Revista da ANPOLL, nº 2, p. 71-93, 1996

INDIVIDUAL DIFFERENCES IN TEXT ORGANIZATION PERCEPTION AND WORKING MEMORY CAPACITY

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ABSTRACT: *The reading processes of better and weaker readers were analyzed as they read complete and distorted texts organized in terms of Problem/Solution (Hoey, 1979). Results indicated that better readers were more aware of text structure and used this knowledge to organize the flow of information processing, thus not overwhelming working memory.*

KEY WORDS: *Text Organization, Distortions, Perception, Working Memory.*

Early theories of short-term memory regarded it as a system containing a fixed number of slots which could temporarily hold information for retrieval after a brief period of time (Miller, 1956; Waugh and Norman, 1965). Today short-term memory is seen as a dynamic system which has processing functions as well as storage functions (Baddeley and Hitch, 1974; Daneman and Carpenter, 1980; Just and Carpenter, 1992; Cantor and Engle, 1993 and others). The term working memory (Baddeley and Hitch, 1974) has been used to refer to this more active system. Working memory is regarded as 'an arena of computation' (Just and Carpenter, 1992) where both functions- storage and processing- compete for capacity in the system (Baddeley and Hitch, 1974; Daneman and Carpenter, 1980, 1983; van Dijk and Kintsch, 1983; Cantor, Engle and Hamilton, 1991; Just and Carpenter, 1992; Engle, Cantor and Carullo, 1992; Cantor and Engle, 1993). Despite the fact that the concept of a short-term passive store has been changed to that of a more active working memory, one aspect of former theories has been preserved: working memory is transient and of limited capacity. However, there is still a major difference in how former and recent theories view the concept of limitation in the system. In former theories, the limitation of short-term memory is in the number of items it can actually hold at any one time. In recent theories, the limitation in working memory is in the resources available to support processing and storage. Ashcraft (1994) captures that difference in a very clear way (emphasis from the original):

> Short-term memory is short- it doesn't last very long. The very term embodies the notion of a limited capacity system. Where is the limitation in capacity? It's in short-term memory. Why is short-term memory limited? It's too short! Working memory, on the

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> other hand, uses the active verb work. This is an action-packed, busy place, a place where mental activity happens. Where is the limitation in the system? It's in how much work can be done at one time, how much working memory capacity there is to share among several simultaneous processes. (p. 146).

1.0 WORKING MEMORY CAPACITY AND READING COMPREHENSION

There is agreement among researchers that working memory plays an important role in all kinds of human cognitive activities (Baddeley, 1990; Engle, Carullo and Collins, 1991; Just and Carpenter, 1992; and others). Taking into account the complex process of reading comprehension and the limited capacity of working memory, one is tempted to ask how a reader manages to construct a meaningful representation of the text considering the great storage and processing demands required in the process of reading. The demands for storage include pragmatic, semantic, and syntactic information which are necessary for computing relationships within and between clauses and sentences (Daneman and Carpenter, 1980; Goldman, Hogaboam, Bell and Perfetti, 1980). Propositions which are of central importance to the theme of the text also have to be maintained in working memory, so that relations between larger portions of the text can be established (van Dijk and Kintsch, 1983). The demands for processing include decoding, lexical accessing, parsing, inferencing and integrating (Daneman and Carpenter, 1980), i.e. all the processes involved in reading comprehension. Therefore, in order to comprehend a text, the reader has to keep a representation of previously read information as well as compute the necessary relationships in the stream of input (Just and Carpenter, 1992).

Researchers have suggested a number of mechanisms which can reduce the demands on storage. Just and Carpenter (1992) suggest three mechanisms. First, the reader tries to interpret each word or phrase as soon as it is encountered, what they call immediacy of processing. Second, the deactivation of lower level representations as higher level structures have been built (e.g. surface representations of words and syntactic structures may be deactivated after referential representations have been created). Third, the context provided in the text facilitates processing, hence reducing the demands for storage. Kintsch and van Dijk (1978) and van Dijk and Kintsch (1983) propose a model of language comprehension according to which only the most recent and most important propositions from preceding text remain activated in working memory, what they call the leading-edge strategy. Fletcher (1986) extends the work of Kintsch and van Dijk and proposes a number of 'potential selection strategies' which might determine the choice of the propositions which will remain activated during the course of reading comprehension. Four of these strategies are described by Fletcher

as local and four as global strategies. Local strategies include Kintsch and van Dijk's leading edge strategy, and three others based on recency, sentence topic and frequency. Global strategies include scripts, plans and goals, discourse topic and discourse structure. Of direct relevance to the present study is the discourse structure strategy (see Fletcher, 1986 for a detailed description of the other mechanisms).

According to Fletcher, 'structure-based' strategies determine the selection of the most recent propositions which pertain to the information located high in the hierarchical organization of the text. As Fletcher observes, this mechanism is the only one of the eight strategies he describes which needs a specific formulation for each type of discourse structure. Fletcher examined the psychological validity of this mechanism for two types of discourse structure: story structure and inverted pyramid (news articles). The present study investigated the psychological validity of another type of text organizational pattern: Problem/Solution (Hoey, 1979). The focus in the present study was on the role of the Problem/Solution pattern in organizing the flow of information processing in working memory and hence in reducing the demands for storage and processing. The processes of better and weaker readers were investigated as they read texts organized in terms of Problem/Solution.

1.1 Research on the role of text structure in reading comprehension

Research on the role of text structure in reading comprehension suggests that proficient readers use their knowledge of the overall organization of a text to facilitate encoding and subsequent retrieval of text information (van Dijk and Kintsch, 1983; Taylor and Samuels, 1983; Meyer, Brandt and Bluth, 1980; Carrell, 1984, 1992; Winograd, 1984; Ohlhausen and Roller, 1988; Roller, 1990). This view assumes that proficient readers process texts in a strategic fashion: they are able to perceive important clues in the text which signal a particular rhetorical pattern and they use their own knowledge of that pattern to organize the incoming information into hierarchical clusters and form a complete macrostructure (van Dijk and Kintsch, 1983). Weaker readers, on the other hand, are less able to make use of text structure. They are less aware of text organization and tend to perceive all ideas in a text as equally important (Meyer, Brandt and Bluth, 1980), thus not being able to form a complete macrostructure. According to van Dijk and Kintsch (1983), macrostructures 'provide a relatively simple semantic structure which may be kept in short-term memory' (p.195). Thus, failure to build a hierarchical macrostructure implies drawing more on working memory resources for the storage and processing of textual information.

The main assumption in the present study is that once the better reader identifies a certain pattern, he/she is able to include more of the incoming input in one single chunk (e.g.

Problem/Solution), this way being able to reduce the large amount of incoming information into a more manageable unit which can be maintained in working memory (van Dijk and Kintsch, 1983). Weaker readers, who are less aware of text structure, have to store more local-level information, overwhelming working memory with the storage and processing of text information.

1.2 Research on the relationship between working memory capacity and reading comprehension

In the light of the dual function of working memory- storage and processing- the more traditional measures of working memory like digit span or word span (Miller, 1956; Simon, 1974) cannot be regarded as full measures of working memory capacity since they only evaluate its storage function. More recently, more complex measures have evolved which take into account both functions of working memory (Daneman and Carpenter, 1980; Turner and Engle, 1989; Haenggi and Perfetti, 1994).

Daneman and Carpenter (1980) created a complex measure of working memory span called the Reading Span Test. In contrast to the simple digit or word span measures which measure the number of digits or words that can be recalled right after presentation, the Reading Span Test (RST) involves the comprehension of sentences in addition to the recall of the last words of a group of presented sentences. According to Daneman and Carpenter, the processing of information by better readers does not consume all the available capacity in working memory and thus leaves more resources for storing sentence final words. They found that the Reading Span Test strongly correlates with two specific measures of reading comprehension ability: fact retrieval and pronominal reference. The same was not true of the traditional digit and word span measures. The finding that complex but not simple measures of working memory capacity correlate with reading comprehension ability has been replicated in other studies (Masson and Miller, 1983; Turner and Engle, 1989).

Research on the individual differences in working memory capacity has found a relationship between complex measures of working memory span and several aspects of reading comprehension ability such as making inferences (Masson and Miller, 1983; Whitney, Ritchie and Clark, 1991; Singer, Andrusiak, Reisdorf and Black, 1992), detecting inconsistencies in sentences containing homonyms (Daneman and Carpenter, 1983), using contextual cues to infer the meaning of a novel word in a text (Daneman and Green, 1986), processing complex syntactic stuctures (King and Just, 1991; MacDonald, Just and Carpenter, 1992), and the resolution of lexical ambiguity (Miyake, Just and Carpenter, 1994). In the present study, as will be seen below, it is expected that there will also be a relationship between working memory span and reading ability.

1.3 The study

Two experiments were carried out in the present study. Experiment 1 investigated the relationship between the Reading Span Test (Daneman and Carpenter, 1980) and two measures of reading ability: free recall and answers to questions about important information in the text. The reason for using these two types of measures of reading ability is that they both involve the storage and processing functions of working memory, two important factors for differentiating better and weaker readers, according to Daneman and Carpenter. As van Dijk and Kintsch (1983) suggest, free recall depends on the formation of a macrostructure which in turn depends on how successfully the incoming information is organized in chunks. This organization draws on working memory resources, since information from various parts in the text has to be integrated. Therefore, readers with a larger working memory capacity are expected to be able to form bigger and richer chunks, leading to a more complete macrostructure which will enable them to recall more from a text. Questions, in turn, tackle information located high in the hierarchical organization of the text. Being able to retrieve information in order to answer questions related to the important points in a text implies that during reading readers were able to encode the important information from the text by making the necessary inferences which the task required within the procedural limitations of working memory.

Experiment 2 investigated whether distortions in the original structure of texts are perceived by readers and how they affect comprehension and recall. The assumption was that better readers are better able than weaker readers to perceive important text organizational aspects and use them to organize and maintain the flow of information processing in working memory. Whenever these elements are missing, as in the case of the distortions used in this study, the flow of information processing may be disrupted and comprehension and recall may be negatively affected. The processes of better and weaker readers, who were also hypothesized to be high and low span readers respectively, were investigated as they read complete and distorted texts organized in terms of the Problem/Solution pattern of text organization..

1.4 Hypotheses

Based on the discussion above, the present study investigated the following hypotheses:

A) Hypotheses related to experiment 1:

1-There is a correlation between working memory span, as measured by means of the Reading Span Test, and reading ability, as measured by means of free recall.

Hypothesis 1 was also tested with data from experiment 2, in an attempt to replicate the findings. Therefore, scores from the Reading Span Test were also correlated with the recall done after reading the complete and distorted texts.

2- There is a correlation between working memory span, as measured by means of the Reading Span Test, and reading ability, as measured by means of answers to questions about important information in the text.

B) Hypotheses related to experiment 2:

3- There is a relationship between reading ability, as measured by means of free recall and answers to questions about important information in the text, and readers' awareness of conventional patterns of text organization, i.e. better readers are more aware of the Problem/ Solution structure of text organization than weaker readers.

4- There is a relationship between reading ability and readers' capacity to notice distortions in terms of text structure, i.e. better readers are more prone to perceive when the text fails to provide information on important parts of the Problem/Solution pattern than weaker readers.

2.0 METHOD

Subjects. The subjects were twelve undergraduate students taking regular courses at UFSC (Universidade Federal de Santa Catarina). They were all Brazilian native speakers of Portuguese and read texts in their own language. The whole experiment was carried out in Portuguese.

Procedure. In the first experiment, subjects took the reading ability tests- free recall and answers to questions about important information in the text- and were later separated into groups[1]: better and weaker readers, according to the mean scores obtained in these two measures of reading ability. After taking the reading ability tests, subjects were also given the Reading Span Test, a measure of working memory capacity, so that the scores could be contrasted with reading performance. In this task, they read a set of of unrelated sentences aloud trying to comprehend them, and memorizing the last word of each sentence. There were 60 sentences and they were arranged in the following way: 3 sets of 2 sentences, 3 sets of 3, 3 sets of 4, 3 sets of 5 and 3 sets of 6 sentences. Each sentence was typed in the center of a card, the

1 Readers with scores 50.25 or above were classified, for the purpose of this research, as 'better readers'. Readers with scores 36.4 or below were classified as 'weaker readers'. Better readers'overall mean in the two measures was 61.14, whereas weaker readers' overall mean was 28.93. Results from the T-test showed that differences between the mean scores of better and weaker readers are statistically significant (Student T= 6.43, df=10, p= .00007).

cards were shown one at a time. Immediately after the subject finished reading one sentence, another card was placed by the researcher on top of the first and the subject began reading the next sentence. The end of each set was indicated by a blank card. When a blank appeared the subject had to recall the last words of all sentences in that set, exactly in the same order they had been presented. The test was terminated when subjects failed all three sets at two subsequent levels. The measure of the subject's reading span was the level at which he/she was correct on at least two sets. Half credit was given for passing one set at a certain level. Thus, if the last level the subject got two sets right was 3 and he also got one set right in 4, his/her span would be 3.5.

In the second experiment, subjects read three texts organized in terms of Problem/Solution. The supposedly complete structure of the texts was distorted in order to try to disturb the flow of processing and see how these distortions affect comprehension and recall. Subjects read one complete text where the complete structure was maintained- 'complete problem/solution', and also read two distorted texts: 'no solution' and 'no problem'. While reading each of the three texts, subjects followed the pause protocol procedure, adapted from Cavalcanti (1987, 1989). They were given the whole text and were asked to stop at points where they encountered a problem or something that called their attention and give a report. They were also asked to stop and give a report at the end of each paragraph. After reading the whole text they also gave a free recall of all they could remember from the text. Immediately after the recall they were asked a set of eight questions about their reading- a retrospective interview (see Appendix).

3.0 RESULTS

Experiment 1. The scores in the Reading Span Test (RST) were correlated with the two measures of reading ability- free recall and answers to questions about important information in the text and also with the recall done after reading the complete and distorted texts in experiment 2. The first hypothesis then was that there would be a correlation between scores on the RST and scores on the free recall, and the second hypothesis was that there would be a correlation between scores on the RST and scores on the answers to questions.

Results from Pearson's correlation coefficient(r) indicated a moderate correlation between RST and the free recall from the reading ability measure ($r = .56$), but it was not significant at the .05 level ($p=.0533$). A moderate correlation ($r =.70$; $p=.01$) was also found between RST and answers to questions. In terms of the free recall done after reading the complete and distorted texts in experiment 2- Whole Text Recall, RST correlated significantly with two of the three texts: 'complete problem/solution' ($r=.77$; $p=.003$) and 'no solution' ($r=.70$; $p=.01$). The only non-significant correlation was that between RST and the 'no

problem' text (r=.34; p=.27). This result will be discussed later on in the discussion of the hypothesis related to the distorted problem text.

The results obtained indicate that the first and second hypotheses were confirmed, i.e. readers who scored higher in the measure of working memory span, also tended to score higher during free recall. Similarly, readers who scored higher in the measure of working memory span, also tended to score higher in the answers to questions. The results in this study corroborate those in the literature of working memory research. Significant correlations were also obtained in other studies which investigated the relationship between the Reading Span Test and other aspects of reading ability such as ability to make inferences (e.g. Masson and Miller, 1983), answering fact questions and computing pronominal reference (Daneman and Carpenter, 1980), using contextual cues to infer the meaning of a novel word in a text (Daneman and Green, 1986), among many others. The results in the present study and in all the research on working memory capacity point to the possibility that an individual's ability to process language is constrained by his/her working memory capacity, with high span individuals performing better than low span individuals in language tasks.

Experiment 2. The main objective of experiment 2 was to investigate better and weaker readers'awareness and use of the Problem/Solution pattern of text organization. The verbal protocols produced by better and weaker readers when reading each of the three texts, the answers to the retrospective interview, and the number of propositions recalled for the complete and distorted texts constituted the data for experiment 2.

*Hypothesis 3- B*etter readers are more aware of the problem/solution structure than weaker readers.

For the complete Problem/Solution structure, a text entitled "Mal pelo ar (Evil by air)" (*Veja*, 1992) was used which contained the complete situation-problem-solution- evaluation structure as follows: situation- 'computers need closed environments with air conditioning systems'; problem- 'this environment is proper for the proliferation of fungi and bacteria, harmful to human health'; solution- 'installation of filters in the air conditioning systems'; evaluation- 'the filter attenuates the reproduction of germs inside the air conditioning tubes'.

Readers' awareness of the Problem/Solution structure was assessed by two measures discussed in Richgels, McGee, Lomax and Sheard (1987): subjects' use of the same pattern as the author to organize recall and subjects' ability to talk about the structure during an interview.

Whole text recall (the recall done at the end of the pause protocol procedure) served as data for the subjects' use of structure during recall, and the answer to the question about the organization of the text (from the retrospective interview) constituted data for the subjects' ability to talk about the structure during the interview. Recall protocols and the subjects' comments about the structure were rated following procedures adapted from those described

in Richgels et al (1987). Recall protocols were rated (on a scale from 0 to 7) for how well the subject used the same organization as the author to organize his/her recall. The answers to the question about the organization of the text ('How do you think the author organized the ideas in this text? Did you notice any kind of organization? If so, how would you describe it?') were rated according to the following criteria: 3 for a description of the structure which included the words (or synonyms) 'problem' and 'solution', 2 for a description including the word 'problem' to describe the problem section and only inclusion of content for the solution section, 2 for bringing in content from the problem section and including the word 'solution' to describe the solution section, 1 for only bringing in content from both parts (problem and solution) without using the specific signal words 'problem' and 'solution', and 0 for a response that could not fit any of the above categories.

A summary of the results in terms of the use of the Problem/Solution structure during whole text recall, the ability to talk about the structure during the interview, and the sum of the two measures ('total awareness') is available in Table 1:

Table 1— Better X weaker readers' scores on the two measures of awareness

AWARENESS MEASURE	BETTER READERS 1 2 3 4 5 6	WEAKER READERS 7 8 9 10 11 12
USE OF STRUCTURE	6 6 5 5 6 6	4 1 5 0 2 5
INTERVIEW	3 3 2 3 3 2	3 0 3 3 0 1
TOTAL AWARENESS	9 9 7 8 9 8	7 1 8 3 2 6

Results from the T-test revealed a significant difference between better and weaker readers in terms of 'total awareness' (Student T= 3.13; df= 10; p= .01) and 'use of structure' (Student T= 3.15; df= 10; p= .01), but not in terms of 'response to interview question about the structure' (Student T= 1.53; df= 10; p= .15).

Even though there is no statistically significant difference in terms of 'response to interview question', the findings from 'total awareness' and 'use of structure' corroborate those in the literature of text structure research. First, better readers tend to use a 'structure strategy'. They seem more able to use the hierarchical organization of the text and form a more complete macrostructure (van Dijk, 1980; Meyer, Brandt and Bluth, 1980; McGee, 1982). In this study, all six better readers made full use of the structure, whereas only two of the six weaker readers did so. One of the weaker readers made partial use of the structure and the other three were not able to benefit from it. Second, readers who follow a 'structure

strategy' recall more information from the text than those who do not (Meyer, Brandt and Bluth, 1980; Richgels et al, 1987). In the present study, better readers recalled significantly more information from the whole text (42.21%) than weaker readers (16.19%) (Student T= 5.21; df= 10; p= .0003). There was also a strong correlation between 'use of structure' and whole text recall (r= 88; p= .0001).

The results presented above show that the third hypothesis was confirmed, i.e. better readers are more aware of the overall organization of a text than weaker readers.

According to van Dijk and Kintsch (1983), recall depends on the formation of a macrostructure, i.e. on how well the input information is organized into chunks. The initial formation of a macrostructure draws on working memory resources since information from various parts in the text has to integrated. Van Dijk and Kintsch also observe that knowledge of text structure provides a mold for forming a macrostructure, which may reduce the demands on working memory and prevent the trade off between storing and computing relationships, and consequently loss of information.

Regarding the fact that three weaker readers referred to the problem/solution structure using signal words, an explanation may be the very practical observation that the world is frequently organized in terms of problem/solution, or at least in terms of problems which need solutions. From this perspective, it is not surprising that some weaker readers, similarly to better readers, did recognize the problem/solution structure: it is part of their everyday life. The problem described in the text is a real-life problem, thus by using world knowledge and lexical signalling, some weaker readers could perceive the structure. It is interesting to note that of the three weaker readers who expicitly referred to the structure by using signal words, only one actually made full use of the structure when recalling information from the text; of the other two, one made partial use and the other only included elaborations without ideas from the text. This finding leads to the possible conclusion that metacognitive awareness, at least when measured the ability to talk about the problem/solution structure, does not necessarily translate into full actual use of the structure and the formation of a complete macrostructure. I return to this issue in the general discussion.

Perception of the distortions

Hypothesis 4- Better readers are more prone to perceive distortions in terms of the problem/solution pattern than weaker readers.

Distorted solution- For the 'no solution' type of distortion, a text entitled "Reciclagem (Recycling)" (*Revista Literária Globo*, 1992) was used. All sections related to the solution- 'recycling'- were omitted, the title was kept so that it would create expectations in the reader in relation to the development of the subject. The text contained the "Problem/Solution" structure as follows: situation- 'the production of manufactured goods cost us a lot more than it looks at first sight'; problem- 'there is waste in all areas (scrap metal, chemicals and glass)';

solution (omitted in the development of the text)- 'recycling the waste we usually throw away'; evaluation - 'preservation of our natural resources and environment'.

In terms of the analysis of the protocols for the 'no solution' text, the subjects' mentions of the distortion were interpreted as follows: direct reference, indirect reference, vague reference and no reference at all. Direct reference was an explicit mention of the structure, referring to a lack of 'solution' in the text. Indirect reference was an explicit mention of the content, referring to the fact that the text failed to provide information on 'recycling', which in fact was the omitted solution. Vague reference was a comment about some lack of organization in the text, without specifically referring to the structure ('lack of solution'), or to content ('lack of information on recycling'). And finally, no reference was when none of the three situations described above applied and the text seemed complete for the subject. Subjects' received the following scores for each mention of the distortion: 3 for a direct reference, 2 for an indirect reference, 1 for for a vague reference and 0 for no reference at all.

A summary of the results for the perception of the distortion related to the solution section is shown in Table 2:

Table 2- Better X weaker readers' perception of the distortion related to the solution section

	BETTER READERS						WEAKER READERS					
	1	2	3	4	5	6	7	8	9	10	11	12
DIRECT REFERENCE	3											
INDIRECT REFERENCE		2	2			2						
VAGUE REFERENCE	1	1	1	1	1	1	1	1	1	1	1	1
NO REFERENCE												
TOTAL	4	3	3	1	1	3	1	1	1	1	1	1

Results from the T-test revealed a significant difference between better and weaker readers in terms of perception of the distortion related to the solution section (Student T= 3.0; df= 10; p= .01). Results indicate that the hypothesis for the perception of the distortion of the solution section was confirmed- better readers are more aware of the problem/solution structure and use the structure to organize the flow of information in working memory. This is suggested by the fact that they more readily named the distortion when they faced it, either by making direct reference (one better reader) or indirect reference (three better readers). In fact, none of the weaker readers referred to the fact that the text failed to fulfil the commitment made in the title, i.e. talk about 'recycling' or about the solution, a comment made by four out of the six better readers.

There was also a difference between the two groups in terms of the way they dealt with the disconnected information in the 'no solution' text, as suggested by the recall protocols. In general, both groups tended to relate the information in the text to their prior knowledge and to provide elaborative inferences, trying to make the text become more coherent. However, weaker readers tended to be carried away by the activated schema, including very little information from the text itself. In fact, weaker readers recalled significantly less information from the 'no solution' text (17.82%) than better readers (39.9%) (Student T=3.71; df=10; p=.004).

The performance of better and weaker readers may be explained in terms of differences in working memory capacity. According to Just and Carpenter (1992), when the comprehension task is demanding, some of the resources which are maintaining old elements active will be deallocated to processing the incoming input, causing a type of forgetting by displacement. In the 'no solution' text, all the information related to 'recycling'- the solution- was ommitted in the development and the paragraphs appeared disconnected and loose, requiring a large amount of inferencing to maintain global coherence. Integrating all the information in the text would draw heavily on working memory resources both to store partial products of comprehension and to compute the necessary relationships among propositions. From the results obtained, it seems that weaker readers (also lower span) were more heavily affected by this demanding task than better readers (also higher span): this is suggested by the fact that they tended to overrely on prior knowledge, providing inferences to the detriment of text information, by the fact that they recalled significantly less information from the text than better readers and also by the fact that there was a significant correlation between working memory span and recall of this text ($r = .70$, $p = .01$).

Distorted problem- A text entitled "[Poluição] recorde pára a Cidade do México (Record [pollution] stops Mexico City)" (*Veja*, 1992) was used to collect data for this part of the research (brackets in the title will be explained below). The problem described in the text is related to an intense air pollution observed in Mexico City, which reached the extreme rate of 800 micrograms of ozone for each cubic meter of air, a rate four times higher than what is considered acceptable by the World Health Organization (*Veja*, 1992:43). All information related to the problem section was either omitted or made vague. The word 'pollution' in the title and all parts of the text which directly related to the problem- 'pollution'- were omitted. The text contained the "Problem/Solution" structure as follows: situation- 'the 20 million inhabitants of Mexico City lived a drama'; problem (omitted)- 'intense pollution'; solution (1)- 'measures taken by the government (schools were closed/ industries had to reduce their production/ vehicles were prohibited to circulate)'; evaluation (1)- 'measures taken only attenuated the problem'; solution (2)- 'installation of electronic indicators'; evaluation (2)- 'garish proposal'; final solution- 'long-term proposals' (not specifically enumerated by the text); and

final evaluation- 'problem (pollution) eradicated' (not explicitly given but which could be inferred from the text- 'What we need are long-term proposals').

Concerning the analysis of the protocols for the distorted text- 'no problem', the subjects' mentions of the distortion were also interpreted as: direct reference, indirect reference, vague reference, and no reference at all. Direct reference was an explicit mention of the structure, referring to a lack of 'problem' in the text. Indirect reference was providing the problem- 'pollution'- from memory, either during recall or by an explicit mention at any point during the pause protocol. Vague reference was a comment about some lack of organization in the text, without specifically referring to the structure ('lack of problem'), or to the content ('pollution'). And no reference was when none of the situations described above applied and the subject considered the text as a complete unit of information. As in the 'no solution' text, here subjects also received a score for each mention of the distortion: 3 for a direct reference, 2 for an indirect reference, 1 for a vague reference and 0 for no reference at all.

A summary of the results for the perception of the distortion related to the problem section is shown in Table 3:

Table 3-Better X weaker readers' perception of the distortion related to the problem section

	BETTER READERS						WEAKER READERS					
	1	2	3	4	5	6	7	8	9	10	11	12
DIRECT REFERENCE	3		3		3							
INDIRECT REFERENCE	2		2		2							
VAGUE REFERENCE	1		1		1	1	1	1	1	1		
NO REFERENCE		0		0							0	0
TOTAL	6	0	6	0	6	1	1	1	1	1	0	0

Although results from the statistical test revealed no significant difference between better and weaker readers in terms of total results (Student T= 1.93; df= 10; p= .08), three out of the six better readers made direct and indirect reference to the distortion, as opposed to none of the weaker readers. This being the case, despite the lack of statistical significance, the results may still be interpreted as indicating that the fourth hypothesis was also confirmed with the 'no problem' text: better readers are more prone to perceive distortions in terms of the problem section than weaker readers.

The performance of better readers (also higher span) and weaker readers (also lower span) is consistent with the Capacity Constrained model of language comprehension (Just and Carpenter, 1992). The two groups exhibited different behavior when trying to interpret

the vague information in the text: higher span readers (including two of the three who picked 'overpopulation' as the 'problem') tended to either set up hypotheses towards the beginning of the passage, checking their predictions in subsequent text, or assign more global perspectives to the vague content of the text. Lower span readers, on the other hand, tended to commit themselves to a single interpretation ('overpopulation') from the beginning and to process the text from that perspective. Similar findings were obtained by Whitney, Ritchie and Clark (1991) in a study about the use of elaborative inferences when processing difficult narrative texts.

In terms of the number of propositions recalled from the 'no problem' text, this time, as opposed to the other two previous texts, there was no statistically significant difference between the two groups (Student T=1.29; df=10; p=.22).

Although better readers recalled as few propositions as weaker readers, they seem to have comprehended the text better. This is suggested by the fact that they were more able to perceive the distortion.

According to Epstein, Glenberg, and Bradley (1984), assessing a reader's ability to detect a 'contradiction' (which may be compared to the 'distortions' in this study), is a valid measure of comprehension. According to the authors, a reader who fails to perceive a contradiction, fails to understand the text, and although he/she may get information at the microlevel of the text, his/her representation at the macrolevel is inaccurate or incomplete. Apparently, this is what also happened in this study. Although weaker readers recalled as much information from the 'no problem' text as better readers, their comprehension at the macrolevel was hindered by the fact that they considered 'overpopulation' as the main problem being discussed in the text and failed to perceive the distortion.

The Capacity Constrained model of language comprehension predicts that high span readers perform better than lower span readers in language tasks. However, as stated by the model, there seems to be a limit to this capacity depending on the demands that the task makes on the resources of working memory: when the maximum capacity is exceeded, performance deteriorates. Therefore, even high span readers will show a detriment in performance, if the task is extremely demanding. As I have already mentioned, this was the only text where there was no correlation between the measure of working span- the Reading Span test- and whole text recall. The language in the 'no problem' text was vague and ambiguous, not allowing the reader to readily construct a mental representation of what was happening. Thus readers had to store incoming propositions while processing subsequent input, looking for more explicit information to compute relationships. The absence of more explicit cues which signalled the problem, might have produced extra demands on working memory, exceeding their maximum capacity, leading better readers to either be misled in the last paragraph (building an innacurate textbase) or to continue searching for the unavailable explicit information until the end (building an incomplete textbase), resulting in a deficit in recall in

the two cases. Lower span readers, on the other hand, who have a smaller capacity for processing language, were probably faced with the demanding activity much earlier. This is suggested by the fact that they tended to provide one single interpretation from the beginning and maintain that interpretation throughout the whole text, although it was not compatible with many other asserted propositions. Having built an innacurate textbase, they could only recall microlevel propositions.

4.0 GENERAL DISCUSSION

The main objective of this study was to investigate better readers'and weaker readers' awareness of the problem/solution structure and their ability to make use of the structure to organize the flow of information processing in working memory. Three measures were used to assess awareness and use of the problem/solution structure: first, readers' use of the same structure as the author to organize recall; second, response to interview question about the structure; and third, perception of the distortions of the structure. In terms of use of structure, results revealed that better readers more frequently followed the author's structure to organize their recall of the information in the text and were more able to elaborate on the main ideas and their supporting details. Regarding response to interview question about the structure, results revealed no significant difference between better and weaker readers, i.e. both groups tended to refer to the organization of the text as being one of problem/solution. However, in terms of perception of the distortions, again, there was a difference between the two groups: better readers tended to more readily perceive the distortions and to name what exactly the distortion was in each case, either directly and/or indirectly (five better readers), whereas weaker readers tended not to spot the distortions and only make vague references, not kowing exactly what the distortion was in each case (none of the weaker readers made direct or indirect references to the distortions).

In the discussion of hypothesis 3- Complete problem/solution, I raised the possibility that weaker readers were simply using their world knowledge of real-life problems and solutions to refer to the structure as problem/solution, but that this 'metacognitive awareness' did not necessarily translate into actual use of the structure. Some other findings in the present study provide further evidence for this interpretation. First, weaker readers did not explicitly refer to the distortions. Second, during the reading of the 'no solution text, some weaker readers made inferences which suggested that they were trying to process the text from the 'Recycling' perspective, i.e. they tried to fix up the text by including the solution. This can be seen as as indication of use of the structure. These weaker readers, however, tended to be carried away by the activated schema, including very little information from the text and failing to report the distortion. Third, in the 'no problem' text, all of the six weaker readers

identified a problem ('overpopulation'), which was in fact part of the internal organization of problem, as defined by Hoey (1983). However, they did not identify 'the missing problem' in focus and failed to report the distortion. Finally, weaker readers recalled less information than better readers from the 'complete problem/solution' and also from the 'no solution'text.

The results in the present study suggest that the sole capacity to detect that a text contains a 'problem' and a 'solution' does not necessarily imply that the subject is able to make use of the structure during reading, i.e. it does not imply that the subject is able to choose the superordinate information related to each of the parts of the structure and organize it in hierarchical clusters. In sum, this ability to talk about the structure using signal words does not necessarily mean that the subject has the procedures necessary to make use of the structure during reading. The point I intend to raise is that weaker readers may possess declarative knowledge (Anderson, 1993, 1995) of 'problems and solutions', brought to the text by their real-life knowledge of 'problems and solutions', but they possibly lack procedural knowledge (Anderson, 1993, 1995) of the structure necessary to make use of it during reading.

Declarative knowledge (according to Anderson, 1993, 1995) includes all our knowledge about facts (Anderson, 1993, 1995), rules, memory for images and sequence of events (O'Malley, Chamot and Walker, 1987), i.e. all our semantic as well as our episodic knowledge (Paradis, in press). Procedural knowledge, on the other hand, includes our cognitive skill or our ability to perform various mental procedures, and also our ability to perform motor skills (Paradis, in press; Anderson, 1995). Declarative kowledge is 'knowing that' and procedural knowledge is 'knowing how to' (Ashcraft, 1994). Knowing that the capital of New Zealand is Wellington, for instance, or that 2 times 4 is 8 or that texts may be organized in terms of problems and solutions, are examples of declarative knowledge. Being able to understand and produce language, to apply a rule to perform a certain procedure (O'Malley, Chamot and Walker, 1987), to shift gears in a car (Ashcraft, 1994) and being able to make use of the problem/solution structure during reading, are examples of procedural knowledge.

The assumption in the present study is that declarative knowledge would enable weaker readers to infer that a problem is being presented, but lack of procedural knowledge would prevent them from identifying the superordinate information related to each of the parts of the structure and also prevent them from organizing the information into hierarchical clusters to form a complete macrostructure which leads to better comprehension, retention and subsequent retrieval. Procedural knowledge would facilitate encoding within the limitations of working memory and thus subsequent retrieval of this information.

5.0 FINAL CONSIDERATIONS

The studies on the individual differences in working memory capacity gave rise to a theory called 'Capacity Constrained Comprehension', proposed by Just and Carpenter

(1992). The basic premise of the theory is that comprehension processes are constrained by working memory capacity, with high span individuals performing better than low span individuals in language tasks. Individual differences in working memory capacity are then explained in terms of 'total capacity' and also in terms of 'processing efficiency'. According to Just and Carpenter, both storage and processing are fueled by the same commodity: activation. The total capacity explanation posits that individuals vary in the amount of activation they have available to support both processing and storage. The processing eficiency explanation posits that some individuals have more efficient processes than others, this way not consuming all the resources in working memory with processing and leaving more resources for storing the intermediate products of comprehension. For Just and Carpenter, the two explanations are mutually compatible, and both can account for individual differences in working memory capacity, although, as they observe, the results they have obtained are better explained in terms of the total capacity explanation. Their reasoning is that differences in processing efficiency should occur independently of the total demand of the task, but the finding they have obtained is that when the comprehension task is easy, high and low span readers exhibit about the same performance, no significant differences are observed; whereas when when the task is demanding, the differences are large and systematic.

The results in the present study revealed systematic differences in the performance of better and weaker readers, also higher and lower span readers respectively, both in terms of comprehension and recall of texts. The two groups were also found to differ in terms of ability to use text structure during reading. These findings thus suggest that there is a difference between the two groups in terms of processing efficiency. However, recently, research in working memory capacity has found that even when two groups are equated for procedural knowledge, i.e. when they are equally proficient at a particular process, there may still be differences in their performance in reading tasks (Just and Carpenter, 1992; Engle, Cantor and Carullo, 1992). Such findings are then explained in terms of differences in activation available to support processing and storage. The findings in the present study give further support for the processing efficency explanation, because the two groups were found to differ in terms of procedural knowledge of the structure. However, one question remains to be answered: when two groups are equated for procedural knowledge of text structure but differ in their working memory capacity, will they still differ in their performance in times of high demands? An answer to the question above may give a small contribution to the understanding of what factors determine the relationship between capacity and task performance.

6.0 PEDAGOGICAL IMPLICATIONS

The findings of the present study support the contention that use of text structure during reading can have beneficial effects on comprehension and on retention of text infor-

mation. Those readers who used the structure during reading were more able to recall more information from the texts and also to elaborate more on the main ideas and their supporting details. It appears that by following the authors' text structure, readers concentrated on the important aspects of the texts, thus not consuming all the available resources in working memory with the processing and storage of the ensuing sentences. According to van Dijk and Kintsch (1983), knowledge of text structure provides readers with a 'mold' for forming a macrostructure, which facilitates encoding and retrieval of text information. If we can accept that this is the case, it seems reasonable to suggest that reading teachers include the teaching of text structure in their classroom curriculum. Indeed, research has indicated that reading comprehension can be facilitated by teaching text structure. Pehrsson and Denner (1988), found support for the 'semantic organizer approach' where students learn to organize the ideas in a text by displaying them graphically as 'clusters of related ideas' (p. 27). Taylor and Beach (1984) and Armbruster, Anderson and Ostertag (1987) obtained positive results with procedures involving summarization. Carrell (1985) found support for a procedure involving detailed training beginning with simple and easy passages and gradually moving to more complex ones.

Besides being less aware of text structure, the weaker readers in this study engaged in the phenomenon described as 'the illusion of knowing' (Epstein, Glenberg and Bradley, 1984). They tended to fail to detect the distortions in each case and also tended to show more comprehension problems both at the micro and macrolevel of the texts. In spite of this, during the retrospective interview, they still tended to overassess their comprehension of the texts. According to Epstein et al, 'the illusion of knowing' interferes with the learning process in two ways: first, a student who overasseses his/her comprehension is likely to reallocate processing resources in the wrong direction and fail to comprehend a text. Second, early failure to detect a contradiction (or a distortion in the present case) in a text which has a logical progression in the author's arguments may take the reader to misunderstand the whole sequence of arguments.

One point which also has to be taken into consideration is that readers who are not able to detect contradictions or distortions demanded from experimental conditions may also be more inclined not to see relationships among important ideas in a text, which is the usual demand in real learning from text situations. Failure to build these relationships may restrict the reader to acquire information at the microstructure level, but to build an inaccurate or incomplete macrostructure of the text (which seemed to be the case with the less proficient readers in this study).

Based on the discussion above, it seems that 'the illusion of knowing' is a phenomenon which should be taken into account by reading teachers. It is part of comprehension monitoring and research has indicated that failures in comprehension monitoring can be amenable to instruction (Dewitz, Carr and Patberg, 1987; Dole, Duffy, Roehler and Pearson, 1991).

Although the present study does not directly speak to the issue of writing, it may have some implications. Reading and writing are not two completely independent processes. A reader who is able to perceive and use an author's organization schema while reading is more likely to use that structure when writing (Hiebert, Englert and Brennan, 1983; Richgels, McGee, Lomax and Sheard, 1987). A reader who fails to see a relationship (or a lack of relationship) among ideas in a text may be more likely to do the same in his/her writing, i.e. he/she may fail to clearly signal the relationship or include contradictory information. Furthermore, writers are also readers of their own work (Meurer, forthcoming) and thus being a competent writer also implies being a competent reader. Therefore, instruction which is aimed at enlarging the students' knowledge of text structure, making them aware of the overall organization of texts, of the relationships among ideas in texts should prepare students to become more competent readers and also more competent writers.

The differences observed in the performance of the better and the weaker readers in this study favored the processing efficiency explanation, i.e. better readers comprehended and recalled more information from the texts possibly because their processing did not consume all the available capacity in working memory. However, results also indicated that the total capacity explanation is not rejected, i.e. better readers' superior performance may also have been due to more activation available to support processing and storage. What are the implications of the two explanations for the teaching of reading? An inefficient process, like failure to follow an author's overall organization schema while reading, is amenable to instruction. Weaker readers can be taken to recognize a certain overall structure and to use that structure while reading through instructional intervention and intensive practice (Carrell, 1985; Slater, Graves and Piché, 1985, among many others). The amount of total activation, on the other hand, does not seem to be affected by instructional intervention and practice (Just and Carpenter, 1992; Engle, Cantor and Carullo, 1992). According to Engle et al, 'the amount of total activation available is an abiding character of the [working memory] system and would change relatively little with changes in the knowledge structure' (p.990). However, the issue of what factors account for the relationship between capacity and performance in language tasks is not totally clear (Just and Carpenter, 1992) and researchers agree that poorly learned processes demand resources from working memory (Just and Carpenter, 1992; Engle, Cantor and Carullo, 1992). Therefore, researchers still have a lot to do while teachers still have a lot to incorporate in order to help students with the acquisition of the processes which lead to reading comprehension.

RESUMO: *Análise do processamento de leitores mais proficientes e menos proficientes durante a leitura de textos completos e incompletos organizados em termos de Problema/Solução (Hoey, 1979). Os resultados indicaram que os leitores mais proficientes perceberam e usaram os aspectos de organização textual para organizar o fluxo de informação, assim não sobrecarregando a memória operacional.*

PALAVRAS-CHAVE: *Organização Textual, Distorção, Percepção, Memória Operacional.*

APPENDIX

QUESTIONS USED DURING THE RETROSPECTIVE INTERVIEW

1) Does the reading of this text flow well? Why/Why not?
2) Is the text difficult? Why/Why not? How would you rate it on a scale from 1 to 6:

very easy					very difficult
1( )	2( )	3( )	4( )	5( )	6( )

3) Would you say that this text is well written? Why/Why not?
4) How do you think the author organized the ideas in this text? Did you notice any kind of organization? If só, how would you describe it?
5) What was the author's objective in writing this text? Do you think he/she attained this objective?
6) Do you consider this to be a complete text? Why/Why not?
7) What made your reading of this text easy or difficult? Why?
8) Was the way the subject was dealt with in the text familiar to you? How would you rate it on a scale from 1 to 6:

very familiar					very unfamiliar
1( )	2( )	3( )	4( )	5( )	6( )

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