British Journal of Educational Psychology (2007), 77, 541–564

The British Psychological Society

www.bpsjournals.co.uk

Learning and memory of factual content from narrative and expository text

Michael B. W. Wolfe* and Joseph A. Mienko
Grand Valley State University, USA

Background. Research on the presentation of information in narrative versus expository text genres is inconclusive with respect to the question of which is more beneficial for student learning.

Aims. We examine the effect of presenting factual content in either narrative or expository genres on student learning. We also consider relevant prior knowledge and working memory capacity (WMC) as potential mediating variables.

Sample. Ninety university undergraduate students.

Methods. Subjects studied circulatory system content embedded in either narrative or expository texts. Prior circulatory system knowledge, knowledge improvement (learning) and free recall were assessed.

Results. Learning and recall did not differ as a function of text genre overall, but did interact with prior knowledge. Learning from the narrative and one expository text was optimal at intermediate levels of prior knowledge, with higher knowledge readers benefiting more from the expository text compared with the narrative text. Prior knowledge was positively related to recall for the expository texts, but unrelated for the narrative text. Subjects' WMC did not predict learning or recall.

Conclusions. Results suggest that narrative and expository processing differ with respect to integration of text content with prior knowledge.

An important issue in comprehension research involves the question of how to deliver content to readers so that they can process it in a meaningful way. Prior research has indicated that readers differ in the strategies they use to process information, and these strategy differences have consequences for how that information is stored in memory and used (Mannes & Kintsch, 1987; McNamara, Kintsch, Songer, & Kintsch, 1996; Narvaez, van den Broek, & Ruiz, 1999; Zwaan, 1994). One factor that may influence processing strategies, and thus the ability to remember and use text information, is the genre in which text content is presented. In this experiment, we are interested in the effects of narrative and expository text genres on readers' ability to remember and learn

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

DOI:10.1348/000709906X143902

from common factual content about the circulatory system. We are also interested in potential interactions between text genre and two individual difference variables, the prior domain knowledge of the reader and working memory capacity (WMC).

We examine the influence of narrative and expository texts in terms of both memory for text information and learning from text information (Kintsch, 1994). Memory refers to reproducing and paraphrasing information, and is often assessed with methods such as free recall. Learning refers to changes in the reader's knowledge about a topic and involves integration of new content with existing knowledge. Learning is often assessed with pre- and post-tests to determine knowledge improvement or with inference questions that cannot be answered directly from the text content (Kintsch, 1994). In previous research, memory and learning have been distinguished empirically (Mannes & Kintsch, 1987; McNamara *et al.*, 1996). Processing that sticks closely to the structure or the organization of the text tends to facilitate memory, while processing that emphasizes integration across content and integration of content with prior knowledge tends to facilitate learning (Coté, Goldman, & Saul, 1998).

Memory and learning from narrative and expository text

Providing precise definitions for the *narrative* and *expository* text labels is difficult because both genre types can encompass a broad range of actual texts. We follow Brewer's (1980) classification system in which narrative texts describe events that occur through time and are 'related through a causal or thematic chain' (p. 223). Expository texts describe the structure and processes involved in a system or event. Brewer's classification system also crosses text type with the notion of *discourse force*, which refers to the intent of the author. In this experiment, all texts have a discourse force to *inform*, because they are designed to provide factual information about the human circulatory system. Thus, when we refer to narrative and expository texts, we refer to a subset of texts within these genres which share a common, informative discourse force.

Another issue regarding narrative and expository texts that needs clarification is the notion of controlling content across text genres. Ideally, narrative and expository genres could be studied with texts that differ in terms of genre but have identical content. In actual texts, however, the content cannot be completely controlled across genre because differences are necessary in order to establish the genre that the texts belong to. These differences, such as presenting a protagonist and establishing a goal versus introducing a topic, create different text macrostructures (van Dijk & Kintsch, 1983). Within these different macrostructures, however, much of the content can be the same. The current study utilizes this strategy of presenting as much common content as possible within texts whose macrostructure indicates that they belong to different genres. These differences, however, set up the very question we are interested in; when the macrostructure of the text indicates to the reader that a text is of a certain genre, how does that understanding influence subsequent processing, memory and learning of information?

In terms of delivering content to readers, some authors have suggested that a narrative style is desirable when possible (Dubeck, Bruce, Schmuckler, Moshier, & Boss, 1990; Storey, 1982). However, research examining differences between narrative and expository texts appears to be mixed. The majority of the research examining narrative versus expository texts deals with memory for the content rather than learning. Many studies in which content is not controlled across genre have shown that memory for narrative content is better than that for expository content (Graesser, Hauft-Smith, Cohen, & Pyles, 1980; Kintsch & Young, 1984; Luszcz, 1993; Tun, 1989; Wolfe, 2005;

Zabrucky & Moore, 1999). When content and genre are confounded, however, it is not possible to draw precise conclusions about the influence of genre on memory. Studies in which content is controlled across narrative and expository genres are mixed with respect to memory advantages. Hartley (1986) found that free recall of text content was better for expository texts than narrative texts. Alvermann, Hynd, and Qian (1995) found that expository texts elicited better performance on short answer questions designed to test memory for text content. Roller and Schreiner (1985), however, found no differences between narrative and expository texts on performance on a multiple choice test or on the quality of summaries written after comprehension. Kintsch and Young (1984) did not control content across the text genres completely, but did have three target sentences that were identical across the narrative and expository texts, and propositional recall of the target sentences did not differ between the narrative and the expository texts. Graesser *et al.* (1980) also did not control content across genres, but did control subjects' ratings of familiarity of the content across genres. When the familiarity was controlled, cued recall performance was better for narrative than expository texts.

With respect to learning, Alvermann *et al.* (1995) collected pre- and post-test data on application and true/false questions, and performed analyses on the post-test data while controlling the pre-test data. They found that expository texts elicited better performance on the application questions and no genre differences on true/false questions. Cunningham and Gall (1990) also used a pre- and post-test to assess knowledge gains. Subjects studied textbook style passages that were presented in either narrative or expository format and were much longer than texts that are typically used in comprehension research (41 and 44 pages for the expository and narrative texts, respectively). While both texts elicited improvements from pre- to post-test, there were no differences in learning as a function of text genre. Thus, for both memory and learning, it is unclear whether there is an overall advantage in presenting content in a narrative or expository format. In the current research, we also examine main effects of narrative versus expository genres on memory and learning. In addition, however, we examine prior knowledge and WMC as potential mediators of genre effects.

Prior knowledge of text content

Some research on memory for narrative and expository texts indicates that the prior knowledge of the reader is utilized differently when processing these different types of texts. Wolfe (2005) found that for expository texts, prior associations in semantic memory between text concepts and the topic of the text was highly predictive of memory for text content. For narrative texts, the organization of the text concepts in the text itself was a much better predictor of memory than these semantic associations. Other studies have used the same texts across conditions, but varied processing instructions so that subjects read for different purposes, such as news versus literary texts (Zwaan, 1994), or study versus entertainment (Linderholm & van den Broek, 2002; Narvaez *et al.*, 1999). In these studies, readers alter their processing strategies in terms of the extent to which prior knowledge is integrated with text content. For example, Zwaan (1994) found that when reading a text as a news story, memory for knowledge-based inferences was stronger than when reading the same text as a work of literature. If the processing strategies that are triggered by narrative versus expository genres differ in terms of the extent to which readers attempt to incorporate prior knowledge while reading, then the amount of prior knowledge readers possess about the topic could affect memory and learning differentially based on the genre. For example, if readers attempt to incorporate text content with prior knowledge to a greater extent while processing expository texts, then the amount of prior knowledge about the topic may be more important when reading expository texts than when reading narrative texts.

Another reason for assessing the prior domain knowledge of the readers is that it may differentially affect the pattern of results for memory versus learning. In terms of memory, many studies have found that people with high prior knowledge in a domain can remember text content better than people with low prior knowledge. Such effects have been found for narrative texts that present specific factual information (Kuhara-Kojima & Hatano, 1991; Schneider, Körkel, & Weinert, 1989; Spilich, Vesonder, Chiesi, & Voss, 1979), as well as for expository texts (Kintsch & Franzke, 1995; Voss & Silfies, 1996). Thus, we expect that memory for text content will favour high knowledge readers for both narrative and expository texts.

With respect to prior knowledge and learning, Wolfe *et al.* (1998) found evidence supporting the zone-of-learnability hypothesis, which states that integration of text content with prior knowledge, and thus learning from text, will be optimal when the match between a reader's prior knowledge of the topic and the content of the text are in an intermediate 'zone.' Readers with varying amounts of knowledge about the circulatory system read one out of four possible texts that presented common content, but differed in terms of the difficulty level of writing. For each subject, the similarity between their circulatory system knowledge and the content of the text was determined using Latent Semantic Analysis (Landauer & Dumais, 1997). Results indicated that when the similarity between prior knowledge and text content was either too low or too high, learning was lower, and when the similarity was in an intermediate range, learning was highest. With such a non-linear function, the peak of the curve indicates the amount of prior knowledge that is optimal for a particular text in terms of learning. Wolfe *et al.* (1998) hypothesized that the match between text content and reader knowledge influences the extent to which processing of the text involves integration of text content with prior knowledge. When the similarity between knowledge and text content was low, subjects were relatively unsuccessful at integrating text content with their knowledge, and when the similarity was intermediate, this process was more successful. When the similarity was high, subjects may have processed the text more superficially, also resulting in little learning. One of the consequences predicted by the zone-of-learnability hypothesis is that texts can differ in terms of the optimal amount of prior knowledge a reader should possess. In the current study, if this non-linear relationship between prior knowledge and learning is found, it will be possible to assess whether the amount of prior knowledge that is optimal for learning differs as a function of the text genre. For example, if the expository texts trigger readers to attempt to integrate text content with prior knowledge to a greater extent than the narrative text, then possession of more knowledge may be necessary for learning from the expository texts than the narrative.

Working memory capacity

A number of studies have found that readers with high WMC perform better at language comprehension tasks than readers with low WMC (Daneman & Carpenter, 1980; Daneman & Merikle, 1996). More specifically, some studies have shown that for expository texts, recall is positively correlated with WMC (Britton, Stimson, Stennett, & Gülgöz, 1998; Linderholm & van den Broek, 2002). For narrative texts, studies also have shown WMC to be correlated with memory (Hambrick & Engle, 2002; Hultsch, Hertzog, & Dixon, 1990; Lee-Sammons & Whitney, 1991). Readers with high WMC are thought to possess greater attentional resources that can be divided up among the multiple cognitive components involved in reading, and thus may be able to coordinate processes such as lexical access, syntactic processing and incorporation of prior knowledge more successfully than low capacity readers. Hartley (1986), however, found no correlation between WMC and memory for narrative or expository text. Hambrick and Engle (2002) also found an interaction between WMC and prior domain knowledge such that high capacity subjects enjoyed more of a benefit from prior knowledge than low capacity subjects when recalling details of an audiotaped transcript of a fictitious baseball game. Linderholm and van den Broek (2002) examined recall of an expository text under different reading purposes, entertainment and study. They found an interaction such that high WMC readers recalled more text information in the study condition, whereas low WMC readers did not differ in recall as a function of study condition. Thus, with respect to memory, high WMC readers generally recall more than low WMC readers, although this result is not always obtained. In addition, there is some evidence suggesting that high WMC readers may be able to adjust processing based on their reading goals. In the current study, the ability of readers to adjust processing may lead to genre differences in memory and learning, but only for high WMC readers. For example, the expository texts may trigger readers to rely on prior knowledge more than the narrative text (Wolfe, 2005), but high WMC readers may be more capable than low WMC readers of actually making these processing adjustments successfully. In that case, we would expect genre influences on memory to be greater for high WMC readers than for low WMC readers.

With respect to learning, McNamara (2004) had subjects answer comprehension questions that required them to apply information learned from science texts, and WMC was uncorrelated with performance on the comprehension questions. There is less research on the effects of WMC on learning from text, hence precise predictions about the relationship between WMC and learning are difficult to make.

Current research

In the current research, we examine memory and learning from one narrative and two expository texts that present common content about the human circulatory system. In the narrative text, the protagonist builds a machine to shrink himself and ends up travelling through a woman's body. His goal is to find his way out of the body and through the course of the story circulatory system content is revealed. The two expository texts contain identical introductory paragraphs, which introduce the topic of the circulatory system. In the body of the text, one expository text presents the content by tracing the path of blood on one cycle through the body. We refer to this text as the *sequential* text. This text presents the content in a spatial/temporal/causal order. In the *topical* text, content is presented as three topics, each described in a separate paragraph. The topics are the heart, blood vessels and blood. Both expository texts also have identical concluding paragraphs. The topical text is perhaps more typical of textbooks, in that it presents the content organized around a list of topics (Goldman & Bisanz, 2002). The spatial, temporal and causal organization of the sequential text may be more effective at satisfying the reader's need for texts to be coherent, however, especially when the reader lacks significant knowledge about the topic

(McNamara *et al.*, 1996). In addition, the spatial, temporal and causal organization of the sequential text matches the organization of the narrative text. As a result, narrative and expository text comparisons can be made between texts that have similar versus different organizational structures.

Prior knowledge of the circulatory system and learning are both assessed with a short item questionnaire developed by Wolfe *et al.* (1998). Subjects complete the questionnaire both before and after studying the text. Scores on the pre-test therefore constitute the prior knowledge of the subjects and improvement from pre- to post-test indicates how much has been learned as a result of studying the text. WMC is assessed with the reading span test of Engle and colleagues (Attention and Working Memory Lab, 2003; Kane *et al.*, 2004).

Method

Participants

Ninety subjects enrolled in an Introductory Psychology course at a large university in the Midwestern United States participated for course credit. All subjects were randomly assigned to study one out of the three texts.

Materials

The circulatory system knowledge test was adopted from Wolfe *et al.* (1998) and was printed on three pages, with instructions printed at the top of the first page. The test consisted of 17 short answer questions about the anatomy and function of the human heart and the circulatory system. All subjects received the questions in the same order. Appendix A contains the questions, answers and number of points possible for each question. Across the 17 questions, there was a total of 40 possible points on the test.

The set of texts consisted of one narrative and two expository texts (see Appendix B). All texts contained the same factual information about the circulatory system. The narrative text, 'Alex's Adventure,' was a story about a man who built a machine to shrink himself and ended up being sucked into a woman's body. This setting created a superordinate goal in which Alex wanted to find a way out of the woman's body. Alex travelled through the circulatory system, and factual information about the anatomy and the function of the circulatory system was presented along with the narrative elements. At the end of the story, Alex clung to a carbon dioxide molecule which entered the lungs, and he was exhaled. The text was 27 sentences long with 378 words, 106 individual content elements and a Flesch grade level score of 6.7. Content elements are the unique concepts referred to in a text, such as LEFT VENTRICLE or OXYGEN. A single word can also refer to more than one element if the word is used to refer to different concepts. For example, PUSH can be an element when referring to blood being pushed out the left ventricle, and a separate element when referring to blood being pushed through the lungs.

The two expository texts were designed to present the same basic factual information about the human circulatory system. The texts contained identical opening paragraphs which stated the importance of the circulatory system, and that the heart, blood vessels and blood were three main components of the circulatory system. The texts differed after the first paragraph. In the 'Sequential' text, information was presented in the spatial/temporal/causal order that it exists in the body. Starting at the left ventricle, the text described the path of blood out to the body through the blood vessels, back to the heart and out to the lungs and back. In the 'Topical' text, three paragraphs centred around the topics of the heart, blood vessels, and blood. All the spatial/temporal/causal information was the same, but the sequencing of the sequential text was not contained in the topical text. Both texts closed with identical paragraphs that restated the importance of the circulatory system. The Sequential text was 26 sentences with 366 words, 91 content elements and a Flesch grade level score of 7.6. The Topical text was 29 sentences with 362 words, 89 content elements and a Flesch grade level score of 6.8. In the science text classification scheme of Goldman and Bisanz (2002), both texts fall under the classification 'textbook' because they presented basic factual content to the reader and were designed to convey that content.

Procedure

Subjects were run individually in a small room with a computer. Upon arrival, the experimenter stated that there were two parts to the experiment, and the first part began with the circulatory system knowledge test. The experimenter read the instructions out loud while the subject followed along. The instructions stated that subjects should answer all questions in complete sentences and include any and all information that the subject thought was relevant. The instructions also stated that once the subject completed an answer, they should not return to it. This rule was established because some of the later questions contained partial answers to earlier questions. The subjects worked at their own pace and had as much time as they wanted to complete the test. Upon completion, they studied one of the three texts. The experimenter again read the instructions out loud, which were also printed above the text. The instructions stated that subjects should 'read the passage as if you were studying for a test.' They were allowed to underline or take notes on the text and were allowed 5 minutes to study. The instructions stated that if subjects finished before the 5 minutes, they should continue to study until the experimenter told them the time was up. After 5 minutes of studying, the experimenter collected the text, and subjects solved math problems for approximately 3 minutes as a filler task. Upon completion of the math problems, the experimenter opened a word processing file and gave the subject a page with the free recall instructions. The instructions stated that 'we would like you to write down as much as you can remember from the passage you just read.' Subjects were instructed that if they could not remember the exact wording of the passage, they should be as close as possible. Subjects typed their free recall into the word processing file and had as much time as they wanted for this task. No subject made any comment regarding poor typing ability. Upon completion, they completed the circulatory system knowledge test again with the same questions and instructions. After that, the experimenter indicated that the first part of the experiment was over and the second part would begin.

The reading span task was run at the completion of the circulatory system knowledge post-test. The task was adopted from Kane *et al.* (2004) and obtained from http://psychology.gatech.edu/renglelab in the form of an Eprime file. For the reading span task, the experimenter sat with the subject at the computer. The subjects saw a series of 12 sets of sentence–letter pairs. Within each set, a sentence was presented on the screen followed by an unrelated letter. The sentences were either sensible or not, with the insensible sentences containing one word that was replaced to make the sentence insensible. As soon as a sentence appeared on the screen, the subjects read the sentence out loud, then said ‘yes’ if the sentence was sensible, and ‘no’ if the sentence was insensible. For example, ‘Because she gets to knife early, Amy usually gets a good parking spot’ (no). ‘Yes’ or ‘no’ responses were recorded by the experimenter. Immediately following, the subject read the unrelated letter and the experimenter pressed a key to advance to the next sentence–letter pair. Each set contained between two and five sentence–letter pairs. At the end of a set, ‘???’ appeared on the screen and the subject wrote down the letters from that set on a response sheet in the order they appeared. The subjects did not know the length of any particular set until the end of it. Each set length was presented three times, for a total of 12 sets. The experimenter was present and advanced to the next sentence in order to ensure that subjects did not pause to rehearse the letters in the middle of the set. Three practice sets of two sentence–letter pairs preceded the task and the experimenter answered questions about the task between the practice sets and the test sets.

Results

The two dependent variables of primary interest in this study are learning from the text and memory for the text information. Learning was determined based on the results of the circulatory system knowledge test and was operationalized as the proportion of achieved improvement relative to possible improvement from the pre- to the post-test. The test was worth a total of 40 points, hence the proportion score was calculated as (post-test – pre-test)/(40 – pre-test). For the memory measure, each text was divided into content elements. Free recall protocols were scored for gist recall of each element separately. Gist recall was considered to be either the exact wording of an element or a close synonym. For example, consider the sentence ‘The heart, blood vessels, and blood must all function together.’ This sentence contains the following elements [FUNCTION, HEART, BLOOD VESSELS, BLOOD, MUST and TOGETHER]. In the recall protocol sentence ‘The heart and the vessels work together.’ the elements HEART, BLOOD VESSELS, FUNCTION and TOGETHER would be coded. Elements that were recalled more than once were counted once and the recall order of elements was not recorded. For each of the three texts, recall protocols were coded independently by two raters in sets of five subjects at a time until at least 90% agreement was reached among coded elements. At that point, the remaining protocols were coded by one of the raters. Disagreements were resolved through discussion. The average inter-rater agreement across the three texts was 91%.

The reading span task was coded as the absolute number of correctly recalled letters from all experimental sets that were perfectly recalled. For example, if a subject recalled all three letters accurately from a three-letter set, and all five letters from a five-letter set, they would receive a score of 8. If the subject recalled the three-letter set perfectly, but only four out of the five letters from the five-letter set, they would receive a score of 3 (zero points for getting four out of five on the larger set). The reading span score for each subject was thus the total number of correctly recalled letters from each perfectly recalled set across the 12 sets. The average reading span score was 13.41 ($SD = 7.42$). Performance on the sensibility judgments did not contribute to the reading span score. All subjects responded correctly to more than 80% of the sensibility judgments, therefore none were eliminated based on this performance. Kane *et al.* (2004) reported an internal consistency score of .78 (Cronbach’s alpha) for this task.

Descriptive data are presented in Table 1. Several factors are notable. First, the two variables that do not depend on text genre (pre-test and reading span) do not differ as a function of text genre. Second, learning and recall measures also do not differ as a function of text genre. Finally, although learning scores do not differ as a function of text genre, they are significantly greater than 0, $t(89) = 11.28$, $p < .0001$, indicating that overall, subjects were able to learn from all three texts. Although we did not have a control group who did not study a text, Wolfe *et al.* (1998) had such a condition. Using the same pre- and post-tests, the average learning score of subjects who did not study a text was .01, suggesting that the learning results obtained here cannot be accounted for by simple practice effects on the test.

Table 1. Descriptive data for dependent measures. Free recall data are the proportion of text elements recalled

Variable	Text genre: Narrative		Sequential expository		Topical expository		$F(2, 87)$
Pre-test	6.70	(6.22)	7.50	(7.52)	7.30	(7.47)	0.10
Post-test	13.07	(4.40)	14.27	(7.91)	13.00	(8.01)	0.31
Learning	0.17	(0.16)	0.20	(0.17)	0.18	(0.13)	0.28
Reading span	13.80	(7.78)	14.37	(7.04)	12.07	(7.48)	0.46
Free recall	0.34	(0.11)	0.31	(0.11)	0.30	(0.10)	1.42

Note. Standard deviations are in parentheses.

The main analyses of interest centre around learning from text and memory for text as a function of three predictors: first, text type (narrative vs. expository, and the two types of expository, sequential vs. topical); second, prior knowledge about the circulatory system (the pre-test score on the circulatory system knowledge test) and third, reading span. The correlations of reading span with learning were $r = .01$ for the narrative text, $r = .16$ for the sequential text and $r = .31$ for the topical text (all r values, *ns*). The correlations of reading span with recall were $r = .16$ for the narrative text, $r = .30$ for the sequential text and $r = .30$ for the topical text (all r values, *ns*). Interactions between reading span and prior knowledge were tested using regression analyses in which reading span, prior knowledge and their interaction were regressed separately on memory and learning for each of the three texts. With one exception, there were no interactions between reading span and prior knowledge in predicting memory or learning. The exception was that there was an interaction between reading span and prior knowledge in predicting learning for the sequential expository text ($F(1, 26) = 13.40$, $\beta = -0.002$, $p = .001$). The negative interaction term indicates that the slope between reading span and learning becomes more negative with the increase in prior knowledge. Thus, in general, reading span was not predictive of learning or memory in this experiment. In the remaining sections we examine learning and memory separately in terms of text type and prior knowledge.

Learning

In addition to the two *df* tests presented in Table 1, learning and memory differences as a function of text type were analysed using two contrast coded predictors to examine the three texts (Judd & McClelland, 1989). With one contrast code, we analysed the narrative text (Alex) versus the average of the two expository texts. With the other, we analysed the two expository texts (sequential and topical) against each other. These contrast codes allowed examination of the *a priori* comparisons we wished to make between text types. There were no differences in amount learned as a function of text type (F values for both contrast coded comparisons < 1.)

The relationship between prior knowledge and learning was analysed in terms of both linear and quadratic relationships. In a regression model that includes both linear and quadratic components of a predictor, the quadratic component represents an interaction of a variable with itself. In this case, the question that is addressed is whether the relationship between prior knowledge and learning changes at different levels of prior knowledge. This change in the prior knowledge × learning slope at different levels of prior knowledge represents the non-linear curve that is predicted by the zone-of-learnability hypothesis. For the narrative text, there was a negative linear relationship between prior knowledge and learning ($r = -.65$, $p < .0001$). For the quadratic relationships, learning was regressed on prior knowledge and prior knowledge squared, in which case the ability of the squared term to account for unique variance indicates a non-linear relationship (see Table 2). For the narrative text, there was a negative quadratic relationship between prior knowledge and learning (for the quadratic component, $t(27) = -3.14$, $p = .004$). This relationship is presented in Figure 1a. For the sequential text, there was no linear relationship between prior knowledge and learning ($r = .21$, *ns*), but there was a negative quadratic relationship (for the quadratic component, $t(27) = -6.23, p < .0001$), which is presented in Figure 1b. For the topical text, there was no linear relationship between prior knowledge and learning ($r = .09$, *ns*) and no quadratic relationship (for the quadratic component, $t(27) = -.97$, *ns*). The topical text data are presented in Figure 1c.

Table 2. Regression equations in which learning is regressed on prior knowledge and prior knowledge squared

Text	Regression equation	R^2	p
Narrative	learn $= .21 + .0144(\text{pre}) - .0164(\text{pre}^2)$	.61	$<.0001$
Sequential	learn $= .11 + .0406(\text{pre}) - .0190(\text{pre}^2)$	.61	$<.0001$
Topical	learn $= .15 + .0095(\text{pre}) - .0003(\text{pre}^2)$	.04	.57

Note. 'pre'= prior circulatory system knowledge; 'learn'= learning score.

The non-linear relationships presented in Figure 1a and b are consistent with the zone-of-learnability hypothesis and indicate that there is an optimal amount of prior knowledge for the narrative and sequential texts in terms of learning potential, indicated by the peak of the regression curves. The topical text did not elicit a non-linear relationship between prior knowledge and learning, and thus no optimal amount of prior knowledge can be discerned. In addition to analysing each text separately, we are interested in whether the peaks of the curves centre over the same range of prior knowledge. This question is interpreted as whether the same amount of prior

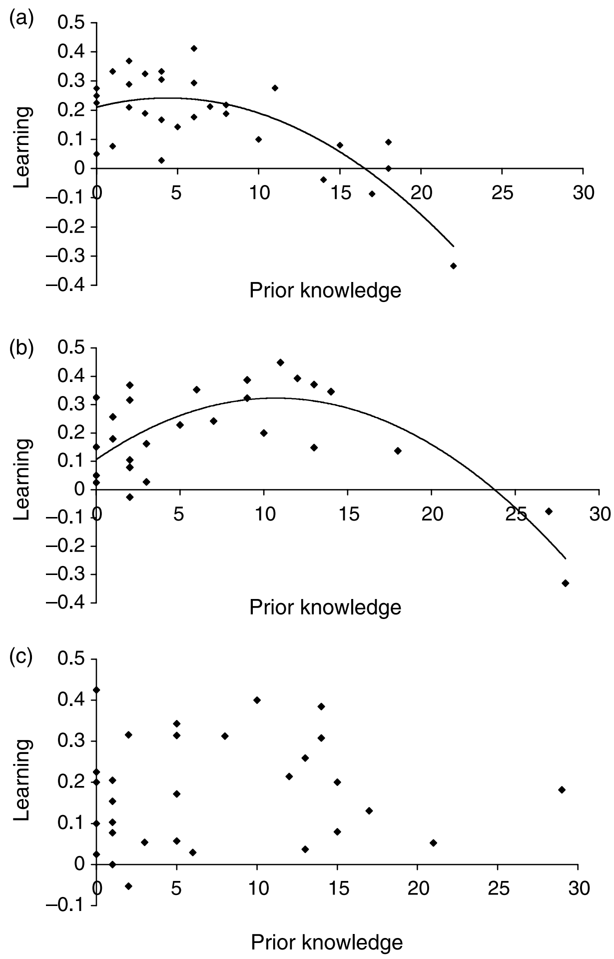

Figure 1. (a) Learning as a function of prior circulatory system knowledge for the narrative text. (b) Learning as a function of prior circulatory system knowledge for the sequential expository text. (c) Learning as a function of prior circulatory system knowledge for the topical expository text.

knowledge is optimal for the narrative and sequential texts or different amounts of prior knowledge are optimal for the two texts. We address this question by examining the slopes of the regression curves at two points. First, the level of prior knowledge for which the narrative text slope equals 0 indicates the optimal amount of prior knowledge for readers of the narrative text (indicated by line A in Figure 2). At that point, we examine whether the slope of the sequential text curve is different from 0 (slope C in Figure 2). If the slope for the sequential text is different from 0 at the peak of the narrative curve, it suggests that the two functions have peaks that centre over different levels of prior knowledge. Second, the level of prior knowledge for which the sequential text slope equals 0 indicates the optimal amount of prior knowledge for that text (line B in Figure 2). By the same logic, we evaluate whether at that value of prior knowledge, the narrative text slope is different from 0 (slope D in Figure 2).

To evaluate the regression slopes at different levels of prior knowledge, we utilize the regression equations presented in Table 1. For the narrative text, the regression slope

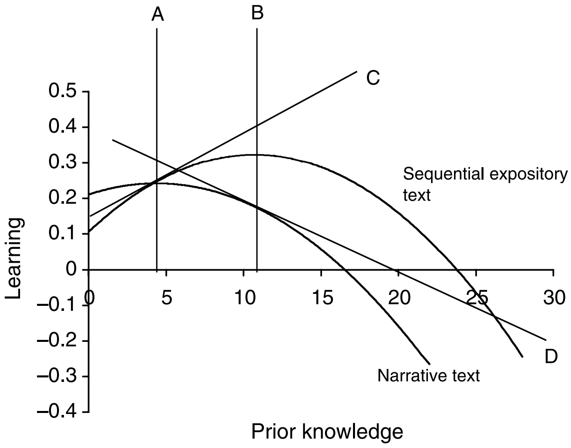

Figure 2. Quadratic functions representing the relationship between prior circulatory system knowledge and learning for narrative and sequential expository texts. Lines A and B indicate the level of prior knowledge at the peak of the narrative and sequential expository curves, respectively. Line C indicates the sequential expository text slope at the prior knowledge level for which the narrative slope is at its peak. Line D indicates the narrative text slope at the prior knowledge level for which the sequential expository text slope is at its peak.

equals 0 at a prior knowledge value of 4.375. To test the sequential text slope at that value, 4.375 was subtracted from all prior knowledge scores and a new regression was conducted in which learning was regressed on these deviated prior knowledge scores (Judd & McClelland, 1989). The logic of this analysis arises from the fact that in any regression equation that has linear and quadratic components of a variable, the linear component indicates the slope of the function when the predictor variable equals 0 (the y-axis). In this case, we wish to make the '0' value meaningful by setting it equal to the value that represents the peak of the narrative text curve, 4.375. Subtracting 4.375 from all prior knowledge scores accomplishes this goal by setting the y-axis value to 4.375 for this deviated regression. In this regression, the overall R^2 and the quadratic component of the regression equation does not change, but the linear component now indicates the slope of the curve for the point at which prior knowledge equals 4.375 (slope C in Figure 2). In this new regression, the sequential text slope was .02 ($t(27) = 4.42$, $p < .0001$), indicating that it was significantly positive. For the sequential text, the regression slope equals 0 at a prior knowledge value of 10.789 (line B in Figure 2). To test the narrative slope at that value, 10.789 was subtracted from the prior knowledge scores and a new regression was conducted on these deviated prior knowledge scores. In this regression, the linear component indicates the slope of the narrative text for the point at which prior knowledge equals 10.789 (slope D in Figure 2). In this regression, the narrative text slope was $-.02$ ($t(27) = -6.39$, $p < .0001$), indicating that it was significantly negative. Thus, at the optimal amount of prior knowledge for the narrative text, the slope for the sequential text was rising and at the optimal amount of prior knowledge for the sequential text, the slope for the narrative text was falling. These results together indicate that the optimal amounts of prior knowledge for the two texts are different and a higher amount of prior knowledge is optimal for the sequential text, whereas a lower amount of prior knowledge is optimal for the narrative text.

Memory

To examine memory performance as a function of text type, contrast codes were again used that assessed the narrative text versus the two expository texts and the sequential text versus the topical text. Both these contrast codes were non-significant (F values < 1). As with the learning measure, we were also interested in how memory performance related to prior knowledge. For the narrative text, there was no significant relationship between prior knowledge and memory ($r = .12$), as shown in Figure 3a. For both the expository texts, memory performance was positively correlated with prior knowledge (sequential text, $r = .68$, $p < .0001$; topical text, $r = .43$, $p = .02$), as shown in Figure 3b and c, respectively. There were no non-linear relationships between prior knowledge and memory for any of the texts.

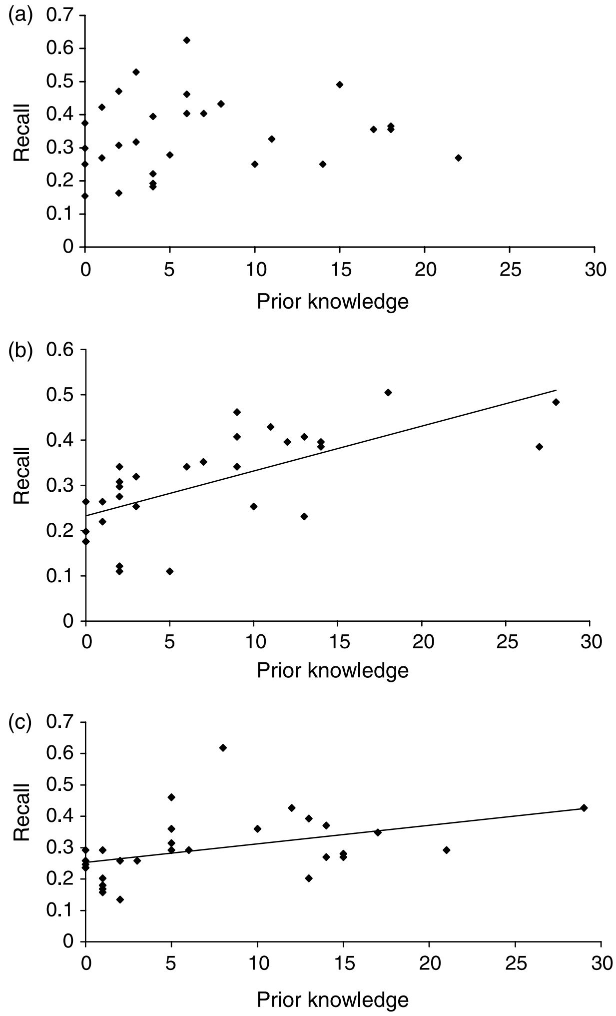

Figure 3. (a) Text recall as a function of prior circulatory system knowledge for the narrative text. (b) Text recall as a function of prior circulatory system knowledge for the sequential expository text. (c) Text recall as a function of prior circulatory system knowledge for the topical expository text.

Common text elements

Another set of memory analyses were conducted using only text elements that were common across all three texts. Across the three texts, 46 elements were shared, with the majority being content nouns and verbs that relate to specific actions in the circulatory system (e.g. PASS-THROUGH, referring to blood passing from the left atrium to the left ventricle). Recall analyses were conducted using these 46 elements for each text in the same manner as the overall recall analyses. Across the three texts, there were no differences in the mean proportion of common elements recalled (narrative $= .38$; sequential $= .42$; topical $= .41$; F values for both contrast codes < 1). The correlations between prior knowledge and memory for the common elements also mirrored the analyses of the overall recall. For the narrative text, there was no significant correlation between prior knowledge and memory for common elements ($r = .17$, *ns*), whereas for both expository texts prior knowledge was correlated with common elements memory (sequential text: $r = .70, p < .0001$; topical text: $r = .44, p = .01$). Thus, when memory performance is examined as a function of only text elements that are common to all texts, the same pattern of results emerges as for the overall recall analyses.

Memory order reversals

In addition to the amount of recall, we were also interested in examining the extent to which the organization of information in subjects' memory was consistent with the structure of the text. Subjects who engage in processing that integrates text content with prior knowledge were expected to have a memory organization that differed somewhat from the text organization. Conversely, subjects who engage in little prior knowledge integration were expected to have a memory organization that adhered more closely to the text organization. To address this issue, each subject's recall protocol was examined to determine the extent to which sentence recall order matched with the order that sentences were presented in the stimulus text. Recalled sentences were coded at the gist level. Similar to the coding of elements, gist recall was considered to be either the exact wording of a sentence or a similarly worded sentence that preserved the main idea of the sentence. As with the elements, recall protocols were coded independently by two raters. These protocols were coded in sets of 10 subjects until at least 90% agreement was reached among the coded sentences, after which the remaining protocols were coded by one of the raters. All disagreements were resolved through discussion. Average inter-rater agreement across the three texts was 90%. After the texts were coded, the number of recall order reversals relative to the text presentation order were coded. The first sentence recalled contrary to the order of the text was counted as one reversal. After any order reversal, the sentence that constituted the reversal was used as the new reference point from which subsequent reversals were determined. For example, consider the sentence recall sequence 3, 5, 8, 4, 6, 11, 9. This sequence contains two reversals, one from 8 to 4 and the other from 11 to 9 (8 to 6 is not a reversal because 4 becomes the new reference point). The total number of sentences recalled by each subject was also recorded. The analyses of interest are the proportion of order reversals relative to the number of sentences recalled for each subject.

In terms of sentence recall, a greater proportion of sentences was recalled from the narrative text (mean $= .51$) than from the average of the two expository texts (means, sequential $= .36$; topical $= .36$; $F(1, 87) = 14.41, p < .0001$), while the sequential and topical texts did not differ from each other ($F < 1$). The average number of reversals did not differ across texts (means, narrative = 1.83; sequential = 2.00; topical = 1.87; F values < 1). For the proportion of order reversals relative to the number of sentences recalled, however, the number of order reversals was marginally lower for the narrative text (means, narrative = .15; sequential = .24; topical = .19; $F(1, 87) = 3.78$, $p = .055$), while the sequential and topical texts did not differ from each other ($F(1, 87) = 2.23$, *ns*).

Discussion

In this study, we examined learning and memory for common factual content about the human circulatory system that was presented in texts that were either narrative or expository genres. There was no overall difference between text genres for either learning or memory, consistent with some prior research on text genre effects (Cunningham & Gall, 1990; Roller & Schreiner, 1985). When the prior domain knowledge of the reader was taken into consideration, however, clear differences emerged between the narrative and expository genres. For learning, both narrative and sequential expository texts revealed non-linear relationships with prior knowledge such that there was an intermediate amount of knowledge that was optimal for learning, replicating the zone-of-learnability effect of Wolfe *et al.* (1998). Furthermore, the amount of knowledge that was optimal in terms of learning was higher for the sequential expository text than for the narrative text, indicating that the comprehensibility of the same content may differ depending on the genre in which it is presented. For memory, there was no relationship between prior knowledge and free recall for the narrative text, which appears to contradict prior research on the benefits of prior knowledge for memory (e.g. Kuhara-Kojima & Hatano, 1991; Schneider *et al.*, 1989; Spilich *et al.*, 1979). For the expository texts, however, readers who possessed more prior knowledge recalled more text content. Finally, the expository texts elicited a marginally greater proportion of sentence order reversals than the narrative text.

The pattern of results obtained has both theoretical and practical significance. As a theoretical issue, it is important to understand the processing differences that are triggered by the use of different text genres. As a practical issue, the results suggest factors that educators could pay attention to when considering educational reading materials for students. We first interpret the pattern of results theoretically by proposing processing differences in which expository texts trigger readers to place relatively greater emphasis on integration of text content with prior knowledge, while narrative texts trigger readers to place relatively greater emphasis on the specific events described in the narrative. Next, we use this theoretical framework to make practical suggestions related to education.

Narrative and expository processing

When processing texts, readers attempt to create mental representations not just of the text content itself, but also of the situation being described in the text (Kintsch, 1998). To create a *situation model* representation, readers have some strategic control over the relative extent to which they focus on different types of processing activities (Linderholm & van den Broek, 2002; Zwaan, 1994). For the narrative texts, our results suggest a processing focus in which readers are primarily concerned with creating a mental representation of the events being described in the narrative, but less concerned with integrating the circulatory system content with prior circulatory system knowledge. First, memory for the text content was unrelated to prior circulatory system knowledge, suggesting that higher knowledge subjects did not draw on that knowledge to help them recall the content. This result held even when examining only text elements that were common to all three texts, which were mostly content elements. Second, the proportion of recall order reversals was marginally lower for the narrative than the expository texts, suggesting the possibility of a greater adherence to the text organization for the narrative text compared with the expository texts. This conclusion should be examined in future research, however, because the effect here is marginal. Finally, in terms of learning, if readers are putting little processing effort into incorporating the circulatory system content with prior knowledge, then we would expect gains on the learning score to reflect memory for the content of the text more than actual integration of the content with prior knowledge. In that case, the learning score would favour those readers who knew the least at the beginning of the experiment.

This interpretation of narrative processing is consistent with the typical discourse force of narratives as being for entertainment rather than to inform. The interpretation is also consistent with other research comparing narrative with expository processing. McDaniel and Einstein (1989, 2005) proposed the material appropriate difficulty (MAD) framework to account for differences in memory patterns across text genres. Results supporting MAD show that processing activities that increase attention allocated to individual text elements improve narrative memory but activities that increase relational processing do not. According to MAD, narrative processing naturally tends to emphasize relations among text concepts; hence, only increases in other types of processing will increase narrative memory. Also, Wolfe (2005) found memory for narrative texts to be better predicted by a simulation model that emphasized the organization of text elements in the text compared with a simulation model that emphasized relations among text elements in semantic memory.

Another important point about the narrative results for memory is that they appear to contradict other results in which narrative texts were better recalled by high knowledge readers. This discrepancy can perhaps be understood in terms of differences in the extent to which the factual content is tied to the narrative elements of the text. In many previous studies that show a prior knowledge advantage for narrative texts (Hambrick & Engle, 2002; Schneider *et al.*, 1989; Spilich *et al.*, 1979), the narratives were texts that described the action in a sporting event. When describing a soccer or baseball game, the factual content relating to the sport and the narrative events are likely to be more closely tied together than they are in the current study. The narrative in the current study may be seen as a more 'artificial' device for delivering content, in that the narrative is not necessary in order to explain the content. Perhaps, in narratives that share this characteristic, the prior knowledge of the reader is less relevant than in narratives in which the content is more central to the story.

For the expository texts, our results suggest a processing focus that involves attempts to integrate the content of the texts with the reader's prior knowledge. First, memory was positively correlated with prior knowledge, both for the entire text contents and for the common elements across texts, indicating that subjects utilized prior knowledge in recalling the texts. Second, the proportion of order reversals in memory was marginally greater for the expository texts compared with the narrative texts, suggesting subjects may focus their processing on integration of content with prior knowledge to a greater extent than with the narrative text.

For learning from expository texts, if subjects are attempting to establish meaningful connections with prior knowledge, then subjects who have some knowledge should be more successful than those who have very little prior knowledge. This explanation is consistent with the current finding that the optimal amount of prior knowledge for learning from the sequential expository text is greater than for the narrative text and also with the zone-of-learnability hypothesis (Wolfe *et al.*, 1998). Subjects who have little prior knowledge will have difficulty in processing the text content because of a lack of knowledge to which they can integrate the content (Kintsch, 1998). Subjects with large amounts of prior knowledge, however, may process the text content in a more superficial manner, thereby failing to incorporate information in the text that could be learned potentially. Subjects with an intermediate amount of prior knowledge, however, will be effortful in processing the text content and successful because they possess enough prior knowledge to be able to integrate new content (Kintsch, 1994).

This interpretation of expository processing is also consistent with prior research. Research that specifically examines readers' expository processing strategies indicates that many readers try to establish connections between text content and relevant prior knowledge (Coté *et al.*, 1998; Kintsch, 1994; McNamara, 2004). Wolfe (2005) found that memory for expository text was predicted by associations among text elements in semantic knowledge to a much greater extent than true for narrative texts, indicating that subjects were drawing on prior knowledge more in recall of expository text. Finally, while the MAD framework does not specifically address the utilization of prior knowledge in expository processing, McDaniel and Einstein (1989) found that expository processing naturally involves more emphasis on individual elements, and less on textual relations, in contrast to narrative processing. The nature of this emphasis may be that individual text elements are processed to a greater or lesser degree depending on how well they match the prior knowledge of the reader.

Practical implications

As a practical issue, neither narrative nor expository genre appears to be uniformly superior as a means for delivering content to students, replicating earlier findings showing no difference between these genres (Kintsch & Young, 1984; Roller & Schreiner, 1985). Instead, the results suggest that learning can be improved across a population if educators consider the processing differences between genres and the relevant prior knowledge of the readers.

Several studies provide evidence demonstrating that processing a text by activating and incorporating relevant prior knowledge leads to superior memory and learning compared with not engaging in these processes (Coté *et al.*, 1998; McNamara *et al.*, 1996; Wolfe & Goldman, 2005). However, if the content of the text is too difficult for students to successfully incorporate it with their prior knowledge, then learning will be less successful (McNamara *et al.*, 1996; Wolfe *et al.*, 1998). In the current study, higher knowledge subjects learned best from the sequential expository text, while lower knowledge subjects learned best from the narrative text. This finding suggests that although expository texts may elicit the type of processing that educators wish to see in students, they may not be beneficial for students who do not have enough knowledge to processes them successfully. With a narrative text, to-be-learned content may be more closely tied to the narrative elements of the story rather than the reader's prior knowledge. This type of processing may be more beneficial for lower knowledge readers because the story provides at least some type of mental structure to which the content can be connected. One caveat about the advantage of narrative texts for lower knowledge readers, however, is that connecting to-be-learned content to the story being told may result in the content being represented as mere details that relate to the central story, rather than being the focus of the reader's processing effort. In this situation, the content may fade from memory more quickly than content that is integrated with prior knowledge. One important issue for future research, therefore, will be to examine the extent to which the learning gains seen in the current study hold up over time. It is conceivable that the learning gains for the narrative text may decay from memory more rapidly than the gains from the expository texts due to differences in prior knowledge integration.

The current findings also suggest that educators consider the role that to-be-learned content plays in the causal/temporal structure of the text for narratives. If readers tend to focus processing effort on the events described in the story being told, then to-be-learned content could be conveyed more successfully if it is integral to the story being told, rather than peripheral. In the current narrative, some of the circulatory system content is not essential to the narrative structure. For example, the story could be told without including the names of the heart chambers, which creates the possibility that readers could follow the story while paying little attention to the factual content that is not essential to the story events. Therefore, rather than considering the narrative genre in general as a means of teaching course content, it may be beneficial to also consider the extent to which the to-be-learned content is directly tied to the narrative events. School topics that inherently have a causal/temporal structure, such as history, will likely lend themselves more easily to incorporating to-be-learned content with the narrative. However, other topics that are more structural and less causal, such as math or anatomy, may not lend themselves to the narrative genre successfully.

Working memory capacity

The lack of a relationship between WMC and learning or memory contradicts some prior research on these relationships. One possible explanation for this lack of relationship is that it is an artifact of our procedure; subjects were allocated a set amount of time to study the text and instructed to continue to go over the material if they finished reading before the time was up. This procedure was used in another study in which WMC did not correlate with text memory (Hartley, 1986). It is possible that low WMC readers can compensate for having fewer processing resources by rereading the text during the study period. A question for future research is whether placing more strict controls on reading rate or rereading would increase the predictive ability of WMC in these tasks.

Sequential versus topical expository texts

In the current study, the sequential and topical expository texts did not differ in terms of overall memory or learning, but differed in terms of the influence of prior knowledge on learning. With the topical text, there was no non-linear relationship between knowledge and learning. This pattern of results suggests that the presence or absence of a causal/temporal organization of the content may be an important factor in determining the relationship between prior knowledge and learning. One possible explanation for the difference in learning patterns is that the greater causal coherence of the sequential text facilitates creation of a coherent representation of the text, whereas the topical text representation is more list-like. Processing the text in a list-like manner may be more challenging to the high knowledge readers, resulting in more learning than was achieved with the sequential text. In addition, the lowest knowledge readers may have been able to recall some isolated facts and use that knowledge to achieve a moderate amount of learning as well, which would account for the overall lack of a relationship between prior knowledge and learning for the topical text.

In a broader sense, there are a large number of actual text organization types that can be used to convey informational content (Brewer, 1980; Goldman & Bisanz, 2002). In addition, texts vary considerably in length, coherence, content and the context in which they are read (e.g. school vs. entertainment). Readers also have individual differences on such dimensions as relevant prior knowledge of the topic being studied, age and motivation. Achieving a full understanding of text genre effects will involve manipulating not only text type, but also other variables. In terms of advancing the practical value of text genre for education, it will be important to develop theoretical models that explain how these factors interact with each other to produce successful comprehension. Theoretical models of genre effects could then provide specific predictions about when comprehension will be likely to succeed and ultimately could be a valuable asset in improving learning.

Acknowledgements

Michael B. W. Wolfe and Joseph A. Mienko, Department of Psychology, Grand Valley State University. The authors would like to thank Deanna Godfrey, Jeremy McClure and John Workman for assistance with the research.

References

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.

Attention and Working Memory Lab. Reading Span Task [Eprime file]. Retrieved September 30, 2003 from http://psychology.gatech.edu/renglelab/

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.

Britton, B. K., Stimson, M., Stennett, B., & Gülgöz, S. (1998). Learning from instructional text: Test of an individual-differences model. *Journal of Educational Psychology*, *90*, 476–491.

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.

Cunningham, L. J., & Gall, M. D. (1990). The effects of expository and narrative prose on student achievement and attitudes toward textbooks. *Journal of Experimental Education*, *58*, 165–175.

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior*, *19*, 450–466.

Daneman, M., & Merikle, P. M. (1996). Working memory and language comprehension: A meta-analysis. *Psychonomic Bulletin and Review*, *3*, 422–433.

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.

Goldman, S. R., & Bisanz, G. L. (2002). Toward a functional analysis of scientific genres: Implications for understanding and learning processes. In J. Otero, J. A. León, & A. C. Graesser (Eds.), *The psychology of science text comprehension* (pp. 19–50). Mahwah, NJ: Erlbaum.

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.

Hambrick, D. Z., & Engle, R. W. (2002). Effects of domain knowledge, working memory capacity, and age on cognitive performance: An investigation of the knowledge-is-power hypothesis. *Cognitive Psychology*, *44*, 339–387.

Hartley, J. T. (1986). Reader and text variables as determinants of discourse memory in adulthood. *Psychology and Aging*, *1*, 150–158.

Hultsch, D. F., Hertzog, C., & Dixon, R. A. (1990). Ability correlates of memory performance in adulthood and aging. *Psychology and Aging*, *5*, 356–368.

Judd, C., M, & McClelland, G. H. (1989). *Data analysis: A model-comparison approach*. San Diego, CA: Harcourt Brace Jovanovich.

Kane, M. J., Hambrick, D. Z., Tuholski, S. W., Wilhelm, O., Payne, T. W., & Engle, R. W. (2004). The generality of working memory capacity: A latent-variable approach to verbal and visuospatial memory span and reasoning. *Journal of Experimental Psychology: General*, *133*, 189–217.

Kintsch, W. (1994). Text comprehension, memory, and learning. *American Psychologist*, *49*, 294–303.

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

Kintsch, W., & Franzke, M. (1995). The role of background knowledge in the recall of a news story. In R. F. Lorch, Jr. & E. J. O'Brien (Eds.), *Sources of coherence in reading* (pp. 321–333). Hillsdale, NJ: Erlbaum.

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

Kuhara-Kojima, K., & Hatano, G. (1991). Contribution of content knowledge and learning ability to the learning of facts. *Journal of Educational Psychology*, *83*, 253–263.

Landauer, T. K., & Dumais, S. T. (1997). A solution to Plato's problem: The latent semantic analysis theory of acquisition, induction and representation of knowledge. *Psychological Review*, *104*, 211–420.

Lee-Sammons, W. H., & Whitney, P. (1991). Reading perspectives and memory for text: An individual differences analysis. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *17*, 1074–1081.

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.

Luszcz, M. A. (1993). Orienting tasks as moderators of narrative and expository text recall in adulthood. *Psychology and Aging*, *8*, 56–58.

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

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

McDaniel, M. A., & Einstein, G. O. (2005). Material appropriate difficulty: A framework for determining when difficulty is desirable for improving learning. In A. F. Healy (Ed.), *Experimental cognitive psychology and its applications* (pp. 73–85). Washington, DC: American Psychological Association.

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

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.

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.

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.

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.

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.

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

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

Voss, J. F., & Silfies, L. N. (1996). Learning from history text: The interaction of knowledge and comprehension skill with text structure. *Cognition and Instruction*, *14*, 45–68.

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.

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

Wolfe, M. B. W., Schreiner, M. E., Rehder, B., Laham, D., Foltz, P. W., Kintsch, W., *et al.* (1998). Learning from text: Matching readers and texts by latent semantic analysis. *Discourse Processes*, *25*, 309–336.

Zabrucky, K. M., & Moore, D. (1999). Influence of text genre on adults' monitoring of understanding and recall. *Educational Gerontology*, *25*, 691–710.

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

Received 16 January 2006; revised version received 23 June 2006

Appendix A

Circulatory system knowledge test with correct answers

Questions	Correct answers (number of points)
How many types of blood vessels are there? Please name them	Five types: capillaries, arteries, veins, arterioles, veinules (6)
How many chambers are there in the heart? Name them	Four chambers: right and left atrium, right and left ventricle (5)
Which chamber of the heart does the blood returning from the body enter first?	Right atrium (1)
What is another name for the right atrioventricular valve?	Tricuspid valve (1)
What is the protein which makes quick oxygen/carbon dioxide transfer possible? How many molecules of oxygen can each such protein carry?	Haemoglobin. Each protein can carry four molecules of oxygen (2)
What is a capillary?	A type of blood vessel involved in oxygen/carbon dioxide exchange (2)
How many continuous, closed circuits of blood are there from the heart? Name them.	Two: pulmonary and systemic (3)
What is an artery?	A blood vessel that carries blood away from the heart (2)
What is an atrium?	A chamber of the heart located at the top of the heart (or receiving chambers for blood) (2)
Where does the blood entering the left atrium come from?	Pulmonary vein (or lungs) (1)
What is a ventricle?	A chamber of the heart located at the bottom of the heart (or dispensing or exiting chambers) (2)
What is another name for the left atrioventricular valve?	Bicuspid or mitral valve (1)
Where does blood entering the left ventricle come from? The right ventricle?	Blood entering the left ventricle comes from left atrium. Blood from right ventricle comes from right atrium (2)
The pacemaker is the common term for what specific part of the heart? Where is it located?	Sinoatrial (or SA) node located in the wall of the right atrium (2)
Which side of the heart is larger? Why?	Left side. It has to pump blood to the entire body (2)
What is unusual about the pulmonary veins?	They carry oxygenated blood (1)
What are the names of the main veins which carry blood back to the heart from the body? How many such veins are there? From what part of the body does each such vein return blood?	Superior and inferior vena cavae. Two. Superior comes from the upper part of the body and inferior from the lower (5)

Appendix B

Alex's adventure (narrative text)
Alex worked for many years on a machine that would allow him to become tiny. One day, he finally finished the machine and made himself tiny. He was so 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 molecule was absorbed into a red blood cell in the blood. He wanted to find a way back outside. Alex was on an adventure through the blood. He saw that carbon dioxide molecules were released from the blood back into the lungs. He needed to hold on to a carbon dioxide molecule and get back to the lungs. First, Alex travelled through the pulmonary veins, which are a type of blood vessel that return blood to the heart from the lungs. He entered the heart into one of the top chambers, the left atrium. Next he went to the left ventricle, which is one of the bottom heart chambers. This chamber pumped Alex out along the systemic loop, a network of arteries and veins going to the body and back to the heart. First he travelled through the arteries, which are blood vessels that carry blood away from the heart. After a while, the oxygen molecule reached the small blood vessels called capillaries. In the capillaries, oxygen was absorbed into the cells. Carbon dioxide was passing through the capillary walls back into the blood. Alex quickly released himself from the oxygen molecule and grabbed on to a carbon dioxide molecule. The carbon dioxide molecule went back toward the heart through the veins. The veins emptied into the right atrium, the chamber of the heart that receives blood from the body. From the right atrium, Alex was pushed down through a valve into the right ventricle, the other bottom heart chamber. He could see the septum, a muscular wall that divides the heart into right and left sides. The right ventricle pushed Alex out the pulmonary loop, which is a separate loop of the circulatory system that goes to the lungs and back. Soon, he was passing through the thin wall of a capillary in the lungs. He was breathed out into the air. The adventure was over.

The circulatory system (sequential expository text)
Virtually all kinds of animals have a circulatory system. One function of the circulatory system is to deliver oxygen to the cells of the body. Another function is to remove carbon dioxide from the cells. The three main components of the circulatory system are the heart, blood vessels and blood. Blood flows through the circulatory system in two separate but connected loops to accomplish these functions.

The systemic loop is a network of arteries and veins going out to the body and back to the heart. Blood travelling to the body is pumped out of the left ventricle, one of the bottom chambers of the heart. From the left ventricle, blood travels out of the aorta and through the arteries. Arteries, a type of blood vessel, carry blood away from the heart. In between arteries and veins are the smallest blood vessels, called capillaries. The capillaries are where oxygen and carbon dioxide are exchanged between the red blood cells in the blood and the cells of the body. The oxygen and carbon dioxide pass through the thin walls of the capillaries. Veins, the third type of blood vessel, carry blood back to the heart. From the veins of the body, blood enters one of the upper heart chambers, the right atrium. It passes through a valve to the right ventricle. The heart is divided into left and right sides by a muscular wall called the septum. From the right ventricle, the other bottom heart chamber, the blood goes out to the lungs. The path of blood to the lungs and back represents a separate loop in the circulatory system called the pulmonary loop. In the lungs, the red blood cells discard carbon dioxide. At the same time, oxygen enters the lungs and is absorbed by the red blood cells. This oxygen-rich blood then travels back to the heart through the pulmonary veins. Blood from the lungs enters the left atrium, the other upper chamber of the heart. From there, it passes to the left ventricle and the continuous loops begin again.

The heart, blood vessels and blood must all function together. The circulatory system also carries out other essential functions. All mammals have a circulatory system.

The circulatory system (topical expository text)

Virtually all kinds of animals have a circulatory system. One function of the circulatory system is to deliver oxygen to the cells of the body. Another function is to remove carbon dioxide from the cells. The three main components of the circulatory system are the heart, blood vessels and blood. Blood flows through the circulatory system in separate but connected loops to accomplish these functions.

Each side of the heart contains a top chamber called an atrium. The right and left atria are the receiving chambers for blood arriving to the heart. The bottom chambers are the ventricles, which pump blood away from the heart. The right atrium receives blood from the body. The blood then passes through a valve to the right ventricle, where it is pumped to the lungs. The left atrium receives blood from the lungs and passes it to the left ventricle. From the left ventricle, blood travels out of the aorta and through the arteries. The two sides of the heart are divided into right and left sides by a muscular wall called the septum.

Blood vessels carry blood throughout the body. Arteries carry blood away from the heart. Veins carry blood back to the heart. The systemic loop is a network of arteries and veins going to the body and back to the heart. The pulmonary loop is a separate network that leads to the lungs and back. In between arteries and veins are the smallest blood vessels, called capillaries.

Blood is the fluid that flows through the circulatory system. The red blood cells are carried in the blood. The red blood cells discard carbon dioxide through the lungs and the red blood cells also pick up oxygen from the lungs which is carried with the blood back through the pulmonary veins. In the cells of the body, oxygen and carbon dioxide are also exchanged through the capillaries. The oxygen and carbon dioxide pass through the thin walls of the capillaries. The blood then travels back to the heart through the veins.

The heart, blood vessels and blood must all function together. The circulatory system also carries out other essential functions. All mammals have a circulatory system.