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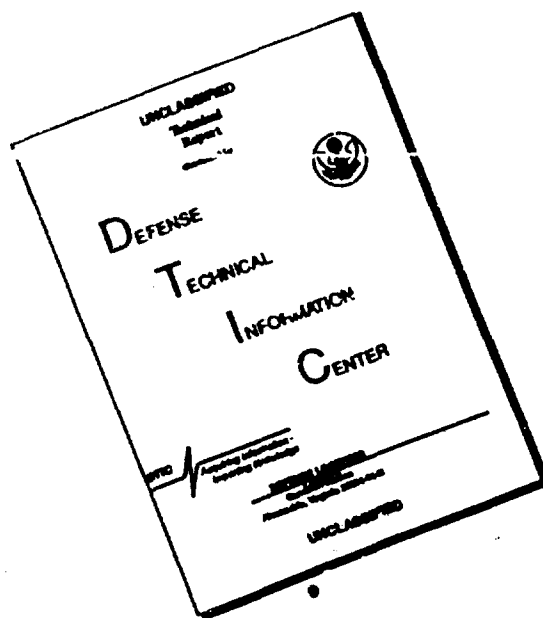
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Results from the first year of the AASERT grant showed that readers high and low in working memory (WM) capacity read expository text in qualitatively different ways, and this resulted in the groups learning different information from the same text. In the first experiment, a probe deadline methodology sampled the contents of WM during the reading of expository passages. The lag between the presentation of expository information and the presentation of a probe question about that information was varied. The questions tested the reader's ability to recall detail or topic information. Subjects performed similarly on the topic probe questions. However, subjects low in WM capacity answered fewer detail probe questions correctly than those high in WM capacity. In the second experiment, subjects read the passages without topic sentences, and answered thematic and detail questions about them. Reading times for identical sentences in a topic absent and topic present conditions and subjects' accuracy in answering detail and topic questions were compared. Subjects performed similarly in the topic present condition, but subjects low in WM capacity answered fewer detail questions correctly in the topic absent condition.			
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Augmentation of Research on Cognitive Control

grant no. F49620-92-J-0243

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FINANCIAL STATEMENT 31

RESEARCH OBJECTIVES

The research supported by this grant is designed to uncover basic principles of cognitive control during the comprehension of expository text. That means we are trying to determine how individuals adapt their strategies for learning from text to both variations in text and to their own information processing limitations. In research in my own laboratory (e.g., Lee-Sammons & Whitney, 1991) and others (e.g., Just & Carpenter, 1992), it has been established that subjects read in a qualitatively different fashion if they are low in working memory (WM) capacity. The capacity of WM is measured as the subjects' ability to actively manipulate information in short-term memory. Previous research in this area has focused on narrative, or story-like, materials. This project focuses on expository text, which people read to learn specific information. Unlike narrative text, which follows a familiar organizational pattern, expository texts vary widely in their organizational schemes. This makes them useful for the study of how people flexibly allocate their WM resources during comprehension. In addition, by studying expository text, we may be able to uncover basic principles that can be applied to improving people's ability to learn from text. In the first year of the AASERT grant, Desiree Budd (the supported student) and I had two specific objectives in mind:

- (1) We wished to establish whether there were tradeoffs in the processing of expository text that were associated with low WM capacity.
- (2) If such tradeoffs could be established, then we wished to begin to develop a theoretical framework that could explain how comprehension processes could vary qualitatively by subject or task conditions.

STATUS OF THE RESEARCH EFFORT

Tradeoffs in Expository Text Processing

Several current theories of text processing (e.g., van Dijk & Kintsch, 1983; Kieras, 1982) make a distinction between macroprocessing (keeping track of the theme of a text) and microprocessing (relating each sentence to the preceding sentence). We reasoned that subjects low in WM capacity (low spans) might face a tradeoff between these two types of processing. That is, they could track sentence-to-sentence connections and learn about the details of a passage, or they could determine how each sentence relates to the overall theme and learn more about the topic of the passage. In contrast, high span readers were expected to perform both types of processing.

To test this hypothesis, we developed a set of expository passages with a simple hierarchical structure. That is, each passage began with a statement of the overall topic, and this was followed by six supporting detail sentences. The passages were adapted from various non-technical science and hobby magazines.

The subjects read the passages in a self-paced, sentence-by-sentence fashion from a CRT screen. The subjects were interrupted at various intervals by true/false probe questions about topic or specific detail information. The probe questions occurred either immediately after the relevant sentence, or after a two or four sentence lag.

Based on pilot testing, we used a 2.5 second deadline for answering the probe questions. Thus, subjects had 2.5 seconds within which to answer probe question. Our pilot experiments showed that both high and low span subjects could answer the probe questions with 70-80% accuracy in the immediate condition when given this deadline. Our interest was in whether probe questions accuracy declined with intervening sentences (lag). In a similar experiment, Glanzer and Nolan (1986) found that, in general, ability to respond to questions about the topic did NOT vary with lag, while responses to detail probes DID VARY with lag. They interpreted this result as showing that topic information is actively maintained in WM throughout the reading of a text.

As shown in Table 1, we replicated Glanzer and Nolan's finding for both high span and low span subjects. That is, there was no evidence that only high span subjects perform macroprocessing.

Table 1: Probe Deadline Experiment
Mean Proportion of Correct Responses

	Topic Probes			Detail Probes		
Span	Lag 0	Lag2	Lag 4	Lag 0	Lag2	Lag 4
High	.825	.808	.783	.875	.792	.750
Medium	.833	.725	.750	.775	.675	.717
Low	.775	.725	.692	.817	.658	.750

Based on an ANOVA, the variations across lags are not significant for the topic probes, but they are significant for the detail probes. There were no significant interactions with WM. Also of interest is the finding that there were no significant main effects of span on answers to the topic probes, but there was a significant effect of span on responses to the detail probes. Inspection of the lag 0 data shows that this is not due simply to the detail probes being more difficult. The finding that low spans performed more poorly than high spans only on detail probes suggests that these readers may have performed macroprocessing at the expense of microprocessing. In other words, the low span subjects may keep track of topic information at the expense of learning the details.

We completed a second experiment designed to provide converging evidence for the hypothesis that low span readers perform macroprocessing at the expense of microprocessing. The same passages were presented to high and low span subjects, but half the passages were given without the topic sentence. Kieras (1982) found that when subjects performed macroprocessing, the reading times to the first few detail sentences were increased in the topic absent condition as subjects tried to infer a topic. The results of the first experiment suggest that low span subjects will attempt to perform thematic processing. They, like other readers, should show increased reading times for at least the first detail in the topic absent as compared to the topic present condition. However, inferring a topic increases the demands on working memory resources, so in the topic absent condition, in particular, the low spans were expected to perform worse than high spans on questions about the details of the passage. Thus, after every six passages subjects were asked a multiple choice question about each passage. Overall, half the questions were about topics and half were about details.

The reading time data (Figure 1) indicate that both groups of subjects were performing macroprocessing. Reading time to the first detail sentence (shown as "sentence 2") was elevated in the topic absent condition. In addition, in the topic present condition reading times for the topic sentence were longer than for the first detail sentence.

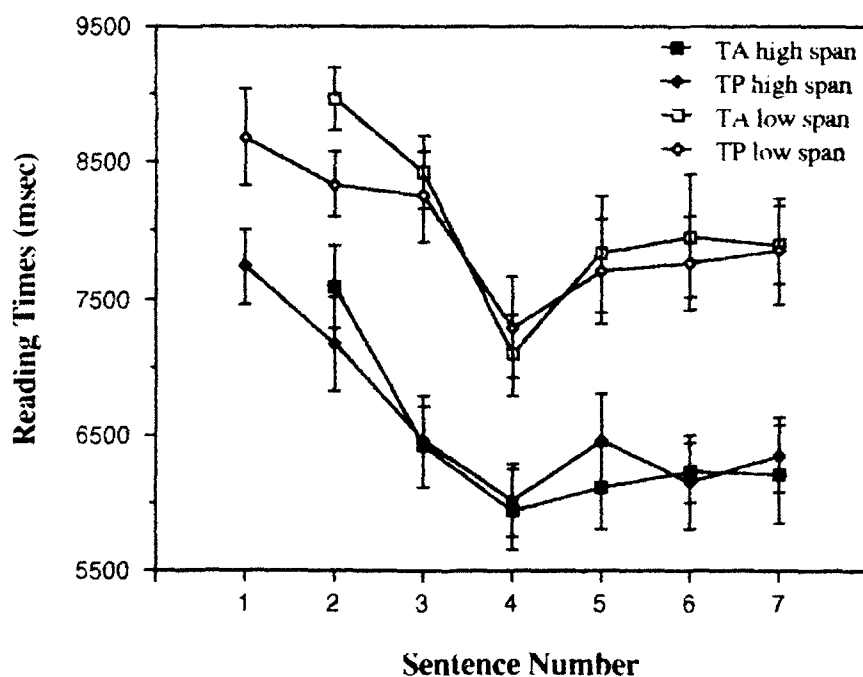


Figure 1: Note that reading times for identical sentences in the two conditions are plotted on the same abscissa point. TA=Topic Absent; TP=Topic Present.

If the hypothesis is correct that low spans perform macroprocessing at the expense of microprocessing, then we should find a span effect for answering detail questions in the topic absent condition. There should be no span effect for topic questions. This result was obtained as shown in the table below.

Table 2: Mean Proportion of Questions Correct
(Topic Absent Condition)

Span	Topic Questions	Detail Questions
High	.77	.81
Low	.77	.68

Performance in the topic present condition did not differ significantly by span. Both groups answered approximately 75% of the detail questions correct and 85% of the topic questions correct.

The important result is that low span subjects only performed worse than high span subjects on the detail questions in the topic absent condition. This is clear evidence that, when low span subjects had to infer a topic, it was to the detriment of microprocessing. It should be noted that in this experiment, there were no probe items to interrupt reading, so the experiment resembled naturalistic reading as closely as possible. These are the first data of which I am aware that show that lower WM capacity is associated with a tradeoff between macroprocessing and microprocessing. We plan to begin a new series of experiments that will test whether higher span readers will face a similar tradeoff with more difficult text. Also, by varying the proportion of topic and detail comprehension questions we can test whether the type of tradeoff obtained in these experiments is under the strategic control of the reader.

Theory Development

Several researchers in the area of text comprehension have claimed that skilled readers adjust their comprehension processes as they read to fit the nature of the text they are reading and their current reading goals (e.g., Just & Carpenter, 1992; Vonk & Noordman, 1990). The adjustment of the comprehension system to such contextual constraints may also include adjustments by subjects to their own WM capacity (Whitney & Waring, 1991; Budd & Whitney, in preparation). This raises the interesting theoretical question of how the comprehension system can be self-organizing to adapt to a variety of contextual constraints.

We are developing a contextualist framework that will provide the basis for understanding how the information processing system

could make context-sensitive adjustments. The architecture for this framework is a hybrid of a semantic network and a production system. We believe that it will be possible to go beyond describing the adjustments that readers make in context, and actually predict what types of adjustments will be made, and in what contexts. The key is to view comprehension research as part of the larger area of research on elaboration in memory. We have completed a literature review on when elaborative processes (such as forming particular connections among the concepts active in memory) are beneficial to retention and when they are not. We are currently relating the data from the memory literature to the problem of retaining certain types of information from text. We hope to use the principles obtained from memory research to predict what types of text comprehension processes will be found in certain contexts.

REPORTS RESULTING FROM THE GRANT

Conference Presentation

Whitney, P., Waring, D.A., & Hewitt (Budd), Desiree. (1992). Task effects on the activation and incorporation of elaborative inferences. Paper presented at the 33rd Annual Meeting of the Psychonomic Society, St Louis, MO.

Manuscripts In Preparation

Whitney, P. & Budd, D. Constructivism, minimalism, and contextualism: Beyond polarized views of inferences and reading.

Budd, D. & Whitney, P. Allocation of working memory resources during the reading of expository text.

Both of these manuscripts will be ready for submission by 8/15/93, and I will furnish copies to AFOSR.

Professional Personnel

The graduate student supported by the AASERT grant was Desiree Budd. She completed her masters thesis while supported by this grant and was awarded the M.S. degree.

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