiment 3 extended the examination to include longer texts based on full arguments. These arguments were manipulated, again, to be congruent (similar assertions with complimentary evidence statements) or distinct arguments. A comprehensive essay-writing task was administered to investigate whether congruent arguments promoted content integration (in terms of the claims and evidence recalled) at the expense of source memory relative to distinct arguments. Thus, the essay-writing task in Experiment 3 allowed us to more directly examine readers' integrated mental models (the nature of the semantic content included in memory) in relation to their intertext models (source recognition performance). In Experiment 3, reading and source recognition times were also collected to distinguish whether source memory deficits reflected differences for encoding or retrieval processes as a function of the congruence manipulation.

Experiment 1

Experiment 1 served as an initial test of the assumption that content integration disrupts source attention and memory. Participants read a series of sentences for the purposes of remembering the exact claims and the actual information sources making the claims. Afterwards, they were asked to recognize the source associated with each statement. Based on the assumption that content integration disrupts source attention and memory, we expected that readers would display poorer recognition and more confusion amongst the sources making similar claims compared to instances where the same sources instead provided unique claims.

Method

Participants

Fifty-five undergraduates (80 % female; *M age* = 23.60, *SD* = 5.59) at a large mid-south university in the United States participated. All participants were fluent English speakers. Compensation for participation was course credit in a research methods and statistics in psychology course.

Materials

Prior knowledge measure Participants were asked to list the benefits and detriments of social media for society. Two orders of the prior knowledge measure were constructed such that half the participants listed the benefits of social media for society first (followed by the detriments), and half listed the detriments first (followed by the benefits).

Intervening "distractor" survey Although this brief survey primarily functioned as a "distractor" task (i.e., to reduce effects related to short-term memory) it also provided valuable descriptive information. Self-reported demographic background information (e.g., age, gender), and information concerning social media usage was requested (e.g., how many hours a day the participant used social media, social media sites used, for what purposes). The survey provided Likert ratings (anchored 1 = *strongly disagree*, 10 = *strongly agree*) concerning familiarity of and interest in the information, as well as the ease of and effort required towards understanding the information.

Text stimuli Forty-eight sentences described reasons that social media may be beneficial or detrimental for society. We used single sentences to distill semantic content that could be provided by information sources into its simplest form (i.e., claims about a topic). The materials were designed to maximize control in directly testing forgetting mechanisms related to congruency amongst claims. That is, the approach sought to reduce potential influences of extraneous factors associated with longer, perhaps more authentic texts that could nevertheless impact comprehension (e.g., additional details that were irrelevant to the manipulation). It should be noted that related experiments have successfully utilized similar materials (i.e., information sources making claims within single sentences), most notably in Braasch et al.'s (2012) testing of the D-ISC mechanism. We first constructed 24 congruent claim sentences. These reflected congruent claim triplets for four benefits and four detriments. Triplets were three sentences that paraphrased one another, while otherwise preserving the textbase meaning across the sentences (see the left-hand column of Table 1 for congruent benefit and detriment examples). To create the 24 sentences in the distinct condition, we altered the semantic content for *two* sentences from each congruent claim triplet to change the meaning of the sentences (adaptations ranged between 1 and 4 words; see the right-hand column of Table 1

Table 1 Example stimuli demonstrating manipulation of claim congruence (congruent, distinct)

	Congruent claim condition	Distinct claim condition
Benefit to society example: Increasing a musician's fan base	An agent specifies that social networking sites provide a way for music recording artists to increase their visibility (Target constant sentence: same across condition)	
	A news anchor announced that social media websites provide a way for *musical* groups to gain access to *a* new *fan base*	A news anchor announced that social media websites provide a way for *support* groups to gain access to new *attendees*
	A blog entry states that, through social media, amateur *musicians* can learn how to build *audiences*	A blog entry states that, through social media, amateur *carpenters* can learn how to build *furniture*
Detriment to society example: Spreading false information	A college professor contends that social networking sites provide immediate access to unreliable information (Target constant sentence: same across condition)	
	A webmaster asserts that social media enables the spread of *false information*	A webmaster asserts that social media enables the spread of *Internet viruses*
	A CNN staff writer critiques that social networking sites provide quick dissemination of *inaccurate* information	A CNN staff writer critiques that social networking sites provide quick dissemination of *demographic* information

for distinct benefit and detriment examples). Congruent sentences displayed comparable average word length ($M = 15.92$, $SD = 3.63$) with distinct sentences ($M = 15.96$, $SD = 3.70$). Flesch–Kincaid grade level was also comparable across the manipulated sentences (Congruent: $M = 13.45$, $SD = 2.19$; Distinct: $M = 13.03$, $SD = 2.67$). Thus, the distinct claim "triplets" all constituted non-overlapping content, while still preserving sentence length and information complexity relative to the semantically-congruent versions of the sentences. Participants read 24 of the sentences: 12 congruent (i.e., two benefit triplets and two detriment triplets) and 12 distinct sentences. Orders were counterbalanced such that, across all participants, the congruent and distinct sentence versions for each triplet were read half of the time.

As the first row within the examples in Table 1 demonstrates, one sentence was held constant across the manipulation. This sentence served to test whether the presence or absence of the two additional congruent claims caused more source forgetting on what will be referred to as *target constant* sentences. As the name implies for the target constant sentences, the information sources *and* the semantic content were held constant across the manipulation. That is, *all* participants read these sentences, regardless of the congruency manipulation. Therefore, any source memory differences on the target constant sentences can *only* be attributed to the content integration readers may have experienced based on the presence of other similarly-themed sentences, and not due to more or less memorable source-content associations.

The current research used information sources that were abstract entities reflecting an author's occupation (e.g., an agent) or a venue of publication (e.g., a blog entry) rather than a specific entity with a given name (e.g., John Smith). This design decision reflected an interest in adhering to source types that are relevant for informing on the topic, while also preserving the kinds of source features that are associated with multiple document comprehension contexts, in terms of experimental stimuli used in previous studies (Braasch et al., 2012). More notably, these source features mimic those that readers come across in their day-to-day, authentic inquiry experiences (Walraven, Brand-Gruwel, & Boshuizen, 2009).

Participants were randomly assigned to receive blocked or semi-randomized orders of the sentences. As described in the Introduction, one processing assumption in the current work is that co-activation is a necessary precondition for semantic content integration to occur. Blocked administration all but ensures co-activation of semantic information in working memory due to sentence-to-sentence argument overlap amongst the sequentially read, congruent texts. However, in alignment with associative mechanisms found within many theories of single text comprehension, random administration of the sentences might also afford opportunities for co-activation of the complementary claims to occur. Thus, this manipulation addresses whether previously read, congruent texts affect processing whether they were read immediately prior or some time ago.

In the blocked condition, participants received a random order treating each distinct sentence as one unit, and each congruent triplet as one unit. Thus, the three paraphrased claims were always presented sequentially as a "block." For the semi-randomized administration, participants received a random order of all 24 sentences. However, alterations were made so that no two congruent sentences were presented sequentially, so as not to create an artificial block. Accordingly, at least one sentence had to come between paraphrased sentences.

Source memory measure Random orders of the claim statements were provided with a blank line replacing the information source (e.g., A ____ asserts that social media enables the spread of (*false information/Internet viruses*). An alphabetized bank of the 24 information sources was provided on a separate sheet of paper. Readers were tasked to accurately select from the list the information source that made the specific claim. Thus, in the current work, we measured the number of information sources that participants could accurately recognize from congruent and distinct claims they previously read. Source recognition memory scores could range from 0 to 12 for distinct, and again for congruent sentences. We also analyzed the incidence of *source confusion errors*. These reflected a subset of inaccurate responses where an individual recalled a source associated with one of the other claims in the triplet. With reference to the "spreading false information" example in Table 1, responding that "A college professor asserts that social media enables the spread of false information" would exemplify a source confusion error. Source confusion errors could also range from 0 to 12 for distinct, and again for congruent sentences.

Design

This experiment used a 2 × 2 mixed design with sentence administration serving as the between-participants variable (blocked, semi-randomized), and claim congruence serving as the within-participants variable [congruent, distinct].

Procedure

After informed consent was obtained, the experimenters distributed folders containing the prior knowledge measure and the text stimuli. Participants were class-administered instructions that their task would be to read to remember information about the benefits and detriments of social media for society. Prior to reading, the experimenter requested that the participants remove the prior knowledge measure from the folder and write down their initial understandings of the benefits and detriments of social media for society in the space provided. Instructions were to be as specific and explanatory as possible when listing possible reasons that social media may be beneficial for society, and again why it may be detrimental. Participants were allotted 5 min to complete the prior knowledge measure.

Participants returned the prior knowledge measure to their folders and took out the sentence packet. Instructions were to read the sentences to understand them well enough to answer questions about both the content and the source from memory. They were told that they should try to remember both the exact claims in the sentences and also the actual information sources that made the claims. Participants read the sentences at their own pace for up to 15 min. When they had finished reading (none read for the entire 15 min allotment), they placed the texts back in the folder and raised their hands for further instruction. The experimenter then distributed the intervening "distractor" survey, asking participants to provide some important demographic information. This task took roughly 3–5 min.

Participants were then provided with the source recognition memory measure along with the source bank. Instructions were to try to remember the source associated with each statement by writing a response in the blank provided. The instructions additionally specified to make a best guess as to the correct answer in the event that participants were unsure. To reduce diffusion of treatment, debriefing was class-administered only after both classes completed the task.

Results and discussion

Descriptive profile

All participants had some prior knowledge of the topic, ranging from 3 to 18 responses with an average of 8.45 benefits/detriments of social media for society ($SD = 3.75$). Participants reported spending a substantial portion of their day on social media ($M = 2.71$ h, $SD = 1.97$), using multiple social media outlets ($M = 2.42$ outlets, $SD = 1.41$), for various purposes ($M = 1.87$ purposes mentioned, $SD = 1.19$). Participants also conveyed a familiarity with ($M = 6.38$,

$SD = 2.56$) and interest in ($M = 6.91$, $SD = 1.95$) the topic. Finally, they rated the sentences as very easy to understand ($M = 8.85$, $SD = 1.92$), requiring very little comprehension effort ($M = 2.27$, $SD = 2.07$). Thus, the descriptive profile suggests that any congruence-related memory decrements are unlikely due to a lack of familiarity with the topic; nor was the topic too difficult to understand or uninteresting.

Memory

For all analyses, the dependent measures were submitted to Analysis of Variance (ANOVA) using sentence administration (blocked, semi-randomized) as the between-participants variable and claim congruence [congruent, distinct] as the within-participants variable.

We first examined whether students displayed worse overall memory for sources making congruent claims compared with those making distinct claims. Using source accuracy as the dependent measure, the analysis produced a significant main effect of claim congruence, $F(1, 53) = 55.81$, $p < .001$, $\eta_p^2 = .51$. However, the main effect for sentence administration [$F(1, 53) = .09$, $p = .76$] and the interaction [$F(1, 53) = 1.38$, $p = .25$] were not significant. Participants recalled fewer sources accurately when claims agreed ($M = 4.00$, $SD = 2.48$) than when distinct claims were offered ($M = 6.42$, $SD = 2.89$), regardless of the nature of the sentence administration. Our second research question concerned the incidence of confusions amongst the information sources making congruent claims. When source confusion errors were used as the dependent measure, the analysis produced a significant main effect of claim congruence, $F(1, 53) = 37.21$, $p < .001$, $\eta_p^2 = .41$. However, the main effect for sentence administration [$F(1, 53) < .01$, $p = .96$] and the interaction [$F(1, 53) = 1.34$, $p = .25$] were not significant. Participants displayed more source confusion errors for congruent sentences ($M = 2.40$, $SD = 1.63$) than for distinct ($M = 0.91$, $SD = 0.96$). This was, again, regardless of the nature of the sentence administration.

We performed a comparable set of analyses to determine whether the presence of two congruent claims caused more source forgetting and errors using the target constant sentences (i.e., the sentences that did not differ across the manipulation) as the dependent measure. There was a significant main effect of claim congruence, $F(1, 53) = 18.03$, $p < .001$, $\eta_p^2 = .25$. However, the main effect of sentence administration [$F(1, 53) = .06$, $p = .81$] and the interaction [$F(1, 53) = .01$, $p = .95$] were not significant. The effects for the constant sentence mirrored the overall source accuracy effects. Participants recalled fewer sources accurately when the claims found in constant sentences were similar in nature to claims found in other sentences ($M = 1.45$, $SD = 1.01$) than when they were not ($M = 2.11$, $SD = 1.08$). Importantly, this occurred regardless of the fact that all participants read the same exact target constant sentences.

Finally, we investigated whether readers displayed more source confusion errors when target constant sentences were or were not previously presented with two congruent claims in the set of to-be-remembered items. When source confusions for the target constant sentences were used as the dependent measure, there was a

significant main effect of claim congruence, $F(1, 53) = 5.84$, $p < .05$, $\eta_p^2 = .10$. As before, the main effect of sentence administration [$F(1, 53) < .01$, $p = .98$] and the interaction [$F(1, 53) = .27$, $p = .61$] were not significant. Participants displayed more source confusion errors when the claims found in the target constant sentences were compatible with claims found in other sentences ($M = 0.74$, $SD = 0.79$) than when they were not ($M = 0.42$, $SD = 0.54$).[1]

Taken together, the moderate-to-large effect sizes (explaining 10–51 % of the overall variance; Cohen, 1988) suggest a rather robust memory disadvantage when information sources are conveying very similar claims. Based on the results of Experiment 1, readers may not spontaneously increase their attention to information sources presenting consistent messages to counteract potential forgetting. The congruency effect in Experiment 1 stands in stark contrast to situations where contradictory claims instigate readers to better attend to information sources making the claims, and thus improve memory (Braasch et al., 2012; Rouet et al., 2016).

Experiment 2

Several memory researchers have investigated whether warnings prior to information encoding might diminish or even eliminate pervasive memory errors with mixed results (Bixter & Daniel; 2013; Ecker, Lewandowsky, & Tang, 2010; Gallo, Roberts, & Seamon, 1997; Marsh & Fazio, 2006; Peshkam, Mensink, Putnam, & Rapp, 2011; Rapp, 2008; Sparks & Rapp, 2011). For example, Ecker et al. (2010) demonstrated that warnings administered before reading can reduce (but not eliminate) a continued influence of misinformation presented earlier in a text. With regards to source awareness, Sparks and Rapp (2011) administered several types of interventions designed to increase considerations of source credibility during reading, many of which resulted in little to no improvements in source awareness during reading. Similarly in Experiment 2 of the current work, we randomly assigned participants to either receive a *source interference warning* prior to reading, or to participate in a no warning control condition. This manipulation was designed to test whether an additional warning could encourage participants to more carefully attend to the information sources during encoding. If the warning is effective, one could expect a reduction of the memory decrements and confusions

[1] One could argue that the source memory differences across the two conditions reflected a benefit for the distinct condition and not a detriment for the congruent condition. That is, it may have been easier to correctly identify sources in the distinct condition based on the relevance of the source to the claim. It is important to note that for the two sentences in which we manipulated the congruency, we ensured they were equally likely to be pertinent to either context (e.g., a news anchor is equally likely to state that social media websites provide a way for *musical* groups to gain access to *a* new *fan base* vs. *support* groups to gain access to new *attendees*). To further address the source relevance concern, however, we conducted additional analyses investigating whether there were inter-condition differences across the two sentences in which we held constant the pertinence of the source to the information. The results were consistent with those obtained in the primary analyses. Participants recalled significantly fewer sources accurately when claims agreed ($M = 2.56$, $SD = 1.75$) than when distinct claims were offered ($M = 4.27$, $SD = 2.21$), regardless of the nature of the sentence administration, $F(1, 53) = 46.55$, $p < .001$, $\eta_p^2 = .47$. Thus, these results suggest that pertinence of the source was not driving the effects reported in the focal analyses.

displayed in Experiment 1. In terms of the theoretical levels of mental representation described in the DMF, warnings might guide readers towards a more balanced consideration in constructing an integrated mental model of the content, but also in accounting for source-content linkages in their mental text representations. However, if congruent assertions pervasively draw readers' attention towards content-integration processes at the expense of source processing, we would still expect less accuracy and more confusion amongst the sources offering consistent compared to unique messages. Thus, a replication of the Experiment 1 findings—irrespective of the presence of the pre-reading warning—would suggest that the "trade off" between content integration and source consideration pervasively reduces source memory.

Method

Participants

Eighty-two undergraduates (75.6 % female; $M\ age = 21.96$, $SD = 6.94$) at an urban Midwestern university in the United States participated. All participants were fluent English speakers. Participants were recruited through the undergraduate subject pool, and were compensated with course credit in an Introductory Psychology course.

Design

The experiment used a $2 \times 2 \times 2$ mixed design with warning condition (warning, no warning) and sentence administration (blocked, semi-randomized) serving as the between-participants variables, and claim congruence serving as the within-participants variable [congruent, distinct].

Materials and procedure

The Experiment 2 materials and procedure were identical to Experiment 1, save for the warning manipulation. Participants were randomly assigned to a source interference warning or typical reading condition (the latter was identical to the Experiment 1 reading instructions). The exact warning was as follows: "Research has shown that, when people read multiple sentences with similar content, they often experience source interference. That is, although the content of a sentence is remembered, who is delivering the message is often confused. Please remember to focus on all of the presented information equally because you will answer a cumulative set of questions at the end of the experiment." Thus, those warned received a definition of source interference, and they were informed of its potential occurrence in their upcoming reading/memory recognition task. Like Experiment 1, they were instructed to attend to both the sentences' content and sources.

Results and discussion

Descriptive profile

Similar to Experiment 1, all participants had some prior knowledge of the topic, ranging from 2 to 15 responses with an average of 6.53 benefits/detriments of social media for society ($SD = 2.78$). Participants reported spending a substantial portion of their day on social media ($M = 3.20$ h, $SD = 3.01$), using multiple social media outlets ($M = 2.60$ outlets, $SD = 1.45$), for various purposes ($M = 1.63$ purposes mentioned, $SD = 0.87$). Participants also conveyed a familiarity with ($M = 6.38$, $SD = 2.26$) and interest in ($M = 6.80$, $SD = 2.44$) the topic. Finally, they rated the sentences as very easy to understand ($M = 8.10$, $SD = 1.86$), requiring very little comprehension effort ($M = 3.76$, $SD = 2.53$). Thus, the descriptive profile again suggests that any congruence-related memory decrements are unlikely due to a lack of familiarity with the topic; nor was the topic too difficult to understand or uninteresting.

Memory

For all analyses, the dependent measures were submitted to Analysis of Variance (ANOVA) using warning condition (warning, no warning) and sentence administration (blocked, semi-randomized) as the between-participants variables, and claim congruence [congruent, distinct] as the within-participants variable.

We first examined whether students displayed worse overall memory for sources making congruent claims compared with those making distinct claims. Using source accuracy as the dependent measure, the analysis produced a significant main effect of claim congruence, $F(1, 78) = 23.29$, $p < .001$, $\eta_p^2 = .23$. The main effect for warning condition did not reach acceptable levels of statistical significance, $F(1, 78) = 2.78$, $p = .10$, $\eta_p^2 = .03$. The remaining effects—the main effect for sentence administration, the two-way interactions, and the three-way interaction—did not approach significance, $Fs(1, 78) < 1$, $ps > .63$. Thus, participants recalled fewer sources accurately when congruent claims were offered ($M = 3.79$, $SD = 2.42$) than when distinct claims were offered ($M = 5.16$, $SD = 2.94$), regardless of the nature of the sentence administration or whether they received a source interference warning.

Our second research question concerned the incidence of confusions amongst the information sources making congruent claims. When source confusion errors were used as the dependent measure, the analysis produced a significant main effect of claim congruence, $F(1, 78) = 43.39$, $p < .001$, $\eta_p^2 = .36$. Participants displayed more source confusion errors when claims were congruent ($M = 2.20$, $SD = 1.35$) than when they were distinct ($M = 0.93$, $SD = 1.08$). Additionally, the main effect for sentence administration produced a significant result, $F(1, 78) = 6.14$, $p < .05$, $\eta_p^2 = .07$. Participants displayed more source confusion errors when they read sentences in blocked administration ($M = 1.80$, $SD = 1.13$) than when sentences were randomly administered ($M = 1.33$, $SD = 1.27$). All remaining effects did not approach significance, $Fs(1, 78) < 1$, $ps > .22$.

We performed a comparable set of analyses to determine whether the presence of two congruent claims caused more source forgetting and errors on the target constant sentences (i.e., the sentences that did not differ across the manipulation). When source accuracy for the target constant sentences was used as the dependent measure, there were no significant effects, $Fs(1, 78) < 1$, $ps > .31$. However, when source confusions for the target constant sentences were used as the dependent measure, there was a significant main effect of claim congruence, $F(1, 78) = 37.58$, $p < .001$, $\eta_p^2 = .33$; the main effects of sentence administration and warning, as well as the congruence × sentence administration interaction did not reach statistical significance, $Fs(1, 78) < 1$, $ps > .48$. The congruence × warning interaction [$F(1, 78) = 2.48$, $p = .12$, $\eta_p^2 = .03$] and the three-way interaction [$F(1, 78) = 2.59$, $p = .11$, $\eta_p^2 = .03$] approached, but did not reach acceptable levels of statistical significance. Thus, the strongest effect denotes that participants displayed more source confusion errors when the claims presented in the target constant sentences were congruent with claims presented in other sentences ($M = 1.17$, $SD = 1.09$) than when they were not ($M = 0.29$, $SD = 0.49$).[2]

Taken together, the moderate-to-large effect sizes (explaining 23–36 % of the overall variance) replicated the findings produced by the Experiment 1 sample drawn from a different university's undergraduate population. Despite a pre-reading warning, there was a rather robust and apparently pervasive memory disadvantage when information sources offered compatible messages compared to those offering unique messages. Thus, although warnings were intended to increase the readers' awareness that source interference could occur, there is no evidence that readers were able to overcome suboptimal processing of source information in the event that there were semantic congruencies in what was "said." This finding corroborates previous research demonstrating that general pre-reading warnings are not particularly effective in promoting source awareness during comprehension (Sparks & Rapp, 2011).

Although Experiments 1 and 2 suggest that the presence of semantically-compatible assertions results in a mismanagement of source-content links, they do not provide direct evidence that content integration processes cause multiple information source forgetting. To revisit, we theorized that readers' development of an integrated mental model disrupts their construction of an intertext model. Experiment 3 adapts the textual materials, adds an additional recall memory test, and captures time data to more directly test this assumption.

Experiment 3

In Experiment 3, participants read a series of full arguments (i.e., various claims providing supporting evidence) for two purposes: writing a comprehensive essay from memory, and recognizing the information sources making exact claims (the

[2] We conducted comparable analyses for the Experiment 2 data to address the pertinence concern raised in Footnote 1. The results were again consistent with those obtained in the primary analyses and, as such, suggest that pertinence of the source was not driving the reported effects.

task administered in Experiments 1 and 2). In addition, to determine if there were encoding and retrieval differences for congruent versus distinct texts, we captured reading times and the time it took to recognize the sources from each type of text. Based on the assumption that congruent content would guide readers' processing efforts towards semantic content integration, we expected longer reading times and better recall memory for congruent relative to distinct arguments. As in Experiments 1 and 2, we expected the opposite pattern for the source recognition test: poorer recognition and more confusion amongst the sources making congruent compared to distinct arguments. Thus, Experiment 3 extends the previous results to directly test whether readers would focus their processing efforts on semantic integration when congruent content is available, at the expense of processing (and accurately remembering) the information sources making the arguments.

Method

Participants

Eighty-two undergraduates (73.2 % female; $M\ age = 21.87$, $SD = 7.19$) at an urban Midwestern university in the United States participated. All participants were fluent English speakers. Participants were recruited through the undergraduate subject pool, and were compensated with course credit in an Introductory Psychology course.

Design

We used a 2-level within-participants variable [congruent, distinct].

Materials

The prior knowledge measure, intervening "distractor" survey, and source memory measure were the same as in Experiments 1 and 2. However, there were three important changes. First, we provided more elaborate text stimuli in Experiment 3 that involved evidence statements associated with each claim. Second, the results of Experiments 1 and 2 suggest that the source detriments associated with congruencies were not contingent on a successive reading of the information (i.e., the blocking manipulation never moderated the effects associated with the congruency manipulation). Accordingly, texts were only presented in a semi-randomized order in Experiment 3. Finally, Experiment 3 also administered an essay-writing task to assess the degree to which the semantic content of the arguments were present in readers' mental representations of the various texts they previously read.

Modifications to text stimuli and reading task Participants received the same instructions for the reading task as in Experiments 1 and 2 with the addition of specifying that they would also be using the information in the texts to write a comprehensive essay explaining the reasons that social media may be beneficial and

detrimental for society. They were told to include the information sources making the various claims in the essay.

We altered the texts to include more information, in that each original claim sentence used in Experiments 1 and 2 was followed by one evidence statement that provided a key piece of support for the claim (see Table 2 for evidence statement examples). Consequently, each evidence statement added one sentence. For each evidence statement, we changed as few words as possible to fit the topic across the congruent and distinct sentence conditions (adaptations ranged between 1 and 6 words).

All congruent texts displayed a comparable number of words ($M = 38.00$, $SD = 6.61$) compared with distinct texts ($M = 38.17$, $SD = 6.70$). Flesch–Kincaid grade level was virtually identical across the text manipulation (Congruent: $M = 12.93$, $SD = 1.72$; Distinct: $M = 12.92$, $SD = 2.01$). Thus, the distinct text "triplets" all constituted non-overlapping content, while still preserving text length and information complexity relative to the congruent version text triplets.

Essay task Participants received the following instructions for the essay writing task: "Now we would like you to write a comprehensive essay explaining the reasons that social media may be beneficial and detrimental for society, which will importantly include the information sources making the various claims." Essays were scored in three ways. First, we counted the number of accurate distinct and congruent text claims that participants included in their essay, with the highest possible total being 12 distinct claims and four congruent claims. Because all congruent claims in a triplet were paraphrases of one another, if a participant recalled a claim from a congruent triplet correctly, it was only counted as one claim. Thus, because there were four congruent triplets, the highest possible congruent claim score was four. Second, we counted the number of sources correctly attributed to the recalled claims, with a total of 24 sources possible (12 distinct and 12 congruent). Last, we counted the number of details (i.e., propositions) from evidence statements included in each essay. For example, in the evidence statement "For example, some fan clubs have increased their membership by 200 % due to an increased social media presence, which also helps promote awareness of their tours", a total of two detail points could be awarded if participants mentioned "200 %" and "promote awareness of their tours" in their essay. Two raters independently classified a 20 % randomly selected sample of the student-generated essays (Cohen's kappa = .87). Disagreements were resolved in discussion; one rater scored the remaining essays.

Procedure

The procedure was the same as in Experiments 1 and 2 except that all materials and instructions were administered via computer using the Qualtrics online survey software program. To advance to each task, participants clicked a red button at the bottom right-hand corner of the screen. Likewise, participants typed answers to the prior knowledge and source memory measures in boxes provided in Qualtrics. The

Qualtrics program allowed us to record reading times for each text. Because of this, each text was provided on its own page, with no back button to re-access previous texts. To allow participants to read texts multiple times (which they may have done in Experiments 1 and 2), once they finished reading all 24 texts, they received an on-

Table 2 Example stimuli from Experiment 3 demonstrating addition of evidence statements (underlined)

	Congruent claim condition	Distinct claim condition
Benefit to society example: Increasing a musician's fan base	An agent specifies that social networking sites provide a way for music recording artists to increase their visibility. Sixty-four percent of people listen to music on YouTube, far more than purchase CDs (Target constant sentence: same across condition)	
	A news anchor announced that social media websites provide a way for *musical* groups to gain access to *a* new *fan base*. For example, some *fan clubs* have increased their membership by 200 % due to an increased social media presence, which also helps promote awareness of their *tours*	A news anchor announced that social media websites provide a way for *support* groups to gain access to new *attendees*. For example, some *self-help groups* have increased their membership by 200 % due to an increased social media presence, which also helps promote awareness of their *cause*
	A blog entry states that, through social media, amateur *musicians* can learn how to build *audiences*. For example, novices can learn new techniques by studying videos on YouTube made by master *musicians*	A blog entry states that, through social media, amateur *carpenters* can learn how to build *furniture*. For example, novices can learn new techniques by studying videos on YouTube made by master *craftsmen*
Detriment to society example: Spreading false information	A college professor contends that social networking sites provide immediate access to unreliable information. In fact, some studies have estimated that 49 % of people have learned of false news via social media sites, and tend to spread that false news to their friends (Target constant sentence: same across condition)	
	A webmaster asserts that social media enables the spread of *false information*. For example, a few years ago hackers took over the Associated Press Twitter account and posted a false *story,* which led to the crashing of *the stock market*	A webmaster asserts that social media enables the spread of *Internet viruses*. For example, a few years ago hackers took over the Associated Press Twitter account and posted a false *link,* which led to the crashing of *followers' computers*
	A CNN staff writer critiques that social networking sites provide quick dissemination of *inaccurate* information. This can be especially *disastrous* when *bogus* information gets picked up and *broadcast* by national *news outlets,* which may lead to *panic*	A CNN staff writer critiques that social networking sites provide quick dissemination of *demographic* information. This can be especially *undesirable* when *personal* information gets picked up and *used* by national *advertising agencies*, which may lead to *junk mail*

screen option to either read through the texts again (up to two more times) or to continue to the next task.

Following completion of reading, a subsequent screen tasked participants to complete the intervening "distractor" survey, followed by the essay-writing task and finally the source memory recognition assessment. As in Experiments 1 and 2, an alphabetized bank of the 24 information sources was provided on the screen. Readers were tasked to accurately select from the list the information source that made the specific claim. Thus, as in Experiments 1 and 2, we measured the number of information sources that participants could accurately recognize from congruent and distinct claims they previously read. To record participants' response times on each source recognition item, the source memory task was administered similar to the reading task. That is, each fill-in-the-blank prompt was provided on its own page, and after completing all 24 items participants received an on-screen option to revise their answers (up to two more times). If they chose to revise their answers, they were able to see their previous responses on screen as well.

Results and discussion

Descriptive profile

Similar to Experiments 1 and 2, all participants had some prior knowledge of the topic, ranging from 1 to 15 responses with an average of 6.13 benefits/detriments of social media for society ($SD = 2.61$). Participants reported spending a substantial portion of their day on social media ($M = 3.47$ h, $SD = 3.04$), using multiple social media outlets ($M = 2.66$ outlets, $SD = 1.26$), for various purposes ($M = 1.75$ purposes mentioned, $SD = 1.02$). Participants also conveyed a familiarity with ($M = 7.00$, $SD = 2.10$) and interest in ($M = 6.21$, $SD = 2.22$) the topic. Finally, they rated the sentences as very easy to understand ($M = 8.06$, $SD = 2.03$), requiring very little comprehension effort ($M = 3.17$, $SD = 2.19$). Thus, the descriptive profile again suggests that any congruence-related memory decrements are unlikely due to a lack of familiarity with the topic; nor was the topic too difficult to understand or uninteresting.

Reading and response times

We first analyzed the reading time data to test whether participants spent more time on the congruent compared to the distinct texts. A *t* test using argument congruence [congruent, distinct] as the within-participants variable confirmed that this was indeed the case. Participants spent, on average, more seconds on congruent ($M = 23.85$, $SD = 7.34$) compared to distinct texts ($M = 22.53$, $SD = 6.99$), $t(81) = -2.78$, $p < .01$, Cohen's $d = .31$. When comparing only the target constant texts (i.e., the texts that did not differ across the manipulation), participants displayed the same pattern: a significantly longer average reading time on constant texts in the congruent text condition ($M = 22.58$, $SD = 8.98$) compared to those in the distinct text condition ($M = 20.82$, $SD = 6.29$), $t(81) = -2.76$, $p < .01$, Cohen's $d = .30$.

The source recognition time data, however, showed that participants spent comparable average times recognizing information sources associated with congruent ($M = 19.12$, $SD = 7.18$) compared to distinct arguments ($M = 19.03$, $SD = 6.74$), $t(81) = -0.14$, $p = .89$. Although there was no overall difference for source recognition time data, there was a significant difference when comparing the target constant texts (i.e., the texts that did not differ across the manipulation), $t(81) = -2.14$, $p < .05$, Cohen's $d = .24$. Participants took longer to recognize sources when the claims presented in the target constant texts were congruent with arguments presented in other texts ($M = 21.34$, $SD = 9.30$) than when they were not ($M = 19.22$, $SD = 8.00$).

Memory

The means, standard deviations, test statistics, and effect sizes associated with analyses of the content recalled in essays and sources recognized are displayed in Table 3. The results demonstrated that readers recalled proportionately more accurate claims from the congruent compared to the distinct texts. Readers also recalled proportionately more details from the supporting evidence statements from the congruent compared to the distinct texts they read, albeit with a small effect size (Cohen, 1988). The frequency of sources recalled in the essays, however, was similarly low across the text manipulation. The source recognition results in Experiment 3, however, completely replicated the results of Experiments 1 and 2. That is, participants displayed less source accuracy and more source confusion errors when claims were congruent than when they were distinct. As in Experiments 1 and 2, this was an overall effect, but also an effect occurring for those sentences specifically held constant across the manipulation (i.e., target constant sentences).[3] The Cohen's *d*s confirm that the robust memory disadvantages displayed with simple sentences in Experiments 1 and 2 also hold for more substantive texts providing congruent or distinct arguments.

Correlations amongst the recall and recognition measures

Exploratory correlations relating semantic content recalled in the essays to source confusions on the recognition test were conducted to further investigate the assumption that congruencies across texts instigate memory benefits for semantic content paired with memory decrements for source-content links. In alignment with the "trade-off" assumption, the inclusion of claims from congruent texts in essays correlated with source confusion errors on the recognition test, r_s $(80) = .32$, $p < .01$. Inclusion of evidence statements from congruent texts in essays also correlated with source confusion errors, r_s $(80) = .28$, $p < .05$. When conducting the same correlations for the memory measures related to the distinct texts, however, neither approached significance, $r_s(80) = -.107$, $p = .34$;

[3] We conducted comparable analyses for the Experiment 3 data to address the pertinence concern raised in Footnote 1. The results were again consistent with those obtained in the primary analyses and, as such, suggest that pertinence of the source was not driving the reported effects.

Table 3 Experiment 3: Content recall measures in essays and source recognition measures

Measure	Distinct texts *M* (*SD*)	Congruent texts *M* (*SD*)	Test statistic	Effect size
Essay recall				
Proportion of claims	0.26 (0.15)	0.66 (0.26)	$t(80) = -13.95$, $p < .001$	$d = 1.55$
Evidence	0.07 (0.07)	0.09 (0.09)	$t(80) = -2.24$, $p < .05$	$d = 0.25$
Sources	0.93 (1.47)	0.91 (1.47)	$t(80) = 0.07$, $p = .95$	
Source recognition				
Accuracy	3.68 (2.46)	1.95 (1.50)	$t(81) = 6.79$, $p < .001$	$d = 0.75$
Confusions	1.13 (0.98)	2.91 (1.61)	$t(81) = -9.21$, $p < .001$	$d = 1.02$
Constant sent. accuracy	1.02 (1.08)	0.44 (0.65)	$t(81) = 4.92$, $p < .001$	$d = 0.54$
Constant sent. confusions	0.38 (0.58)	0.95 (0.77)	$t(81) = -5.66$, $p < .001$	$d = 0.63$

One participant did not complete an essay, reducing the degrees of freedom from 81 to 80 for all essay-related analyses

$r_s(80) = -.054$, $p = .63$. Thus, the better readers remembered congruent semantic content, the more source confusion errors they made.

General discussion

Previous research has demonstrated that individuals are often inattentive to source characteristics during reading and, accordingly, do not appear to include these features as part of their mental representations of what was read (Britt & Aglinskas, 2002; Goldman et al., 2012; Sparks & Rapp, 2011; Wiley et al., 2009; Wineburg, 1991). The goal of the present set of experiments was to systematically examine semantic content integration as an explanation of source inattention and forgetting when reading for the purposes of remembering multiple texts. To address this goal, we experimentally manipulated the degree of semantic overlap amongst messages provided by various information sources. Guided by the Documents Model Framework (DMF; Britt et al., 1999; Britt & Rouet, 2012), the main assumption was that congruent assertions or arguments would direct processing efforts towards developing an integrated mental model of the situation described across multiple texts, which would come at the expense of encoding and remembering the characteristics of the information sources. As such, across the three experiments, we expected poorer memory and more confusion amongst the sources conveying consistent compared to unique messages.

For all three experiments, congruencies sufficiently disrupted memory for the respective information sources conveying the messages. The memory reduction was substantial and pervasive, even when readers received a prior warning that source confusions might occur due to the similar nature of the claims being made. Experiment 3 provided a landscape of differences with respect to "processes" (reading time, response time) and "products" (generated essays, source recognition) that most directly informs on a trade-off between semantic content integration and

source attention and memory. In alignment with predictions, readers spent a longer amount of time processing the congruent compared to the distinct texts. This was paired with a greater presence of congruent claims and evidence within their mental representations of what was read—as evidenced by the comprehensive essays generated from memory—compared to claims and evidence that were distinct. Participants' increased memory for congruent claims is likely due, at least in part, to the effect of repetition of the textbase. Better memory for repeatedly encoded information is one of the long-standing effects in the memory literature, dating back to Ebbinghaus (1885). Nevertheless, repetition alone does not explain participants' better memory for the *unique* evidence statements paired with the congruent claims. Thus, the pairing of the two effects suggests that memory benefits are not solely due to repetition, rather they are due to readers integrating compatible semantic content.

Source recognition performance, however, displayed the opposite pattern: poorer memory when sources provided semantically-related compared to distinct arguments. Correlations amongst the various memory measures in Experiment 3 were also informative with respect to a potential trade-off. The more readers remembered congruent content in their essays (for both claims and evidence statements), the more errors they made when attempting to recognize the information sources. The same correlation, however, was absent when analyzing the memory patterns for information derived from distinct texts.

Thus, the current work uniquely contributes to research on the cognitive underpinnings of source attention and memory. To the best of our knowledge, this is the first study to examine the role of message consistency in readers' construction of an integrated mental model and an intertext model as specified in the DMF (Britt & Rouet, 2012). Moreover, in replicating the effects across various samples, given various instructions, and with various kinds of materials (e.g., simple claims, more complex arguments), we can say with some confidence that information compatibility may serve a primary reason that source attention and memory is impoverished in contexts where individuals read multiple texts, as many have demonstrated in previous research (Britt & Aglinskas, 2002; Sparks & Rapp, 2011; Walraven et al., 2009; Wiley et al., 2009). The current results, in concert with related experimental and correlational results (Anmarkrud et al., 2014; Braasch et al., 2012; Bråten & Strømsø, 2015; Kim & Millis, 2006; Rouet et al., 2016; Stadtler et al., 2013; Strømsø et al., 2010; Strømsø, Bråten, Britt, & Ferguson, 2013), suggest that a complex relationship exists between readers' development of an integrated mental model and an intertext model.

In alignment with the processing assumptions specified in the Knowledge Revision Components Framework (KReC) of Kendeou and O'Brien (2014), we assume that the current, to-be-processed text input activates semantically relevant information from previously-processed text, which will re-enter working memory from long-term memory. KReC specifies that this process occurs as a function of a sufficient degree of semantic content overlap. In the current case, it is very likely that previously-read congruent arguments would return to working memory because they share many semantic features. It is important to restate that the blocking manipulation in Experiments 1 and 2 never moderated the effects of the congruency manipulation. Such a pattern suggests that relevant, congruent information was

returned to working memory whether the texts were just read, or whether they were read some time ago. Thus, the data support that re-activation of previously processed congruent information likely occurs via passive, automatic, and memory-based spreading of activation, as others have previously demonstrated (Gerrig & O'Brien, 2005; Kintsch, 1988, 1998; Myers & O'Brien, 1998; O'Brien & Myers, 1999).

Co-activation in working memory affords opportunities for integrative processing of the current information in relation to the information retrieved from long-term memory (Kintsch, 1998; van den Broek & Kendeou, 2008), the goal of which is to establish a coherent mental model through means of elaborations and inferences. When the current text input and information retrieved from long-term memory contradict one another, readers will attempt to establish coherence. The extent to which they are successful depends upon many factors including the text features that are available, and readers' propensities to expend additional resolution-driven processes. For example, research in the refutation text tradition demonstrates that texts containing features that acknowledge and discount inaccurate world knowledge afford opportunities to co-activate said knowledge with the to-be-processed accurate conception. This sets the stage for integrative processing to occur with the potential for readers to revise their inaccurate knowledge (Kendeou, Muis, & Fulton, 2011; Kendeou & van den Broek, 2007; van den Broek & Kendeou, 2008). When information sources are providing contradictory accounts with no clear indication of who is right or wrong, readers appear to instead construct mental representations of texts that include source-content links as organizational components. In terms of empirical evidence, readers spend more time processing the information sources and display a better memory for them after reading (Barzilai & Eshet-Alkalai, 2015; Braasch et al., 2012; Bråten & Strømsø, 2015; Rouet et al., 2016). In terms of the levels of representation specified in the DMF, if one cannot easily establish coherence based on the semantic content within their integrated mental model, an adequately constructed representation of an intertext model may be warranted.

Consistent with the current findings, when congruent information is instead returned from long-term memory into working memory and is thusly co-activated with the current text input, readers appear to take advantage of the opportunities to process the relationships between the semantic content of the arguments (likely via elaborations and inferences). The processing and memory effects in the current work may reflect that cognitive resources, however, are limited and are subject to competition (Goldman & Saul, 1990; Goldman et al., 1996; Kendeou & O'Brien, 2014). That is, additional processing activities might draw increasing amounts of activation towards the integrated mental model and, at the same time, draw activation away from any source features that may have been, at least initially, represented. In related research by Kim and Millis (2006), instructions to attend to and remember information sources disrupted integration of related semantic content from multiple messages relative to other conditions where sourcing instructions were absent. With respect to the levels of representation in the DMF (Britt & Rouet, 2012), instructional encouragement to focus attention on facets of the intertext model (e.g., constructing linkages between the news agencies and their messages)

may have reduced readers' development of an integrated mental model of the semantically-related events described across the texts, as evidenced by their poorer memory for the messages. Thus, the current findings—when paired with the findings of Kim and Millis (2006)—elucidate a potential trade-off in constructing the various levels of representation outlined in the DMF, likely due to limited cognitive resources. Future work could incorporate computational models to investigate whether capacity-limited processing competition accounts for memory patterns when "readers" engage with consistent, discrepant, and unique arguments written by multiple information sources.

All told, we interpret the memory patterns in relation to the time data captured during encoding and retrieval as follows: Readers prioritized establishing a coherent mental model of the semantic content across the texts and, as a result, shallowly encoded the links between the information sources and their respective semantic assertions for congruent texts. Johnson et al.'s (1993) Source Monitoring Framework (SMF) defines source monitoring as a set of processes involved in individuals' attributions about the origins of memory based on the information available at retrieval. In the current work, readers likely attempted to discriminate amongst the various information sources at retrieval on the basis of the qualitative characteristics of the memory representations they constructed during reading (Johnson et al., 1993). If the information sources were shallowly encoded (i.e., if the quality of the memory trace was poor), this would increase the likelihood that such relations were mismanaged in memory and, as a result, forgotten or easily confused at retrieval.

At the same time, one could interpret the pattern of results based on alternative mechanisms. Most notably, the memory patterns may not be evidence of poorer source-content link encoding at all, but rather increased associative interference during retrieval. That is, readers may have, in fact, adequately mentally represented linkages between the information sources and the textbase of the content during encoding. In the case of congruent texts, the textbase, by design, has a high degree of semantic overlap. Accordingly, poorer memory for the information sources may reflect competition between the similar textbase memory traces made in association with three separate, unique sources (a mechanism akin to the "fan effect" of Anderson, 1974). When readers were tasked to retrieve the accurate information source associated with each claim, congruencies may have resulted in a "fanning" of more associative links between the textbase of the retrieval cue and the relevant sources, thus creating more interference during retrieval. If interference did affect retrieval, there should have been more frequent source confusions and slower retrieval time for congruent as compared with distinct texts. The memory effects clearly align with this characterization, however the retrieval time data are less clear. Overall, participants spent a relatively *similar* amount of time retrieving information sources associated with distinct and congruent texts, however they did spend a longer amount of time retrieving the sources associated with "target constant" sentences from congruent compared to distinct texts. This was despite the fact that everyone read the same arguments and received the same claim at retrieval for target constant sentences. Thus, the coarse grained nature of the time data collected during encoding and retrieval cannot truly differentiate whether the

detriments for source memory reflect poorer encoding of the source-content links, poorer retrieval due to interference, or perhaps a combination of the two.

Based on the theoretical orientation in the current work, readers *should* spend more of their attentional resources (e.g., fixating more often, gazing for a longer amount of time) on the content and less on the source information for congruent texts relative to distinct texts. Similarly, if readers were tasked to verbalize their thought processes during encoding, one could expect more connections about the semantic content and a relative inattentiveness to information sources when reading congruent texts relative to distinct texts. If the pattern of effects in the current work instead reflects interference at retrieval, reading behaviors and verbalized thoughts during reading should be relatively similar regardless of the congruency manipulation. Thus, future research could incorporate cognitive trace methodologies (e.g., tracking eye movements produced during reading, think aloud protocols) to further investigate the depth with which congruent and unique arguments, as well as the information sources presenting them, are processed when readers are tasked to remember or comprehend multiple texts. Fine-grained processing data could more clearly differentiate the mechanisms that operate when readers interact with multiple documents that vary in terms of their agreement about a topic.

Across all experiments, participants were asked to try to remember the semantic content and the specific information sources within the sentences/texts they read. It is possible that the distinct condition simply required readers to remember the textbase to accurately recognize a source, whereas the congruent condition required readers to remember the surface form to accurately recognize a source. Because research has demonstrated that memory traces for the surface form are fleeting and therefore are most likely not stored in long-term memory (Kintsch, Welsch, Schmalhofer, & Zimny, 1990), the memory task for the congruent condition may have been a more cognitively demanding task. Thus, it is possible that we created a context that requires readers to increasingly focus their attention on the surface form in the congruent conditions compared to the distinct conditions, which one could interpret as an explanation for the poorer source memory and more source confusions associated with congruent claims. As mentioned above, future research could incorporate eye movement and/or think aloud methodologies to address this limitation. Research could compare performance on indices such as first fixations and gaze durations on congruent and distinct texts, which others have highlighted as evidence of more shallow versus more integrative processing, respectively (Rayner, 1998).

Of course, our findings are potentially constrained not only by the undergraduate sample that participated, but also by the particular tasks and text manipulations. The current work does not rule out, for example, that administering the knowledge measure directly prior to reading might have stimulated integrative processing of semantic information, as has been demonstrated in prior work (Langer, 1984; McKeown, Beck, Sinatra, & Loxterman, 1992). Additional research could assess prior knowledge in a separate experimental session. Extensions could also provide clearer expectations for what readers should remember within the task instructions. In Experiment 3, readers were tasked to remember the exact arguments and the information sources presented to them. Thus, the instructions—regretfully—did not

highlight that readers should focus on two facets of arguments (i.e., the main claims but also the evidence statements supporting the main claims). This lack of clarity might have contributed to the small, albeit significant, inter-condition difference with respect to evidence memory. Thus, although we interpreted that better memory for textual evidence from semantically congruent texts reflects readers' integration processes, extensions featuring clearer reader expectations might verify that this is indeed the case. All told, there are several avenues by which future research could probe the generalizability of our findings.

In conclusion, this set of experiments has important implications for comprehension in the information age. It is the first to identify degree of semantic overlap as a mechanism for source inattention and memory. The current work may offer insight into ways to potentially flesh out a more comprehensive theory of multiple document comprehension that accounts for the dynamic interplay between constructing an integrated mental model and an intertext model during reading. Moreover, future empirical work could further examine the extent to which semantic relatedness draws resources away from, or perhaps obviates a need to consider, the information sources presenting their messages. An important charge for research will be to identify optimal conditions by which readers attend to and represent both the relationships amongst the semantic content presented in the various documents they read, but also the relationships between the information sources and their respective pieces of content information (Britt & Rouet, 2012). Information consumption in the twenty-first century all but requires that readers increase their mindfulness of "who says what," even when there is a sufficient agreement amongst the information providers.

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References

Alexander, P. A. (2012). Reading into the future: Competence for the 21st century. *Educational Psychologist, 47*, 259–280.

Anderson, J. R. (1974). Retrieval of propositional information from long-term memory. *Cognitive Psychology, 6*, 451–474.

Anmarkrud, Ø., Bråten, I., & Strømsø, H. I. (2014). Multiple-documents literacy: Strategic processing, source awareness, and argumentation when reading multiple conflicting documents. *Learning and Individual Differences, 30*, 64–76.

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

Beck, I. L., McKeown, M. G., Sandora, C., Kucan, L., & Worthy, J. (1996). Questioning the author: A year classroom implementation to engage students with text. *The Elementary School Journal, 96*, 385–414.

Bixter, M. T., & Daniel, F. (2013). Working memory differences in illusory recollection of critical lures. *Memory & Cognition, 41*, 716–725.

Braasch, J. L. G., Bråten, I., Strømsø, H. I., Anmarkrud, Ø., & Ferguson, L. E. (2013). Promoting secondary school students' evaluation of source features of multiple documents. *Contemporary Educational Psychology, 47*, 447–479.

Braasch, J. L. G., Rouet, J.-F., Vibert, N., & Britt, M. A. (2012). Readers' use of source information in text comprehension. *Memory & Cognition, 40*, 450–465.

Bråten, I., & Strømsø, H. I. (2015). *Who said what? Investigating the plausibility-induced source focusing assumption with Norwegian undergraduate readers* (manuscript submitted for publication).
Britt, M. A., & Aglinskas, C. (2002). Improving students' ability to identify and use source information. *Cognition and Instruction, 20*, 485–522.
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: Erlbaum.
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: Cambridge University Press.
Britt, M. A., Rouet, J.-F., & Braasch, J. L. G. (2013). Documents experienced as entities: Extending the situation model theory of comprehension. In M. A. Britt, S. R. Goldman, & J.-F. Rouet (Eds.), *Reading from words to multiple texts* (pp. 160–179). New York: Routledge.
Climate change: Basic information. (2015, February, 18). Retrieved from http://www.epa.gov/climatechange/basics/.
Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.
Coiro, J., & Dobler, E. (2007). Exploring the online reading comprehension strategies used by sixth-grade skilled readers to search for and locate information on the Internet. *Reading Research Quarterly, 42*, 214–257.
Ebbinghaus, H. (1885). *Über das Gedächtnis. Untersuchungen zur experimentellen Psychologie*. Leipzig: Duncker & Humblot.
Ecker, U. K. H., Lewandowsky, S., & Tang, D. T. W. (2010). Explicit warnings reduce but do not eliminate the continued influence of misinformation. *Memory & Cognition, 38*, 1087–1100.
Gallo, D. A., Roberts, M. J., & Seamon, J. G. (1997). Remembering words not presented in lists: Can we avoid creating false memories? *Psychonomic Bulletin & Review, 4*, 271–276.
Gerrig, R. J., & O'Brien, E. J. (2005). The scope of memory-based processing. *Discourse Processes, 39*, 225–242.
Global Warming. (2015, February 18). Retrieved from http://www.conservapedia.com/Global_warming.
Goldman, S. R. (2004). Cognitive aspects of constructing meaning through and across multiple texts. In N. Shuart-Faris & D. Bloome (Eds.), *Uses of intertextuality in classroom and educational research* (pp. 317–352). Charlotte: Information Age Publishing.
Goldman, S. R., Braasch, J. L. G., Wiley, J., Graesser, A. C., & Brodowinska, K. (2012). Comprehending and learning from Internet sources: Processing patterns of better and poorer learners. *Reading Research Quarterly, 47*, 356–381.
Goldman, S. R., & Saul, E. U. (1990). Flexibility in text processing: A strategy competition model. *Learning and Individual Differences, 2*, 181–219.
Goldman, S. R., Varma, S., & Coté, N. (1996). Extending capacity-constrained construction integration: Toward "smarter" and flexible models of text comprehension. In B. K. Britton & A. C. Graesser (Eds.), *Models of understanding text* (pp. 73–113). Hillsdale, NJ: Erlbaum.
Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin, 114*, 3–28.
Kendeou, P., & O'Brien, E. J. (2014). The knowledge revision components (KReC) framework: Processes and mechanisms. In D. N. Rapp & J. L. G. Braasch (Eds.), *Processing inaccurate information: Theoretical and applied perspectives from cognitive science and the educational sciences* (pp. 353–377). Cambridge, MA: MIT Press.
Kendeou, P., & van den Broek, P. (2007). Interactions between prior knowledge and text structure during comprehension of scientific texts. *Memory & Cognition, 35,* 1567–1577.
Kendeou, P., Muis, K. R., & Fulton, S. (2011). Reader and text factors on reading comprehension processes. *Journal of Research in Reading, 34*, 365–383.
Kim, H.-J. J., & Millis, K. (2006). The influence of sourcing and relatedness on event integration. *Discourse Processes, 41*, 51–65.
Kintsch, W. (1988). The role of knowledge in discourse comprehension: A construction–integration model. *Psychological Review, 95*, 163–182.
Kintsch, W. (1998). *Comprehension: A paradigm for cognition*. New York: Cambridge University Press.
Kintsch, W., Welsch, D., Schmalhofer, F., & Zimny, S. (1990). Sentence memory: A theoretical analysis. *Journal of Memory and Language, 29*, 133–159.

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*, 335–362.

Langer, J. A. (1984). Examining background knowledge and text comprehension. *Reading Research Quarterly, 19*, 468–481.

Marsh, E. J., & Fazio, L. K. (2006). Learning errors from fiction: Difficulties in reducing reliance on fictional stories. *Memory & Cognition, 34*, 1140–1149.

McKeown, M. G., Beck, I. L., Sinatra, G. M., & Loxterman, J. A. (1992). The contribution of prior knowledge and coherent text to comprehension. *Reading Research Quarterly, 27*, 78–93.

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

O'Brien, E. J., & Myers, J. L. (1999). Text comprehension: A view from the bottom up. In S. R. Goldman, A. C. Graesser, & P. van den Broek (Eds.), *Narrative comprehension, causality, and coherence: Essays in honor of Tom Trabasso* (pp. 35–53). Mahwah, NJ: Erlbaum.

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: Erlbaum.

Peshkam, A., Mensink, M. C., Putnam, A. L., Rapp, D. N. (2011). Warning readers to avoid irrelevant information: When being vague might be valuable. *Contemporary Educational Psychology, 36*, 219–231.

Rapp, D. N. (2008). How do readers handle incorrect information during reading? *Memory & Cognition, 36*, 688–701.

Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin, 124*, 372–422.

Rouet, J.-F. (2006). *The skills of document use: From text comprehension to Web-based learning*. Mahwah, NJ: Erlbaum.

Rouet, J.-F., Favart, M., Britt, M. A., & Perfetti, C. A. (1997). Studying and using multiple documents in history: Effects of discipline expertise. *Cognition and Instruction, 15*, 85–106.

Rouet, J.-F., Le Bigot, L., de Pereyra, G., & Britt, M. A. (2016). Whose story is this? Discrepancy triggers readers' attention to source information in news reports. *Reading & Writing*. doi:10.1007/s11145-016-9625-0.

Sparks, J. R., & Rapp, D. N. (2011). Readers' reliance on source credibility in the service of inference generation. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 37*, 230–247.

Stadtler, M., & Bromme, R. (2014). The content-source integration model: A taxonomic description of how readers comprehend conflicting scientific information. In D. N. Rapp & J. Braasch (Eds.), *Processing inaccurate information: Theoretical and applied perspectives from cognitive science and the educational sciences* (pp. 379–402). Cambridge, MA: MIT Press.

Stadtler, M., Scharrer, L., Brummernhenrich, B., & Bromme, R. (2013). Dealing with uncertainty: Readers' memory for and use of conflicting information from science texts as function of presentation format and source expertise. *Cognition and Instruction, 31*, 130–150.

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*, 192–204.

Strømsø, H. I., Bråten, I., Britt, M. A., & Ferguson, L. E. (2013). Spontaneous sourcing among students reading multiple documents. *Cognition and Instruction, 31*, 176–203.

van den Broek, P., & Kendeou, P. (2008). Cognitive processes in comprehension of science texts: The role of co-activation in confronting misconceptions. *Applied Cognitive Psychology, 22*, 335–351.

Walraven, A., Brand-Gruwel, S., & Boshuizen, H. P. A. (2009). How students evaluate information and sources when searching the World Wide Web for information. *Computers & Education, 52*, 234–246.

Wiley, J., Goldman, S. R., Graesser, A. C., Sanchez, C. A., Ash, I. K., & Hemmerich, J. A. (2009). Source evaluation, comprehension, and learning in Internet science inquiry tasks. *American Educational Research Journal, 46*, 1060–1106.

Wineburg, S. S. (1991). Historical problem solving: A study of the cognitive processes used in the evaluation of documentary and pictorial evidence. *Journal of Educational Psychology, 83*, 73–87.

Wineburg, S. S. (1994). The cognitive representation of historical texts. In J. Castellan, D. B. Pisoni, & G. Potts (Eds.), *Teaching and learning in history* (pp. 85–135). Hillsdale, NJ: Lawrence Erlbaum Associates.

Wolfe, M. B. W., & Goldman, S. R. (2005). Relations between adolescents' text processing and reasoning. *Cognition and Instruction, 23*, 467–502.