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A memory-retrieval view of discourse representation: The recollection and familiarity of text ideas

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Abstract

According to most theories of text comprehension, readers construct and store in memory at least two inter-related representations: a text base containing the explicit ideas in a text and a discourse model that contains the overall meaning or "gist" of a text. The authors propose a refinement of this view in which text representations are distinguished by both encoding and retrieval processes. Some encoding processes "unitize" concepts in a text and some "relate" units to one another. Units are retrieved based on familiarity processes in recognition, whereas related units are retrieved based on recollective processes. This distinction was tested in two experiments. In Experiment 1, readers comprehended sentence pairs in which some could be related by means of a causal inference, whereas others were only temporally related. Overall recognition was high in both conditions, but recollection, much more than familiarity, was sensitive to the causal manipulation. In Experiment 2, sentences began with a definite article as a linguistic cue to connect noun phrases or began with an indefinite article. The discourse manipulation had its primary influence on recollection. The authors suggest that the discourse model may be a collection of text ideas that are available to consciousness at retrieval. The gist-level representation of a text may not be a pre-stored structure; rather, it may be generated, in part, as a summary description of recollected text ideas.

Keywords

Text memory; Text representation

Most theories of text comprehension claim that readers store in memory at least two interrelated mental representations when they comprehend a text. One representation, sometimes called the *text base*, consists of the ideas that are explicitly stated in a text and the relations among them. A second representation consists of the text's overall meaning, that is, a representation of the real or fictional situation that the text describes (Gernsbacher, 1990;

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Kintsch, 1998). This representation, often called the discourse model, contains text information that has been interpreted in light of relevant world knowledge.

The text base and the discourse model are distinguished primarily by content. The text base contains the explicit ideas from the text, whereas the discourse model contains the "gist" of the text, a description of what the text is about. It is possible, however, to conceptualise readers' representations in other ways. In the current study, we propose a text-base/discourse model distinction in which the status of a text idea in memory is based on the processes that are involved at encoding and those that are involved at retrieval. This conceptualisation is founded in models of recognition memory that distinguish between "unitizing" processes and "relational" processes at encoding and between "familiarity" and "recollection" at retrieval.

The study that we describe here is in the spirit of other research aimed at understanding the role of basic memory processes in comprehension. The dominant framework for investigating this issue is the memory-based text processing approach. When readers comprehend a text, they must access information that was processed previously and stored in long-term memory if they are to create a representation that is coherent at both local and global levels. The memory-based text processing model proposes a resonance-like process in which concepts and propositions in long-term memory (LTM) that share features with text elements in working memory (WM) resonate and their activation increases (Albrecht & O'Brien, 1993; Gerrig & McKoon, 1998; McKoon, Gerrig, & Greene, 1996; McKoon & Ratcliff, 1998; Myers & O'Brien, 1998). These newly activated concepts and propositions are then available for use in interpreting information in WM.

The focus of most research on memory-based text processing has been to understand how background information is activated "on-line" during the comprehension process. Our study extends this research in an effort to understand how models of recognition memory can be used to understand the nature of readers' text representations such that information from a text can be used at a later time, once comprehension is complete. In the next section, we provide a brief description of the memory framework that we use for making predictions about the relation between text comprehension and text memory.

DUAL-PROCESS MODELS OF RECOGNITION MEMORY

Dual-process models of recognition claim that recognition judgments are influenced by two memory processes: recollection and familiarity (e.g., Jacoby & Dallas, 1981; Mandler, 1980; Yonelinas, 2002). *Recollection* involves memory for an item that is accompanied by information about the context in which the item was studied, such as information about the item's source (Clark, 1992; Hintzman & Caulton, 1997; Hintzman & Curran, 1994; Humphreys, 1978; Jacoby, 1991; Mandler, 1980; Yonelinas, 1994, 1997). It is often conceptualised as a threshold process; that is, contextual information about the item is or is not retrieved. In contrast, *familiarity* involves memory for an item that is accompanied by high confidence that an item has been studied, but no specific information about its context. It involves a quantitative assessment of the similarity (perceptual and conceptual) between a test item and information that has been stored in memory. Familiarity is conceptualised as a

signal detection process (Clark & Gronlund, 1996; Gillund & Shiffrin, 1984; Hintzman, 1988; Humphreys, Bain, & Pike, 1989; Murdock, 1982).

Recollection and familiarity are estimated from patterns of recognition judgments. The two most common paradigms for obtaining these estimates are the remember/know procedure and the process-dissociation procedure. In the *remember/know* procedure (Gardiner, 1988; Gardiner & Java, 1991; Gardiner & Parkin, 1990; Rajaram, 1993; Tulving, 1985), participants make subjective judgments about their memories for recognised items. They respond *remember* if their memory is accompanied by episodic details about an item and they respond *know* if they recognise the item, but do not recall anything specific about it. Remember judgments are used as an estimate of recollection. Familiarity is estimated as the conditional probability that an item received a know response given that it did not receive a remember response (Yonelinas & Jacoby, 1995).

In the process-dissociation procedure, participants are asked to study two lists of items; subsequent recognition judgments are obtained in different instructional conditions (Jacoby, 1991; Jacoby, Toth, & Yonelinas, 1993; Yonelinas & Jacoby, 1995). In an inclusion condition, participants are asked to respond “old” to all studied items. These judgments are assumed to result from both recollection and familiarity. In an exclusion condition, participants are asked to respond “old” only if the item appeared in a specified list and to respond “new” if it appeared in the other list. Recognition judgments in this condition require recollection, that is, memory for the context in which an item appeared. Quantitative estimates of recollection and familiarity can be obtained by comparing performance in the inclusion and exclusion conditions (see Yonelinas & Jacoby, 1995, for details about the procedure).

The remember/know and process-dissociation procedures have been used extensively to identify factors that differentially affect recollection and familiarity (for a review see Yonelinas, 2002). Recollection tends to be influenced by many of the same factors that affect recall. Like recall, recollection increases as a function of elaborative encoding, as seen in studies using levels-of-processing manipulations. Items are combined by means of a conjunctive process yielding a memory trace that is distinct from the items that contributed to it. Recollection is also sensitive to manipulations of attention during both encoding and retrieval. Familiarity, in contrast, is affected by item-specific processing, that is, processing that enhances the distinctiveness of individual items. Retrieval of individual items is primarily driven by the perceptual match between a test item and a memory trace. It is also affected by fluency manipulations, such as subliminal masked priming. Manipulations of response bias generally influence familiarity more than they do recollection, which is consistent with the conceptualisation of familiarity as a signal detection process (Yonelinas, 2002).

Recently, memory researchers have begun to investigate a counterintuitive finding in the literature on recognition memory. As discussed above, relational processing (broadly defined as elaboration based on semantic/conceptual processing) generally yields retrieval that is based on recollection. This is not always the case, however. In some situations, relational processing can give rise to recognition that is based primarily on familiarity. This

appears to occur when distinct items (e.g., a *square* and the colour *green*) can be encoded as a single unit (e.g., a green square), a process that has been called "unitization" (Diana, Yonelinas, & Ranganath, 2008; Quamme, Yonelinas, & Norman, 2007). One form of unitisation involves the construction of compound words (Giovanello, Keane, & Verfaellie, 2006; Quamme et al., 2007). For example, Quamme et al. (2007) conducted a study in which participants received word pairs in the context of a definition that denoted a single object (e.g., "motor-bear" was defined as "a motorized stuffed animal") or they received the pairs and were asked to judge whether or not they fit a sentence frame (e.g., The —— sounded loud in the early morning and scared the wildlife including the ——. Familiarity-based retrieval was enhanced in the definition condition relative to the sentence condition, whereas recollection was enhanced in the sentence condition relative to the definition condition. Quamme et al. argued that the definition condition encouraged item-specific processing to encode the two words as a single unit, whereas the sentence condition encouraged relational processing that created a new memory trace based on the combination of ideas across clauses in the sentence.

The unitisation/relation distinction can be applied easily to the domain of text comprehension. Consider the following example:

1. Sarah took the aspirins.
2. Her pain went away.

If readers unitise words to create an individual "item" (e.g., Sarah took aspirins; Sarah's pain was gone), then these item-level representations can support recognition judgments via familiarity. If readers are also able to apply relevant world knowledge in comprehending a text, then they will represent connections among sentences (Sarah's pain went away because she took aspirins; Aspirin relieved Sarah's pain), leading to subjective experiences of recollection at test.

In the next section, we discuss how text memory has been investigated in light of the distinction between familiarity and recollection in recognition memory. We then discuss how the unitisation/relational distinction and the familiarity/recollection distinction can be applied to understanding the text representation.

RECOLLECTION, FAMILIARITY, AND READERS' TEXT REPRESENTATIONS

Long and her colleagues have argued that the recollection and familiarity estimates can be used to examine the nature of readers' text representations (Long & Prat, 2002; Long, Prat, Johns, Morris, & Jonathan, 2008; Long, Wilson, Hurley, & Prat, 2006). According to dual-process models, recollection increases when studied items are elaborated, that is, when semantic and conceptual processing yields relations among items. This is the same type of process that is presumably executed when readers create a discourse model: a discourse model is constructed when readers form a network of connections to integrate text ideas with each other and with relevant world knowledge. Therefore, factors that influence the extent to which readers can create a coherent discourse model should be positively related to readers' recollection of ideas in texts.

Familiarity, in contrast, should be sensitive to the reader's ability to identify the individual ideas that are contained in a text. If readers are able to execute orthographic, lexical, and syntactic processes to extract ideas from sentences, then they should have relatively rich representations of individual items (e.g., propositions). These item representations should be sufficient to support accurate recognition of individual ideas from a text. However, the ability to understand individual ideas in sentences does not necessarily produce a coherent model of the text as a whole. Constructing a discourse model requires elaboration to link ideas within and across sentences. In the absence of such elaborative associations, readers have "list-like" representations, in which text ideas are represented individually or in clusters, loosely linked by theme (Long, Oppy, & Seely, 1994, 1997).

The distinction between memory for individual ideas that can be retrieved on the basis of familiarity and connections among ideas that can be retrieved based on recollection can explain previous research showing that recognition is relatively insensitive to factors that influence a reader's ability to construct a discourse model; recognition scores tend to be high irrespective of properties of the text and characteristics of the reader. For example, the extent to which a reader possesses prior knowledge about the topic of a text has large and robust effects on recall (Anderson, 1981; Anderson & Pitchert, 1978; Bower, Black, & Turner, 1979; Fass & Schumacher, 1981; Johnson & Kieras, 1983; Schneider, Korkel, & Weinert, 1990; Spilich, Vesonder, Chiesi, & Voss, 1979; Sulin & Dooling, 1974), but few studies have found knowledge effects on recognition (Alba, Alexander, Hasher, & Caniglia, 1981; Alba & Hasher, 1983; Moravcsik & Kintsch, 1993; Schneider et al., 1990; Summers, Horton, & Diehl, 1985).

Other studies have reported knowledge effects on particular aspects of recognition performance. These studies usually involve responses to distractor sentences. When distractors are paraphrases or inferences that high-knowledge participants are likely to make, knowledge can impair recognition performance. (Bransford, Barclay, & Franks, 1972; Bransford & Franks, 1971; Graesser, Gordon & Sawyer, 1979; Summers et al., 1985)

Long et al. (Long & Prat, 2002; Long et al., 2006) hypothesised readers who execute basic sentence-level processes construct distinct item-specific representations that can support recognition judgments via familiarity. If readers also construct new memory traces based on combinations of items, then they can retrieve these items via recollection. Thus, both high-knowledge and low-knowledge readers should recognise text ideas very well. The groups should differ, however, in the nature of their recognition judgments, with low-knowledge readers experiencing familiarity at retrieval and high-knowledge readers experiencing recollection.

Long and Prat (2002) and Long et al. (2006) examined familiarity-based and recollection-based retrieval in a series of studies investigating knowledge effects on recognition using both the remember/know task and the process-dissociation procedure. Participants in their experiments were assessed with respect to their knowledge about the sciencefiction saga, *Star Trek*. Participants read *Star Trek* and control stories and then made judgments concerning the nature of their memories for test sentences. Long and Prat (2002) found that no knowledge effects on overall recognition (*d* prime), replicating previous studies in which

recognition was insensitive to readers' prior knowledge about a text. They did find knowledge effects, however, when they examined recollection and familiarity separately. High-knowledge readers had higher recollection estimates than did low-knowledge readers, but only for *Star Trek* items. The two groups' familiarity estimates did not differ as a function of knowledge. Long et al. (2006) found similar results in a study manipulating the amount of domain-relevant content in the *Star Trek* texts, adding or deleting descriptions of characters, objects, and events from the *Star Trek* domain; knowledge influenced recollection estimates for high-knowledge, but not low-knowledge, readers.

The findings described above clearly demonstrate that recollection is influenced by the extent to which readers have knowledge about the topic of a text, but these findings are limited in their scope. Long et al.'s (Long & Prat, 2002; Long et al., 2006) studies are specific to the enhancement of recollection when readers have expertise about a knowledge domain. The knowledge that an expert has about a topic may be special in that it is readily accessible to consciousness; it can be recollected, thought about, and discussed. This begs the question as to whether relational processing that is based on general world knowledge, rather than domain-specific expertise, also gives rise to recollection at retrieval. These experiments were designed to answer this question.

EXPERIMENT 1

Readers track several types of information in a text in order to establish relations among text ideas (e.g., characters, time, space). One very important type of information is causality. Readers expect that events in a text will be related and they make causal links between sentences when the link is not explicit. Consider the following pairs of sentences (Singer, Halldorson, Lear, & Andrusiak, 1992):

1. Dorothy threw a bucket of water on the fire

   The fire went out.

2. Dorothy placed a bucket of water by the fire.

   The fire went out.

The causal relation between the first and second sentences is not explicit in either (1) or (2). The causal relation can be inferred easily in (1) based on the reader's knowledge that water can put out a fire. The sentences in (2) have many of the same content words as those in (1), but the sentences cannot be causally connected because placing water by a fire has no apparent causal relation to the fire going out. Thus, the sentences in (1) are more likely to be processed relationally than those in (2) (Singer et al., 1992).

Our goal in this experiment was to examine how causal relations influence recollection and familiarity for text ideas. Participants read sentence pairs like (1) and (2) above. They received a subsequent recognition test consisting of old sentences (the second sentence from each pair of sentences), foils that were inferences related to the causal pairs (e.g., "The water put out the fire".), and new sentences. One should note that we use sentences as our items on the recognition test, but we do not suggest that sentences are always encoded as a unit in readers' text representations. Rather, sentences include more than one unit (e.g.,

proposition). These units are likely to be combined within sentences as they are across sentences. We used sentences as a convenient unit of analysis because the majority of our sentences contained a single proposition.

Participants were asked to make recognition judgments to each sentence on the test by responding *remember*, *know*, or *new*. Recollection and familiarity estimates were calculated from the remember/know judgments. If recollection is affected by the extent to which readers form connections among text ideas, then recollection estimates should be higher in the causal than noncausal condition, whereas familiarity should not differ in the two conditions. In addition, new combinations of ideas can be created from the integration of explicit text ideas with world knowledge (e.g., our inference items). Thus, we also expected higher recollection estimates to inferences in the causal than noncausal condition.

Method

Participants—Participants were 96 undergraduate Psychology students who received the task as an in-class exercise.

Materials—The study materials consisted of 24 two-sentence passages used previously by Singer et al. (1992; Experiment 2, Appendix B). There were two versions of each passage: one causal, and the other noncausal. In the causal version, the second sentence of the passage (e.g., “Her pain went away”.) could be linked easily to the event in the first sentence (e.g., “Sarah took the aspirins”.) by means of a causal inference (the aspirin relieved Sarah’s pain). In the noncausal version, the second sentence of the pair (e.g., “Her pain went away”.) occurred after an event in the first sentence (e.g., “Sarah refused the aspirin”.) that did not invite a causal inference. The causal and noncausal versions of each passage were counterbalanced across two lists. Each list contained 24 experimental passages; half of the passages were causally related and half were noncausally related. Each list also included 24 filler passages. These passages were similar in style to the experimental ones.

One recognition test was constructed. It contained the second sentence from each of the 24 experimental passages. The test also contained 24 inference foils. These were sentences that described the inference that participants were expected to generate in response to passages in the causal condition (e.g., “The aspirin relieved Sarah’s pain”.). The correct answer to all of these items was “new”, because none of these sentences were stated explicitly in the passages. Finally, we included 24 new items. These items were created by forming new combinations of ideas from studied sentences (e.g., “Sarah refused to put out the fire”.)

Procedure—Participants received a booklet with the study passages and recognition test. The first page of the booklet contained an explanation of the task. Participants were told that they would be given 5 minutes to read a set of passages and that they should read them carefully because they would be asked questions about them later. After reading the passages, participants received a distractor task. They were asked to solve anagrams for 5 minutes. This was followed by the recognition test. The remember/know instructions were adapted from Rajaram (1993) and appear in Table 1.

Results and discussion

We calculated recollection and familiarity estimates for old and inference items using the Independence Remember-Know (IRK) procedure described by Yonelinas and Jacoby (1995). In this procedure, remember judgments (*R*) are conceptualised as an index of recollection. Familiarity (*F*) is conceptualised as the probability of an item receiving a know response given that it was not recollected ($F = \text{know}/(1 - R)$). We conducted separate repeated measures ANOVAs on recollection and familiarity estimates to the three types of items (old, inference, and new). Passage type (causal, noncausal) was a within-participants variable. All effects were reliable at $p < .05$ unless stated otherwise. Table 2 contains the proportion of remember and know responses and the recollection and familiarity estimates for remember, know, and new items.

Recollection and familiarity estimates for old items—Responses to old items were analyzed by means of a 2 (passage type) × 2 (memory estimate) ANOVA. Both passage type (causal vs. noncausal) and memory estimate (recollection vs. familiarity) were within-participant factors. We found two reliable main effects: sentences were recognised more frequently in causal than in noncausal passages, $F(1, 95) = 4.02$, $MSE = 0.27$, and recollection estimates were higher than familiarity estimates, $F(1, 95) = 3.91$, $MSE = 0.07$. More importantly, these main effects were modified by the critical two-way interaction between passage type and memory estimate, $F(1, 95) = 11.77$, $MSE = 0.06$. Recollection estimates were higher for causal passages than noncausal passages, $F = 32.74$, $MSE = 1.76$, whereas familiarity estimates did not differ as a function of passage type, $F < 1$.[1]

Recollection and familiarity estimates for inference items—As can be seen in Table 1, participants did not make many false alarms to inference items; nonetheless, we found reliable effects of passage type and memory estimates. Estimates were higher for sentences from causal passages than noncausal ones, $F(1, 95) = 5.07$, $MSE = 0.03$. In addition, familiarity estimates were higher than recollection estimates, $F(1, 95) = 6.78$, $MSE = 0.02$. We also found a marginally reliable interaction between passage type and memory estimate, $F(1, 95) = 3.13$, $MSE = 0.09$, $p = .08$. Recollection estimates were higher in the causal than the noncausal condition, $F(1, 95) = 4.41$, $MSE = 0.07$. Familiarity estimates did not differ reliably across conditions, $F(1, 95) = 2.08$, $MSE = 0.04$.

The results from this experiment suggest that recollection is more sensitive than is familiarity to the relation of ideas across sentences by means of a causal inference. Readers reported stronger, more vivid memory experiences to sentences from causal than noncausal pairs. The ability to recognise sentences by means of familiarity, however, was relatively unaffected by the causal manipulation.

Our analysis of the inference items yielded results that were consistent with our findings for studied items. We found that false alarms to inferences were affected by the causal relation between sentences. Once again, though, we found stronger effects for recollection than for

[1]We also conducted analyses on old items in which we adjusted hit rates by subtracting false alarms. In a first analysis, we used false alarms to inferences to adjust hits. In a second analysis, we used false alarms to new items to adjust hits. In a final analysis, we used the mean of false alarms to adjust the hit rate. The results were virtually identical to those that we present above.

familiarity.[2] The false alarm data are interesting, in part, because dual-process models make no predictions about patterns of errors. Errors are considered to be noise in these models, thus, systematic variation is unexpected. Long et al. (2006) have argued that the false recollection in the retrieval of text ideas may be a source error. Readers may include the inference in their text representation and then, at test, they falsely attribute the inference to the text rather than to their prior knowledge.

The interaction between passage type and memory estimate for the inference items is consistent with our findings in a previous study (Long et al., 2008). In that study, we examined recognition memory for sentences from science texts as a function of individual differences in domain knowledge, comprehension skill, working-memory capacity, and reasoning ability. We found that domain knowledge strongly influenced false alarms to inference items. As in the current experiment, recollection was affected more by world knowledge than was familiarity.

EXPERIMENT 2

In Experiment 1, we found an effect of general world knowledge on the vivid retrieval of ideas from a text. In Experiment 2, we tested the generality of these findings by investigating memory retrieval for ideas that are combined based on linguistic information rather than on general world knowledge. This issue is important because it counters the claim that recollection of text ideas based on world knowledge is due to the fact that the information in world knowledge may itself be subject to recollection; that is, recollection-based retrieval of world knowledge may act as a scaffold for recollection-based retrieval of text ideas that are connected to it. Thus, in this experiment we examined the recollection of text ideas by means of a cue to integration that does not involve access to world knowledge: a linguistic cue that signals repeated reference (Haviland & Clark, 1974; Gernsbacher & Robertson, 2002).

In the English language, one cue to combining text ideas is the definite article, *the*. Consider the list of sentences from a classic study by Bransford and Franks (1971):

1. The jelly was on the table.
2. The ants in the kitchen ate the jelly.
3. The ants ate the sweet jelly which was on the table.

In Bransford and Franks's (1971) study, these sentences were interleaved in a list with sentences that described other events. Participants studied the sentences and then received a recognition test consisting of old and new items. Among the new items were sentences consisting of new combinations of studied ideas. For example, participants received the sentence "The ants in the kitchen ate the sweet jelly which was on the table". The correct answer to this item was "no" because this sentence was not presented at study. Bransford and Franks found, however, that participants were confident that these sentences were

[2]It should be noted that the overall level of false recollection can be influenced by the nature of the remember/know instructions (Geraci & McCabe, 2006: McCabe & Geraci, 2009). Although some instructions produce higher rates of false recollection than do others, there is no reason to expect the wording of the instruction to interact with our causal manipulation.

studied items. Readers appeared to integrate text ideas at study into a single coherent structure, even though the text ideas were interspersed among other ideas throughout the list.

Our goal in this experiment was to examine how the relation of text ideas across sentences in a list using linguistic knowledge influences the component processes of recognition. We adapted materials from Bransford and Franks (1971) and used them in an incidental memory task. Participants read a list of sentences and were asked to answer a yes/no question about each one. They then received a recognition test consisting of old and new sentences. Some of the new sentences were lures in that they contained new combinations of studied ideas. The critical manipulation concerned the type of article that was used on the study and test lists. Some participants received lists in which all text ideas were introduced with a definite article; other participants received lists in which all ideas were introduced with indefinite articles (e.g., a, some); indefinite articles are a cue that signals the introduction of new referents. Participants were later asked to make remember/know judgments to test sentences.

If recollection is sensitive to the processes involved in relating one text idea with another, then it should be sensitive to the discourse manipulation (i.e., definite or indefinite article). Recollection estimates to old sentences should be higher in the definite article than in the indefinite article condition. Moreover, recollection estimates to new combinations of old ideas should also be higher in the definite article than indefinite article condition. This should occur even though a remember judgment to this type of sentence is a recognition error. Familiarity estimates, in contrast, should be relatively unaffected by the discourse manipulation.

Method

Participants—Participants were 138 undergraduate Psychology students in a research methods course who received the task as a class exercise.

Materials—The materials were adapted from Bransford and Franks (1971). A list of sentences was derived from four idea sets. An example set appears in Table 3. The sentences were constructed such that they contained one or more ideas from a set. Some sentences contained one idea (e.g., “The ants were in the kitchen”. “The rock crushed the hut”.), some contained combinations of two ideas (e.g., “The sweet jelly was on the table”. “The rock crushed the tiny hut”.), some contained combinations of three ideas (e.g., “The ants in the kitchen ate the jelly which was on the table”.), and one sentence from each set contained all of the ideas (e.g., “The ants in the kitchen ate the sweet jelly which was on the table”.).

A study list was created consisting of sentences from each idea set: two one-idea sentences, two two-idea sentences, and two three-idea sentences. A total of 24 sentences appeared on the list (eight one-idea, eight two-idea, and eight three-idea sentences) in a single random order. We also created a yes/no comprehension question for each study sentence (e.g., “Did some ants eat some jelly?” “Were the ants that ate the jelly on the stove?”).

A test list was created in a similar manner. The test list contained old items, lure items, and new items. The old items consisted of three sentences from each idea set that appeared on the study list: one three-idea sentence, one two-idea sentence, and one one-idea sentence.

This resulted in a total of 12-old sentences. Lure sentences were combinations of text ideas that were consistent with the idea sets but had not been presented at study: one four-idea sentence, one three-idea sentence, two two-idea sentences, and two one-idea sentences. This resulted in a total of 24 lure sentences. New items were created by combining ideas across idea sets (e.g., “The ants were in the hut”. “The boulder crushed the boy’s red cap.”). We created a total of 16 new sentences: four four-idea sentences, four three-idea sentences, four two-idea sentences, and four one-idea sentences). The entire test list contained 52 items in a single random order.

Discourse coherence was manipulated by creating a second study list in which all definite articles were replaced with indefinite ones (e.g., “Some ants in a kitchen ate some jelly”.). A new test list was created in the same manner.

Procedure—Participants were randomly assigned to two groups: the definite-article or indefinite-article group. Each participant received a booklet that contained instructions on the first page, followed by an answer sheet, a page with 20 anagrams, and then the recognition test. Participants were told that they would read a list of sentences. They should read each carefully because it would be followed by a comprehension statement. They were to use their answer sheet to record their responses. They should respond “yes” if the statement was true about the preceding sentence and respond “no” if it was not true. Each study item was projected on an overhead screen for three seconds by means of a computer controlled projector. The item was followed by a yes/no comprehension question that was also projected for three seconds. The question was followed by a screen containing a series of asterisks as a cue that the next trial was to begin.

After receiving all of the study sentences, participants solved anagrams for 5 minutes as a distractor task and then they were asked to perform the recognition task. They were told to discriminate between old items (items that they had read previously) and new items (items that they had not seen before). They were told that an item was old only if it was worded exactly as they had seen it previously. They were to respond new even if an item had the same meaning as a studied one but was worded differently. In addition, they were asked to make a remember/know judgment in response to all old items. They received the same remember/know instructions that were used in Experiment 1.

Results and discussion

Recollection and familiarity estimates were calculated from the remember and know judgments as described in Experiment 1. Estimates for old items were analysed by means of a 2 (article condition) × 2 (memory estimate) × 3 (number of ideas) repeated measures ANOVA. Article condition (definite article, indefinite article) was a between-subjects variable; number of ideas and memory estimate (recollection and familiarity) were within-subjects variables. Estimates for lure items were analyzed by means of a 2 (article condition) × 2 (memory estimate) × 4 (number of ideas) repeated measures ANOVA. Participants made very few false alarms to new items; so, new items were not analyzed.

Recollection and familiarity for old items—Memory estimates as a function of number of ideas and article condition appear in Figure 1. We found a main effect of memory

estimate such that familiarity estimates were higher than recollection estimates, $F(1, 137) = 42.31$, $MSE = 4.18$. In addition, we found a marginally reliable effect of article condition such that recognition judgments were higher in the definite than in the indefinite condition, $F(1, 137) = 3.13$, $MSE = 0.31$. Importantly, we found a reliable memory estimate × article condition interaction, $F(1, 137) = 5.50$, $MSE = 0.63$. Recollection estimates were higher in the definite article than indefinite article condition, $F = 52.54$; whereas article condition had no reliable effect on familiarity estimates $F = 2.27$.

Recollection and familiarity to lure items—Mean memory estimates for lure items as a function of estimate type, number of ideas, and article condition appear in Figure 2. We found main effects of number of ideas and response type, $F(3, 136) = 28.04$, $MSE = 0.96$ and $F(1, 138) = 20.40$, $MSE = 3.47$, respectively. These effects were modified by three reliable interactions: number of ideas × article condition $F(3, 136) = 2.79$, $MSE = 0.38$, memory estimate × article condition, $F(1, 136) = 10.04$, $MSE = 1.71$, and number of ideas × memory estimate, $F(3, 136) = 3.23$, $MSE = 0.11$. The means reflected the predicted pattern. Article condition primarily affected recollection. Participants reported more vivid, contextually specific memories for lure sentences in the definite article than indefinite article condition.

Our results are consistent with those that we reported in Experiment 1. Recollection and familiarity were influenced differently by the coherence manipulation. Recollection estimates were higher when study sentences contained cues to discourse coherence (i.e., definite articles) than when they did not contain coherence cues (i.e., indefinite articles). This occurred for both studied and lure items. In contrast, the article manipulation affected familiarity less than it affected recollection.

GENERAL DISCUSSION

Current theories of discourse comprehension, such as the Construction-Integration Model, conceptualise text representation at multiple levels, including a conceptual level consisting of text ideas and their semantic relations (a text base) and a “gist” level consisting of text ideas that have been integrated by means of some overarching thematic structure (a discourse model). The text base and discourse model are valuable as separate theoretical constructs only to the extent that they are differentially reflected in readers’ behaviour. Ideally, some measures should be sensitive to the quality of a reader’s text base representation, whereas other measures should be sensitive to the reader’s ability to construct a discourse model. The text base and discourse model are presumed to be interrelated representations; thus, it is unlikely that we can discriminate between them completely. Nonetheless, we should expect some measures to be affected more by one type of representation than by another.

Our goal in this study was to examine readers’ memories for text ideas as a means of illuminating the nature of their text representations. We based our predictions on a distinction in the verbal memory literature—the distinction between item memory and relational memory. Numerous studies have documented dissociations between memories for individual items and memories for relations among them (Cleary, Curran, & Greene, 2001;

Kelley & Wixted, 2001; Nairne, 1983; Yonelinas, 1997). Relational memory appears to be a recall-like process, whereas item memory appears to be a familiarity-based process. This dissociation is reflected in neuropsychological studies of memory. Relational memory is mediated by the hippocampus (Achem & Lepage, 2005; Henke, Weber, Kneifel, Wiesner, & Buck, 1999), whereas item memory is mediated by structures in the peri-hippocampus (Achem & Lepage, 2005). If propositions from a text are represented as individual items, and relational processing yields memory traces that are combinations of propositions, then we would expect to see the same dissociations in text memory as we do in the verbal memory literature.

The results of the current study are consistent with the dissociation of item and relational memory. We found that identification of individual ideas in a text was sufficient to produce recognition by means of familiarity, whereas manipulations that encouraged readers to relate ideas to each other led to experiences of recollection (Long & Prat, 2002; Long et al., 2006, 2008). In Experiment 1, we found that recollection estimates were higher when two sentences could be related causally than when no causal relation was possible. In Experiment 2, we found that recollection was influenced by a linguistic cue that signalled the need to relate ideas across sentences—the use of a definite article. Recollection estimates were higher when noun phrases included definite articles than when they included indefinite ones. In contrast, we found little influence of relational processing on familiarity estimates in either experiment.

We argue that the distinction between items and relations in the text representation is reflected in readers' memory experiences. When readers receive a test sentence to recognise, they execute processes to extract "units" from it; these processes are the same as those that were executed at encoding and are likely to be executed somewhat more fluently at test. This fluency is interpreted as familiarity. Recollection, in contrast, is likely to occur when a test item functions as a cue to text ideas that underwent relational processing during encoding. When readers retrieve contextually associated information in response to a test sentence, they experience the retrieval as recollection.

One criticism of our results is that they merely reflect a levels-of-processing effect rather than a qualitative distinction between item memory and relational memory in text comprehension. For example, readers in Experiment 1 may have elaborated text ideas in the causal condition more extensively than text ideas in the noncausal condition. Elaboration resulted in a strong memory trace, one that could be retrieved by means of recollection. However, explanations that evoke elaboration as the mechanism for memory enhancement have always been somewhat circular—it can be difficult to determine, a priori, which encoding condition is more elaborate than another. Consider, for example, the study of item and relational memory that we discussed in the introduction. Quamme et al. (2007) had subjects encode word-pairs in two conditions: a definition condition and a sentence condition. Both of these conditions involved considerable semantic and conceptual processing. A priori, neither condition appears more elaborate than the other. Nonetheless, the two conditions were dissociated at test based on the type of elaboration that occurred at encoding. In the definition condition, the word pairs could be "unitized" such that one element could be encoded as feature of the other. In the sentence condition, the two items

were not a single unit; rather they appeared in separate idea units that could be combined by means of semantic relations. Thus, elaboration, per se, may be less important than whether processing leads to the representation of a unitized item or a new memory trace based on the relation of items.

Current models of text comprehension do not distinguish between representations that can be retrieved based on familiarity from those that can be retrieved based on recollection, although these models do have memory implications. Consider, for example, the CI Model (Kintsch, 1998). It makes no distinction between memory traces that represent individual propositions in a text and memory traces that are created from combinations of propositions. Both are accessible in memory as a function of their activation level. This view of accessibility accords well with a signal-detection view of text retrieval. Retrieval is graded according to trace strength. There is no mechanism or representational distinction on which to base recollection. However, most models of recognition memory view recollection as a threshold process, one that is distinct from a signal detection process.

An important aspect of the recollection/familiarity distinction with respect to understanding the nature of discourse representation concerns the definition of a discourse model. According the CI Model, the integrated representation that is left after inconsistencies and irrelevancies have been deactivated, is the discourse model. We suggest that the role of recollection in the retrieval of text ideas is important in defining the discourse model. If combinations of texts ideas have a special status in the text representation because they can be accessed by means of conscious retrieval, then they may be used to generate a summary-level description at test. Thus, the discourse model may not be a structure that is pre-stored in the sense of a coherent, integrated representation. Rather, the structured representation may arise when readers are able to retrieve text ideas based on recollection and then generate a summary based on their explicit recollection. This would make the discourse model a retrieval-based phenomenon as well as a comprehension-based one.

We also suggest that it may not be necessary to propose a distinction between a text base and a discourse model. Our results can be accommodated in a model that consists of a single representation in which some text ideas are more strongly connected than are others. When text ideas are connected, the retrieval of one idea is likely to activate connected ideas. The simultaneous retrieval of text ideas would then support context-dependent, recollection judgments at test. When a text idea is superficially represented or weakly connected to other ideas, it may be retrieved, but not in a context, leading to a judgment of familiarity. Thus, our results may result from differences in the coherence of a single representation rather than separate discourse model and text base representations.

In summary, we suggest a view of text representation that is based on the distinction between item-specific and relational processing at encoding and the distinction between familiarity and recollection at retrieval. Our findings are consistent with current theories of recognition memory and make new predictions about how comprehension-related factors should influence text memory.

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References

Achem AM, Lepage M. Neural correlates of memory for items and associations: An event-related functional magnetic resonance imaging study. Journal of Cognitive Neuroscience. 2005; 17(4):652–667. [PubMed: 15829085]

Alba JW, Alexander SG, Hasher L, Caniglia K. The role of context in the encoding of information. Journal of Experimental Psychology: Human Learning and Memory. 1981; 7:283–292.

Alba JW, Hasher L. Is memory schematic? Psychological Bulletin. 1983; 93:203–231.

Albrecht JE, O'Brien EJ. Updating a mental model: Maintaining both local and global coherence. Journal of Experimental Psychology: Learning, Memory, and Cognition. 1993; 19:1061–1070.

Anderson JR. Effects of prior knowledge on memory for new information. Memory & Cognition. 1981; 9:237–246.

Anderson JR, Pitchert RD. Recall of previously unrecallable information following a shift in perspective. Journal of Verbal Learning and Verbal Behavior. 1978; 17:1–12.

Bower GH, Black JB, Turner TJ. Scripts in memory for text. Cognitive Psychology. 1979; 11:117–220.

Bransford JD, Barclay JR, Franks JJ. Sentence memory: A constructive versus interpretive approach. Cognitive Psychology. 1972; 3(2):193–209.

Bransford JD, Franks JJ. The abstraction of linguistic ideas. Cognitive Psychology. 1971; 2:331–350.

Clark SE. Word frequency effects in associative and item recognition. Memory & Cognition. 1992; 20(3):231–243. [PubMed: 1508049]

Clark SE, Gronlund SD. Global matching models of recognition memory: How the models match the data. Psychonomic Bulletin & Review. 1996; 3(1):37–60. [PubMed: 24214802]

Cleary AM, Curran T, Greene RL. Memory for detail in item versus associative recognition. Memory & Cognition. 2001; 29(3):413–423. [PubMed: 11407418]

Diana RA, Yonelinas AP, Ranganath C. The effects of unitization on familiarity-based source memory: Testing a behavioral prediction derived from neuroimaging data. Journal of Experimental Psychology: Learning, Memory, & Cognition. 2008; 34:730–740.

Fass W, Schumacher GM. Schema theory and prose retention: Boundary conditions for encoding and retrieval effects. Discourse Processes. 1981; 4:17–26.

Gardiner JM. Functional aspects of recollective experience. Memory & Cognition. 1988; 16(4):309–313. [PubMed: 3210971]

Gardiner JM, Java RI. Forgetting in recognition memory with and without recollective experience. Memory & Cognition. 1991; 19(6):617–623. [PubMed: 1758306]

Gardiner JM, Parkin AJ. Attention and recollective experience in recognition memory. Memory & Cognition. 1990; 18(6):579–583. [PubMed: 2266859]

Geraci L, McCabe D. Examining the basis for illusory recollection: The role of remember/know instructions. Psychonomic Bulletin & Review. 2006; 13:466–473. [PubMed: 17048732]

Gerrig RJ, McKoon G. The readiness is all: The functionality of memory-based text processing. Discourse Processes. 1998; 26:67–86.

Gernsbacher, M. Language comprehension as structure building. Hillsdale, NJ: Erlbaum; 1990.

Gernsbacher, MA.; Robertson, RRW. The definite article *the* as a cue to map thematic information. In: van Peer, W.; Louwerse, MM., editors. Thematics: Interdisciplinary studies. Philadelphia: John Benjamins; 2002. p. 119-136.

Gillund G, Shiffrin RM. A retrieval model for both recognition and recall. Psychological Review. 1984; 91:1–67. [PubMed: 6571421]

Giovanello KS, Keane MM, Verfaelie M. The contribution of familiarity to associative memory in amnesia. Neuropsychologia. 2006; 44:1859–1865. [PubMed: 16643967]

Graesser AC, Gordon SE, Sawyer JD. Recognition memory for typical and atypical actions in scripted activities: Tests of a script pointer + tag hypothesis. Journal of Verbal Learning and Verbal Behavior. 1979; 18:319–332.

Haviland SE, Clark HH. What's new? Acquiring new information as a process in comprehension. Journal of Verbal Learning and Verbal Behavior. 1974; 13:512–521.

Henke K, Weber B, Kneifel S, Wiesner HG, Buck A. Human hippocampus associates information in memory. Proceedings of the National Academy of Sciences. 1999; 96(10):5884–5889.

Hintzman DL. Judgments of frequency and recognition memory in a multiple-trace memory model. Psychological Review. 1988; 95:528–551.

Hintzman DL, Caulton DA. Recognition memory and modality judgments: A comparison of retrieval dynamics. Journal of Memory and Language. 1997; 37(1):1–23.

Hintzman DL, Curran T. Retrieval dynamics of recognition and frequency judgments: Evidence for separate processes of familiarity and recall. Journal of Memory and Language. 1994; 33(1):1–18.

Humphreys MS. Item and relational information: A case for context independent retrieval. Journal of Verbal Learning & Verbal Behavior. 1978; 17:175–187.

Humphreys MS, Bain JD, Pike R. Different ways to cue a coherent memory system: A theory for episodic semantic, and procedural tasks. Psychological Review. 1989; 96:208–233.

Jacoby LL. A process dissociation framework: Separating automatic from intentional uses of memory. Journal of Memory and Language. 1991; 30(5):513–541.

Jacoby LL, Dallas M. On the relationship between autobiographical memory and perceptual learning. Journal of Experimental Psychology: General. 1981; 100:306–340. [PubMed: 6457080]

Jacoby LL, Toth JP, Yonelinas AP. Separating conscious and unconscious influences of memory: Measuring recollection. Journal of Experimental Psychology: General. 1993; 122(2):139–154.

Johnson W, Kieras D. Representation-savings effects of prior knowledge in memory for simple technical prose. Memory & Cognition. 1983; 11:456–466. [PubMed: 6656605]

Kelley R, Wixted JT. On the nature of associative information in recognition memory. Journal of Experimental Psychology: Learning, Memory, and Cognition. 2001; 27(3):701–722.

Kintsch W. The role of knowledge in discourse comprehension: A construction-integration model. Psychological Review. 1988; 95:163–182. [PubMed: 3375398]

Long DL, Oppy BJ, Seely MR. Individual differences in the time course of inferential processing. Journal of Experimental Psychology: Learning, Memory, and Cognition. 1994; 20:1456–1470.

Long DL, Oppy BJ, Seely MR. Individual differences in readers' sentence- and text-level representations. Journal of Memory and Language. 1997; 36:129–145.

Long DL, Prat CS. Memory for *Star Trek*: The role of prior knowledge in recognition revisited. Journal of Experimental Psychology: Learning, Memory, and Cognition. 2002; 28:1073–1082.

Long DL, Prat CS, Johns CL, Morris PE, Jonathan E. The importance of knowledge in vivid text memory. Psychonomic Bulletin and Review. 2008; 15(3):604–609. [PubMed: 18567262]

Long DL, Wilson J, Hurley R, Prat CS. Assessing text representations with recognition: The interaction of domain knowledge and text coherence. Journal of Experimental Psychology: Learning, Memory, and Cognition. 2006; 32:816–827.

Mandler G. Recognizing: The judgement of previous occurrence. Psychological Review. 1980; 87:252–271.

McCabe D, Geraci L. The influence of instructions and terminology on the accuracy of remember-know judgments. Consciousness and Cognition. 2009; 18:401–413. [PubMed: 19344688]

McKoon G, Gerrig RJ, Greene SB. Pronoun resolution without pronouns: Some consequences of memory-based text processing. Journal of Experimental Psychology: Learning, Memory, and Cognition. 1996; 22:919–932.

McKoon G, Ratcliff R. Memory-based language processing: Psycholinguistic research in the 1990s. Annual Review of Psychology. 1998; 49:25–42.

Moravcsik JE, Kintsch W. Writing quality, reading skill, and domain knowledge as factors in text comprehension. Canadian Journal of Psychology. 1993; 47:360–374.

Murdock BB. A theory of the storage and retrieval of item and associative information. Psychological Review. 1982; 89:609–626.

Myers JL, O'Brien EJ. Accessing the discourse representation during reading. Discourse Processes. 1998; 26:131–157.

Nairne JS. Associative processing during rote rehearsal. Journal of Experimental Psychology: Learning, Memory, and Cognition. 1983; 9:3–20.

Quamme JR, Yonelinas AP, Norman KA. Effect of unitization on associative recognition in amnesia. Hippocampus. 2007; 17:192–200. [PubMed: 17203466]

Rajaram S. Remembering and knowing: Two means of access to the personal past. Memory and Cognition. 1993; 21(1):89–102. [PubMed: 8433652]

Schneider, W.; Körkel, J.; Weinert, FE. Expert knowledge, general abilities, and text processing. In: Schneider, W.; Weinert, FW., editors. Interactions among aptitudes, strategies and knowledge in cognitive performance. New York: Springer-Verlag; 1990. p. 93-128.

Singer M, Halldorson M, Lear JC, Andrusiak P. Validation of causal bridging inferences in discourse understanding. Journal of Memory and Language. 1992; 31(4):507–524.

Spilich GJ, Vesonder GT, Chiesi HL, Voss JF. Text processing of domain-related information for individuals with high and low domain knowledge. Journal of Verbal Learning and Verbal Behavior. 1979; 18:275–290.

Sulin RA, Dooling DJ. Intrusion of a thematic idea in the relationship of prose. Journal of Experimental Psychology. 1974; 103:255–262.

Summers WV, Horton DL, Diehl VA. Contextual knowledge during encoding influences sentence recognition. Journal of Experimental Psychology: Learning, Memory, and Cognition. 1985; 11:771–779.

Tulving E. Memory and consciousness. Canadian Psychology. 1985; 26:1–12.

Yonelinas AP. Receiver-operating characteristics in recognition memory: Evidence for a dual-process model. Journal of Experimental Psychology: Learning, Memory & Cognition. 1994; 20:1341–1354.

Yonelinas AP. Recognition memory ROCs for item and associative information: The contribution of recollection and familiarity. Memory & Cognition. 1997; 25(6):747–763. [PubMed: 9421560]

Yonelinas AP. The nature of recollection and familiarity: A review of 30 years of research. Journal of Memory and Language. 2002; 46:441–517.

Yonelinas AP, Jacoby LL. The relation between remembering and knowing as bases for recognition: Effects of size congruency. Journal of Memory and Language. 1995; 34:622–643.

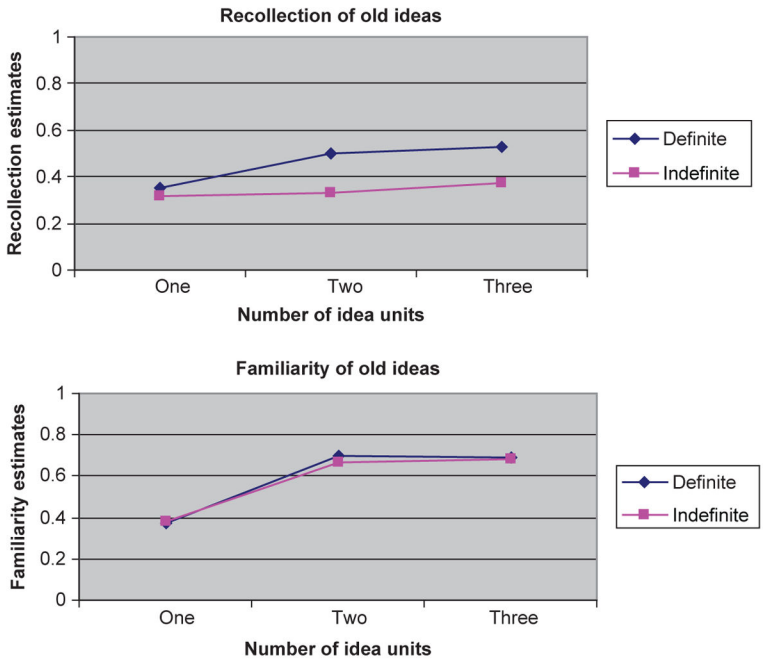

Figure 1.

Recollection and familiarity estimates for old items as a function of number of ideas and article condition.

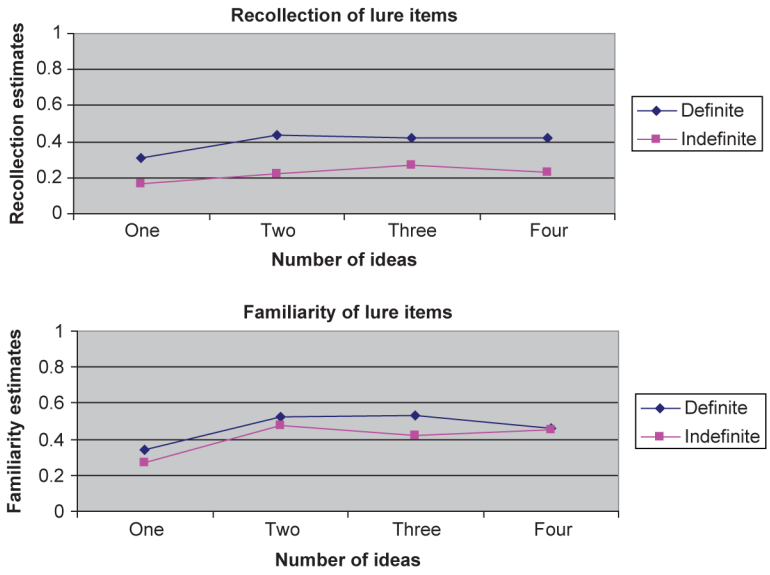

Figure 2.

Recollection and familiarity estimates to lure items as a function of number of ideas and article condition.

TABLE 1

Remember and know instructions

We are interested in your memory for the passages that you just read. Below you will see a list of sentences. Some of these sentences appeared in the passages; other sentences are similar in content to the ones that you read, but did not actually appear. For each of the following sentences, we would like you to decide if it is an old sentence (one that you read) or is a new sentence (one that you did not read).
If you decide that the sentence is old, we would like you to think about your memory experience. Sometimes, when we remember something, we have a vivid, detailed recollection of it. We can imagine it in our head or we can recall specific details about it. For example, if you see a woman on the street, you might remember her name and when or where you met her before. At other times, when we remember something, we are confident that we have experienced it before, but we do not remember specifics about it. For example, you might see a woman and be confident that you have met her in the past, but you might not remember her name or when you met her.
If you recognize a sentence from the passage, we would like you to decide if you "remember" it or if you just "know" that it was in one of the passages. "Remember" is your conscious awareness that you experienced the sentence at study. You might remember some aspect of the sentence (e.g., its physical appearance, something that happened in the room while you were reading, what preceded or followed the sentence) or you might remember what you were thinking while you were reading the sentence. That is, a "remembered" sentence should bring back to mind a particular association, thought, or image. If you are confident that a sentence is old, but you do not "remember" it, you should respond "know". A "know" response means that you are certain that you recognize the sentence, but you have no specific, conscious recollection of it. If you do not recognize the sentence at all, please respond "new".

TABLE 2

Experiment 1: Responses and estimates (in proportions) to old, new, and inference items as a function of passage type

	Passage type					
	Causal			Noncausal		
	Old	New	Inference	Old	New	Inference
Response						
Remember	0.68 (0.23)	0.02 (0.07)	0.10 (0.16)	0.49 (0.31)	0.01 (0.06)	0.06 (0.13)
Know	0.14 (0.16)	0.07 (0.10)	0.11 (0.19)	0.24 (0.25)	0.08 (0.10)	0.09 (0.16)
Estimate						
Recollection	0.68 (0.23)	0.03 (0.07)	0.10 (0.16)	0.49 (0.51)	0.03 (0.06)	0.06 (0.13)
Familiarity	0.43 (0.33)	0.05 (0.07)	0.13 (0.22)	0.46 (0.37)	0.06 (0.08)	0.11 (0.19)

Note: Standard deviations are in parentheses.

TABLE 3

An example idea set from Bransford and Franks (1971)

Number of ideas	Example sentences
Four	The ants in the kitchen at the sweet jelly which was on the table.
Three	The ants ate the sweet jelly which was on the table. The ants in the kitchen ate the jelly which was on the table. The ants in the kitchen ate the sweet jelly.
Two	The ants in the kitchen at the jelly. The ants ate the sweet jelly. The sweet jelly was on the table. The ants ate the jelly which was on the table.
One	The ants were in the kitchen. The jelly was on the table. The jelly was sweet. The ants ate the jelly.