British Journal of Educational Psychology (2010), 80, 341–362

The British Psychological Society

www.bpsjournals.co.uk

Processing and memory of information presented in narrative or expository texts

Michael B. W. Wolfe* and Joshua M. Woodwyk

Grand Valley State University, Allendale, Michigan, USA

Background. Previous research suggests that narrative and expository texts differ in the extent to which they prompt students to integrate to-be-learned content with relevant prior knowledge during comprehension.

Aims. We expand on previous research by examining on-line processing and representation in memory of to-be-learned content that is embedded in narrative or expository texts. We are particularly interested in how differences in the use of relevant prior knowledge leads to differences in terms of levels of discourse representation (textbase vs. situation model).

Samples. A total of 61 university undergraduates in Expt 1, and 160 in Expt 2.

Methods. In Expt 1, subjects thought out loud while comprehending circulatory system content embedded in a narrative or expository text, followed by free recall of text content. In Expt 2, subjects read silently and completed a sentence recognition task to assess memory.

Results. In Expt 1, subjects made more associations to prior knowledge while reading the expository text, and recalled more content. Content recall was also correlated with amount of relevant prior knowledge for subjects who read the expository text but not the narrative text. In Expt 2, subjects reading the expository text (compared to the narrative text) had a weaker textbase representation of the to-be-learned content, but a marginally stronger situation model.

Conclusions. Results suggest that in terms of to-be-learned content, expository texts trigger students to utilize relevant prior knowledge more than narrative texts.

A continuing question in comprehension research involves the extent to which readers vary their comprehension strategies under different circumstances, and what consequences these strategies have in terms of how information is remembered and used. Previous research suggests that one of the factors that influences comprehension strategies is the genre in which information is presented (Alvermann, Hynd, & Qian, 1995; Hartley, 1986; McDaniel & Einstein, 1989; Wolfe, 2005; Wolfe & Mienko, 2007). Much of this research suggests that narrative processing tends to be more focused on

* *Correspondence should be addressed to Dr Michael B. W. Wolfe, Psychology Department, Grand Valley State University, 2224 ASH, Allendale, MI 49401, USA (e-mail: wolfem@gvsu.edu).*

DOI:10.1348/000709910X485700

understanding the organization of events in the story, while expository processing tends to be more focused on the activation and integration of relevant prior knowledge into the discourse representation. In the current research, we are interested in the theoretical implications as well as the practical benefits or drawbacks of using narrative and expository texts to present to-be-learned information to students.

It is important to note that the labels 'narrative' and 'expository' encompass many different subtypes of texts. Brewer's (1980) genre classification system is followed, in which a narrative text is defined as a text in which events are related causally or thematically, and happen through time. Expository texts are defined as texts that describe a system or event in terms of its processing or structure. In the current research, both narrative and expository texts contain factual content that the reader is instructed to learn. Accordingly, the discourse force of the texts in both genres is *informative* (Brewer, 1980). Thus, we are interested in the effect of genre specifically in terms of the influence on processing and memory of informational content that the reader is attempting to learn.

Processing and levels of discourse representation

Van Dijk and Kintsch (1983) described three levels at which memory for text information can be represented. The *surface structure* refers to the mental representation of the literal wording of the text. The *textbase* is a representation of the concepts in the text organized according to the text structure. The textbase represents the meaning of the text in a way that is relatively encapsulated with respect to other knowledge that the reader possesses. The *situation model* is a mental representation in which the content of the text is used to create an understanding not just of what the text says, but of the 'situation' that is described by the text. In addition to text content, the situation model includes inferences and connections to relevant prior knowledge that have been generated and added to the mental representation (Graesser, Singer, & Trabasso, 1994; Kintsch, 1998; Zwaan & Radvansky, 1998). Readers with a strong situation model are typically able to remember the gist of what was in the text, but also can apply their knowledge to new circumstances and use their knowledge to solve problems (Coté, Goldman, & Saul, 1998; Mannes & Kintsch, 1987; McNamara, Kintsch, Songer, & Kintsch, 1996). As a practical issue, therefore, students will benefit more from comprehension circumstances in which they create coherent situation models rather than textbase representations.

The creation of a textbase versus a situation model during comprehension depends on both the knowledge and the goals of the reader. There are a few circumstances in which readers will tend to generate a textbase but little in the way of a situation model. Readers who process a text by sticking closely to the content of the text without incorporating other relevant information tend to have a textbase (Coté *et al.*, 1998; Kintsch, 1998). Readers also may have little relevant prior knowledge of the topic, in which case they have little choice but to stick to a textbase representation (Coté *et al.*, 1998; Moravcsik & Kintsch, 1993). Finally, if the goals of the reader are such that they are not prompted or motivated to integrate text content with prior knowledge, then readers will tend to construct a textbase representation (Linderholm & van den Broek, 2002; van den Broek, Lorch, Linderholm, & Gustafson, 2001).

Incorporation of relevant prior knowledge, which leads to a strong situation model, tends to occur if readers have some relevant prior knowledge, and when either the text itself or the reader's goals trigger this integrative processing (Mannes & Kintsch, 1987;

McNamara *et al.*, 1996; van den Broek *et al.*, 2001). In general, readers who establish more connections to prior knowledge, and integrate that knowledge into their discourse representation, have a stronger situation model (Coté *et al.*, 1998; McNamara, 2004). In the current study, we are interested in the extent to which narrative versus expository texts may trigger readers to focus on the construction of textbase versus situation model representations.

Comprehension of narrative and expository texts

Many studies have addressed narrative and expository comprehension separately. Research on the processing of typical narratives indicates that readers process narratives in order to achieve coherence that is explanation based (Trabasso & Magliano, 1996; Trabasso, Suh, Payton, & Jain, 1995). Readers use general world knowledge to generate inferences that explain how goals, events, actions, and outcomes in stories are related (Graesser *et al.*, 1994; Trabasso & Magliano, 1996). These inferences represent connections among story events, connections to readers' prior knowledge, and predictions about what events will take place. Expository comprehension is typically characterized by readers' attempts to create a coherent representation of the text content, and attempts to integrate text content with relevant prior knowledge when available (Coté *et al.*, 1998; Graesser, León, & Otero, 2002; McNamara, 2004). Expository comprehension is often more difficult than narrative comprehension, partly because readers are more likely to lack relevant prior knowledge that is needed in order to generate inferences and establish a coherent representation of the content (McKeown, Beck, Sinatra, & Loxterman, 1992; McNamara *et al.*, 1996).

Comparisons between separate narrative and expository studies are problematic in terms of drawing conclusions about the use of genre for acquiring to-be-learned content. There are typically large differences in content across genres, and readers have different reading goals under the typical circumstances in which they read narrative or expository texts. A few approaches to studying genre effects have been utilized in an effort to more carefully control the materials and reading goals. van den Broek and colleagues (Linderholm & van den Broek, 2002; Narvaez, van den Broek, & Ruiz, 1999; van den Broek *et al.*, 2001) had subjects read expository texts and varied the goals for reading (study vs. entertainment). Subjects reading for study generated more inferences that explained the text content and they had better recall. Subjects reading for entertainment generated more associations to information that was not helpful for comprehension. Narvaez *et al.* also crossed the reading goal with the text genre by using narrative and expository texts (although they were not matched in terms of content). Subjects altered their processing based on reading goal to a greater extent during expository comprehension than narrative comprehension. Zwaan (1994) had subjects read texts that were ambiguous with respect to genre, and instructed subjects that they were either literary or news texts. Subjects reading with the news perspective had better situation model memory, indicating greater incorporation of the content with relevant prior knowledge compared to the literary perspective.

These studies in which reading goals or genre information are manipulated provide valuable information about the extent to which processing is under deliberate control of the reader. But they do not directly address the question of how identification of a genre by the reader may influence the way in which information is subsequently processed and remembered. The approach we follow in the current research is one in which

common content is embedded into a narrative or expository text and we examine processing and memory of the common content. Several such studies have been conducted, often with the goal of determining whether memory for common content is better when presented in a narrative or expository text. Some studies have found no difference in memory as a function of genre (Kintsch & Young, 1984; Roller & Schreiner, 1985), while others have found memory to be better with expository texts (Alvermann *et al.*, 1995; Hartley, 1986).

In an attempt to understand the mixed results with regard to genre influences on memory, Wolfe and Mienko (2007) examined the interaction between text genre and prior domain knowledge. Subjects studied narrative or expository texts that included common content about the human circulatory system. In terms of memory, subjects who read the narrative text showed no relationship between prior knowledge and recall, in contrast with previous research on the influence of prior knowledge on memory (Schneider, Körkel, & Weinert, 1989; Spilich, Vesonder, Chiesi, & Voss, 1979). Subjects who read the expository text showed a positive correlation between prior knowledge and memory, however, suggesting that they utilized their relevant domain knowledge in the recall task. Wolfe and Mienko also used a pre- and post-knowledge assessment test to measure learning (improvements in knowledge) as a function of reading. There were no overall differences in the amount learned from the texts as a function of genre. However, higher knowledge subjects benefited more from the expository text while lower knowledge subjects benefited more from the narrative text. This pattern of results was interpreted by Wolfe and Mienko as suggesting that expository texts prompt subjects to make more efforts to incorporate prior knowledge with text content while processing the information. Subjects reading a narrative text were proposed to put relatively more effort into comprehending the narrative aspects of the text, with to-be-learned content being more or less relevant depending on the role it plays within the narrative structure of the text.

Wolfe and Mienko's (2007) conclusions about the processing and memory consequences of presenting to-be-learned content in narrative versus expository texts lead to some specific predictions that we test in the current research. First, in a task that measures processing more directly than has been done in past research, we should find evidence that students do, in fact, put more effort into incorporating relevant content with prior knowledge when they read an expository text compared to a narrative text. Studies comparing narrative and expository comprehension typically have either not directly measured processing, or have compared texts in which there is no common content across genres (Narvaez *et al.*, 1999). Thus, it remains unclear if text genre influences processing or later memory retrieval. It is possible that genre has little or no influence on initial processing, but rather acts as a kind of schema that directs or biases access to information during retrieval (Alba & Hasher, 1983; Anderson & Pichert, 1978). In Expt 1, we addressed processing more directly by having subjects think out loud as they processed common factual content about the circulatory system from a narrative or expository text. Second, if processing differences across genres cause the to-be-learned content to be better represented in memory in terms of a textbase for the narrative text and a situation model for the expository text, we should be able to find evidence for this difference with a task that assesses memory in more detail than in past studies. In Expt 2, we assessed the memory representation that results from comprehension with a recognition task that allowed us to distinguish surface, textbase, and situation model levels of memory representation (Fletcher & Chrysler, 1990; Kintsch, Welsch, Schmalhofer, & Zimny, 1990; Schmalhofer & Glavanov, 1986).

EXPERIMENT 1

In Expt 1, we wished to engage in a relatively direct assessment of the way in which genre influences processing by collecting think aloud data while subjects read a set of identical sentences (referred to as 'common sentences') from a narrative or expository text that provide factual information about the human circulatory system. A think aloud task is an on-line task in which subjects verbalize the thoughts they have after reading each individual sentence (Pressley & Afflerbach, 1995). The think aloud data also allowed an examination of the extent to which processing varied as a function of prior knowledge. According to the zone-of-learnability hypothesis (Kintsch, 1994; Wolfe *et al.*, 1998), readers at relatively intermediate levels of knowledge will be most successful at integrating relevant prior knowledge with new text content. Thus, it is possible that readers at intermediate levels of prior knowledge will generate more associations between text content and prior knowledge than readers with greater or lesser amounts of knowledge. Finally, we collected pre- and post-knowledge assessments, and free recall, in order to assess whether learning and memory were consistent with our processing data and with prior research. Specifically, three primary questions were addressed:

(1) When subjects are reading common content with a learning goal, do narrative and expository texts trigger different processing of the content?
(2) Does the prior knowledge of the reader influence the processing activities that are engaged in, and does prior knowledge relate to processing differently as a function of the text genre?
(3) Are there differences in memory and learning outcomes as a function of genre?

In addition to our three primary questions, we addressed two questions related to the confound between text content and genre that is created by embedding common sentences in texts of different genres. Our goal is to draw conclusions about genre influences on to-be-learned content. But differences in comprehension of the common sentences could potentially be due to characteristics of the non-common content, rather than the genre *per se*. For example, the structural relationship between the common and non-common sentences may be different across texts. The common sentences may also vary across texts in how representative they are of the to-be-learned content overall. Thus, we wished to assess the common sentences both in terms of their organization within each text, and whether the processing of them is representative of processing of the rest of the to-be-learned content. First, we addressed the extent to which the common sentences are comparable in terms of the structural role they play within their texts by examining the causal organization of the texts. The causal organization was examined using a causal network analysis of the sentences in each text (Trabasso, van den Broek, & Suh, 1989).

Second, we addressed whether processing of the common sentences was representative of processing of the circulatory system content more broadly. The common sentences differ in a number of ways from the non-common sentences, perhaps most importantly in that they do not contain any mention of the story aspects of the narrative text. We wished to establish that the genre manipulation influences processing of the to-be-learned content in general, and that the common sentences merely represent this content in a manner that is controlled across texts. To address this issue, a set of non-common sentences that discuss circulatory system content were also coded. If the pattern of processing across the common sentences

mirrors the processing of the non-common sentences, this would suggest that genre differences are influencing processing of the content overall and not just for the common sentences.

Method

Subjects

Sixty-one subjects from a large Midwestern United States university participated as part of an Introductory Psychology course requirement. Thirty-one subjects were assigned to the narrative text and 30 were assigned to the expository text. Data from one subject in the narrative condition were not analysed due to failure to follow instructions.

Materials

Materials included a circulatory system knowledge assessment test, one narrative and one expository text that explained circulatory system content (see Appendix), a short practice text on the USA Civil War, and a short math test.

The circulatory system knowledge assessment is a 17-question short answer test adopted from Wolfe and Mienko (2007). The questions are written on three pages with instructions on the top of the first page. The instructions state that subjects should answer the questions in complete sentences and should guess if they are not sure of the answers. Each question is worth between 1 and 6 points, with a total of 40 possible points.

The expository text is 43 sentences with 411 words. It introduces the topic of the human circulatory system, and presents basic information about the heart, blood vessels, blood flow, and gas exchange in a sequential fashion beginning at the left ventricle. This sequential ordering preserves the temporal, spatial, and causal nature of the content. The narrative text is 41 sentences with 444 words. It tells the story of Alex, who builds a machine that shrinks him. Alex is sucked into a woman's lungs, which sets up a goal to find his way out of the woman's body. While pursuing this goal, Alex travels through the circulatory system, and then escapes at the end. Through the course of the adventure, factual information about the circulatory system is revealed in a sequential fashion comparable to the expository text. The texts contain factual content that is equated as much as possible, and the 10 common sentences are identical across the texts. The common sentences are italicized in the Appendix, although they were not italicized for the subjects.

The causal analysis of the texts was performed according to the rules for causal relatedness between text clauses as explained by Trabasso *et al.* (1989). Sentences were coded as causally related based on the criteria of necessity, as determined by a counterfactual argument test. Necessity refers to the notion that event X caused event Y if it is the case that if X had not occurred within the context of the text, then event Y would also not have occurred. For each text, the causal relationships among the sentences were determined by one of the authors in consultation with an expert in causal network analyses. The average number of causal connections per sentence did not differ between texts (means = 2.03 for narrative and 1.86 for expository, $F(1, 40) = 0.25$, ns). The total number of causal connections also did not differ among the common sentences (means = 1.50 for the narrative text and 1.80 for the expository text, $F(1, 18) = 0.45$, ns). The common sentences were also examined in terms of the number of local and

distant connections they contained. A local connection is a causal connection to either the immediately preceding or following sentence, while a distant connection is a connection between any two non-adjacent sentences. Each of the common sentences was coded in terms of whether it contained at least one distant connection, or only local connections. For the narrative text, 20% of the common sentences (2 out of 10) contained a distant connection, while for the expository text 70% of the sentences contained a distant connection ($F(1, 18) = 6.08$, $p = .02$). Thus, while the number of causal connections for the common sentences do not differ across the texts, the number of distant causal connections is greater for the expository than for the narrative text.

Procedure

Subjects were run one at a time in a small room. After signing an informed consent sheet, subjects completed the knowledge assessment test at their own pace (note that the scores on this test are referred to as 'pre-knowledge'). Next, subjects read the practice text followed by either the narrative or expository text. The texts were read one sentence at a time on the computer while thinking aloud. Instructions were presented on the computer and read aloud by the experimenter. Subjects were told to study the material and that they would answer questions about it afterwards. The think aloud instructions were adapted from Coté *et al.* (1998), and stated 'after each sentence, tell me everything the sentence is making you think about – what it means to you, other things you know, other ideas in the passage, if you understand the sentence or if there is something you don't understand in the sentence, or other things the sentence makes you think of'. If after reading a particular sentence, the subject did not begin to think out loud for 5 s, the experimenter responded with the prompt 'tell me what you are thinking'. After thinking out loud, subjects pressed the space bar to move on to the next sentence. Subjects could also go back to a previous sentence by asking the experimenter. The practice text, 'The USA Civil War', afforded the opportunity for subjects to practice the think aloud procedure, and for the experimenter to prompt the subject if the subject did not think aloud after all sentences. The entire think aloud portion of the experiment was audio recorded.

After the think aloud task, subjects completed a sheet of math questions that took 3–5 min. Next, subjects recalled as much of the text content as they could. The free recall was not timed, and instructions stressed that subjects should recall the exact wording of the text if possible, but if they could not, then to be as close as possible. Subjects were given the option of typing on the computer or writing the free recall (all subjects typed). Following the free recall, subjects completed the circulatory system knowledge assessment test again. The entire experiment took 45–60 min.

Think aloud coding

Think aloud comments were coded for 22 of the sentences in each text. Ten of the sentences were the common sentences that were identical across texts, and 12 sentences were unique to the narrative or expository text. The 12 sentences were chosen from the narrative text, and represented all of the sentences that (1) contained factual content about the circulatory system and (2) made some reference to the protagonist, Alex. For the expository text, 12 sentences were chosen that contained the most similar factual content to the 12 narrative sentences. In most cases, the content between the sets of coded sentences was very similar or identical. For example,

in the narrative text, the sentence 'He entered the heart into one of the top chambers, the left atrium' was coded. In the expository text, the comparable sentence was 'The left atrium is the other upper chamber of the heart'.

After each sentence that was read (referred to as the focal sentence), the entire utterance generated by a subject represents a think aloud comment. Each think aloud comment was first parsed into events (Coté *et al.*, 1998). An event represents a single idea unit put forth by a subject. Supporting information that is related to an event was coded as part of the same event. Events may or may not correspond to sentences; some events span more than one sentence, and a single sentence may contain more than one event. Thus, a single think aloud comment contains one or more events. There were six event categories. Of the events, 4.4% could not be categorized (e.g., 'I don't think anything about that' or 'I got nothing').

Paraphrases are events that rephrase or restate the content of a focal sentence without adding any substantive content or comments. For example, a paraphrase of the sentence 'From the right ventricle the blood goes out to the lungs' was 'Blood is transferred out from the right ventricle to the lungs'.

Evaluations are comments that make a judgment about the text content, the author, or the subject. An example of an evaluation of the text content was 'I don't think it would be interesting for kids anymore'.

Monitoring events represent subject statements about their comprehension successes 'I understood that' or comprehension problems 'I think this story is making me confused'. Asking for additional information was also coded as a monitoring event.

Affective events are emotional reactions on the part of the subjects to the text content. Across all subjects, there were a total of two affective events, so they will not be discussed further.

Elaborations add content beyond what is stated in the focal sentence. For each elaboration event, the content of the elaboration was checked against earlier text content. If the elaboration content came from an earlier text sentence, it was coded as a *prior text elaboration*. If the content did not come from earlier text content, it was coded as a *prior knowledge elaboration* (the term 'prior knowledge' is used in the think aloud context to distinguish from the pre-knowledge score on the knowledge assessment test).

A final coding category was used specifically for the narrative text. A *story* event was coded when an event mentioned the protagonist of the story or some other narrative aspect of the story. Story codes were not separate events, so they were coded in addition to the actual event code. Story codes allowed for the examination of the extent to which subjects mentioned the story when processing circulatory system content.

Two raters coded the first 17 subjects, with disagreements resolved through discussion. Across these subjects, agreement on the number of events was 91%. For event categories, kappa was calculated based on the agreed-upon events ($\kappa = .78$). The remaining subjects were coded by one of the raters. Kappa was also calculated separately for each of the event categories by comparing agreement on each category to all other categories. Kappas for each event are: paraphrase = .93, prior text elaboration = .80, prior knowledge elaboration = .77, evaluation = .78, and monitoring = .72.

Free-recall coding

Free-recall data were coded at two levels, individual text elements and whole sentences. For the element coding, the texts were divided into independent concepts (elements).

As an example, consider the sentence 'This chamber of the heart receives blood from the body'. The previous sentence referred to the right atrium, making that the referent of 'this'. This sentence contains the following text elements [RIGHT-ATRIUM, CHAMBER, HEART, RECEIVES, BLOOD, BODY]. Note that the elements are text concepts, not specific words, and that elements may be indicated by more than one word. Each text element was coded separately at the gist level. Text elements that were recalled more than once were recorded once, and recall order was not considered. The narrative text contains 121 elements and the expository text contains 112 elements. Two raters separately coded free recall of five narrative and five expository texts ($\kappa = .90$). The remainder of the recall protocols were coded by one of the raters.

Sentence memory was coded only for the 10 common sentences. Sentences were coded at the gist level, so the subject needed to recall the main idea in a sentence in order for the sentence to be coded. Recall order was measured in terms of the number of order reversals, which was any recall of a sentence that was presented earlier in the text than the previously recalled sentence.

Results

We address three main questions in the results. First, did the narrative and expository texts influence how circulatory system content was processed, as revealed by the think aloud protocols? Second, did the pre-knowledge of the reader predict processing? Third, did the post-test and memory scores differ as a function of text genre?

Processing of circulatory system content as a function of text genre

The mean number of think aloud events are presented in Table 1 for narrative and expository texts. ANOVAs were conducted separately for the common and non-common sentences in which each think aloud event type was analysed across text genre. For the common sentences, subjects who read the expository text made more prior knowledge elaborations than subjects who read the narrative text ($F(1, 58) = 5.40$, $p = .02$). Also, the number of story references in response to the common sentences for the narrative text was greater than zero ($t(29) = 5.11$, $p < .0001$). For the non-common sentences, subjects who read the expository text also

Table 1. Mean number of think aloud events (and standard deviations) for the 10 common and 12 non-common sentences as a function of text genre

	Common sentences		Non-common sentences	
	Narrative	Expository	Narrative	Expository
Total events	12.30 (3.27)	13.70 (3.43)	14.40 (3.24)	16.23 (4.51)
Paraphrase	2.00 (2.10)	1.13 (1.74)	1.37 (1.65)	1.00 (1.17)
Prior text elaboration	3.10 (2.41)	3.30 (2.32)	2.87 (1.81)	3.07 (2.78)
Prior knowledge elaboration	2.83 (2.21)	4.20 (2.34)*	4.10 (2.71)	6.53 (3.40)*
Evaluation	0.77 (1.57)	0.90 (1.24)	1.30 (1.95)	1.23 (1.55)
Monitoring	3.53 (2.53)	4.17 (2.98)	4.77 (2.96)	4.40 (2.67)
Story	1.83 (1.97)***	–	4.23 (2.99)***	–

*$p < .05$; ***$p < .001$.

made more prior knowledge elaborations than subjects who read the narrative text ($F(1, 58) = 9.40$, $p = .003$). Finally, the number of story references was greater than zero for the non-common sentences ($t(29) = 7.75$, $p < .0001$).

Relationship between pre-knowledge and processing

We examined potential relationships between pre-knowledge and processing of the common sentences as revealed by the think aloud data. Processing was not related to pre-knowledge for any of the event types for either the narrative or the expository texts. In addition to linear relationships, we also examined quadratic relationships, consistent with the zone-of-learnability. We regressed each event type variable on pre-knowledge and pre-knowledge squared. In such regressions, the squared term constitutes a test of the non-linear relationship between pre-knowledge and processing. There were no non-linear relationships between pre-knowledge and event types for either text. Thus, there is no evidence in the think aloud data that the amount of pre-knowledge of the subjects in these tasks predicts the way in which the texts were processed.

Circulatory system knowledge post-test and free recall of text content

Pre- and post-test data and free-recall data are presented in Table 2. There were no significant differences across texts for pre and post scores (F's < 1). There also was no significant difference in post scores while controlling for pre scores ($F(1, 57) = 1.98$, ns). Free recall for all text elements was greater for the narrative than the expository text ($F(1, 58) = 4.94$, $p = .03$). Table 2 also presents data for the common elements. Across the narrative and expository texts, 59 of the elements were common to both texts. Many of these elements were part of the common sentences, and others were circulatory system concepts that were part of other sentences. The common elements represent a more principled means of comparing memory for the circulatory system content. In particular, many of the non-common elements in the narrative text refer to elements of the narrative. For the expository text, many of the non-common elements are part of the macrostructure of the text that serve to introduce and conclude the topic. Recall of the common elements was greater for the expository text than the narrative text ($F(1, 58) = 8.45$, $p = .004$). Thus, although narrative subjects recalled more content overall, expository subjects recalled more of the elements that were shared across the texts. At the sentence level, recall of the 10 common sentences was also greater for

Table 2. Data for pre and post circulatory system knowledge assessment test and free recall as a function of text genre (standard deviations in parentheses)

	Text	
	Narrative	Expository
Pre-knowledge	8.77 (6.01)	7.90 (5.80)
Post-knowledge	13.03 (6.96)	14.00 (6.45)
Memory (all elements)	33.00 (11.58)*	27.20 (8.38)
Memory (common elements)	16.00 (5.55)	20.20 (5.39)*
Common sentence memory	1.30 (1.51)	2.67 (2.51)*
Order reversals	0.009	0.097*

*$p < .05$.

the expository text than the narrative text ($F(1, 58) = 6.53$, $p = .01$). The number of sentence order reversals was calculated as the proportion of recalled sentences that were order reversals. There were a greater number of order reversals for subjects who read the expository text than for subjects who read the narrative text ($F(1, 36) = 7.53$, $p = .009$). Note that there are fewer degrees of freedom using this proportion measure because some subjects did not recall any sentences.

In addition to overall memory differences, we were interested in the relationship between pre-knowledge and the memory measures for each text. Table 3 presents correlations between pre-knowledge and post-test scores, as well as correlations between pre-knowledge and the content memory measures. Pre-knowledge scores were highly correlated with post-test scores for both the narrative and the expository text. For the memory measures, pre-knowledge was not correlated with memory for either the common elements or sentences for the narrative text, nor was it correlated with the number of order reversals. For the expository text, however, pre-knowledge was correlated with both common elements and sentence memory, as well as with the number of order reversals. We also conducted regression analyses to assess whether the correlations between pre-knowledge and memory differed across genres. In these analyses, pre-knowledge, a variable coding for genre (narrative vs. expository), and their interaction were regressed on the memory variables. In these regressions, the interaction term indicates whether the slope representing the pre knowledge × memory correlation differs across the two genres. For the common elements, the correlations between pre-knowledge and memory did not differ significantly across genres. For sentence memory and order reversals, the correlations were marginally higher for the expository than the narrative text ($F(1, 56) = 3.30$, $p = .075$ for sentence memory, and $F(1, 34) = 3.67$, $p = .064$ for order reversals).

Table 3. Correlation of pre-knowledge score with post-knowledge score and memory measures a function of text genre

	Text	
	Narrative	Expository
Post-knowledge	.77***	.69***
Common elements memory	.28	.41*
Common sentence memory	.24	.49**
Order reversals	.04	.48**

*$p < .05$; **$p < .01$; ***$p < .001$.

Discussion

Subjects in Expt 1 generated more prior knowledge elaborations in response to the common sentences when they were reading the expository text compared to the narrative text. This result expands on previous research by suggesting that the utilization of prior knowledge happens during comprehension, and is not merely a memory retrieval phenomenon. Consistent with previous research (Wolfe & Mienko, 2007), memory for the to-be-learned content was also greater for the expository text, in terms of both individual content elements and the gist of the sentences. There were more recall order reversals for the expository text. Finally, amount of knowledge was

correlated with order reversals, and this correlation was marginally greater than the same correlation for the narrative text. The combination of greater content memory and less adherence to the order of the original text suggests that subjects who read the expository text were attempting to integrate the content with relevant prior knowledge. This integration would result in a better developed situation model for expository subjects, which would allow subjects to recall content well, but not preserve the order of the text well, as would be the case if the textbase were stronger.

For the narrative text, the pattern of results suggest that processing was relatively more focused on the narrative elements of the story compared to the to-be-learned content. Subjects made reference to the story events when processing to-be-learned content, which is consistent with narrative research indicating that subjects track the actions of story protagonists (Rich & Taylor, 2000; Zwaan, Langston, & Graesser, 1995). Subjects also recalled less content, and their recall protocols adhered to the story order to a greater extent than for the expository texts. Finally, memory of the text content was not correlated with pre-knowledge. This result is inconsistent with typical results in which high knowledge subjects recall more text content than low knowledge subjects (Schneider *et al.*, 1989; Spilich *et al.*, 1979). High knowledge subjects' advantage in recall has been found for both expository and narrative texts, but the lack of a correlation here does replicate the results of Wolfe and Mienko (2007). We interpret this result the same way Wolfe and Mienko did, which is that the to-be-learned content may be less tied to the narrative structure in this experiment than in previous experiments. Much of the previous work with narrative texts involved descriptions of sporting events. In a story about a sporting event, the to-be-learned content is more likely to be integrated with the story itself than is the case in the present narrative. In our text, the content could potentially be described without the story of the man who shrinks himself, and conversely the story could be told without some of the content that is presented. In General discussion, we consider the implications of using narratives in this way.

We did not find a relationship between the level of pre-knowledge and processing types in Expt 1, which was contrary to our hypothesis, and contrary to predictions implied by the zone-of-learnability hypothesis (Kintsch, 1994; Wolfe *et al.*, 1998). One possible explanation is that the think aloud task altered processing for some subjects. In particular, the zone-of-learnability hypothesis states that high knowledge subjects should engage in relatively superficial processing of text content if they think the content is easy to understand. The think aloud task may slow down these subjects and cause them to engage in more processing than they might if they were reading silently. It is also possible that the effectiveness of the elaborations may vary as a function of pre-knowledge even if their frequency does not. For example, low knowledge readers may produce prior knowledge elaborations that are somewhat less relevant to the content than moderate or higher knowledge readers. The think aloud method should thus be considered as one method for assessing on-line processing of information, but other on-line measures could provide valuable converging evidence regarding processing.

In Expt 1, we also addressed two issues related to the role of the common sentences across genres. The causal analysis indicated that for the common sentences the total number of causal connections did not differ across texts, but there were more distant connections in the expository text. This difference did not result in a greater number of prior text elaborations for the expository text. However, it is possible that more of the prior text elaborations represented distant connections across the text, which could partially explain the greater number of order reversals in memory for the expository text. In this experiment, we also analysed think aloud data from a set of non-common

content sentences. These analyses suggest that the common sentences are processed in a manner that is comparable to the rest of the circulatory system content. This result suggests that the text genre is influencing processing and memory of to-be-learned content in general. The alternative possibility, which was not supported, was that the common sentences were somehow unique within the circulatory system content, and that their processing did not represent influences of the to-be-learned as a function of text genre overall. These two results lend support to the validity of our research approach because they suggest that we were relatively successful at creating texts that present comparable to-be-learned content in texts that differ in genre.

EXPERIMENT 2

In Expt 2, our goal was to assess the memory representation of the common circulatory system content in terms of textbase and situation model representations. This distinction is important because previous research has indicated that students with a strong situation model are better able to apply their knowledge to new situations than students with a textbase representation but less of a situation model (Coté *et al.*, 1998; Mannes & Kintsch, 1987). Also, a situation model representation is more stable over time (Kintsch *et al.*, 1990) than a textbase. Expt 1 suggests that subjects reading the expository text put more processing effort into integrating the content with relevant prior knowledge. This processing should lead to a stronger and longer lasting situation model than when content is presented in a narrative text. For the narrative text, if processing focuses on the events of the narrative, and factual content is tied to the narrative events, then the textbase representation of the common sentences should be stronger than for the expository text. Previous research using free-recall and post-text questions have provided evidence consistent with these predictions (Wolfe & Mienko, 2007). In Expt 2, we use a sentence recognition task to provide a more detailed and converging examination of these memory representations.

Subjects study the Expt 1 texts at their own pace, followed by a sentence recognition task modelled after Schmalhofer and Glavanov (1986; also Fletcher & Chrysler, 1990; Kintsch *et al.*, 1990; Zwaan, 1994). In this task, subjects indicate whether test sentences are verbatim copies of sentences that were in the text. Sentences are old (presented in the text), or new sentences that vary from the text in specific ways: (1) paraphrases of the 10 common sentences (2) plausible inferences that could reasonably have been in the text but were not, and (3) distractor sentences that are related to the general topic but could not be inferred from the text. These sentence recognition data can then be analysed to determine the strength of the three levels of discourse representation. For each subject, the difference in performance between old sentences and paraphrase sentences indicates the surface structure strength in memory. The logic of this analysis is that old sentences and paraphrases differ only in the surface structure; not the textbase or situation model. Thus subjects can only differentiate old sentences from paraphrases through use of the surface structure. Similarly, the difference in performance between paraphrases and inferences indicates the strength of the textbase. If subjects have a strong textbase, they will tend to accept paraphrase sentences as old, but will successfully reject inference sentences as being ones they did not see in the text. Finally, the difference between performance on the inference and distractor sentences indicates situation model strength in memory. If subjects do generate inferences and add them to their discourse representation, they will be more likely to accept as old those sentences

that represent the content of the inferences that could plausibly be generated from the text. Those subjects should still reject the distractors as new, so the difference between inference and distractor sentence ratings represents the extent to which inferences have been generated and added to the discourse representation.

In Expt 2, we also wished to test how the different levels of representation are affected by a delay. If the expository text triggers subjects to connect the text content with prior knowledge to a greater degree, then memory for the critical sentences may be more durable over time for the expository text than for the narrative text. Kintsch *et al.* (1990) tested the three levels of representation over time using the same method that we use in this experiment. The surface structure faded from memory quickly (within 40 min of reading), the textbase decreased substantially (although not completely) over a 2-day period, and the situation model did not fade measurably after 4 days. In the current experiment, subjects were tested either 5 min or 2 days after study. Based on Kintsch *et al.*'s findings, we reasoned that a 2-day delay would allow us to examine potential differences in the decrease of textbase strength as a function of genre. We predicted that subjects who read the narrative texts would have a stronger textbase representation after 5 min, but that the textbase would fade over 2 days to a greater extent for the narrative subjects than for the expository subjects. For the situation model, if we replicate Kintsch *et al.*, then it should not fade measurably over 2 days for either text group.

Method

Subjects

One hundred and sixty subjects from a large Midwestern United States university participated as part of a course requirement for an Introductory Psychology course. Forty subjects were randomly assigned to each of the four text conditions created by crossing text genre (narrative vs. expository) with delay condition (immediate vs. 2 days). Data from one subject in the narrative delay condition and one in the expository delay condition were lost due to computer errors.

Materials

The pre-knowledge test, narrative and expository texts, and the math test are identical to the materials utilized in Study 1. The sentence recognition test consists of 25 sentences that vary in their relation to the original text sentences. The 25 sentences that a subject responded to were drawn from a pool of 35 sentences made up of five different types: old sentences unique to the text (5), old common sentences (10), new sentences that are paraphrases of the common sentences (10), sentences that represent plausible inferences that could be generated from the text (5),[1] and factually accurate sentences

[1] *The inference sentences were determined empirically in a pilot study. In the study, 11 subjects read the expository text and 11 read the narrative text. The text was read out loud one sentence at a time on the computer, and the common sentences were underlined. When subjects read an underlined sentence, they generated an inference about the sentence. The instructions stated that if subjects needed help generating an inference, they could think about the following questions: 'Why did X occur or why was it stated in the text, when did X occur, how does X occur, or what happens after X?' Inferences generated during this task were categorized and tabulated. The five inference statements that were generated by the greatest number of subjects served as the content for the inference sentences. Each inference statement was generated by at least one subject reading each of the two texts. In total, 5–10 subjects generated each of the inference statements. Inference test sentences were then written that reflected the gist of the content of the inference statements.*

that are content relevant, but that could not be generated as inferences (5). To create the set of 25 sentences that each subject responded to, the list of old common sentences was randomly split in half. Each of the two sets of five sentences were then paired with the five paraphrase sentences that did not correspond to the old sentences in the set. This pairing of sentences ensured that a subject did not respond to an old sentence and a paraphrase of the same sentence. Thus, each subject saw five old common sentences and the paraphrases of the five old common sentences that they did not see. In addition, all subjects saw all of the old sentences unique to their text, as well as all of the inference and distractors, making a total of 25 sentences per set.

Procedure

The study was administered to subjects individually. Subjects first completed the pre-knowledge test as in Expt 1. Next, the subjects studied either the narrative or expository text for 6 min. Subjects were instructed to 'read as if you were studying for a test', and were encouraged to reread and take notes on the text until the time was up. The assigned text was removed after 6 min and subjects solved the math problems at their own pace. Next, subjects read the instructions for the sentence recognition test, then completed the test at their own pace on the computer. The experimenter remained in the room to answer any questions before the test began. Subjects viewed sentences one at a time on the computer and rated each sentence in terms of whether that sentence was presented in the text in the exact same wording as the test sentence. Subjects responded on a 1–6 scale as follows: (1) positive sentence was presented (old sentence) (2) fairly sure the sentence was presented (3) uncertain, but guess the sentence was presented (4) uncertain, but guess the sentence was *not* presented (5) fairly sure the sentence was *not* presented (6) positive the sentence was *not* presented (new sentence). A card with these ratings was placed in front of the subject while he or she completed the ratings. The average completion time for the experiment was 30 min.

In the delay condition, the procedure was identical through the studying of the text. After studying, the subjects were released and instructed to return 2 days later at the same time. Upon returning, the subjects completed the math problems followed by the sentence recognition test.

Results and discussion

Mean recognition ratings were calculated for each sentence type for each subject, and these ratings were used to calculate recognition scores for each level of text representation. Results from the two sets of old and paraphrase sentences did not differ, so we collapsed across materials sets for all analyses. The surface structure representation is defined as the difference between paraphrase and verbatim ratings for the common sentences. The textbase is defined as the difference between inference and paraphrase sentences, and the situation model is defined as the difference between the distractor and inference sentences.

The mean pre-knowledge and sentence recognition scores are presented in Table 4. As expected, pre-knowledge scores did not differ as a function of delay or text genre (both F's < 1). Differences in sentence recognition scores as a function of text and delay were analysed with ANOVAs in which text and delay were between-subject variables. The surface structure was stronger for the expository text than for the

Table 4. Pre-knowledge scores and mean sentence recognition scores for levels of text representation as a function of text genre and delay

	Text			
	Narrative		Expository	
Sentence type	Immediate	Delay	Immediate	Delay
Pre-test	9.23 (6.50)	9.05 (6.27)	9.85 (7.52)	8.26 (5.11)
Text representation				
Surface	0 (1.00)	0.04 (0.89)	0.62 (1.09)	0.34 (1.04)
Textbase	1.88 (0.93)	1.12 (0.96)	1.46 (0.97)	0.93 (0.99)
Situation model	1.10 (0.72)	1.27 (0.79)	1.39 (0.69)	1.46 (0.92)

narrative ($F(1, 155) = 8.16$, $p = .005$), but there was no delay effect or interaction. Note, however, that the immediate surface structure strength was zero for the narrative text, so no decrease with delay was possible. The textbase was stronger for the narrative than the expository text ($F(1, 155) = 4.03$, $p = .047$). The textbase representation also decreased significantly across the 2-day delay ($F(1, 155) = 17.63$, $p < .0001$), but the interaction between text genre and delay was not present ($F < 1$). For the situation model, the expository text elicited a marginally stronger representation than the narrative text ($F(1, 155) = 3.60$, $p = .059$), and there were no significant delay or interaction effects.

The results are somewhat mixed, but generally consistent with our predictions about processing and memory as a function of genre. The textbase strength for the common sentences was stronger for the narrative text, however the situation model strength was only marginally stronger for the expository text. The main effect of delay for the textbase but not the situation model replicates Kintsch *et al.* (1990). Our secondary prediction that the textbase representation would decay more for the narrative than the expository text was not supported.

One result that we had not predicted was the stronger surface structure for the common sentences when they were in the expository text compared to the narrative text. It is not clear from the think aloud data in Expt 1 what processing differences may have led to this result, as prior knowledge associations should not necessarily lead to a strong surface structure. One possible explanation is that the effort to create an integrated representation of the factual content led subjects to linger on the exact wording of sentences for longer when reading the expository text compared to the narrative text.

GENERAL DISCUSSION

In two experiments, we tested two primary predictions regarding the influence of text genre on the processing and mental representation of factual information that students are attempting to learn. First, in a think aloud task, subjects made more prior knowledge elaborations when processing to-be-learned information that was embedded in an expository text compared to when the same information was embedded in a narrative text. This result expands on previous research by providing relatively direct evidence for processing differences of common content across genres. Second, we obtained direct

and indirect evidence that to-be-learned content in a narrative text is represented as a stronger textbase, while the same content in an expository text is represented as more of a situation model. In the second experiment, the recognition memory results indicated that subjects reading the expository text had a weaker textbase representation of the common content compared to subjects reading the narrative text, but a marginally stronger situation model. In addition, subjects reading the expository text in Expt 1 recalled more circulatory system content that was shared between the two texts, and recall of this content was correlated with the level of prior knowledge of the subjects. Expository subjects also recalled the content in an order that deviated more from the order of the text, which is consistent with a stronger situation model rather than a textbase. These results suggest that genre influences processing and memory of to-be-learned content, and this influence is over and above a general goal that students have of learning the material they study.

As a theoretical issue, it is important to consider how the genre differences we obtained can be understood in the context of previous research on both narrative and expository comprehension. Our claim is that when a reader discerns the genre of a text, subsequent processing and memory of the text is influenced by the reader's perception of what is typical for that genre. For expository comprehension, the typical goal is to understand the content. In an effort to accomplish this goal, readers attempt to utilize relevant prior knowledge when available, and integrate that knowledge into a coherent representation of the situation being described by the text (Coté *et al.*, 1998; Graesser *et al.*, 2002; McNamara, 2004). The current results for the expository text corroborate these conclusions by suggesting that subjects engage in integration of to-be-learned content with relevant prior knowledge to a greater extent than when that same content is embedded in a narrative text.

Narrative comprehension research indicates that readers process stories by linking together events, goals, actions, and outcomes into a coherent representation (Trabasso & Magliano, 1996; Trabasso *et al.*, 1995). Our results with the to-be-learned content are consistent with this processing focus. First, subjects mentioned the protagonist when processing content sentences that did not involve him, suggesting that the actions and location of the protagonist were being tracked throughout processing (Zwaan & Radvansky, 1998). Also, the lack of a relationship between pre-knowledge and content memory is consistent with a relative focus on the narrative events rather than a specific focus on the content. It is important to note that our conclusions about pre-knowledge refer specifically to the processing and memory of the 10 sentences that were identical across the texts. A large amount of research and theory indicates that subjects utilize general world knowledge during the creation of situation models while reading narratives (Graesser *et al.*, 1994; Kintsch, 1998; Zwaan & Radvansky, 1998). Our results are not inconsistent with general conclusions about narrative processing. Rather, they suggest that when narratives are used as a rhetorical device for delivering content, the content itself is not processed or remembered in the same way as when it is embedded in an expository text.

Creating a representation of the story aspects of the narrative text may also be seen as the primary goal of comprehension for that text, even though readers are instructed to learn the content. This inappropriate processing goal could have the effect of drawing attention away from the to-be-learned content. When the narrative elements of a story are used primarily as a rhetorical vehicle for delivering content, the attention that should be devoted to the content may directly compete with the story itself. In this way, our results are similar to results supporting the seductive detail effect

(Harp & Mayer, 1998; Mayer, Heiser, & Lonn, 2001). Mayer and colleagues find that when interesting but irrelevant details are added to texts or diagrams that are designed to explain to-be-learned content, memory and learning of the content is worse than when the interesting information is not presented. They explain these findings by suggesting that the seductive details set up inappropriate expectations about what the goal of the reader should be. These expectations then lead the reader to focus more attention on information that will not be helpful in terms of learning the content. Our narrative text could function similarly; even though subjects are told to learn the content, the story could cause subjects to draw processing resources away from the content and on to the narrative. The story could also suggest to subjects that their related circulatory system knowledge is less important than it would be for the expository text. This interpretation suggests that using a narrative as a rhetorical device to deliver content could work against the learning goals rather than in favour of them.

A final theoretical consideration relates to the confound in our materials between text content and genre. This confound is present to some degree in all studies that attempt to equate content across genres. We view this confound to be necessary in order for the text itself to establish the genre for the reader. We wished for the current texts to be as unambiguous as possible with respect to genre in order to increase the ecological validity of the task. Other studies addressed related questions by presenting identical texts and instructing subjects that they belonged to literary or news genres (Zwaan, 1994). Still other studies present subjects with expository texts and vary the reading goals that subjects are instructed to adopt (Linderholm & van den Broek, 2002; Narvaez *et al.*, 1999; van den Broek *et al.*, 2001). We view all of these studies as moving towards the goal of understanding the range of flexible processes that readers can adopt based on different reading materials and circumstances. As such, the current studies are consistent with the notion that readers adopt different *standards of coherence* for different types of text genres (van den Broek *et al.*, 2001). In future research, it would be fruitful to examine genre influences both by manipulating instructions and continuing the attempt to create texts that are as similar as possible while still preserving genre distinctions.

As a practical issue, educators should consider these processing differences when attempting to deliver content to students. Some authors suggest the use of narratives as a means for delivering content, under the general assumption that stories make to-be-learned content more engaging and easier to understand than 'traditional' educational methods (Dubeck, Bruce, Schmuckler, Moshier, & Boss, 1990; Storey, 1982). In addition, studies in which narrative and expository recall are compared, but the content is not equated, typically find that narrative recall is superior (Graesser, Hauft-Smith, Cohen, & Pyles, 1980; Luszcz, 1993; Tun, 1989). However, the processing activities associated with the expository text are the ones that have been associated with better meaningful comprehension (Coté *et al.*, 1998; Graesser *et al.*, 2002; McNamara, 2004). Thus, our results suggest that educators should use caution when attempting to teach content by integrating it into narratives. In particular, situations in which the story is not central to the to-be-learned content may result in worse learning of the content, not better.

Acknowledgements

The authors wish to thank Joe Magliano for the assistance with the causal network analysis and Kim Marshick for assistance with collecting and coding the data.

Expt 1 was presented at the 2007 meeting of the Society for Text and Discourse, Glasgow, Scotland. Expt 2 was presented at the 2008 meeting of the Association for Psychological Science, Chicago, IL, USA.

References

Alba, J. W., & Hasher, L. (1983). Is memory schematic? *Psychological Bulletin*, *93*, 203–231. doi:10.1037/0033-2909.93.2.203.

Alvermann, D. E., Hynd, C. E., & Qian, G. (1995). Effects of interactive discussion and text type on learning counterintuitive science concepts. *Journal of Educational Research*, *88*, 146–154.

Anderson, R. C., & Pichert, J. W. (1978). Recall of previously unrecallable information following a shift in perspective. *Journal of Verbal Learning and Verbal Behavior*, *17*, 1–12. doi:10.1016/S0022-5371(78)90485-1.

Brewer, W. F. (1980). Literary theory, rhetoric, and stylistics: Implications for psychology. In R. J. Shapiro, B. C. Bruce, & W. F. Brewer (Eds.), *Theoretical issues in reading comprehension* (pp. 221–239). Hillsdale, NJ: Erlbaum.

Coté, N. C., Goldman, S. R., & Saul, E. U. (1998). Students making sense of informational text: Relations between processing and representation. *Discourse Processes*, *25*, 1–53. doi:10.1080/01638539809545019.

Dubeck, L. W., Bruce, M. H., Schmuckler, J. S., Moshier, S. E., & Boss, J. E. (1990). Science fiction aids science teaching. *Physics Teacher*, *28*, 316–318.

Fletcher, C. R., & Chrysler, S. T. (1990). Surface forms, textbases, and situation models: Recognition memory for three types of textual information. *Discourse Processes*, *13*, 175–190. doi:10.1080/01638539009544752.

Graesser, A. C., Hauft-Smith, K., Cohen, A. D., & Pyles, L. D. (1980). Advanced outlines, familiarity, and text genre on retention of prose. *Journal of Experimental Education*, *48*, 281–290.

Graesser, A. C., León, J. A., & Otero, J. (2002). Introduction to the psychology of science text comprehension. In J. Otero, J. A. León, & A. C. Graesser (Eds.), *The psychology of science text comprehension* (pp. 1–15). Mahwah, NJ: Erlbaum.

Graesser, A. C., Singer, M., & Trabasso, T. (1994). Constructing inferences during narrative text comprehension. *Psychological Review*, *101*, 371–395. doi:10.1037/0033-295X.101.3.371.

Harp, S. F., & Mayer, R. E. (1998). How seductive details do their damage: A theory of cognitive interest in science learning. *Journal of Educational Psychology*, *90*, 414–434. doi:10.1037/0022-0663.90.3.414.

Hartley, J. T. (1986). Reader and text variables as determinants of discourse memory in adulthood. *Psychology and Aging*, *1*, 150–158. doi:10.1037/0882-7974.1.2.150.

Kintsch, W. (1994). Text comprehension, memory, and learning. *American Psychologist*, *49*, 294–303. doi:10.1037/0003-066X.49.4.294.

Kintsch, W. (1998). *Comprehension: A paradigm for cognition*. New York: Cambridge University Press.

Kintsch, W., Welsch, D. M., Schmalhofer, F., & Zimny, S. (1990). Sentence memory: A theoretical analysis. *Journal of Memory and Language*, *29*, 133–159. doi:10.1016/0749-596X(90)90069-C.

Kintsch, W., & Young, S. R. (1984). Selective recall of decision-relevant information from texts. *Memory and Cognition*, *12*, 112–117.

Linderholm, T., & van den Broek, P. (2002). The effects of reading purpose and working memory capacity on the processing of expository text. *Journal of Educational Psychology*, *94*, 778–784. doi:10.1037/0022-0663.94.4.778.

Luszcz, M. A. (1993). Orienting tasks as moderators of narrative and expository text recall in adulthood. *Psychology and Aging*, *8*, 56–58. doi:10.1037/0882-7974.8.1.56.

Mannes, S. M., & Kintsch, W. (1987). Knowledge organization and text organization. *Cognition and Instruction*, *4*, 91–115. doi:10.1207/s1532690xci0402_2.

Mayer, R. E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. *Journal of Educational Psychology*, *93*, 187–198. doi:10.1037/0022-0663.93.1.187.

McDaniel, M. A., & Einstein, G. O. (1989). Material-appropriate processing: A contextualist approach to reading and study strategies. *Educational Psychology Review*, *1*, 113–145. doi:10.1007/BF01326639.

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*, 79–93. doi:10.2307/747834.

McNamara, D. S. (2004). SERT: Self-explanation reading training. *Discourse Processes*, *38*, 1–30. doi:10.1207/s15326950dp3801_1.

McNamara, D. S., Kintsch, W., Songer, N. B., & Kintsch, E. (1996). Are good texts always better? Interactions of text coherence, background knowledge, and levels of understanding in learning from text. *Cognition and Instruction*, *14*, 1–43. doi:10.1207/s1532690xci1401_1.

Moravcsik, J. E., & Kintsch, W. (1993). Writing quality, reading skills, and domain knowledge as factors in text comprehension. *Canadian Journal of Experimental Psychology*, *47*, 360–374. doi:10.1037/h0078823.

Narvaez, D., van den Broek, P., & Ruiz, A. B. (1999). The influence of reading purpose on inference generation and comprehension in reading. *Journal of Educational Psychology*, *91*, 488–496. doi:10.1037/0022-0663.91.3.488.

Pressley, M., & Afflerbach, P. (1995). *Verbal protocols of reading: The nature of constructively responsive reading*. Hillsdale, NJ: Erlbaum.

Rich, S. S., & Taylor, H. A. (2000). Not all narrative shifts function equally. *Memory and Cognition*, *28*, 1257–1266. doi:10.1080/0270271850060104.

Roller, C. M., & Schreiner, R. (1985). The effects of narrative and expository organizational instruction on sixth-grade children's comprehension of expository and narrative prose. *Reading Psychology: An International Quarterly*, *6*, 27–42. doi:10.1016/0749-596X(86)90002-1.

Schmalhofer, F., & Glavanov, D. (1986). Three components of understanding a programmer's manual: Verbatim, propositional, and situational representations. *Journal of Memory and Language*, *25*, 279–294. doi:10.1037/0022-0663.81.3.306.

Schneider, W., Körkel, J., & Weinert, F. E. (1989). Domain-specific knowledge and memory performance: A comparison of high- and low-aptitude children. *Journal of Educational Psychology*, *81*, 306–312. doi:10.1016/S0022-5371(79)90155-5.

Spilich, G. J., Vesonder, G. T., Chiesi, H. L., & Voss, J. F. (1979). Text processing of domain-related information for individuals with high and low domain knowledge. *Journal of Verbal Learning and Verbal Behavior*, *18*, 275–290.

Storey, D. C. (1982). Reading in the content areas: Fictionalized biographies and diaries for social studies. *Reading Teacher*, *35*, 796–798. doi:10.1080/01638539609544959.

Trabasso, T., & Magliano, J. P. (1996). Conscious understanding during comprehension. *Discourse Processes*, *21*, 255–287.

Trabasso, T., Suh, S., Payton, P., & Jain, R. (1995). Explanatory inferences and other strategies during comprehension and their effect on recall. In R. F. Lorch, Jr. & E. J. O'Brien (Eds.), *Sources of coherence in reading* (pp. 219–239). Hillsdale, NJ: Erlbaum. doi:10.1080/01638538909544717.

Trabasso, T., van den Broek, P., & Suh, S. (1989). Logical necessity and transitivity of causal relations in stories. *Discourse Processes*, *12*, 1–25.

Tun, P. A. (1989). Age differences in processing expository and narrative text. *Journal of Gerontology: Psychological Sciences*, *44*, P9–P15.

van den Broek, P., Lorch, R. F. Jr., Linderholm, T., & Gustafson, M. (2001). The effects of readers' goals on inference generation and memory for texts. *Memory and Cognition*, *29*, 1081–1087.

van Dijk, T. A., & Kintsch, W. (1983). *Strategies of discourse comprehension*. New York: Academic Press. doi:10.1037/0278-7393.31.2.359.

Wolfe, M. B. W. (2005). Memory for narrative and expository text: Independent influences of semantic associations and text organization. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *31*, 359–364. doi:10.1348/000709906X143902.

Wolfe, M. B. W., & Mienko, J. A. (2007). Learning and memory of factual content from narrative and expository text. *British Journal of Educational Psychology*, 77, 541–564. doi:10.1348/000709906X143902.

Wolfe, M. B. W., Schreiner, M. E., Rehder, B., Laham, D., Foltz, P. W., Kintsch, W., & Landauer, T. K. (1998). Learning from text: Matching readers and texts by latent semantic analysis. *Discourse Processes*, *25*, 309–336. doi:10.1080/01638539809545030.

Zwaan, R. A. (1994). Effect of genre expectations of text comprehension. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *20*, 920–933. doi:10.1037/0278-7393.20.4.920.

Zwaan, R. A., Langston, M. C., & Graesser, A. C. (1995). The construction of situation models in narrative comprehension: An event-indexing model. *Psychological Science*, *6*, 292–297. doi:10.1111/j.1467-9280.1995.tb00513.x.

Zwaan, R. A., & Radvansky, G. A. (1998). Situation models in language comprehension and memory. *Psychological Bulletin*, *123*, 162–185. doi:10.1037/0033-2909.123.2.162.

Received 9 July 2008; revised version received 29 July 2009

Appendix

The circulatory system (expository text)

Virtually all kinds of animals have a circulatory system. The circulatory system performs many important functions. One function is to deliver oxygen to the cells of the body. Another function is to remove carbon dioxide from the cells. The circulatory system has three main components. The components are the heart, blood vessels, and blood. Blood flows through the circulatory system. One loop that the blood flows through is called the systemic loop. *This loop consists of blood vessels that go out to the body and back to the heart*.

Blood travelling to the body is pumped out of the left ventricle. *The left ventricle is one of the bottom heart chambers.* From there, blood travels out the aorta. *The aorta is the main artery leaving the heart.* Blood then travels through the arteries. Arteries are a type of blood vessel. They carry blood away from the heart. Arteries eventually reach small blood vessels called capillaries. Capillaries are the smallest blood vessels in the body. Capillaries exchange oxygen and carbon dioxide. Oxygen is released from the red blood cells. *Oxygen is absorbed through the capillary walls into the cells. Carbon dioxide passes through the capillary walls back into the blood.* Veins then carry blood back to the heart. The veins empty blood into the right atrium. *This chamber of the heart receives blood from the body.* Blood passes through a valve to the right ventricle.

The right ventricle is another bottom heart chamber. The heart is divided into left and right sides by a muscular wall. This wall is called a septum. *From the right ventricle the blood goes out to the lungs.* The path that blood follows to the lungs and back is a separate loop. This loop is called the pulmonary loop. In the lungs, red blood cells discard carbon dioxide. The carbon dioxide passes through the thin walls of the capillaries into the lungs. At the same time, oxygen enters the lungs. The oxygen is absorbed through the capillaries into the red blood cells. This blood goes back to the heart through the pulmonary veins. *These veins are blood vessels that return blood to*

the heart from the lungs. Blood from the lungs enters the left atrium. The left atrium is the other upper chamber of the heart. *From the left atrium, blood passes to the left ventricle.* At this point, the continuous loops begin again.

The heart, blood vessels, and blood must all function together.

Alex's adventure (narrative)

Alex worked for many years on a machine that would allow him to become tiny. One day, he finally finished the machine. He shrunk himself down to the size of a tiny molecule. He was so small and light that he could fly. When passing by a woman, Alex got sucked into her lungs. He held on to an oxygen molecule that had also entered the lungs. The oxygen was absorbed into a red blood cell. Alex was on an adventure through the blood. He wanted to find a way back outside. He saw that carbon dioxide molecules were released from the blood back into the lungs. He knew that carbon dioxide was discarded through the lungs. He needed to grab on to a carbon dioxide molecule and get back to the lungs.

First, Alex travelled through a pulmonary vein. These veins are blood vessels that return blood to the heart from the lungs. He entered the heart into one of the top chambers, the left atrium. From the left atrium, blood passes to the left ventricle. The left ventricle is one of the bottom heart chambers. This chamber pumped Alex out along the systemic loop. This loop consists of blood vessels that go out to the body and back to the heart. Arteries are blood vessels that carry blood away from the heart.

The aorta is the main artery leaving the heart. Alex was travelling away from the heart out towards some part of the woman's body. Alex's oxygen molecule reached small blood vessels called capillaries. *Oxygen is absorbed through the capillary walls into the cells. Carbon dioxide passes through the capillary walls back into the blood.* Alex thought this was his chance, and he let go of the oxygen molecule. He then grabbed on to a carbon dioxide molecule. The blood went back towards the heart through the veins.

The veins emptied blood into the right atrium. *This chamber of the heart receives blood from the body.* From the right atrium, he was pushed down through a valve into the right ventricle. *The right ventricle is another bottom heart chamber.* In the right ventricle, Alex could see the septum. This is a muscular wall that divides the heart into right and left sides. *From the right ventricle the blood goes out to the lungs.* The right ventricle pushed Alex out the pulmonary loop. This is a separate loop of the circulatory system that carries blood to the lungs and back.

Soon, Alex was back in the lungs. He was passed through the thin wall of a capillary in the lungs. He was breathed out into the air. The adventure was over.