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Distinct Characteristics of Verbatim, Propositional and Situational Representations in Text Comprehension

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While cognitive scientists have investigated in some detail how subjects remember texts (Kintsch, 1974; Kintsch & Van Dijk, 1978; Schank & Abelson, 1977), in real life texts are often studied with a completely different intention. For example, a student studying a computer science textbook or a car mechanic studying a repair manual is more interested in acquiring knowledge about the respective subject domain as opposed to merely remembering the wording or meaning of the text. In order to become a successful computer programmer, a person must form a general representation of the respective computer language and how to use it, including many possible situations which arise when programming a computer.

It may therefore be expected that in addition to verbatim and propositional text representations, a reader also forms a cognitive representation of real or hypothetical situations addressed by a text. Van Dijk and Kintsch (1983) have presented several arguments that the representation of a text and the representation of real or possible situations mentioned by a text do not always coincide and may therefore have their own distinct cognitive existence, so that three different cognitive structures should be distinguished: Whereas verbatim memory and the propositional textbase reflect the wording and the meaning-structure of a particular text, respectively, a situational or mental (Johnson-Laird, 1980) model is assumed to represent situations of the real or some possible world about which a given text presents some new information.

The cognitive architecture of verbatim and propositional text representations on the one hand, and representations of the situations referred to by a text on the other, were examinined in four experiments. By instructing subjects to either read a text for text summarization or for knowledge acquisition, the first experiment investigated differences in the encoding processes of the textbase and the situational model, while the second experiment examined differences in the resulting cognitive structures. In order to test the different information retrieval speeds from the three cognitive structures, a speed-accuracy trade-off analysis was employed in a third experiment. A fourth experiment investigated how the construction of propositional and situational representations depends upon a reader's prior domain knowldege.

Experiment 1

Because the textbase and the situational model may be constructed by possibly interacting, but nevertheless separate, mental processes from different cognitive elements (Anderson, 1983), it is expected that subjects who read a text in order to write a summary (text summarization or TS readers) thereafter, would show different reading time patterns than readers who study the same text in order to acquire knowledge about the respective subject domain (knowledge acquisition or KA readers). In order to investigate the construction of a textbase and a situational model in a realistic but controlled setting, 64 subjects who did not know anything about LISP were given part of a LISP programmer's manual to study. The experimental text had a clearly identifiable hierarchical structure. Whereas the paragraphs at the highest level (level 1) in the text hierarchy expressed the text's macrostructure, substantive LISP information, which is needed for the construction of a situational model, was presented at the lower levels of the text hierarchy. Since the most important information for constructing a textbase and a situational model were contained in different paragraphs, differences in the cognitive processing of TS and KA readers could be assessed by comparing the reading times of different text segments.

The average reading times per word for the different text levels are shown in Figure 1, for each of the two subject groups. Whereas TS readers show a clear levels effect with the longest word reading times for the highest level in the text hierarchy, KA subjects showed the longest word reading times for the second text level, which presented substantial information about the programming language LISP.

These results suggest that, by emphasizing macroprocessing TS readers were more thoroughly engaged in constructing a textbase, whereas KA readers focussed on developing a situational model by processing the more substantive information about LISP. The cognitive products of these differential encoding processes were examined in a second experiment.

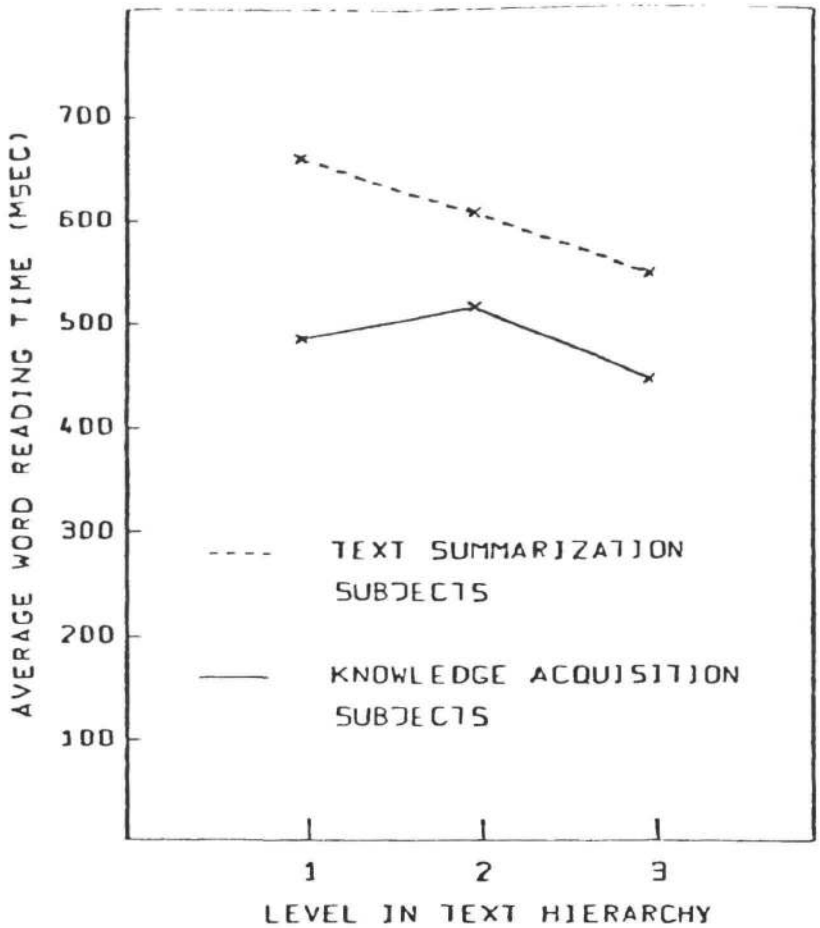

Figure 1. Average reading times per word (msec) as a function of the level in the text hierarchy for each of the two study instructions (studying in order to write a text summary or studying in order to acquire knowledge about the subject domain).

Experiment 2

In order to examine the relative strength of verbatim, propositional and situational representations, a retrieval model was specified for the three cognitive structures. It was assumed that during the recognition processing of a sentence, the retrieval results of the three structures are continuously combined (e.g. added) to yield the currently accumulated recognition strength at any point in time. In addition, it was assumed that the accumulated recognition strength determines a subject's recognition decision. By presenting subjects with test sentences which differ only by the contribution of one of the three cognitive structures, the strength of the respective structure may be examined. Four different types of test sentences can be constructed: A sentence may be presented in the original form it occurred in the text (O-sentences); it may be paraphrased (P-sentences); its meaning may be changed, while preserving its situational correctness (M-sentences); and its situational correctness could be changed in addition (C-sentences). As shown in Table 1, the O-P, P-M, and M-C sentence pairs differ only by the contribution of the verbatim, the propositional and the situational representations, respectively.

TABLE 1

Contribution of verbatim memory, the textbase, and the situational model to each of the four sentence forms

	test sentence			
	correctness changed	meaning changed	paraphrased	original
verbatim memory	-	-	-	+
textbase	-	-	+	+
situational model	-	+	+	+

Note. The "+" and "-" indicate whether a cognitive structure supplies evidence for a yes (old) or no (new) recognition decision, respectively.

The strength of verbatim, propositional and situational representations may thus be assessed in a signal detection analysis by respective d' values. The mean d' scores of verbatim, propositional and situational representations obtained for TS and KA readers, whose overall text study time was controlled, are shown in Table 2.

TABLE 2

d' accuracy-scores of each processing goal

for the three cognitive structures

processing goal	representation		
	verbatim	propositional	situational
test summarization (TS)	-0.10	0.84	1.15
knowledge acquisition (KA)	0.38	0.25	1.42

These results show that TS and KA readers emphasized different components of text processing. Whereas TS readers developed a better propositional text representation, KA readers emphasized the construction of a situational model. By demonstrating how the development of cognitive structures depends upon a reader's processing goals, these results provide additional evidence for the distinction of a propositional text representation and a situational model.

Experiment 3

In order to eliminate the influence of short term memory and to further examine the speed with which information is retrieved from the three cognitive structures, an experiment with an interfering task between the study and the test phase was performed. Figure 2 shows the average d' retrieval scores of verbatim, propositional, and situational information which were obtained for the different processing times.

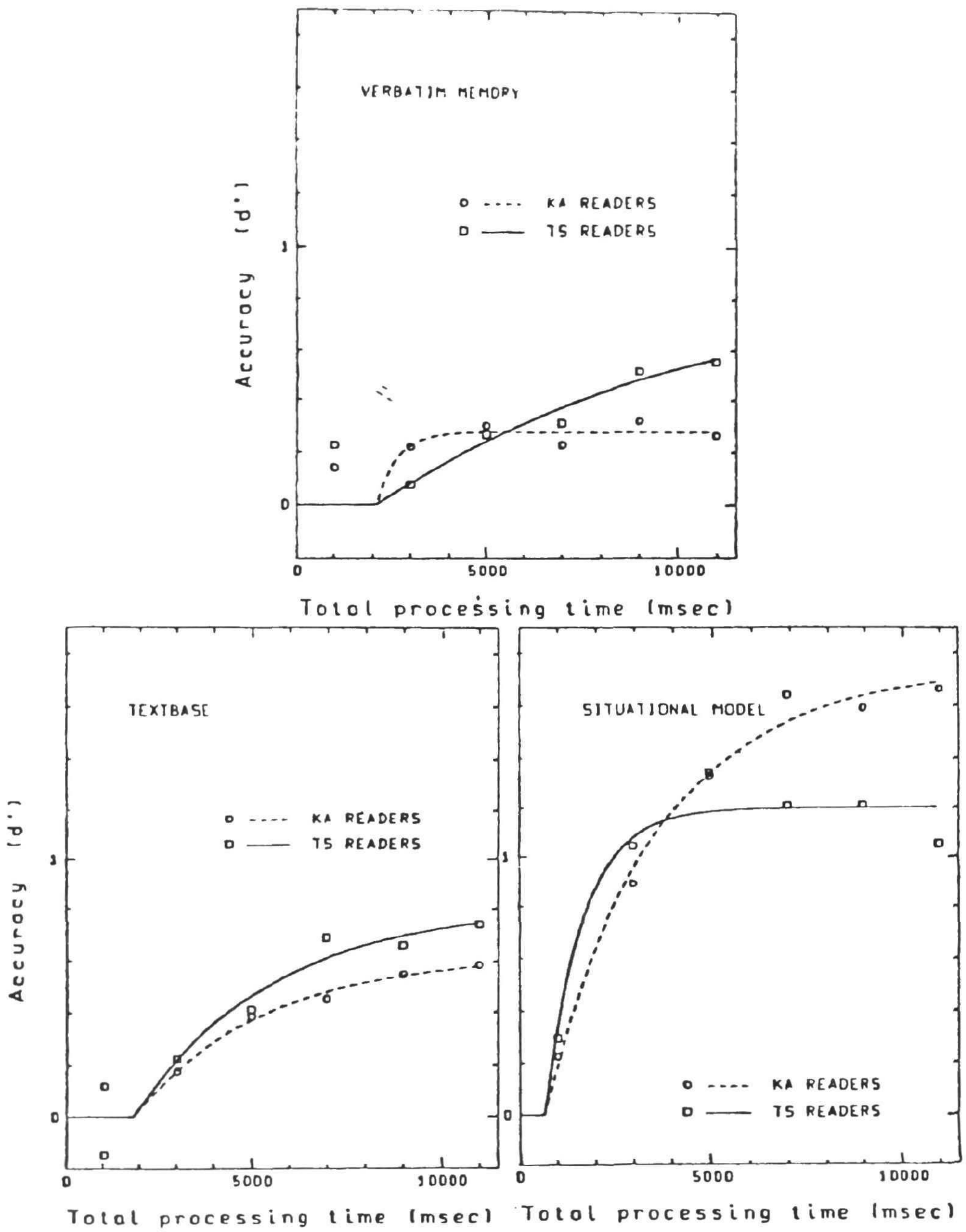

Figure 2. Accuracy scores (d') at different processing times for each of the three retrieval components (verbatim memory, textbase, and situational model) and the two study instructions (studying in order to write a text summary, TS, or studying in order to acquire knowledge, KA. The smooth curves represent best fitting speed-accuracy trade-off functions.

Instead of verbatim information, subjects based their recognition decisions mostly upon propositional and situational information. Also, KA readers retrieved more situational information than TS readers, although situational information was retrieved faster than propositional information for both subject groups. The results thus indicate that accessing a situational model is faster and proceeds at a higher speed than accessing a textbase. Even for recognition decisions, situational information is more important than verbatim or propositional information. It thus appears that in addition to verbatim and propositional text representations, the construction of a situational model is an important component of representing knowledge about the subject domain of a text. Subjects seem to utilize situational information for judging a sentence by its plausibility (Reder, 1982) which proceeds faster than searching memory for a propositional match with the textbase.

Experiment 4

Subjects with and without prior knowledge about computer programming studied a programmer's manual (LISP). For all subject groups, sentence reading times increased with the number of propositions in a sentence, indicating the construction of a textbase. All subjects successfully remembered the text by its meaning rather than by its wording. While subjects without prior domain-specific knowledge only remembered the text itself, subjects with prior domain-specific knowledge in addition acquired general knowledge about LISP. The construction of a situational model is thus more dependent upon a reader's prior knowledge than the construction of a situational model. It may thus be concluded that text memory is a by-product of general comprehension heuristics, such as micro- and macroprocesses. However, the updating of world knowledge critically depends upon a reader's prior knowledge.

In the four experiments, distinct characteristics of verbatim, propositional, and situational representations were thus determined in the domain of technical texts by examining encoding and retrieval processes, cognitive structures, different processing goals, and expert-novice differences.

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