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7

READING: TEXT ORGANIZATION PERCEPTION AND WORKING MEMORY CAPACITY

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In *Reading: Text Organization Perception and Working Memory Capacity*, the seventh volume of the Advanced Research in English Series (ARES), Lêda M.B. Tomitch examines the reading processes of better readers and weaker readers as they read complete and distorted texts organized in terms of Problem/Solution (Hoey, 1979) and Prediction (Tadros, 1985). The claim is that better readers are more aware of text organizational patterns and use them to organize the flow of information processing, thus not overloading working memory with the storage and processing of text information. Two experiments were carried out in the study. Experiment 1 investigated whether there was a correlation between a measure of working memory span the Reading Span Test (Daneman & Carpenter, 1980) and two measures of reading ability free recall and answers to questions about important information in the text. Experiment 2 investigated better and weaker readers' awareness and use of the two text-organizational aspects mentioned above. Twelve undergraduate students at a Brazilian university participated in the study. The entire study was carried out in Portuguese. In the first experiment, subjects were assigned to two groups: better and weaker readers, according to the mean scores obtained in the two measures of reading ability. In the second experiment, subjects read

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PREFACE

This work is based on doctoral research carried out at the Graduate Program in English Language and Literature at UFSC, under the supervision of Dr. José Luiz Meurer, during the period of 1989 to 1995. The major theoretical frameworks which nurtured the study at the time of writing the dissertation came mainly from three groups of researchers: Marcel A. Just and colleagues from Carnegie Mellon University, Randall W. Engle and colleagues from the Georgia Institute of Technology, both groups in the USA; and Alan Baddeley and co-workers from the University of Bristol in the UK.

In the past eight years a lot has happened in terms of the research on working memory capacity and language comprehension, and the field has been greatly influenced by technological advances which have allowed more precise investigations of how cognitive processes are implemented in 'the human mind' , or to use more up-to-date terminology, in 'the human brain'. Technological tools such as pupilometry, event-related brain potential (ERP), and more recently, neuroimaging tools such as positron emission tomography (PET) and functional magnetic ressonance imaging (fMRI) have been used in an attempt to relate high level cognition to brain function.

Since 1995 Just and colleagues have been using a leading-edge tool, functional magnetic ressonance imaging (fMRI), to investigate high level cognitive processes such as language comprehension, visuo-spatial thinking and problem solving. In relation to the 'Capacity Constrained Comprehension' model, proposed by Just and Carpenter (1992), and used as framework for the study here reported, Just and colleagues have been working on it since then (e.g. Just, Carpenter & Varma, 1999; Just & Varma, 2002) and have very recently (Just, Carpenter & Miyake, 2003) retaken the model and investigated its relation to neural networks. Engle and colleagues have expanded their working memory model,

previously based on central executive capability, to include controlled attention and general fluid intelligence (e.g. Engle, Laughlin, Tuholski & Conway, 1999), using tools such as pupilometry and event-related brain potential (ERP). Baddeley (2000) has also revised his three-component model of working memory (initially composed of a central executive, a phonological loop and a visuospatial sketchpad) to include a fourth component called the episodic buffer. Nevertheless, in a very recent paper with colleagues (Bayliss, Jarrold, Gunn & Baddeley, 2003), this 'episodic buffer' is not retaken and Baddeley seems to go back to the very initial three-component model proposed by Baddeley and Hitch (1974).

In terms of the more recent findings which try to relate working memory to brain regions, researchers tend to agree that, although it is unlikely that the system is connected to one single anatomic region, the frontal lobe is likely to be very important for working memory processes (e.g. Allain, Etcharry-Bouyx & Le Gall, 2001; Jiang, Haxby, Martin, Ungerleider & Parasuraman, 2000; Baddeley, 2000; Engle et al., 1999; D'Esposito et al., 1999; Petrides, 1994). Results from fMRI and PET studies on working memory have shown areas of activation in some specific areas of the frontal lobe - the ventrolateral prefrontal cortex (Petrides, 1994; D'Esposito et al., 1999, Carpenter, Just & Reichle, 2000) and the dorsolateral prefrontal cortex (Petrides, 1994; D'Esposito, Postle, Ballard & Lease, 1999; Carpenter, Just & Reichle, 2000; Newman, Just & Carpenter, 2002). Areas of brain activation have also been found in the inferior parietal lobe (Awh, Jonides, Smith, Schumacher, Koeppe & Katz, 1996; Newman, Just & Carpenter, 2002), in Broca's area (Awh et al., 1996; Newman et al., 2002), in the left superior temporal gyrus (Carpenter, Just & Reichle, 2000), in the premotor cortex and in the supplementary motor area - anterior part of the left hemisphere (Awh et al., 1996), and also in the hippocampus and parahippocampus (Abrahams, Morris, Polkey, Jarosz, Cox, Graves & Pickering, 1999).

To conclude, although there have been advances in terms of the research on the relationship between working memory capacity and language comprehension, the more recent data only seem to add to but not actually refute the theories used as basis for this study.

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ABSTRACT

In the present study the reading processes of better readers and weaker readers are analyzed as they read complete and distorted texts organized in terms of Problem/Solution (Hoey, 1979) and Prediction (Tadros, 1985). The claim is that better readers are more aware of text organizational patterns and use them to organize the flow of information processing, thus not overwhelming working memory with the storage and processing of text information. Two experiments are carried out in this study. Experiment 1 investigates whether there is a correlation between a measure of working memory span – the Reading Span Test (Daneman & Carpenter, 1980) and two measures of reading ability – free recall and answers to questions about important information in the text. Experiment 2 investigates better and weaker readers' awareness and use of the two-text organizational aspects mentioned above. Twelve undergraduate students taking regular courses at UFSC participated in the study. The entire study was carried out in Portuguese. In the first experiment, subjects were assigned to two groups: better and weaker readers, according to the mean scores obtained in the two measures of reading ability. In the second experiment, subjects read five texts following the Pause Protocol Procedure (Cavalcanti, 1987, 1989). 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 for each of the text organizational aspects being investigated, namely Problem/Solution and Prediction, and also read three distorted texts, namely 'no solution', 'no problem' and 'distorted prediction'. Regarding the first experiment, significant correlations were obtained between the Reading Span Test and the two measures of reading ability. In relation to the second experiment, results indicate that better readers (also with a higher memory capacity) were better

able to perceive and use the two-text organizational aspects than weaker readers (also with a lower memory capacity). Furthermore, in general, better readers were able to comprehend and recall more from the texts than weaker readers. Results are analyzed in the light of other studies about text structure awareness and about the relationship between working memory capacity and reading comprehension. The present investigation indicated that processing efficiency is an important component in the relationship between working memory capacity and reading comprehension. Finally, pedagogical implications of the study are discussed.

RESUMO

O presente trabalho investiga o processamento de leitores mais proficientes e menos proficientes durante a leitura de textos completos e incompletos organizados em termos de Problema/ Solução (Hoey, 1979) e Predição (Tadros, 1985). O argumento principal é que leitores mais proficientes são mais capazes de perceber os aspectos de organização textual e fazem uso desses aspectos para organizar o fluxo de informação durante a leitura, desta forma não sobrecarregando a memória operacional. Dois experimentos são conduzidos. O primeiro investiga a correlação entre a capacidade da memória operacional, medida através do teste de capacidade de Leitura (Daneman e Carpenter, 1980), e a compreensão em leitura, medida através de duas tarefas – evocação do conteúdo lido e respostas a perguntas de compreensão geral sobre o texto. O segundo experimento investiga a percepção e o uso dos aspectos textuais mencionados acima, por leitores mais proficientes e menos proficientes. Doze alunos de graduação da UFSC participaram do estudo. Todo o estudo foi conduzido em língua portuguesa. No primeiro experimento, os leitores foram divididos em dois grupos: mais proficientes e menos proficientes, de acordo com a média dos resultados obtidos nas tarefas de compreensão. No segundo experimento, os sujeitos leram cinco textos seguindo a técnica introspectiva do Protocolo de Pausa (Cavalcanti, 1987, 1989). A estrutura supostamente completa dos textos foi distorcida com o objetivo de criar textos incoerentes que, conseqüentemente, pudessem causar uma ruptura no fluxo normal de processamento. Os sujeitos leram um texto completo para cada tipo de organização textual investigado, ou seja, 'Problema/Solução' e 'Predição' e também leram três textos distorcidos, ou seja, 'sem solução', 'sem problema' e 'predição distorcida'. Em relação ao primeiro experimento, correlações significativas foram encontradas

entre a capacidade da memória operacional e as duas tarefas de compreensão. Em relação ao segundo experimento, os resultados indicaram que os leitores mais proficientes (também com mais capacidade de memória) foram mais capazes de perceber e de fazer uso dos aspectos de organização textual durante a leitura do que os leitores menos proficientes (também com menos capacidade de memória). Além disso, em geral, os leitores mais proficientes compreenderam e retiveram mais informações dos textos do que os leitores menos proficientes. Os resultados são analisados à luz de outros estudos sobre a percepção da estrutura do texto e sobre a relação entre a capacidade da memória operacional e a compreensão em leitura. Como um todo, o presente estudo indica que a eficiência no processamento é um componente importante na relação entre a capacidade da memória operacional e a leitura. Finalmente, são discutidas as implicações pedagógicas do estudo.

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CHAPTER 1
INTRODUCTION

1.0 - Preliminaries

Early theories regarded short-term memory 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 & Norman, 1965). Today short-term memory is seen as a dynamic system which has processing functions as well as storage functions (Baddeley & Hitch, 1974; Daneman & Carpenter, 1980; Just & Carpenter, 1992; Cantor & Engle, 1993 & others). The term working memory (Baddeley & Hitch, 1974) has been used to refer to this more active system. Working memory is regarded as 'an arena of computation' (Just & Carpenter, 1992) where both functions – storage and processing – compete for capacity in the system (Baddeley & Hitch, 1974; Daneman & Carpenter, 1980, 1983; van Dijk & Kintsch, 1983; Cantor, Engle & Hamilton, 1991; Just & Carpenter, 1992; Engle, Cantor & Carullo, 1992; Cantor & 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 <u>short</u> – 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 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)

1.1 Working memory 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 & Collins, 1991; Just & Carpenter, 1992; & 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 is necessary for computing relationships within and between clauses and sentences (Daneman & Carpenter, 1980; Goldman, Hogaboam, Bell & 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 & Kintsch, 1983). The demands for processing include decoding, lexical accessing, parsing, inferencing and integrating (Daneman & 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 & 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, which they call immediacy of processing. Second, lower level representations are deactivated as higher level structures are 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

aims to investigate the psychological validity of two other types of organizational aspects: Problem/Solution (Hoey, 1979) and Prediction (Tadros, 1985). The focus in the present study is on the role of text organizational aspects in organizing the flow of information processing in working memory and, hence, in reducing the demands on storage and processing. The processes of better and weaker readers are investigated as they read texts organized in terms of Problem/Solution and Prediction.

1.2 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 & Kintsch, 1983; Taylor & Samuels, 1983; Meyer, Brandt & Bluth, 1980; Carrell, 1984, 1992; Winograd, 1984; Ohlhausen & 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 & 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 & Bluth, 1980), thus not being able to form a complete macrostructure. According to van Dijk & Kintsch (1983), a macrostructure 'provides 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 & Kintsch, 1983). The same is assumed to occur with text organizing mechanisms such as Prediction. Once the better reader spots a predictive signal, he/she knows what kind of incoming information he/she should look for to fulfill the tacit commitment of the writer, thus putting less burden on working memory. 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.

1.3 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 & Carpenter, 1980; Turner & Engle, 1989; Haenggi & Perfetti, 1984).

Daneman and Carpenter (1980) created a complex measure of working memory span called the Reading Span Test. In contrast to the simple digit of 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 & Miller, 1983; Turner & 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 & Miller, 1983; Whitney, Ritchie & Clark, 1991; Singer, Andrusiak, Reisdorf & Black, 1992), detecting inconsistencies in sentences containing homonyms (Daneman & Carpenter, 1983), using contextual cues to infer the meaning of a novel word in a text (Daneman & Green, 1986), processing complex syntactic structures (King & Just, 1991; MacDonald, Just & Carpenter, 1992), and the resolution of lexical ambiguity (Miyake, Just & 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.

1.4 The study

Two experiments are carried out in the present study. Experiment 1 investigates the relationship between the Reading Span Test (Daneman & 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 of 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 investigates whether distortions in the original structure of texts (see section 3.5 for types of distortions) are perceived by readers and how they affect comprehension and recall. The assumption is 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 are also hypothesized to be high and low span readers respectively, are investigated as they read complete and distorted texts organized in terms of Problem/Solution and Prediction.

1.5 Hypotheses investigated in the study

Based on the discussion above, the present study investigates 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.

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.

5. There is a relationship between reading ability and readers' capacity to recall elements explicitly predicted in the text.

6. There is a relationship between reading ability and readers' capacity to notice distortions in terms of the text organizing mechanism of Prediction; i.e., better readers are more likely to perceive when the text fails to completely fulfill the expectations set up by the writer in the predictive member of the Prediction pair.

7. Distortions in terms of the Problem/Solution pattern will have a greater negative effect on recall than the distortion related to the mechanism of Prediction.

1.6 Significance of the study

The study extends previous research in the following ways. First, up to the present date, and to this researcher's knowledge, no studies in the literature of working memory research have investigated the relationship between working memory span and the two aspects of reading ability used in this study: free recall and answers to questions about important information in the text. Second, since the present study is viewed from a process-oriented perspective, part

of the data was collected through verbal protocols. Only one study was found in the literature of working memory research which adopted the same methodology (Whitney, Ritchie & Clark, 1991), and no studies were found in text structure research using the same methodology. Third, up to the present time, and again, to this researcher's knowledge, this study is the first attempt to investigate the relationship between individual differences in working memory capacity and the use of text structure during reading. Therefore, the results obtained in the present study may contribute to further research in this area.

CHAPTER 2
REVIEW OF THE LITERATURE

This chapter is divided in two parts: the first (section 2.1) reviews studies in the literature of working memory and the second (section 2.2) reviews studies on text structure.

2.1 Research on working memory

Baddeley (1992) describes the current research on working memory as being mainly of two types: one based on the psychometric correlational approach and another based on both dual-task methodology and neuropsychological cases. The psychometric approach concentrates on devising tasks which involve the processing and storage of information in working memory. One example of such tasks is the Reading Span Test devised by Daneman and Carpenter (1980). Results obtained from these tasks are then used to predict performance on other cognitive skills such as reading, comprehension and reasoning. The other approach, which includes Baddeley's research, makes use of dual-task methodology and evidence from neuropsychological cases, with the objective of analysing the structure of the working memory system. The dual-task procedure consists of asking subjects to perform two attention-consuming tasks simultaneously (e.g. recall of digits or letters at the same time as performing a reasoning task). The rationale behind this methodology is that if performance on one task does not interfere with the other, then the two tasks possibly rely on separate components of the working memory system. If there is interference, the two tasks are possibly drawing on a common pool of mental resources or on the same component (Ashcraft, 1994).

Baddeley and colleagues propose a multicomponent model of working memory consisting of a central executive, and two slave

systems – the phonological loop and the visuo-spatial sketchpad (these components will be defined later in this chapter). According to Baddeley (1992) the two current approaches to working memory tackle different parts of the system, having strengths and weaknesses. As Baddeley observes, the psychometric approach can shed light on the central executive but does not allow for an analysis of how the other components of the system work. The dual-task and neuropsychological approach, on the other hand, allows for an analysis of the slave components but has made little progress in tackling the functioning of the central executive. The present study is related to the psychometric approach to working memory and this researcher is primarily interested in individual differences in working memory capacity, more specifically in how a reader's working memory capacity for language influences the processing of complete and distorted texts.

This section will briefly describe the multicomponent model of working memory proposed by Baddeley and colleagues and will then review studies on individual differences in working memory capacity which more directly relate to the present study.

2.1.1 The multicomponent model of working memory

The multicomponent model of working memory was first developed by Baddeley and Hitch (1974) and consists of a central executive, a phonological loop and a visuo-spatial sketch pad.

According to Baddeley (1990), the central executive is an 'attentional controller' and exerts control over the other two slave systems – the phonological loop and the visuo-spatial sketchpad. As Baddeley observes, the central executive controls and integrates actions and activities. Smyth, Collins, Morris and Levy (1994) include the following activities as being performed by the central executive: control of the flow of information, access to information in long-term memory and storage and processing of incoming information. The central executive directs attention and mental

resources, makes decisions and initiates the rehearsal process when it is required (Ashcraft, 1994).

Baddeley (1990) relates the central executive to the supervisory system for the control of action proposed by Norman and Shallice (1986, as cited in Baddeley, 1990): the Supervisory Activating System or SAS is responsible for planning, making decisions, initiating activities and preventing well-learned schemas from taking control when not required. These activities are the same which are said to be performed by the central executive (Smyth, Collins, Morris & Levy, 1994).

The phonological or articulatory loop is regarded as the inner voice (Baddeley & Lewis, 1981) and deals with the phonological code; it has a phonological store and a verbal rehearsal loop (Gathercole & Baddeley, 1990), also called articulatory control process (Baddeley, 1990). As Baddeley (1990) observes, the phonological store holds verbal information for a very brief period of time (from 1.5 to 2s), but the articulatory control process can then enter into play and refresh the memory trace by reading it off and then feeding it back to the phonological store. The articulatory control process is able to convert written information into phonological form and register it in the phonological store.

Evidence for the loop comes from a range of different phenomena which have been observed such as the phonological similarity effect, the unattended speech effect and articulatory suppression (see Baddeley, 1990 for a complete description). However, its role in reading comprehension is not totally clear. Researchers have suggested that it may be used as a verbal rehearsal loop on demanding occasions such as when the material to be read is very complex, or when the visual signals on the page are unclear (Levy, 1981); when the exact wording of the passage has to be remembered (Baddeley & Lewis, 1981) or when the young reader is trying to decode an unfamiliar word (Baddeley, Papagno & Vallar, 1988). More recently, Cantor and Engle and co-workers have

suggested that the phonological loop, which they term short-term memory, is involved in the temporary storage of surface-level information such as names of characters or colors (Cantor, Engle & Hamilton, 1991) or exact words of a recent clause or phrase (Cantor, Engle & Carullo, 1992).

The visuo-spatial sketchpad or scratchpad (VSSP) is regarded as the inner eye (Baddeley & Lewis, 1981). The VSSP deals with visuo-spatial information. Neuropsychological studies (Morris, 1987) point to the existence of separate subsystems for verbal and visuo-spatial representations: brain-damaged populations with no verbal deficits were found to have spatial deficits; other patients with brain lesions showed an intact visual short-term memory but impaired auditory short-term memory. Baddeley (1990) reports results from studies with both normal and brain-damaged subjects which suggest that the sketchpad may have related but separate components for visual and spatial information. Studies in the area of reading comprehension point to the fact that there are more aspects involved in the reading process in addition to verbal information – visual imagery seems to be one of these aspects (van Dijk & Kintsch, 1983; Long, Winograd & Bridge, 1989; among many others). Glenberg and Langston (1992) include the VSSP in their mental model theory. For Glenberg and Langston, a mental model is a 'representation of what the text is about' (p.130), and involves working memory, more specifically the visuo-spatial sketch pad. Just (personal communication, January 2, 1995) also includes a spatial component in his working memory model – the Spatial Resource Pool.

The research by Baddeley and colleagues which gave rise to the multicomponent model of working memory focuses on structural aspects of the system; i.e,., the main concern is with identifying different structures or memories which constitute the system (Cantor, Engle & Hamilton, 1991). As Baddeley (1992) observes, 'the dual-task and neuropsychological approach can be utilized to successfully

analyze the constituent processes of the slave systems but has made less headway in teasing apart the complexities of the executive controller' (p.557). The approach adopted in the present study involves the investigation of the relationship between working memory capacity and reading comprehension. It is concerned with the functional properties of working memory and allows for a more direct analysis of the central executive.

2.1.2 Research on the individual differences in working memory capacity

The most influential study in the area of working memory capacity was that by Daneman and Carpenter (1980), already described in the first chapter. Much of the research in this area has evolved from Daneman and Carpenter's work and has used, with little modifications, their Reading Span Test as a measure of working memory capacity, investigating how it correlates with a number of other cognitive skills including reading comprehension. The focus in these studies is on the functional properties of working memory.

Significant correlations have been obtained between the Reading Span Test and standardized measures of reading comprehension ability such as the Verbal Scholastic Aptitude Test – VSAT (Daneman & Carpenter, 1980; Turner & Engle, 1989) and the Nelson-Denny Reading Test (Masson & Miller, 1983; Baddeley, Logie, Nimmo-Smith & Brereton, 1985; Turner & Engle, 1989).

Reading Span has also been shown to correlate to a fairly great extent with a number of specific aspects of reading comprehension ability such as making inferences, processing complex syntactic structures and resolving lexical ambiguities. However, up to the present time, no studies have investigated the relationship between reading span and the two measures of reading ability investigated in the present study: free recall and answers to questions about important information in the text. Similarly, no studies were found which have investigated the relationship between working memory capacity and use of text structure during reading.

Among the studies which have investigated the ability to make inferences we find Masson and Miller (1983), Daneman and Green (1986), Whitney, Ritchie and Clark (1991) and Singer, Andrusiak, Reisdorf and Black (1992). Masson and Miller (1983) found a strong correlation between Reading Span and readers' capacity to infer ideas not explicitly stated in the text and which thus depended on the integration of information given in different parts of the text. They included a distractor between passage presentation and the related test statements (inferential and explicit), thus being able to examine performance on the test as dependent on the quality of encoding information into long-term memory.

Daneman and Green (1986) found that readers with higher spans were more able to use contextual cues to infer the meaning of a novel word in a text. According to the authors, the ability to exploit the contextual cues and draw appropriate inferences depends in part on the reader's working memory span. In order to infer the meaning of a certain word from context, individuals must keep contextual cues active as well as compute the relationships among them while reading. This process may be more difficult for readers with low spans, who have a smaller storage capacity and process information less efficiently.

Whitney, Ritchie and Clark (1991) found that working memory capacity as measured by the Reading Span Test correlated with the type of inferences readers made while processing difficult narrative texts. The texts used in the study contained ambiguous information which did not readily allow an exact interpretation of what was happening. Whitney et al. observed that high span readers tended to provide more general interpretations of the ambiguous content towards the beginning of the passage, awaiting for more information to come to check their hypotheses, whereas low span readers tended to choose one single interpretation and to adjust the incoming information to fit into it.

Singer, Andrusiak, Reisdorf and Black (1992) observed that an individual's ability to provide bridging inferences in contexts such

as 'The spy quickly threw his report in the fire. The ashes floated up the chimney', was related to his/her working memory capacity, especially when the two sentences were separated by intervening text. According to Singer et al., higher span readers are more likely to have the antecedent idea still active in working memory (or more able to reinstate it from long-term memory to working memory) in order to provide the necessary bridging inference. Lower span readers, on the other hand, devote so much of their working memory capacity to processing the intervening text that their inference process is hindered.

A few studies have investigated the processing of complex syntactic structures: King and Just (1991) and MacDonald, Just and Carpenter (1992). King and Just (1991) observed that an individual's ability to process complex syntactic structures such as center-embedded relative clauses was related to his/her working memory capacity, with higher span individuals performing better than lower span individuals on recall and comprehension tests. Their explanation for these results is that a sentence like 'The reporter that the senator attacked admitted the error', taxes working memory resources: information from the main clause has to be held in working memory (or reactivated later on) while the embedded clause is processed; proper thematic roles have to be assigned to the two noun phrases; and two different roles have to be assigned to a single syntactic constituent.

MacDonald, Just and Carpenter (1992) obtained support for a model of syntactic parsing called 'The Capacity Constrained Parsing Model', which aims to explain how working memory capacity can influence the processing of syntactic ambiguities in garden-path sentences such as 'The soldiers warned about the dangers…'. Their model predicts that both high and low span readers initially construct multiple representations (main verb and relative clause) and that the preferred representation (syntactically simpler, pragmatically more plausible, or more frequently encountered) is

maintained in a higher level of activation than the unpreferred interpretation. However, low span readers cannot maintain both representations active while processing the rest of the sentence and have to abandon one of them (unpreferred) before the disambiguating information comes in the sentence, whereas high span readers keep both interpretations active. The model predicts that if the ambiguity is resolved with the preferred interpretation, both high and low span readers encounter no difficulties to comprehend the sentence. However, if the unpreferred interpretation is necessary for disambiguating the sentence, then low span readers tend to make more errors than high span readers, since they no longer have the unpreferred resolution active in working memory.

The resolution of lexical ambiguity has been investigated by Daneman and Carpenter (1983) and Miyake, Just and Carpenter (1994). Daneman and Carpenter (1983) observed that readers with smaller spans were less able to detect inconsistencies in sentences like 'He found a bat that was very large and brown and was flying back and forth in the gloomy room', where the previous context primed one meaning of the homonym (bat – baseball stick) but the target sentence gave an inconsistent disambiguation (bat – animal). It was even more difficult for smaller span readers to resolve the ambiguity when a sentence boundary intervened between the inconsistent disambiguation and the word to be reinterpreted as in 'There is a sewer near our home. He makes terrific suits'. According to Daneman and Carpenter (ibid), in order to recover from an inconsistency, the reader has to be able to relate the inconsistent information to information read earlier in the text. This process of information integration seems to pose more difficulties for low span readers, who are less likely to have earlier information still active in working memory.

Using the same theoretical construct as that for the syntactic parsing model presented above, Miyake, Just and Carpenter (1994) obtained support for a model for the resolution of lexical ambiguity

- 'The Capacity-Constrained Model of Lexical Ambiguity Resolution'. The model proposes that when a lexical ambiguity is encountered in a text, multiple representations are initially constructed, but higher span readers are more likely to maintain multiple representations until the disambiguating information is encountered. This is so because this type of task demands extra resources from working memory – multiple representations have to be stored until the disambiguating information is provided, while at the same time subsequent input information is processed.

The reading span measure has also been shown to be sensitive to task demands and to individual differences in prior knowledge. Fincher-Kiefer, Post, Greene and Voss (1988) found that working memory capacity is constrained by the processing demands required by a certain task. They asked individuals with higher and lower knowledge in a given domain to read domain-related and neutral passages. They found that domain-related material led to greater processing demands upon individuals with lower knowledge than upon individuals with higher knowledge, but only when subjects were required to recall the contents of the sentences besides their final words. As Fincher-Kiefer et al. observe, the requirement to recall content information taxed working memory resources, since subjects had to use their prior knowledge to structure the information. Low knowledge individuals may encounter difficulties in integrating all the incoming information in the sentence and must store information until further related input helps to construct an interpretation.

The study of 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' (p.123). The total capacity explanation posits that individuals vary in the amount of activation they have available in working memory for storage and processing. The processing efficiency explanation posits that some individuals have more efficient mental processes than others. According to Just and Carpenter, 'the two explanations are mutually compatible' (p.125), although, as they observe, the results of the studies they have carried out are better explained in terms of the total capacity account. 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 the task is demanding, the differences between the two groups are 'large and systematic'.

Most studies on individual differences in working memory capacity have dealt with short stretches of discourse. Most of them have investigated processing at the sentence level (e.g. Turner & Engle, 1989; King & Just, 1991; MacDonald, Just & Carpenter, 1992; Miyake, Just & Carpenter, 1994) or at the paragraph level (e.g. Daneman & Carpenter, 1980, 1983; Fincher-Kiefer, Post, Greene & Voss, 1988; Yuill, Oakhill & Parkin, 1989; Singer, Andrusiak, Residorf & Black, 1992). Very few studies have dealt with longer texts (Masson & Miller, 1983; Daneman & Green, 1986 and Whitney, Ritchie & Clark, 1991). A considerable lack of research was found with longer and naturally occurring texts. Little research in working memory capacity has been carried out from a process-oriented perspective, only one study was found (Whitney, Ritchie & Clark, 1991), as previously mentioned. The present study is in the same line of research on working memory capacity as that by Whitney, Ritchie and Clark (1991). The data (to be reported on in the next chapter) is analyzed from a 'cognitive control perspective', the main interest being on how high and low span readers deal with

information in text when the overall structure is complete and when it is distorted.

2.2 Research on text structure

2.2.1 Text organizational aspects

Hoey (1983) defines text organization or pattern as the 'combination of relations organizing (part of) a discourse' (p.31). According to Hoey, discourses are not merely built as collections of sentences, with one sentence being related to the previous one and to the next, nor can they treated as a collection of paragraphs; discourses do have an overall hierarchical organization. Hoey points out that text organization may be signaled in the surface structure and that signaling in turn may lead readers/listeners to perceive how texts are organized.

Although there are other elements in written texts which signal important text relations to the reader, this study will focus on two aspects of text organization: Problem/Solution and Prediction.

These two aspects of text organization have a very important characteristic in common: they create certain expectations in the reader in relation to what is going to come next. This way the flow of input can be organized by the reader and chunking may be facilitated.

Both Problem/Solution and Prediction can organize the text at the macro level as well as at the micro level. The researcher of the present study chose to investigate Problem/Solution as a macrolevel organizer and Prediction as a micro organizer.

2.2.1.1 Problem/solution as a conventional pattern of text organization

According to Stanley (1984), the Problem/Solution pattern of text organization can be very effective because unlike many others, it integrates 'surface linguistic study and local levels of text analysis with the overall structure of text' (p.156).

The Problem/Solution pattern (Hoey, 1979, 1983) regularly consists of the following sequence: situation; problem; solution or response; result and evaluation. According to Hoey, situation and evaluation are the basic units which roughly answer the questions "what are the facts?" and "what do you think of them?" respectively. Problem, response and result come from special combinations of situation and evaluation.

In the following example (Hoey, 1979, p.11),

> (1) I was on sentry duty. (2) I saw the enemy approaching. (3) I opened fire. (4) I beat off the enemy attack.

the four sentences would sequentially correspond to situation, problem, solution and evaluation.

As Hoey observes, there are twenty-four possible sequences which can be made out of those four sentences, but only the one above can be considered totally acceptable and unmarked, not requiring any special intonation or special context to occur, for example, in answer to a question.

According to the author, sequence is not the only important factor for the organization of those four sentences; it is also necessary that all of them be present. Each one of them plays an important role in the overall structure. Therefore, any version of this text which does not include one of the four sentences mentioned above is somewhat incomplete, according to Hoey. Hoey's argument is that the omission of one of the four sentences may result in either ambiguous or vague texts, requiring some kind of inferencing to round off the discourse (some information is presupposed), or requiring a special context to occur (e.g. answer to a question).

Thus, it seems reasonable to assume that any incomplete version of the Problem/Solution structure will pose difficulties for the reader and may hinder comprehension. This is one of the perspectives investigated in the present study, the texts here being more complex than the example quoted from Hoey. It is hypothesized that better

readers will be more inclined to perceive and report when one of the parts in the Problem/Solution structure is missing and that their comprehension and recall of distorted texts (see chapter 4) will also be negatively affected.

2.2.1.2 Prediction as a text organizing mechanism

According to Tadros (1985), a difference must be made between Prediction and anticipation. In her use of the terms, Prediction involves signals in the text that commit the writer to fulfill an expectation; whereas anticipation does not involve predictive signals and the reader can only "anticipate" or "guess" what is going to come next in the text.

Prediction, as described by Tadros, involves a pair with two members: the predictive member and the predicted member. The predictive member carries signals which imply that a Prediction has been set up and the predicted member contains the realization of that Prediction. The writer is the one person who has control over the Prediction relationship.

Tadros describes six categories of Prediction: enumeration, advance labeling, reporting, recapitulation, hypotheticality and question. This researcher chose to investigate the category of 'enumeration' (see Tadros, 1985, for a complete description of the six categories).

As suggested by Tadros, enumeration is a type of Prediction in which the writer commits himself/herself to enumerate. Regularly, enumeration involves the specification of more than one element in the predicted member. The predictive member of the pair contains a numeral (exact such as 'two', 'three' or inexact such as 'several', 'a number of') and an enumerable which includes 'sub-technical' nouns (e.g., 'functions', 'advantages') and 'discourse self-reference nouns' (e.g., 'examples', 'definitions'). The nouns which belong to the group of enumerables indicate that their referents will be in the text and thus do not include open-set nouns (e.g. 'computers', 'surgeries') which already have referents in the real world.

In the present study, it is hypothesized that better readers will be more prone to perceive when one of the elements of the predicted member is missing and to report the distortion.

2.2.2 Studies on text structure awareness

The following findings from the research on text structure are of direct relevance to the present study: first, better and older readers use a "structure strategy". They are more capable of identifying the superordinate information in a text and of forming hierarchical clusters (van Dijk, 1980; Meyer, Brandt & Bluth, 1980; McGee, 1982). In a study about structural awareness of good and poor ninth-grade readers, Meyer et al. (1980) found that skilled readers tend to follow the same top-level pattern as the author to organize their recall, whereas less skilled readers did not and tended to list ideas as if they were equally important. McGee (1982) found the same pattern of results with fifth-grade readers. Second, readers who employ a structure strategy recall more information from the text than those who do not (Meyer, Brandt & Bluth, 1980; McGee, 1982; Taylor & Beach, 1984; Carrell, 1984, 1992; Richgels, McGee, Lomax & Sheard, 1987). Third, structure-aware readers recall more information from a normal or well organized passage than from a scrambled or badly organized one (Taylor & Samuels, 1983; Richgels, McGee, Lomax & Sheard, 1987). Finally, readers who use a structure strategy are more capable of identifying 'intruded information' which was actually not stated in the text (Meyer, Brandt and Bluth, 1980) or which is not compatible with the structure (Hiebert, Englert & Brennan, 1983). On the basis of the research cited above it seems reasonable to hypothesize that the better readers in this study will be more likely to perceive and report the distortions in the overall structure of texts than weaker readers.

Among the studies which have directly dealt with the Problem/ Solution pattern, some have investigated structural awareness (e.g. Meyer, Brandt & Bluth, 1980; Carrell, 1984; Stanley, 1984; Richgels, McGee, Lomax & Sheard, 1987). Others have

investigated the effects of signaling (Meyer, Brandt & Bluth, 1980; Spiridakis & Standal, 1987) or of direct instruction about the structure (Carrell, 1985; Slater, Graves & Piché, 1985; Armbruster, Anderson & Ostertag, 1987) on reading comprehension and recall. Of direct relevance to the present study is the issue of awareness.

The most common measure of awareness used by text structure researchers is readers' use of the same pattern used by the author to organize recall of the information in the text (Meyer et al., 1980; Carrell, 1984; Richgels, McGee, Lomax & Sheard, 1987). A second type of assessment is students' use of the Problem/Solution structure when writing (Richgels et al., 1987). A third type of measure is response to interview question about the structure (Richgels et al., 1987; Carrell, 1992).

There has been a concern among text structure researchers to use more than one type of assessment to measure structure awareness (Richgels et al., 1987; Roller, 1990; Carrell, 1992). One reason cited by these researchers is that different types of measures have provided different results, i.e., awareness of text structure has been found to vary with the type of task that is used to measure it. According to Roller, using different assessments is a way to 'calibrate' structure awareness; more reliable conclusions can be arrived at when several measures are used and compared with one another. Another reason (more important, according to Richgels et al., 1987) is that measures vary in their cognitive demand, with use of structure being the least demanding and response to interview question the most demanding of the three types mentioned above, according to them. The present study makes use of two of the measures described above – use of structure in recall and response to interview question – and includes a third measure which is based on an exploratory study developed by Stanley (1984).

Stanley investigated native and non-native readers' awareness of the Problem/Solution structure. In the methodology used by Stanley, subjects read two texts and after reading each one of them they ranked four summaries of each text in order of preference. The

summaries were constructed so that one contained the complete structure - 'situation', 'problem', 'solution' and 'evaluation'; another distorted the original complete structure of the texts by omitting all information related to the problem section; a third one distorted the original structure by omitting the sections which referred to the solution; and a last one was the result of summarizing every third sentence of the original texts.

In the present study, a similar methodology was used. However, two main modifications were made so that the methodological approach could better fit the purposes of the present study. One modification was that the distortions were applied not to summaries presented after reading the complete texts but to the text themselves. The other modification was related to data collection. Instead of asking subjects to rank summaries in order of preference, in this study verbal protocols were collected while reading. The reasoning was that these modifications would allow for a better analysis of the reading process of better and weaker readers, besides providing an assessment of awareness of the two organizational aspects being investigated (Problem/Solution and Prediction).

The present study extends previous research on awareness of the Problem/Solution structure in the following ways. First, different measures of awareness are used. Only one of the studies mentioned above used more than one type of measure (Richgels et al., 1987). Second, the subjects in the present study are Brazilian college students. In the studies mentioned above, the subjects were sixth-grade students (Richgels et al., 1987), ninth-grade students (Meyer et al., 1980), ESL students of different language groups (Carrell, 1984) and native and non-native postgraduate students (Stanley, 1984). Finally, up to the present time, no studies have investigated the relationship between working memory capacity and use of text structure during reading.

Regarding the research on the relationship between working memory capacity and reading comprehension, several aspects of

reading ability have been investigated, as can be seen from the review presented in section 2.1.2. However, at present, no studies have investigated the relationship between working memory capacity and the two measures of reading ability used in the present study: free recall and answers to questions about important information in the text. Similarly, no studies were found in the literature of working memory research which have investigated the relationship between capacity and use of text structure during reading. This study is a first attempt to explore this relationship.

CHAPTER 3
METHOD

3.1 Subjects

The subjects were twelve undergraduate students – three men and nine women – taking regular courses at UFSC. Seven subjects were in their second semester of the Letters-Portuguese B.A. course and five were in their second semester of Medical School. All of them were Brazilian native speakers of Portuguese and read texts in their own language. The whole experiment was carried out in Portuguese.

3.2 Reading ability measures

All data was collected individually (see section 3.9) with each of the twelve subjects, who were later separated into two groups, better and weaker readers, according to the mean scores obtained in two reading ability measures: free recall and answers to questions about important information in the text (see Appendix C). For the reading ability measures, a text entitled "O delicioso paradoxo francês" (The delicious French paradox) (*Veja*, 1992) containing 298 words was used (see Appendix C). Subjects were allowed to read the text silently for four minutes and then the text was collected and subjects were instructed to write down everything they could remember in complete sentences. As soon as they had finished the free recall task, they received a sheet of paper containing eight open-ended questions about important information in the text. The text reports findings from a scientific research about the French 'foie gras' and the human death rate of coronary diseases in the southwestern region of France. The first question involves information

about the conclusion of the study. The conclusion of the study is given by the text as the key idea, the 'news', and appears in the subtitle and also as the topic sentence in the first paragraph. Two questions require information about the traditional belief which the new finding can displace and about the objective of the reported study. Two other questions are related to the methodology used. The next two questions are about the results obtained and how these results are explained in the text. And the last question relates to the doubt raised by the American scientific community about the conclusion of the study.

The recall protocols were scored for the number of propositions recalled using a method described in section 3.10 later in this chapter (see Appendix G for an example). 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 (see Appendix D), with a standard deviation of 7.19, a minimum score of 50.25, and a maximum score of 70.01. Weaker readers' overall mean was 28.93 (see Appendix D), with a standard deviation of 8.56, a minimum sore of 11.99, and a maximum score of 36.40. Results from the T-test show that differences between the mean scores of better and weaker readers are statistically significant (Student T= 6.43, df= 10, p= .00007).

3.3 Measure of working memory span

The Reading Span Test (Daneman & Carpenter, 1980) was used to measure the subjects' working memory span, so that a correlation could be established between this measure of working memory and the two reading ability measures previously mentioned – free recall (hypothesis 1) and comprehension questions (hypothesis 2). Hypothesis 1 was also investigated in Experiment 2, to see whether the Reading Span Test would correlate with the number of propositions recalled from each of the five texts. Thus, the Reading

Span Test was also correlated with Whole Text Recall – the recall done after reading each of the five texts (see section 4.2 in the next chapter for a description of the data).

The Reading Span Test consisted of 60 unrelated sentences (see Appendix B), ranging from 13 to 17 words in length. All sentences ended in a different word. Each sentence was typed in the center of a 14x22 cm card. The 60 sentences were arranged in the following way: three sets of two sentences, three sets of three, three sets of four, three sets of five and three sets of six sentences. The end of each set was indicated by a blank card. In the studies carried out by Daneman and Carpenter, in a group of 100 subjects, the best performance in the Reading Span Test was the recall of all the final words in five-sentence sets; i.e., the largest working memory span found was five words.

The test was preceded by a training section, and each one of the twelve subjects was told that the number of sentences in each set would gradually increase.

Each subject was instructed to read each sentence aloud (see Appendix A, item III for instructions) trying to comprehend it, memorizing the last word of each sentence. Immediately after the subject finished reading a sentence, another card was placed by the researcher on top of the first and the subject began reading the next sentence. When the blank card appeared, the subject had to try to recall the last words of all sentences in that set, exactly in the same order they had been presented.

When subjects failed all three sets at two subsequent levels, the test was terminated. 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 (Masson & Miller, 1983). As shown in Table 1, better readers' scores (3.58) were higher than weaker readers' (2.41)

Table 1 – Better vs weaker readers' scores on the Reading Span Test

	Better readers	Weaker readers
	3.5	2.5
	4.0	2.0
	3.0	2.0
	3.5	2.0
	3.5	2.5
	4.0	3.5
AVERAGE	3.58	2.41

Results from the T-Test show that there is a statistically significant difference between the scores of better and weaker readers in the Reading Span Test (Student T= 4.11, df= 10, p= .002); i.e., better readers showed a larger working memory span than that of weaker readers. Among the studies which have used the Reading Span Test to measure working memory capacity, there is not much agreement in terms of what constitutes high and low working memory spans. Daneman and Carpenter (1980) refer to a span of 2 as being low and to spans of 4 and 5 as being high, but do not classify spans of 3 words, despite the fact that readers with spans of 3 words are also included in their study. Daneman and Carpenter (1983) add a new category – intermediate span readers – which includes those subjects with spans of 3 and 3.5 words. In their study, spans of 2 and 2.5 are considered low, and spans of 4 and 5.5 are large spans. This same classification is used by King and Just (1991) and Miyake, Just and Carpenter (1994). However, MacDonald, Just and Carpenter (1992) consider spans of 3.5 words or more as being high, although keeping the same 2.5 or less as low spans. In the present study, weaker readers, who have a medium span of 2.41, are classified as 'lower span readers' and 'better readers, who

have a medium span of 3.58, are classified as 'higher span readers'.

3.4 Texts used in experiment 2

Five texts were used in Experiment 2. The criteria for selection were the following: the texts should contain general interest information (for this reason they were selected from current issues of well-known magazines) and they should be structured according to the conventional pattern of text organization and the text organizing mechanism used in this study. Thus, three texts contain the Problem/Solution structure and two contain Prediction (see Appendix E).

3.5 Distortions

The Problem/Solution pattern appears in three versions: complete, no problem, and no solution; and Prediction appears in two versions: complete and incomplete. 'No problem', 'no solution' and incomplete' Prediction are here called 'distortions'.

In relation to the 'no problem' text, besides the deletion of the problem section, all the information which referred to the problem itself was made vague. The text signals that there is a problem but does not make clear what exactly the problem is (see Appendix E for the text).

In the 'no solution' text, the omitted information was that related to the solution section. The title of the text signaled the solution and, therefore, was kept so that an expectation would be created in the reader, but this expectation was not fulfilled; only the problem was described throughout the text (see Appendix E for the text).

In relation to the text containing 'distorted Prediction', the predictive signal was kept but was not completely fulfilled: one of the predicted elements was missing in the text; i.e., the text signals that there are three types of antivirus vaccines but mentions only two of them (see Appendix E).

The point in trying to distort the original and supposedly 'complete' text structure is to try to disturb the flow of processing in order to see how these distortions affect comprehension and recall. The assumption behind this methodology is that if subjects report the distortions, it is possible that they are using the structure to organize the flow of information during reading. As previously presented in the hypotheses for the present investigation, it is expected that better readers will be more prone to notice these distortions. The subjects' perception of the distortions is expected to show in the pause protocols, during recall of the information in the texts, and also during the retrospective interview applied at the end of each text, (see section 4.2 in the next chapter for description of the data).

3.6 Verbal reports

Although the use of verbal protocols as a method for data collection is controversial in fields other than Problem Solving theory (Cavalcanti, 1987), it is becoming more and more popular in the field of reading research (Davies, 1995) – readers are asked to report on their own cognitive processes or to 'think aloud' while reading (Olshavsky, 1976-7; Fletcher, 1986; Cavalcanti, 1989; Long, Winograd & Bridge, 1989; Wade, Trathen & Schraw, 1990; and Pritchard, 1990, among many others).

The most common procedure is to ask for the reports at the end of every major clause or sentence (Olshavsky, 1976-7; Fletcher, 1986 and Pritchard, 1990, among many others). However, some procedures have been used which do not encourage clause or sentence reading and which seem to have less interference with the reading process. Examples of these are pause protocols (Cavalcanti, 1987; 1989) and marking the text with signals to stop at points where there is a major topic shift (Wade, Trathen & Schraw, 1990) or at points which evoke imagery (Long, Winograd & Bridge, 1989). In the present study, the 'pause protocol', adapted from Cavalcanti, was used (see Appendix A, item IV). Thus, subjects were given the

whole text and were asked to stop at points where they encountered a 'problem or something that caught their attention' (Cavalcanti, 1987, p.250) and give a report. Following the same procedure described by Cavalcanti, the subjects in this study were also asked to stop and give a report at the end of each paragraph. A red dot at the end of each paragraph was used as signal to remind the subjects that they would have to stop and give a report.

Cohen (1987) describes three types of verbal reports: self-report, self-observation and self-revelation. 'Self-report' refers to the reader's general description of his/her reading behavior. It has to do with the way the reader thinks or believes he/she acts during the reading situation in general. 'Self-observation' (called 'retrospective verbalization' by Ericsson & Simon, 1980) refers to the reader's description of his/her reading behavior related to a specific reading task. The third type of verbal report mentioned by Cohen is 'self-revelation' (called 'concurrent verbalization' by Ericsson and Simon). It refers to the reader's report given during the ongoing process of reading, as he/she is attending to the information.

According to the classification presented above, the pause protocol procedure used in this study involves 'concurrent verbalization' (or 'self-revelation'), since the reader is asked to stop at any point during his/her reading and report on problems he/she encountered or on anything that called his/her attention. It also involves 'retrospective verbalization' (or 'self-observation'), since the reader is also asked to stop at the end of every paragraph and give a report.

As a complement for the pause protocol procedure, a retrospective interview consisting of eight questions was designed to be applied orally right after the recall of each complete and distorted text (see Appendix F). In the classification described above, these questions involve 'retrospective verbalization' and were designed in order to take the reader into a retrospection and

evaluation of what he/she just read. The type of questions used at this point required the subject not only to try to describe but also to evaluate aspects of the process he/she had just gone through as well as aspects of the text.

3.7 The pilot study

A pilot study was carried out in February 1993, four weeks before the main study. Four native speakers of Brazilian Portuguese participated in the pilot experiment. All of them had a university degree: two in electrical engineering, one in architecture and one in physical education.

The pilot experiment was very useful in the sense that it shed light on the following aspects of data collection:

1) The number of sessions for data collection. It had already been decided that data collection would be conducted in two sessions: one for the Reading Span Test and the test of reading proficiency and another session for the pause protocol procedure plus the retrospective interview. But since the pause protocol procedure required detailed training, there was a fear that this session could become tiresome and unfeasible due to the number of texts the subject would have to handle. The pilot study showed that training plus the actual experiment took around 50 minutes, and would thus not be a burden for the subjects.

2) Procedure for the Reading Span Test. In the procedure described by Daneman and Carpenter (1980), the test was terminated when the subject failed all three sets at a particular level. In this study, the test was terminated only when the subject failed all three sets at two subsequent levels. This was decided during the development of the pilot experiment, where it became clear that subjects might fail one or two sets at a certain level at the beginning

of the procedure, probably due to anxiety, but as the test went on, they would be able to get two or three sets right again.

3) Procedure for the pause protocols. In the procedure described by Cavalcanti (1989), the subject was interrupted once during his/her reading in order to answer some questions about the ongoing process. However, the pilot experiment showed that for the objectives of this study, more could be concluded from the subject spontaneously interrupting his/her reading and from the answers given during the retrospective interview conducted after reading and recall, than from researcher-based interruptions. The reason is that in this experiment the point was to see where the flow of processing would be interrupted and researcher's questions during reading would interfere with the process.

4) Retrospective interview. The pilot study contributed to establish the order in which the questions would have to be asked so that they would flow smoothly. It also showed the necessity to add one or more questions to the original questionnaire: 'What was the author's objective in writing this text? Do you think he/she attained this objective?' This question is directly related to the next one in the original questionnaire about the text completeness: 'Do you consider this to be a complete text?', and it is also intended to reveal whether the subject was able to get the writer's message.

3.8 Design

3.8.1 Experiment 1

In this experiment, the measure of working memory capacity (Reading Span Test) was correlated with the two measures of reading comprehension ability (free recall and answers to questions) and also with the recall done after reading each complete and distorted text in Experiment 2 (Whole Text Recall), as shown in Table 2.

Table 2 – Experimental design for Experiment 1

SUBJECTS	RST	FREE RECALL	QUESTIONS	WTR1	WTR2	WTR3	WTR4	WTR5
BETTER READERS								
WEAKER READERS								

RST= Reading Span Test
WTR= Whole Text Recall

3.8.2 – Experiment 2

As already observed, subjects were assigned to two groups: better and weaker readers, according to the mean scores obtained in the two measures of reading ability mentioned above (see Appendix D for scores).

All better and weaker readers read one complete text for the two text organizational aspects being investigated, namely Problem/Solution and Prediction, and also read all distorted texts, namely 'no solution', 'no problem' and 'distorted prediction'. The sequence in which the subjects read the texts is shown in Table 3.

Table 3 – Experimental design for Experiment 2

	PROBLEM/SOLUTION			PREDICTION	
SUBJECTS	P/S	NOS	NOP	P	DP
BETTER READERS					
WEAKER READERS					

COMPLETE TEXTS — DISTORTED TEXTS

P/S= Problem/Solution
P= Prediction

NOS= No Solution
NOP= No Problem
DP=Distorted Prediction

Subjects read all texts, complete and distorted, following the pause protocol procedure, adapted from Cavalcanti (1989), as already observed (see Appendix A, item IV for instructions). They were also asked to give a free recall after reading each text. Subjects were also required to answer the questions from the retrospective interview, described in section 3.6. This was done immediately after reading and recalling each complete and distorted text.

3.9 – Procedure

The two experiments were conducted individually with each one of the twelve subjects. Each subject received written instructions before the experiments began (see Appendix A, item I).

The data collection was divided into three main parts: the first consisted of the measures of reading comprehension ability and the second part consisted of the measure of working memory span. The third part consisted of the reading of the five texts following the pause protocol procedure and of the retrospective interview for each one of the five texts. The third part included a training session to acquaint the subjects with the pause protocol procedure. One text was used during the training session, collected from one of the magazines which served as the source for the other texts used in the study. The three parts were conducted on two different days: the first and second parts in the first encounter and the third part on a subsequent date.

The data for Experiment 1, which is an attempt to expand on Daneman and Carpenter's (1980) findings, came from the Reading Span Test, from the two measures of reading comprehension ability mentioned above and from Whole Text Recall (WTR), collected after reading each complete and distorted text.

The data for Experiment 2 came from the pause protocols collected while the subjects read the complete and distorted texts and also from the retrospective interview conducted immediately after the subjects finished reading each of the complete and distorted texts.

3.10 – Propositional analysis

In order to score the recall protocols mentioned above, all texts used in this study were propositionalized (see Appendix G) using a method developed by myself. The method was created and informally used at the Reading Laboratory at UFSC in 1988/89. It was also used by this researcher in an experiment conducted in Tomitch (1990). The method was found to be a useful tool for measuring recall.

According to van Dijk and Kintsch (1983), a proposition is defined as 'an intentional unit corresponding to the meaning of a sentence in linguistic theory and to the conceptual representation of a sentence in a cognitive model of language comprehension' (p.112). As they observe, a proposition is usually composite; i.e., it consists of several other 'atomic' propositions.

What the present method does is try to identify these atomic propositions. The first step is to identify the central proposition or propositions in each sentence and then the modifiers or attributes which modify the central proposition. One of the main characteristics of the present method is the use of the text itself instead of a list of propositions (Bovair & Kieras, 1981). A parenthesis is put before any attribute which creates a new proposition; i.e., which modifies the central proposition. The recall protocols are then matched with the propositionalized texts for the number of (atomic) propositions recalled in each case (see Appendix G for an example).

In the present study, a proposition was scored as mentioned whenever the subject literally recalled it or when a certain idea recalled by the subject was a paraphrase from a proposition in the presented sentence.

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Experiment 1

The purpose of the first experiment was to investigate whether there is a correlation between the Reading Span Test – RST (Daneman & Carpenter, 1980) and two measures of reading ability: free recall (Hypothesis 1) and answers to questions about important information in the text (Hypothesis 2). As mentioned in the previous chapter, 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 each one of the complete and distorted texts (Whole Text Recall).

As already mentioned above, twelve subjects participated in the study and were separated into two groups: better and weaker readers, according to the mean scores obtained in the two measures of reading ability mentioned above. They were also given the Reading Span Test. Table 4 shows the subjects' scores.

Table 4 – Better vs weaker readers' scores on the RST (raw) and on the reading ability measures (%)

	RST	% RECALL	% QUESTIONS
1	3.5	31.75	68.75
2	4.0	35.13	87.50
3	3.0	38.51	87.50
4	3.5	37.16	100.00
5	3.5	58.78	81.25
6	4.0	32.43	75.00
7	2.5	20.94	50.00
8	2.0	29.05	43.75
9	2.0	20.94	50.00
10	2.0	11.46	12.50
11	2.5	19.59	31.25
12	3.5	20.27	37.50

1 to 6= Better Readers
7 to 12= Weaker Readers

Results from Pearson's Correlation Coefficient (r) showed a moderate correlation between scores on the RST and on the free recall test (r= .56), but it was not significant at the .05 level (p= .0533). This may be explained by the fact that one subject (S12), who may be considered an outlier, scored low on the recall test (20.27) and obtained a high score on the RST (3.5). Although I cannot speculate as to why she obtained this high rate, the fact is that when her scores are left out of the correlation, significant results are obtained (r= .65, p= .03), which also indicate a moderate correlation.

A moderate correlation (r= .70, p= .01) was also found between scores on the RST and on answers to questions. Again, when S12's scores are not included in the statistical test, a strong correlation is obtained (r= .80, p= .002).

In terms of Whole Text Recall (WTR), RST correlated significantly with four of the five texts: WTR1 (r= .77, p= .003), WTR2 (r= .70, p= .01), WTR4 (r= .61, p= .03) and WTR5 (r= .65, p= .02); i.e., the number of propositions recalled from each of the texts mentioned above was directly related to capacity. Higher span readers performed better than lower span readers during recall of the following texts: 'complete Problem/Solution ' (WTR1), 'no solution' (WTR2), 'complete Prediction' (WTR4) and 'distorted Prediction' (WTR5). The only non-significant correlation was that between RST and WTR3 - 'no problem' text. This result will be discussed later on in this chapter, together with the discussion of hypothesis 4 for the 'no problem' text.

The results presented above show that the first and second hypotheses were confirmed. The first hypothesis was confirmed with the recall done at the end of the pause protocol procedure; i.e., readers who scored higher in the measure of working memory span, also tended to score higher during Whole Text Recall. Similarly,

readers who scored lower in the measure of working memory span also tended to score lower during Whole Text Recall. The second hypothesis involved the correlation of RST and answers to questions about important information in the text (reading ability measure), and it was also confirmed; i.e., scores on the RST correlated significantly with scores on the answers to questions.

The correlations between RST and recall and RST and questions obtained in this study, which range from .56 to .77, are similar to those obtained in other related studies. Daneman and Carpenter (1980) found correlations ranging from .72 to .93 in a study about the ability to answer fact questions and to compute pronominal reference. Masson and Miller (1983) found a correlation of .56 in a study about the ability to make inferences. Daneman and Green (1986) found a correlation of .69 in a study about the ability to deduce the meaning of a novel word from context.

Therefore, the results from answers to questions about important information in the text and from Whole Text Recall corroborate those in the literature of working memory research, reviewed in Chapter 2. Significant correlations were also obtained in other studies which investigated the relationship between RST and other aspects of reading ability. 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.

4.2 Experiment 2

The second experiment investigated the role of a conventional pattern of text organization, namely Problem/Solution (Hoey, 1979) and of a text organizing mechanism, namely Prediction (Tadros, 1985), regarding their relationship to the flow of information processing in working memory.

In Experiment 2, the same 12 subjects who had participated in Experiment 1 read five texts, produced verbal reports for each of

them while reading, and answered a questionnaire immediately after reading each of the texts.

The verbal protocols produced by better and weaker readers when reading each of the five texts, the answers to the retrospective interview after reading, and the number of propositions recalled for each of the complete and distorted texts constituted data for Experiment 2.

The comments made by the twelve subjects during the pause protocol procedure and during the retrospective interview were recorded and later literally transcribed, with an attempt to preserve the exact wording used by subjects as well as silences and hesitations. All the extracts from the transcription used in this chapter were translated into English, since the whole experiment dealt with and was carried out in the subjects' mother tongue – Portuguese. Sometimes it was very difficult to represent the same ideas in English, and many times there were mistakes in Portuguese which made it difficult for the researcher to know what exactly the subject intended. On these occasions, a tentative translation was provided in English and the exact wording the subject used in Portuguese was kept in parentheses.

The pause protocols produced by better and weaker readers when reading each of the five texts were qualitatively and quantitatively analyzed.

The qualitative analysis consisted of a subjective analysis of the comments made by the twelve subjects, which directly related to the hypotheses investigated in this study, regarding awareness of the two text organizational aspects and perception of the distortions related to those aspects. The way each group of subjects – better (also higher span) and weaker (also lower span) readers – managed the information while reading is presented and discussed in the light of other studies which have investigated individual differences in working memory capacity for processing language (Daneman & Carpenter, 1980, 1983; King & Just, 1991; Just & Carpenter, 1992; MacDonald, Just & Carpenter, 1992; Miyake, Just & Carpenter, 1994, among many others).

The quantitative analysis consisted of counting the number of propositions recalled by the subjects in each of the five texts. The quantitative data was obtained as follows: as already specified, each subject was asked to give a recall after reading each paragraph and also after reading the whole text. These recall protocols were scored for the number of propositions recalled for each text. Thus, each subject had the following numeric results for each of the five texts: 1) paragraph recall, which includes the number of propositions recalled during the recall of each paragraph of the text; 2) total paragraph recall (TPR), which includes the sum of all propositions recalled in the text during paragraph recall; and 3) whole text recall (WTR), which includes the number of propositions recalled during recall of the text as a whole. In addition, each subject had an average recall for all five texts: 4) in terms of total paragraph recall (ATPR) and also 5) in terms of whole text recall (AWTR).

This section is organized in the following way: each of the hypotheses posed at the beginning of the study is retaken and followed by the presentation and discussion of both qualitative and quantitative results.

4.2.1 Hypotheses related to the problem/solution pattern

4.2.1.1 Hypothesis 3

There is a relationship between reading ability and readers' awareness of conventional patterns of text organization, i.e., better readers are more aware of the overall organization of a text than weaker readers.

Complete problem/solution

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' (see Appendix E for the whole text).

Two factors account for the use of a text containing the complete Problem/Solution structure: one is to have a measure of the subjects' awareness of the structure (detection of the distortions – covered in the discussion of Hypothesis 4 – will also serve as a measure of awareness), and the other is to serve as a control for the comprehension and recall of the distorted texts. Awareness of the complete structure will be dealt with in this section, and comprehension and recall of the complete versus distorted texts in the discussion of Hypothesis 7.

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. According to Richgels et al., using the same structure as the author to organize recall is less demanding because only reproduction skills are required from the reader; being able to talk about the organization of the text, on the other hand, is more demanding because it requires self-analysis and metacognitive awareness of structure.

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 scale is shown in Table 5.

Table 5 – Scale for use of the Problem/Solution structure in the organization of Whole Text Recall (adapted from Richgels et al., 1987)

USE OF STRUCTURE	PROBLEM/SOLUTION
Full	7 topic identified in four clusters of ideas, each cluster related to one of the four parts: situation, problem, solution and evaluation, with at least one lower level idea related to each of the following parts: situation, problem and solution (evaluation included no details); words (or synonyms) 'problem' and 'solution'stated 6 the same as in 7, except only includes either word 'problem' or 'solution' 5 the same as in 7, except neither word 'problem' nor 'solution' stated
Partial	4 at least two clusters of ideas: one related to problem and another related to solution; includes either word 'problem' or 'solution' or both 3 the same as in 4, except does not include words 'problem' or 'solution'
None	2 only lower level ideas included in either problem or solution or in both 1 list like recall of ideas with no clustering OR only one idea
Other	0 structure other than Problem/Solution OR elaborations not including ideas from the text

The answers to the questions 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.

Use of structure to organize recall

All six better readers made full use of the problem/solution structure to organize their recall of the passage. Four of them included the word 'problem'; none of them, however, explicitly mentioned the general term 'solution' (S1/S2/S5/S6):

S1: The text talks about the problem that is caused by…the air conditioning…Computers need a system of air…of refrigeration…not to damage…the maintenance of the computers themselves…Then it's saying that this environment…with air conditioning, carpeted…closed…is proper for microorganisms which cause diseases…A paragraph says that people who work in closed places have more diseases…that stress lowers the resistance to diseases…And that in the United States…companies…say that filters should be used…to kill the microorganisms. It's little known in Brazil… there is an importer that is now…bringing these products to Brazil.

S2: …It begins saying that …evil by air…closed places…with carpet and air conditioning are good for computers but not for the person… it talks about the problem of… that is the air conditioning, where germs proliferate, mainly in the…inside the tubing… These closed places…lower the…the person gets more sensitive to diseases…because of that too stress can be harmful…and also allergy…and now they are thinking about putting filters…to diminish…this proliferation…in order to diminish this disease rate. In Brazil this concern is new…now they are launching a filter…

S5: The text explains…the problem of contaminated air for allergic people. It gives the example of computers which need air

conditioning, carpeted room, closed room, to maintain them in good shape and…many people are harmed by that, for example, in…big office buildings, in these rooms with air conditioning, people are more likely to have allergy, respiratory problems than people who work in open places, and… as …the majority of the people who work in these offices are likely to have stress and stress lowers resistance against the…fungi and bacteria which accumulate in these places, but in…in the United States there is the concern of…putting filters in the air conditioning to purify the air…the air in places for computers. Here in Brazil the idea is new, still, but there is a…a multinational company which makes these filters…that avoid the proliferation of microorganisms.

S6: The text talks about the problems that the central air conditioning brings, …computers need this closed environment, this place that is more likely for people to have diseases, mainly allergic…because of the germs… Then, someone who works in a place like a sedentary office instead of an open place, he is more likely to get diseases than someone who works in an open place…and…besides that…this work that…is more tiresome causes stress…which lets the person less resistant to…these diseases and today people talk about …putting filter in the central air conditionings to avoid…the multiplication of these germs. A company is bringing this filter to Brazil.

The other two better readers also made full use of the structure but did not explicitly refer to 'problem' nor 'solution':

S3: It talks about refrigerated air…the companies that work with computers, generally the rooms are closed and with central refrigerated air…proper environment for the proliferation of bacteria… And doctors say that people who work with closed windows like this…with central refrigerated air …this type of

thing…are more prone to diseases (têm muito mais incidências à doenças) like allergy than people who work in open environments… Here in Brazil there is no concern yet to put a filter inside the central air conditioning, as there is in the United States. This filter diminishes the production of bacteria… But there is a company already that is launching this filter in the market.

S4: It said that air conditioning, places with air conditioning, curtain, carpet are ideal for…computers but they are also bad for people who have allergy because germs proliferate…and then it says that people who…live in closed places, in these places which are proper for computers, they get sick more often than those who live in open places. And then it says that there is the concern of North Americans that produce computers, who know that these computers are used in closed places, with air conditioning, to put filter in the air conditioning tubes, it diminishes the proliferation of bacteria… and this novelty is still newer in Brazil, now it's beginning to make use of it.

Regarding weaker readers, only two made full use of the structure. However, they did not include the general terms 'problem' nor 'solution' (S9/S12):

S9: Ok…then in closed environments to work with computers it's necessary that they have an ambient temperature (temperatura ambiente) …a temperature that is always the same…and in this case they have to use the air conditioning. But it brings many…many germs…inside this environment …and it gets humid…with this closed environment inside the offices, it brings stress for people and computers have to stay in refrigerated environments…and they invented…in the United States there is a filter to eliminate this…to eliminate these microorganisms …and that here in Brazil, it is not available, but they have another type of device which is a plastic strip.

S12: Ok… closed environments, carpeted…air conditioning on…this brings …is harmful to health because it brings fungi and bacteria. Then, open environment…eliminates …this kind of disease …the bacteria and the fungi. As microcomputers need environments with air conditioning on…then a filter was invented, if I am not mistaken, in the United States…to purify this air…and that this filter will be launched in Brazil … to help…

One weaker reader made partial use of the structure, not referring to the situation presented, but explicitly mentioning 'problem'(S7):

S7: They say that air conditionings have to be kept in closed environments …and that this is a good place for bacteria…to grow…and they also make a comparison …people who work in this type of environment …have more allergic problems than people who don't work…and that there are countries already worried about this type of problem…they make…I'm not sure…a certain material…to put in the air conditionings…so that this type of environment is not needed… In Brazil it is still…it began but it's …

One weaker reader tried to reproduce the sequence used by the author but tended to list the ideas from the situation section as if they were equally important, not clearly stating the main idea. She did not clearly state the problem described in the text, neither did she make any reference to the evaluation section. In addition, she misunderstood the solution given in the text – installing filters inside the air conditioning systems'- and wrongly provided installing filters inside the computers':

S11: …about the…the air …the air conditioning and about computers…that carpeted environments…all reminds of the air

conditioning and the computer, but care has to be taken with allergic people, allergic people have to be careful about that. The second text…ok, then it talks about…that the more open environment…it…the other people …the people who work in more open environments…they…have less problems with…the air, because the air is pure…where people who work with air conditioning they have …find difficulty with that…and **that they are making computers which have filters** because these…since they have to be worked in a more ventilated (arejado) place then **they make filter** (eles fazem filtro) **in the computers…**

Another weaker reader (S8) included the signal word 'problem' when recalling information from the problem section but tended to list topics of each paragraph instead of complete ideas:

S8: The first paragraph talks about …the problems of the air conditioning …the second talks about health problems which it may bring… … and the second (segundo) talks about the…places that…that have computers… …the Americans have made a …kind of strip to …to immunize…to take the germs out of the air.

Finally, one weaker reader only provided elaborations during whole text recall, not including ideas from the text (S10).

Retrospective interview

When asked about the structure of the text, four of the six better readers (S1/S2/S4/S5) described the type of text organization using the signal words 'problem' and 'solution' (or synonyms):

S1: I think he organized…he gave an introduction…he began…talked about the problem …and the end …which talks about the solution…

S2: In the beginning he talked…about the problem which is the air conditioning…at the end …he showed …a kind of solution …an attempt to solve this problem…

S4: First he describes the place, says this place is bad for allergic people…these places make people sicker…and that this problem can be diminished by using filters in the air conditioning.

S5: First he put...the examples...of the rooms for computers…what these rooms look like … and then he showed the kind of problem the air conditioning brings and then…what could be done to improve this.

One of the other two better readers included 'problem' but only content from the solution section (S3). The other better reader used 'solution' to describe the solution section but only included content from the problem section (S6):

S3: He begins talking about closed rooms…an this may cause problems… …he says that in the U.S there is this filter which diminishes the incidence… …

S6: First he talked about the environment …for computers and that this environment is proper for this…proliferation of fungus…people who work at these places are more susceptible to diseases and then he reported the solution.

Regarding weaker readers, three out of the six also included the signal words 'problem' and 'solution' when describing the structure (S7/S9/S10):

S7: They begin like this… where the air conditioning has to be… how the air conditioning has to be placed…kept…I am not sure…the kind of problem it brings …and how it can be remedied.

S9: I think the author was able to attain his objective because there is the problem and there is already the solution for that.

S10: First he talked about the problems and then on the second part he talked about the human being…which has problems …and on the third the problem of wanting to improve… that is…first he approached the subject matter, second the problems human beings have and third why the human being has to improve the system.

One weaker reader only included content without explicitly referring to 'problem' nor 'solution' (S12):

S12: In terms of the paragraphs…he made a scale like this…first talking about closed environments and what this may bring…then he explained that in open environments this does not happen…and then he showed that a filter has been invented which can help purify…the air.

The other two weaker readers were not able to talk about the structure of the text, neither in terms of signal words nor in terms of content (S8/S11):

S8: I didn't pay attention to that. Well, I saw the three chapters (capítulos) which talked about three different things very clearly.

S11: The organization is a little …confusing….I think it should be ….simpler…it should be more…..talk about one thing until the end and then… go to the next.

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 6.

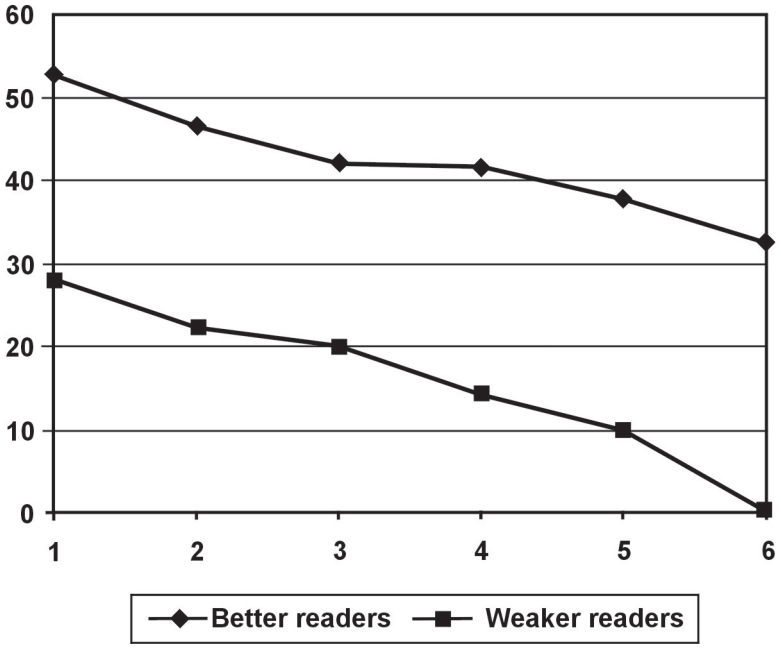
Table 6 – Better vs. weaker readers scores on the two measures of awareness

AWARENESS MEASURE	BETTER READERS						WEAKER READERS					
	1	2	3	4	5	6	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, 1984b; Meyer, Brandt & Bluth, 1980; Meyer & Rice, 1982; 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 & 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) (see Figure A). There was also a strong correlation between 'use of structure' and whole text recall (r= 88; p= .0001).

Figure A - Better vs weaker readers' recall of the Complete Problem/Solution Text (%)a – Whole Text Recall



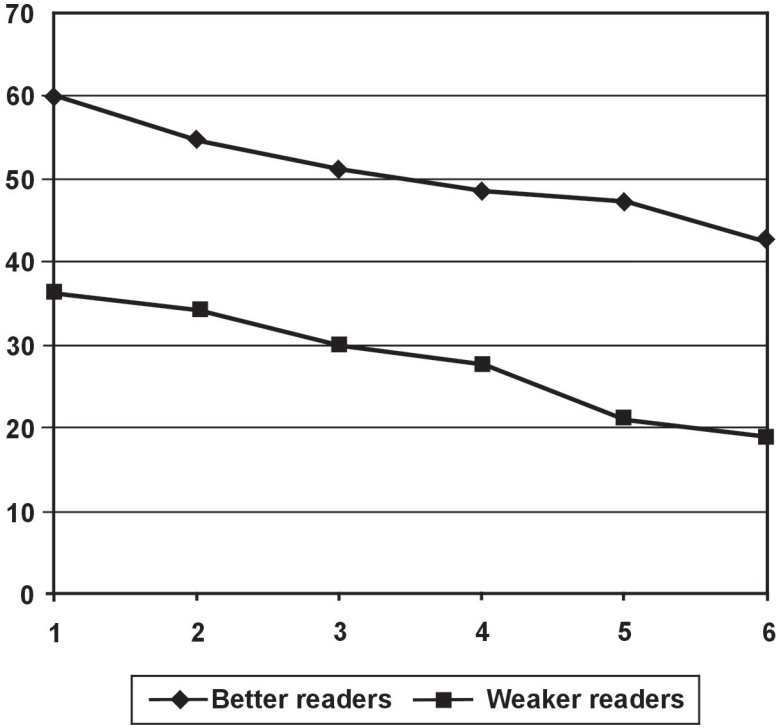
The results presented above show that the third hypothesis was confirmed; i.e., better readers were more aware of the overall organization of a text than weaker readers. As pointed out previously, all better readers took advantage of the structure of the text to organize their recall, whereas only two weaker readers were able to do so. Furthermore, all better readers were able to talk about the structure – four of them demonstrated full structure awareness and the other two explicitly referred to one of the parts, either problem or solution, using signal words. Weaker readers, on the other hand, did not seem so aware of structure – only three of six (50%) demonstrated

full structure awareness; of the other three, one brought in content from both problem and solution, without including signal words and the other two did not talk about structure at all.

The results reveal that there are both qualitative and quantitative differences between the recall of better and weaker readers in this study. Generally speaking, although the weaker readers also seemed to be reading for the gist, they did not seem to be able to form a hierarchical macrostructure, relating clusters of information to each of the parts of the structure as efficiently as the better readers.

Macrostructure formation draws on working memory resources. According to van Dijk and Kintsch (1983), in order to form a hierarchical macrostructure, input information from the text is organized into chunks. There would be two prerequisites for chunking: a rich knowledge base and an automatization of the storage and retrieval operations, which have to be realized both rapidly and with minimum effort, so that working memory is not overloaded. It seems reasonable to assume that higher span readers are less affected by the demands of forming a macrostructure, since they were more likely to hold more information in working memory and thus richer chunks, which would in turn allow them to elaborate more on the main ideas and their supporting details. This assumption is based on the fact that better readers (also higher span) also recalled significantly more information during paragraph recall than weaker readers (also lower span) (Student T= 5.94; df= 10; p= .0001) (see Figure B). It is also based on the fact that better readers are more aware of text structure and that, according to van Dijk and Kintsch, text structure provides a 'mold' for forming a macrostructure, which also may reduce the demands on working memory.

Figure B - Better vs weaker readers' recall of the Complete Problem/Solution Text (%) – Total Paragraph Recall



According to the Capacity Constrained model of language comprehension proposed by Just and Carpenter (1992), an individual's ability to process language is constrained by his/her working memory capacity. As Just and Carpenter observe, low span readers would be more affected by task demands, and would thus show a detriment in performance on such occasions; high span readers, on the other hand, who have a greater working memory capacity, would exhibit a better performance. According to Chase and Ericsson (1981, as cited in Daneman & Carpenter, 1983), 'successful retrieval depends on initially coding material in a form

that can be meaningfully associated with knowledge structures in long-term memory and maintaining some retrieval cue in working memory that would serve to reinstate the coding operations' (p.562). It is possible that weaker readers (also lower span) did not sufficiently integrate input information with previous knowledge and were thus not able to develop efficient retrieval clues which could help them to successfully retrieve information from long-term memory.

The fact that lower span readers recalled less information than higher span readers does suggest that they were more affected by task demands, as suggested above. In order to comprehend the text, they were probably faced with the trade off between storing and computing relationships, and some partial results may have been displaced or 'forgotten' (Just & Carpenter, 1992). This is further supported by the fact that there was a strong correlation between working memory span and whole text recall for this text ($r = .77$, $p = .003$).

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 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 passage is a real-life problem, thus by using world knowledge and lexical signaling, some weaker readers could perceive the structure. It is interesting to note that of the three weaker readers who explicitly referred to the structure 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 of structure 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 by 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. This finding will be further discussed in section 4.2.1.3 later in this chapter.

As pointed out in the beginning of this section, perception of the distortions related to the Problem/Solution structure will also serve as a measure of awareness. The rationale behind this methodology is that if readers were able to perceive the distortions, it may be possible that they were using the structure to organize the flow of information during reading. Perception of the distortions of the Problem/Solution structure will be discussed in the next section.

4.2.1.2 Hypothesis 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.

Distortion (no solution text)

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, but the title was kept so that it would create expectations in the reader in relation to the development of the subject (see Appendix E for the whole 'no solution' text). The text contained the "Problem/Solution" structure as follows: situation – the production of manufactured goods costs 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 (natural inference) – preservation of our natural resources and environment, which could be inferred from the situation presented in the text: 'The production of manufactured goods costs us a lot more than it looks at first sight… the natural sources of energy, like petroleum, natural gas

and coal are being extinguished; … the destruction of rain forests contributes to the increase of the greenhouse effect… and the environment has been dangerously and irreversibly polluted…' .

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'). 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 and indirect reference, 1 for a vague reference and 0 for no reference at all.

In relation to better readers, all six of them considered the text incomplete, badly written and disorganized. Only one of these six subjects made direct reference to the fact that the text failed to give a solution to the problem (S1). When asked whether the text was complete, he replied:

S1: No. I would say no… because it would have to talk about the products… a cause …and give a solution…

Three other better readers made indirect reference to the fact that a solution was missing (S2/S3/S6) and one of them commented that the researcher was the one who had manipulated the text (S3):

S2: (Comment made during the retrospective interview – when asked whether the text was complete) It's incomplete… the title talks about recycling, but he doesn't talk about recycling at any moment in the text… He induces the reader to think

…these cars are going to be recycled …what if silver is not wasted…

S3: (Comment made during the retrospective interview – when asked about the organization of the text) First he talks about recycling… in fact, he ends up talking about a lot of things except recycling…

(Comment made during the retrospective interview – when asked whether the text was complete) A lot of pieces are missing there… I think the text began like this – recycling – they began to talk… and you took a sentence out… they gave examples of recycling and you hid a lot of words… and changed everything… it becomes very difficult (laughter)…

S6: (Comment made during the retrospective interview – when asked whether the text was well written)… I think he should have talked more about recycling … I think he should have said that those (products mentioned in the text) could be recycled.

(Comment made during the retrospective interview – when asked whether the text was complete) He talked about recycling only in the title… he didn't touch this subject in the whole text.

The two other better readers made vague references to the fact that the text was disorganized and segmented, but did not refer to what exactly was missing (S4/S5):

S4: (Comment made during the retrospective interview – when asked whether the text was complete) It's not complete… it seems that the paragraphs were thrown… it's not organized… it doesn't flow well…It lacks a relationship between one paragraph and the other, so that we can make a continuous reading and not interrupt one idea and begin another.

S5: (Comment made during the retrospective interview – when asked whether the text was well written) He begins… talking about a subject… and then he changes the subject radically when he's talking about sources of energy, the greenhouse effect, pollution, then he begins talking about a new subject, which is the scrap metal, recycling, the problem of the cars, so it became a little… between this transition it was a little… you become a little lost.

Regarding weaker readers, none of them made direct or indirect reference to the missing solution. The six weaker readers only made vague reference to the distortion, without explicitly referring to the structure ('lack of solution') or to content ('lack of information on recycling'). Despite the fact that all six of them said something was wrong with the text, they didn't say exactly what was missing. It is noteworthy that five of them seemed confused and made comments which clashed with observations they had previously made (S7/S8/S9/S10/S11):

S7: (Comment made during the retrospective interview – when asked whether the text flowed well) I didn't see any specific difficulty… Sometimes I had to reread some parts, this was because I got distracted…

(Comment made during the retrospective interview – when asked whether the text was well written) … I didn't' see anything wrong…

(Comment made during the retrospective interview – when asked whether the text was compete)… It's not complete… I think… something else is missing …because it finishes there with glass and I didn't' see any conclusion…it didn't say anything…why…what made him write all that…

(Comment made during the retrospective interview – when asked what had made the text an easy or difficult reading) I

thought it was an easy reading … I think the text is written with organization…

S8: (Comment made during the retrospective interview – when asked whether the text flowed well) Yes, because it's an easy reading.

(Comment made during the retrospective interview – when asked whether the text was well written) As I told you before (about the first text), it's not the type of thing I write, maybe because I read it quickly, I didn't notice anything… a wrong structuring of the sentences…or anything like that, I didn't notice.

(Comment made during the retrospective interview – when asked whether the text was complete) I think he should have explored more each chapter…

(Comment made during the retrospective interview – when asked whether the writer had attained his objective) I think so. Yes, but he could have done something… he could have said more…

S9: (Comment made during the retrospective interview – when asked whether the text flowed well) The text doesn't flow very well… because some parts get a little complicated…

(Comment made during the retrospective interview – when asked whether the text was well written) It seems that parts are missing to complete the text… The one about silver was a little confusing for me.

(Comment made during the retrospective interview – when asked about the organization of the text) I think it was well written… as there was one part which was incomplete, the others I think were all right…

S10: (Comment made during the retrospective interview – when asked whether the text flowed well) For me some things were left … maybe it could have said a little more… some things were left vague…

(Comment made during the retrospective interview – when asked whether the text was well written) It is well written. The only thing is that at the end… I think he could have said more… instead of glass… maybe something which is being destroyed … paper…

(Comment made during the retrospective interview – when asked about the organization of the text) First he talked about the problems… the environment … it was well structured…

(Comment made during the retrospective interview – when asked what had made the text easy or difficult reading) I didn't have any specific difficulty… I know the subject was well developed, the only thing is that when he approached the subject, he tried to be clear… but for me… for example… he talked about oil…then suddenly he talked about the greenhouse effect. Of course they are all things about nature… But it is well put…

S11: (Comment made during the retrospective interview – when asked whether the text was difficult) It is not difficult…

(Comment made during the retrospective interview – when asked whether the text was well written) yes

(Comment made during the retrospective interview – when asked about the organization of the text) Each paragraph talks about one thing, isn't it? Was it all written by the same author? But he didn't want to develop… one only one subj… how can I say?

(Comment made during the retrospective interview – when asked whether the text was complete) Yes, it is complete.

S12: was the only weaker reader who did not seem confused, since all her comments during the retrospective interview pointed to a distortion. However, like those of the other five weaker readers, her references were vague ones:

S12: (Comment made during the retrospective interview – when asked whether the text was difficult) The text is not difficult. Only the third paragraph was a little complicated.

(Comment made during the retrospective interview – when asked whether the text was well written) No, I don't think it is well written.

(Comment made during the retrospective interview – when asked about the organization of the text) I didn't notice… Things got mixed up…

(Comment made during the retrospective interview – when asked whether the text was complete) I don't think so. It left me in doubt in the third paragraph… It could have explained a little more…

(Comment made during the retrospective interview – when asked about the author's objective) I think it was to confuse me.

A summary of the results for the perception of the distortion related to the solution is shown in Table 7 below:

TABLE 7 – Better and 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
DR	3											
IR		2	2			2						
VR	1	1	1	1	1	1	1	1	1	1	1	1
NR												
TOTAL	4	3	3	1	1	3	1	1	1	1	1	1

DR= direct reference
IR= indirect reference
VR= vague reference
NR= no reference

Results from the T-test revealed a significant difference between better and weaker readers in terms of perception of the distortion related to the 'no solution' section (Student T= 3.0; df= 10; p= .01).

In the light of the qualitative and quantitative results just presented above, it can be said that the fourth hypothesis was confirmed; i.e., better readers seem more prone to perceive when the text fails to provide information related to the 'solution' section than weaker readers. Although weaker readers were still able to notice a distortion, all of them only made vague references to it, not pointing out what exactly this distortion was.

It seems that 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 directly to the fact that the text failed to fulfill 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. Even the two other better readers, who only made vague references, showed a different behavior from that of weaker readers – their comments did not clash with each other, as was the case with five of the six weaker readers.

Results from the T-test for the number of propositions recalled from the 'no solution' text revealed that the difference between the two groups was statistically significant, both in terms of Total Paragraph Recall (Student T= 3.55, df= 10, p= .005) (see Figure C) and also of Whole Text Recall (Student T= 3.71; df= 10, p= .004) (see Figure D).

Figure C - Better vs weaker readers' recall of the Distorted Solution Text (%)- Total Paragraph Recall

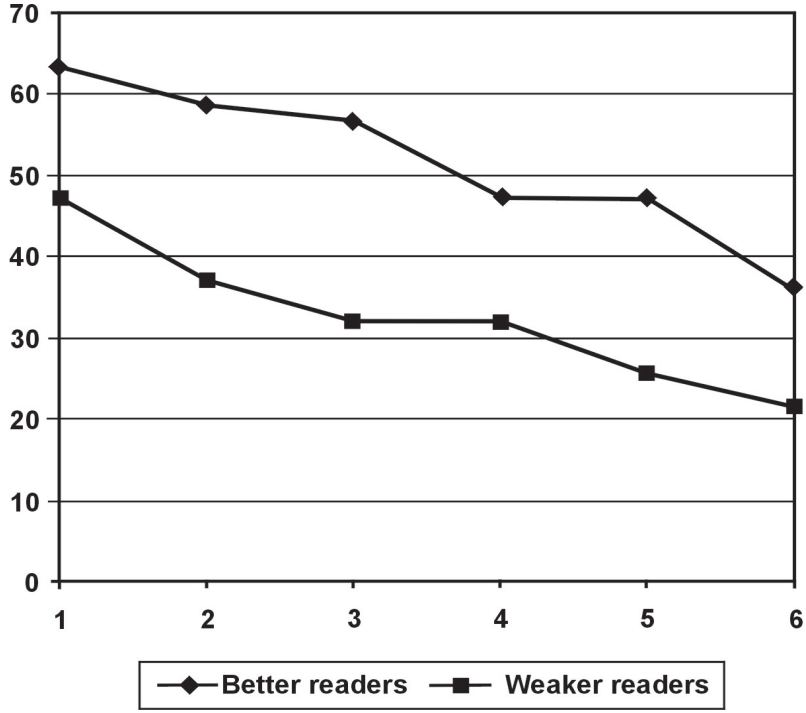
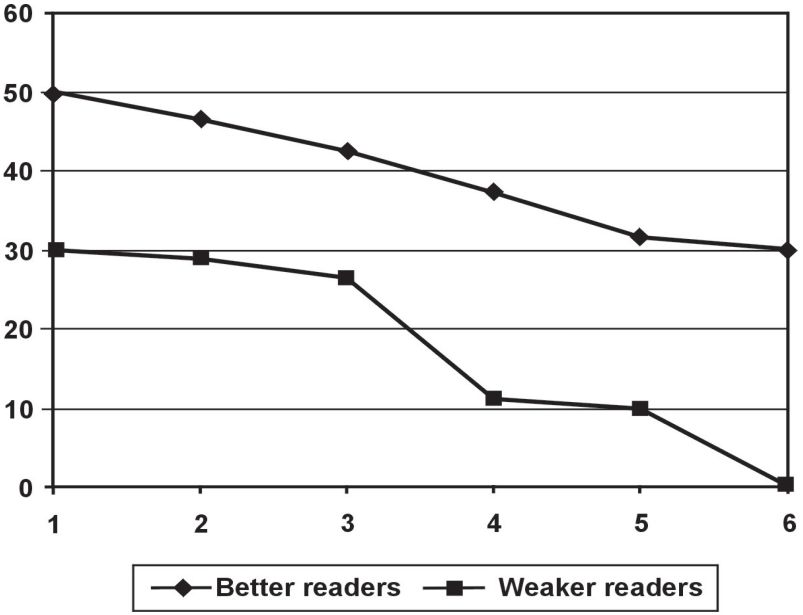


Figure D - Better vs weaker readers' recall of the Distorted Solution Text (%) - Whole Text Recall



Before I discuss these results properly, it is necessary to make some comments about the way subjects dealt with the disconnected information in the 'no solution' text, as suggested by the recall protocols. A closer examination of the recall protocols indicates that, in general, both groups of subjects – better and weaker readers – tended to relate the information in the text to their prior knowledge and to provide elaborative inferences, trying to make the text more coherent. However, three weaker readers (S8/S10/S11) tended to get carried away by the activated schema, including inferential statements to the detriment of text information: S8 seems to have forced the 'recycling' schema on her interpretation; S11 tried to activate a 'trash collecting' schema and S10 tried to use the overall

schema of 'destruction of nature and of material goods' in order to make sense of the distorted text. All three of them included very little information from the text itself during both paragraph recall and whole text recall. Overreliance on prior knowledge seems to have caused these three weaker readers to deviate their attention from what was effectively mentioned, resulting in fewer propositions recalled. This finding supports that of McCormick (1992), who found that low achieving students tended to overrely on prior knowledge when answering inferential questions, thus dismissing important text information and providing more incorrect and 'intuitive' answers based on already existent schemata. Block (1986) also observed that a group of poor readers, which she called 'nonintegrators', tended to focus on their own experiences rather than on the information in the text during recall.

Van Dijk and Kintsch (1983) define 'elaborations' as 'inferences which occur when the reader uses his/her knowledge about the topic under discussion to fill in additional detail not mentioned in the text, or to establish connections between what is being read and related items of knowledge' (p.51). According to these authors, inferences which allow for a better integration between the information in the text and the knowledge possessed by the reader can be highly beneficial and aid in comprehension and retention. However, as they also point out, elaborative inferences may be produced to 'cover up an inability to recall details of the original text' (p.52) and may have detrimental effects on text information. It seems that both effects of elaborative inferencing can be observed in this study: a positive effect for better readers, and a negative effect for weaker readers.

Results suggest that it seems more difficult for weaker readers to make use of the relations among the propositions in the text to form chunks of meaning or to recognize the structure and make the necessary inferences when the text is less coherent, and thus assure recall at the end.

The results related to the distorted no solution text, as presented above, can be further explained by individual differences in working memory capacity (Daneman & Carpenter, 1980, 1983). According to Daneman and Carpenter, high and low span readers differ in the amount of space they have available for storing and computing the necessary relationships in the stream of input. Low span readers devote so much of their capacity to processing input information that little is left for storing the intermediate products of reading (Daneman & Carpenter, 1983).

In the present study, in order to detect the distortion of the solution section, readers would need to have kept the title of the text - 'Recycling' - active in working memory while processing the stream of input, checking the text for pertinent information. This was a very demanding task, since all information related to 'recycling' was omitted in the development and the paragraphs appeared disconnected and loose. Consequently, in order to maintain global coherence, readers would have to build the necessary inferences to connect information from the various parts in the text. From the analysis of the protocols, it is clear that better (also higher span) and weaker readers (lower span) showed different behaviors when trying to deal with the information in the text. Although both groups attempted to provide the necessary inferences, weaker readers did so to the detriment of text information; i.e., they provided information relevant to the schema they were able to activate (sometimes plausible), but included very little of what was mentioned in the text, probably because this information was displaced during reading.

According to Just and Carpenter (1992), when the comprehension task is demanding, some of the resources that are maintaining old elements active will be deallocated to processing incoming input, causing a type of forgetting by displacement. In the 'no solution' text, integrating the information from the first paragraph ('The production of manufactured goods costs us a lot more than it looks at first sight') with the rest of the text ('waste in all areas'),

required the production of a great amount of inferencing: first, the bridging inference that cars, films and x-rays, and glass are manufactured goods; second, the inference that what connected the last three paragraphs is the fact that these 'manufactured goods' are being 'wasted'; and third the inference that the reason 'manufactured goods cost us a lot more' is the fact that 'for their production, natural resources have to be consumed and the environment is destroyed'. Integrating all this information in the text draws heavily on working memory resources both to store partial products of comprehension and to compute the necessary relationships among propositions. From the results obtained in this study, it seems that weaker readers (also lower span) were more heavily affected by this demanding task than better readers. A closer examination of the protocols indicated that whereas five better readers included information from the first paragraph of the text during whole text recall, only three weaker readers did so and to a lesser extent than better readers. This may suggest that weaker readers (also lower span) were once again faced with the trade off between storing and processing much more than better readers (also higher span) were, as predicted by the Capacity Constrained model proposed by Just and Carpenter. The moderate correlation obtained between working memory span and whole text recall for this text further supports this possibility ($r = .70$, $p = .01$).

Distortion (no problem text)

A text entitled "[Poluição] recorde para a cidade do México" (Record [pollution] stops México 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 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 'pollution' were omitted. Words directly related to 'pollution', as for example 'fans', and the specific words 'problem' and 'solution' cited in the text were made vague; i.e., they were replaced with more ambiguous words such as electronic indicators', 'drama' and 'proposals' (see Appendix E for the whole 'no problem' text). The text contained the following "Problem/Solution" structure: situation – the 20 million inhabitants of Mexico City were living 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 texts); 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.

Four of the six better readers indicated that there was something wrong with the text, referred to the fact that it did not flow well and

rated it as badly written, incomplete and difficult (S1/S3/S5/S6). Three out of these four subjects explicitly mentioned that the text failed to provide specific information on the problem, making direct and indirect reference to it (S1/S3/S5); the other one only made vague references to the fact that something was missing, not specifying exactly what it was (S6):

S1: (comment made during a pause) I stopped here in held (the emergency), because until a certain point, the text implied that the problem was overpopulation… in the first sentence , it says that it is the biggest ant hill in the world… it implies that the problem is a lot of people… and now I began to think… I haven't got to the end yet … **but it hasn't talked about pollution, which I think is the problem.**

(comment made during recall of the first paragraph) The paragraph says that the city was stopped… but it hasn't yet…**I know it's about …pollution because I remember…**I know the subject…but the text doesn't say anything…

(comment made during the retrospective interview – when asked what had made the text an easy or difficult reading) … What makes it difficult is that the problem is not given in the text… you get disappointed at the end of the text for not knowing what in fact the problem is.

S3: (comment made during recall of the first paragraph) …the authorities had to take come measures…**I think that because of pollution…**

(comment made during the retrospective interview – when asked whether the text flowed well) It doesn't flow well because they are talking about a problem which they don't tell us what it is… you think that… you realize that that is the problem…

S5: (comment made during recall of the whole text) It talks about Mexico City, which is … a very big and overpopulated… city

and this disturbs a little … a lot of people… a lot of automobiles in town, **pollution is intense…**

(comment made during the retrospective interview – when asked about the organization of the text)… he began to talk about something which seemed that he was talking to someone who already knew what was happening, who knew what the problem was but for someone who's reading for the first time and is not acquainted with the subject… gets lost.

S6: (comment made during the retrospective interview – when asked whether the text was well written) So so…Because he first said that… that Mexico City suffered that… that difficulty but he didn't explain …he only explained at the end… the reason… for that.

(comment made during the retrospective interview – when asked whether the text was complete) I don't think so…According to the author's objective… which was to say that Mexico City is over… overpopulated and it also has problems… because of … the area … but … and that all this resulted in… in those problems… schools were closed… I think so but it lacks data, I think … it was not enough to…

As can be observed in the quotation above, S6's recall differs significantly from the other three subjects. Although she found the text incomplete, she seemed confused, not referring to the distortion, neither directly nor indirectly. What possibly happened is that she tried to accommodate all the information in the text under the major schema 'overpopulation' (actually given by the text as one of the possible 'causes' of the problem). This is suggested by the fact that she said the author's objective was to 'say that Mexico City was overpopulated'; nevertheless, she did not seem satisfied with this alternative, and considered the text as incomplete.

The other two better readers (S2/S4) reported that the text flowed well, was easy and complete. They misunderstood the information given in the text and considered 'overpopulation' as the

main problem being discussed. However, unlike S6 above, they seemed satisfied with this alternative. In fact, S2 had made direct reference to the lack of problem during recall of the first paragraph, but then as she continued reading, she erroneously picked up 'overpopulation' from the last paragraph as the problem itself. She even commented that it was the writer's strategy to hold the reader, leaving the problem to the end:

S2: (comment made during recall of the first paragraph) The first paragraph talks about a lot of things which I haven't found out what it is yet.

(comment made during recall of the third paragraph) Ah ok…**then this chapter shows what the problem is… urban… growth … disordered. And another problem is… of a geographical nature… it's not only growth…**

(comment made during the retrospective interview – question about the organization of the text) First he talks about the problem… then he talks about the solu… he makes comments on the effects of the problem… until then we don't know yet what the problem is… then he gives the solution, it is at the end that he says… it's a way to hold the reader, isn't it?

S4: (comment made during recall of the first paragraph) This text is talking about the **the big population of Mexico City…** that … … the city stopped … a lot of cars stayed in their garages, a lot of people didn't go to school, to… **exactly because of this ant hill that the city was becoming…**

Regarding weaker readers, five out of the six made no direct nor indirect reference to the distortion. They said that the text flowed well and rated it as well written and well organized (S8/S9/S10/S11/S12) . Three of these five made vague references to a distortion and the other two (S11/S12) made no reference at all. Two of the

three who made vague references, rated the text as incomplete (S8/S10), and one (S9), despite having rated the text as complete, said that the writer had not attained his objective. Two weaker readers referred to a lack of solution (S9/S10) and another one referred to the shortness of the text and to a lack of information on 'geographical difficulties' and 'garish ideas' (S8):

S8: (comment made during the retrospective interview – when asked whether the text flowed well) yes, it's an easy text.

(comment made during the retrospective interview – when asked whether the text was difficult) The kind… the way the text is formulated… there are no difficult words, there are no… I didn't feel any difficulty.

(when asked about the organization) I felt … the organization of the paragraphs is normal… At least I didn't perceive any…

(comment made during the retrospective interview – when asked whether the text was complete) No, it lacks information… the texts are very short, then… generally texts are longer… then they explain everything… they talk about … I think it should talk about… geographical difficulties… and it should say what these geographical difficulties are, it talks about the garish ideas, it should talk about others besides that, the electronic systems… some others… it should mention some others.

(when asked what had made the text an easy of difficult reading) I had no difficulties. The text is easy

(comment made during the retrospective interview – when asked whether the text flowed well) It does. … I think it is in an order that we are really able to understand what it means…

(comment made during the retrospective interview – when asked whether the text was difficult) … (silence) … There are some words which I couldn't understand… one can think it is a little difficult.

(when asked about the organization of the text) He organized well… he began by showing what happens (acontece) there and … what would be needed not to happen anymore…

(when asked whether the text was complete) It is.

(when asked whether the writer had attained his objective) He didn't … because I would like something to solve … something which would solve the problem and it wasn't solved…

S10: (comment made during the retrospective interview – when asked whether the text flowed well) Yes. This one flows well… this was the best of all…

(when asked whether the text was difficult) No. It is well approached, it is well written… … it is well structured.

(when asked whether the text was complete) yes, I mean … not totally… because in terms of the problem … he approached the subject … yes, it's complete … he approached … I mean … he can't put details to solve… it is complete.

(when asked whether the text flowed well) It did.

(when asked whether the text was difficult) No, it is not difficult.

(when asked whether the text was well written) It is.

(when asked about the organization of the text) Ok, he began talking about how the city stopped… then about… what people… some people gave ideas and then it was at the end that he solved… he gave the reason for what was happening.

(when asked whether the text was complete) Yeah… complete.

S12: (when asked whether the text flowed well) Yes… it is easy, it is simple… very simple… of course.

(when asked whether the text was well written) It is well written. Well structured.

(when asked about the organization of the text) Yes … He begins talking about how Mexico is a metropolis, which has 20 million inhabitants and goes on… trying to solve… trying to show and solve…the problem … the text…

(when asked whether the text was complete) Complete.

S8's comments above differ somewhat from those of the other weaker readers. She got very near to naming the distortion, since her observations in terms of the lack of information in the text were related to words ('difficulty of a geographical nature' and 'garish ideas') which were actually not further elaborated in the distorted text because this elaboration in the original was directly related to the omitted problem - 'pollution'. Nevertheless, as the other weaker readers, she found the text easy, well organized and also said that no difficulties were encountered.

The five weaker readers above, like the three better readers mentioned before, were misled and erroneously picked up 'overpopulation' as the problem and processed the text from that perspective:

S8: (comment made during recall of the first paragraph) … … the first paragraph talks about the problems of Mexico City which has 20 million inhabitants, and that to end with all these difficulties… the city stopped… there was a day… they stopped, schools were closed, people stayed home everything… **so that the city would become less agitated… so that not… so many people wouldn't be on the streets… this is because … there are many inhabitants.**

(comment made during recall of the whole text) The first talks about … the problems which the city was facing… **the bunch of inhabitants** … they had a day when the city stopped… … **a small geographic space for millions of people**… the

second …paragraph talks about **garish proposals** for … this to happen … **to control … this flux of people.**

S9: (comment made during recall of the first paragraph) … this part here says that Mexico City is a city which has many inhabitants… about 20 million inhabitants… **and there was a big turmoil because of the great number of people**… schools, **because of that**… schools were closed… But this… only worked that day… and they would like a solution… which would persist every day…

(comment made during recall of the last paragraph) … **The drama in Mexico City is the same** as that which torments all big cities… **the disordered growth of the population.**

S10: (comment made during recall of the first paragraph) What it says… there is… a metropolis… where…**the thousands of human beings are trying to survive… … there are a lot of people in a small place…**

S11: (comment made during recall of the whole text) … Then schools stopped… half a million cars stayed… stayed… in their garages… … and **this is due … to growth … the big population growth in the city, in the country and that there is little territory.**

S12: (comment made during recall of the first paragraph) Mexico is… the largest city… the concentration of people… in Latin America…**And the situation was so serious… so many people… that on a Tuesday the authorities closed schools and put half a million cars in the garage… so that the great flux of people in the city would diminish…**

One weaker reader (S7) had made a direct reference to the distortion during recall of the first and second paragraphs, but then, like the other five weaker readers, she was misled and erroneously

picked up one of the causes of the problem - 'overpopulation' - as the problem itself (S7):

S7: (comment made during recall of the first paragraph) This text says that… I don't know what happened in Mexico… that people were prohibited to go out… the students to go to school… … the idea worked out … What happened there for them to do this? Do you understand?

(comment made during recall of the second paragraph) They say that in order to solve the drama in Mexico… which I don't know what it is… they would have to install electronic indicators in all residences there… **maybe Mexico City has an overpopulation… maybe that's the problem…**

(comment made during recall of the third paragraph) **That's it… the problem in Mexico is the growth … of the population… too fast…**

Despite having erroneously confirmed her hypothesis in the last paragraph, the last weaker subject (S7) made a vague reference to the distortion during the retrospective interview. She referred to the fact that the text didn't flow well and rated it as badly written and incomplete:

S7: (when asked whether the text flowed well) No. There is a confusion to understand why they are writing that first paragraph… what in fact you are reading about… you want to know…

(when asked whether the text was difficult) It's not difficult… you begin reading the first paragraph and you don't understand what you are reading… the reason for that…5 (when asked to rate the text in terms of difficulty).

(when asked whether the text was well written) Not for me… For me, it's confusing…

(when asked about the organization of the text) Lack of organization… I think the last paragraph should be the first …the second… I don't know…

(when asked whether the text was complete) I don't think so. Because they say there that it worked… and I didn't understand very well.

(when asked what had made the reading of the text easy or difficult) What made it difficult for me was the lack of organization of the text.

A summary of the results for the perception of the distortion related to the problem section is shown in Table 8:

TABLE 8 – Better and weaker readers' indicated 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
DR	3		3		3							
IR	2		2		2							
VR	1		1		1	1	1	1	1	1		
NR		0		0							0	0
TOTAL	6	0	6	0	6	1	1	1	1	1	0	0

DR= direct reference
IR= indirect reference
VR= vague reference
NR= no reference

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 & 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 (S1/S2/S3), or assign more global perspectives to the vague content of the text (S5/S6). 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 (S8/S9/S10/S12). Similar findings were obtained by Whitney, Ritchie and Clark (1991) in a study about the use of elaborative inferences when processing difficult narrative texts. Whitney et al. found that high span readers tended to assign more open-ended interpretations towards the beginning of the passage, awaiting for more information to come to check their hypotheses, whereas low span readers selected a single interpretation from the beginning and forced the remaining information to fit into it.

Regarding the number of propositions recalled from the 'no problem' text, this time, as opposed to the other two previous texts ('complete Problem/Solution' and 'no solution'), there was no statistically significant difference between the recall of better and weaker readers, neither in terms of Total Paragraph Recall (Student T= .69, df= 10, p= .50) (see Figure E) nor in terms of Whole Text Recall (Student T= 1.29, df= 10, p= .22) (see Figure F). Nevertheless, although the better readers recalled as few propositions as the weaker readers, they seem to have comprehended the text better. This is suggested, among other things, by the fact that they were able to perceive the distortion. Even one of the better readers who seemed to have chosen the 'overpopulation' perspective, referred to the fact that the text was incomplete (S6).

Figure E - **Better vs weaker readers' recall of the Distorted Problem Text (%) Total Paragraph Recall**

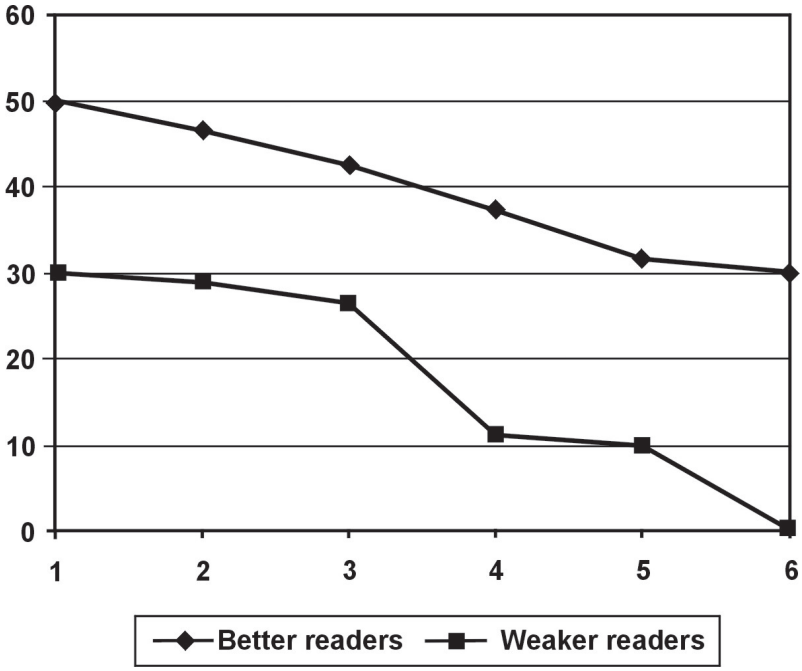
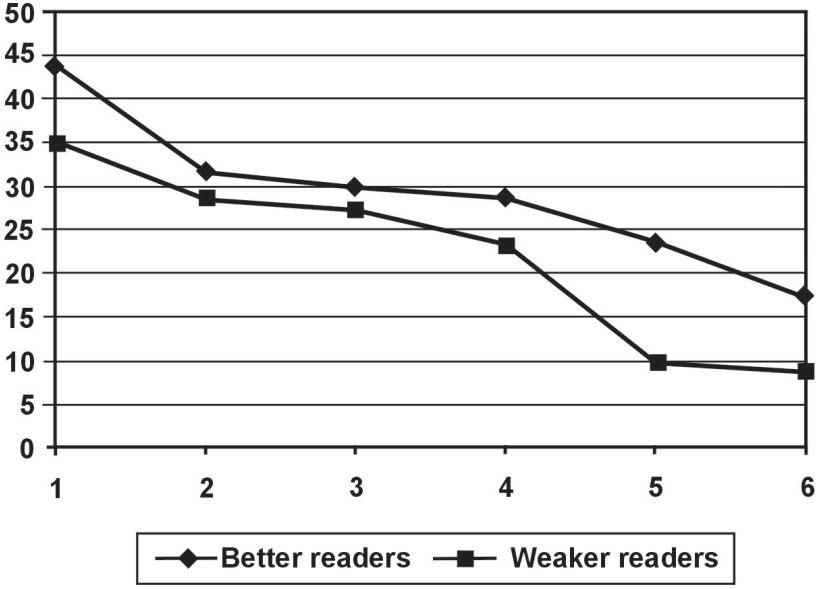


Figure F - Better vs weaker readers' recall of the Distorted Problem Text (%) - Whole Text Recall



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 proposed by Just and Carpenter (1992) and based on psychometric

research carried with colleagues (Daneman & Carpenter, 1980, 1983; Daneman & Green, 1986; King & Just, 1991; MacDonald, Just & Carpenter, 1992; among others) predicts 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. However, 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 (Turner & Engle, 1989, Just & Carpenter, 1992). As results from Pearson's correlation coefficient indicate, this is the only text where there is no significant correlation between working memory span and whole text recall ($r = .34$, $p = .27$).

In the present study, the 'no problem' text, similarly to what happened with the 'no solution' passage, may have put extra demands on working memory resources, since the language in the text was vague, not allowing the reader to readily construct a coherent mental representation of what was happening – no single interpretation could be readily assigned. Thus, readers had to store incoming propositions while processing subsequent input, looking for more explicit information to compute the relationships. The absence of more explicit clues which signaled the problem might have produced extra demands on working memory, exceeding their maximum capacity. According to Just and Carpenter (1992), as already mentioned previously, when the maximum capacity is exceeded, some of the resources which are maintaining old elements active have to be deallocated causing a displacement of partial products of comprehension.

As mentioned before, better (also higher span) readers tended to set up hypotheses of what was happening towards beginning of the passage and check their predictions across the whole text. Since no single interpretation was explicitly supported by the text, no relationship was formed among propositions, thus preventing them from forming a coherent textbase (van Dijk & Kintsch, 1983) which could help them to successfully retrieve the information during recall.

Maintaining open-ended interpretations and checking them in subsequent text is a demanding activity which draws heavily on working memory resources. According to Just and Carpenter (1992), high span readers can usually deal with this demand better than low span readers, even in situations such as comprehending a sentence containing a reduced relative construction, which requires that two interpretations be active in working memory until it is disambiguated with more input. However, as they also point out, 'even high span readers do not hold onto multiple interpretations indefinitely' (p.131). In the present study, contextual clues were so vague that they did not serve as disambiguation, and higher span readers were faced with the demand of holding possible interpretations throughout the whole text while processing subsequent input. Consequently, some of the old elements stored in working memory would have to be displaced, leading readers either to be misled in the last paragraph (building an inaccurate 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 working memory capacity for 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 inaccurate textbase, they could only recall microlevel propositions.

4.2.1.3 General discussion of the hypotheses related to the problem/solution pattern

The main objective of this part of Experiment 2 was to investigate better and weaker readers' awareness of the Problem/Solution pattern of text organization and their ability to use the structure to

organize the flow of information processing in working memory. It was hypothesized that if readers were able to report the distortions, it would mean that they were using the structure during their reading. As indicated by the results, better readers reported the distortions much more often than weaker readers. Five of the six better readers (S1/S2/S3/S5/S6) reported the distortions directly by referring to the structure ('lack of solution'/ 'lack of problem') and/or indirectly by referring to the missing content ('recycling'/'pollution'), whereas none of the weaker readers did so. It is interesting to note that not even those three weaker readers (S7/S9/S10) who explicitly referred to the complete text as 'problem/solution', reported the distortions of the structure.

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, two weaker readers (S8/S11) 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 an indication of the use of the structure. These weaker readers, however, tended to get 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' (Hoey, 1983). However, they did not identify 'the missing problem' in focus ('pollution') and failed to report the distortion. Finally, they recalled less information than the 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 he/she is able to choose the superordinate information related to each of the parts of the 'Problem/Solution' pattern and organize it in hierarchical clusters, nor that he/she is able to compute the necessary relationships among propositions. In sum, this 'metacognitive' awareness of 'problems and solutions' 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 about 'problems and solutions', but they possibly lack the 'procedural knowledge' (Anderson, 1993, 1995) of the structure necessary to make use of it during reading.

Declarative knowledge includes all our knowledge about facts (Anderson, 1993, 1995), rules, memory for images and sequence of events (O'Malley, Chamot, & Walker, 1987), i.e., all our semantic as well as episodic knowledge (Paradis, 1994). Procedural knowledge, on the other hand, includes our cognitive skill or ability to perform various mental procedures and also our ability to perform motor skills (Paradis, 1994; Anderson, 1995). Declarative knowledge 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 X 4 is 8, or that texts may be about 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, & 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.

Paradis (1994) refers to 'declarative knowledge' as 'explicit knowledge or explicit memory or declarative memory' and 'procedural knowledge' as 'implicit competence or implicit memory or procedural memory'. According to Paradis, explicit memory is flexible and can integrate information from different modalities, whereas implicit memory is inflexible and specific to each task. Thus, it is possible to assume that the knowledge weaker readers are bringing to the text is their world knowledge of 'problems and solutions', but this knowledge does not enable them to benefit from the structure while reading, since what is needed for use of the structure is procedural knowledge, which is task-specific- reading, in this case.

The assumption in the present study is that declarative knowledge would enable weaker readers to infer that a problem and a solution are being presented, but the 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 which leads to better comprehension, retention and subsequent retrieval.

The issue raised above is directly related to working memory capacity. According to Just and Carpenter (1992), 'a capacity theory deals centrally with the resources underlying thought' (p.143). Their theory assumes an underlying architecture consisting of a working memory, procedural knowledge and declarative knowledge, and also the dynamic aspects of processing and storage. As Paradis (1994) observes, 'when we speak, we speak about something. What we talk about must be explicitly evoked before it can be encoded by implicit automatic processes' (p.4). By analogy, when we read, we read about something, it is clear that we need declarative knowledge to interpret the information in the text. However, the act of processing the input information also requires procedural knowledge so that the computations can be performed and the text can be comprehended.

Considering the processes involved in reading comprehension – decoding, lexical accessing, parsing, inferencing, and integrating (Daneman & Carpenter, 1980) – and the limited capacity of working memory, one has to agree that there should be mechanisms which enable all the processes to occur without consuming all the available capacity. Procedural knowledge seems to be one essential mechanism (see discussion of Hypothesis 5 for other related mechanisms). According to Paradis (1994), tasks relying on automatic processes (procedural knowledge) do not require attention and can be executed in parallel. Therefore, a possible assumption is that the more automatized the processes are during reading, i.e., the more procedural knowledge there is available to the system, the less resources have to be allocated from working memory. Procedural knowledge of the Problem/Solution structure would enable readers to organize the input information into chunks, thus facilitating encoding within the limitations of working memory and also facilitating subsequent retrieval of this information.

4.2.2 Hypoteses related to the mechanism of prediction

4.2.2.1 Hypotesis 5

There is a relationship between reading ability and readers' capacity to recall elements explicitly predicted in the text.

Complete prediction

In order to investigate the text organizing mechanism – Prediction – a text called "Sopro de beleza" (Puff of Beauty) (*Veja*, 1992) was used (see Appendix E for the complete text). As mentioned before, the Prediction pair consists of a predictive member, which sets out an explanation to be fulfilled, and of a predicted member, which fulfils that expectation. The text used in this experiment contains three paragraphs and the Prediction pair is located in the last paragraph. The first paragraph introduces a new

liposuction surgery with ultrasound, which is supposed to have a major advantage over the traditional liposuction practice: it provokes a minimum loss of blood. The second paragraph gives a general description of the new surgery; and the last paragraph, which contains the Prediction pair, describes the new surgery in greater detail. The predictive member contains a numeral – 'three'– and an enumerable – 'steps' – as follows: 'The new surgery is developed in **three steps'**. The predicted member of the Prediction pair contains the three items which fulfill the expectations as follows: '**First** the surgeon gives an injection with distilled water, sodium bicarbonate and anesthetics… **Next**, an ultrasound canula is introduced, which provokes the burst of the fat cells only. **Last,** the region where the ultrasound was applied is pressed with a roll for the liquid fat to be expelled through the incision'. The Prediction pair is immediately followed by a favorable evaluation of the new surgery - 'The loss of blood is six times less than in the traditional liposuction'. In the present study, the numeral plus the enumerable in the predictive member will be called 'predictive signal', and the elements in the predicted member which fulfill the Prediction will be called 'predicted items'.

In terms of better readers, three subjects recalled both the predictive signal and the predicted items correctly (S2/S4/S5):

S2: (comment made during recall of the paragraph containing Prediction) … Then in the last paragraph it says that <u>there are three steps… first</u> they give an injection … distilled water and sodium bicarbonate and **analgesics**…to make the place swell where… where there's an excess of fat… <u>then</u> they put the ultrasound … … it breaks this fat… <u>and afterwards</u> it goes out.

(comment made during recall of the whole text) <u>It is divided into three steps</u>… <u>the first</u> is an injection … sodium bicarbonate … distilled water… and **analgesics** are introduced… <u>and then afterwards</u> the ultrasound is introduced where by means of waves the ultrasound breaks… the fat cells… they open …

become liquid… then they use a cylinder to press … then the fat goes out…

S4: (comment made during recall of the paragraph containing Prediction) It is saying that this surgery is developed in three steps: the first a solution with a bunch of things is injected in the region where there's an excess of fat, to make it swell to facilitate the surgery… … In the second, they put the device that will bombard…**the laser beam**, and then it will bombard the fat cells. And in the third, a cylinder is put on top of the region, which will take out the excess of fat in liquid form…

(comment made during recall of the whole text) … This surgery is developed in three steps: the first makes an edema in the region which has an excess of fat… putting a liquid inside … … in the second, the device which will bombard is put…**the laser beam** and …**not laser beam… the ultrasound**… then it breaks the fat cells and these cells become liquid and go out… through the incision and after that… they roll…not after that… a cylinder is rolled for these cells to go out through the incision…

S5: (comment made during recall of the paragraph containing Prediction) … this liposuction with ultrasound is … developed in three steps. First, they inject distilled water, sodium and an anesthetic in the region with … fat… to make this region swell… in a second step, they… make the incision and introduce an ultrasound canula where it emits the high frequency waves… in a frequency … that … makes the adipose … cells… break and become liquid and then in the third step, they roll a cylinder… on top of the region and it makes possible for this liquid … quantity… liquid fat to be expelled through the incision.

An interesting aspect regarding memory occurred in S2's and S4's recall above. S4 insisted on mentioning laser beam instead of

ultrasound, but then during recall of the whole text she corrected herself. In fact, the two devices can be used in surgery, but the difference between them may not be very clear for a layman, which could easily lead to an interchange between the two during retrieval from memory.

S2 showed a similar behavior when trying to retrieve 'anesthetics', except that she did not correct herself. She recalled 'analgesics' both during recall of the last paragraph and also the whole text. In this case, besides belonging into the same 'drugs' schema, 'anesthetics' and 'analgesics' also share sound characteristics. According to Smyth, Collins, Morris and Levy (1994), the likelihood of a word substitution increases when the two words share meaning and sound features.

There might be one difference between the recall of S2 and S4: S2 did not correct herself; therefore, we can not be sure whether the change occurred during encoding; i.e., she internalized 'analgesics' instead of 'anesthetics' at the very moment she perceived the word on the page; or during retrieval; i.e., she encoded 'anesthetics', but during retrieval, she got mixed up and recalled 'analgesics'. As for S4, it seems more likely that she encoded 'ultrasound', since she corrected herself during recall of the whole text.

The phenomenon observed above is described in the literature of memory as 'slips of the tongue'. Smyth, Collins, Morris and Levy (1994) define this phenomenon as 'involuntary and unintentional speech errors' (p.186), where the speaker intends to say one word and actually produces another. According to these authors, the factors which lead to word substitutions may be the following: similarity in terms of meaning and/or sound, frequency of use of the word and also the communicative context in which the selection of the word occurs.

Another better reader (S6) did recall the predictive signal correctly - 'three steps'- but in the recall of the predicted items she showed comprehension problems in step number two – she did not mention the ultrasound and misunderstood that the fat cells became liquid because they were pierced:

S6: (comment made during recall of the paragraph containing Prediction)… it is developed in three steps: first, the surgeon gives a… needle with distilled water, sodium bicarbonate and anesthetics… …then he… he makes an incision only in the fat cells and … then **since they became liquid because of this incision they … are expelled…**

(comment made during recall of the whole text) … This surgery is developed in three steps… first the surgeon … he introduces a needle only in the fat cells… … **afterwards the fat cells are pierced… incised… they become liquid forming a kind of material since they were incised…**

In fact, S6 made a pause during her reading of the paragraph containing Prediction, she asked to reread the paragraph, and during the retrospective interview, she said she found the text 'more or less' difficult and gave it a 3 on the 1 – very easy/ 6 – very difficult scale; she also said that what made the text difficult was the fact that 'it talked about the techniques of the surgery, which demanded more attention'. She also gave the text a 3 on the familiarity scale (1 – totally familiar/ 6 totally unfamiliar) and commented that she had never heard of the new surgery. S6's reported difficulties with the text were confirmed by her recall protocol: she had the second worst score during paragraph recall and also during whole text recall.

Another better reader did not mention the predictive signal, but referred to the structure of the paragraph using the general term 'description' (S1). He had got confused when describing the third step, but then seemed to have made up for that during recall of the whole text:

S1: (comment made during recall of the paragraph containing Prediction) There is a new description of the method, but now in a more… detailed way… Well, first, a series of injections are given to swell … … this injection is given which is … distilled

water, sodium bicarbonate and then anesthesia… an incision is made and in this incision, an ultrasound canula is introduced… and then in the case in point the ultrasound is switched on, bombards the place an then a cylinder is rolled … … **I don't know if it is the cylinder which leaves the fat in liquid form or if the cylinder is simply used to let the fat out.**

(comment made during recall of the whole text) … A series of injections are given… and then the device is put in **which breaks the fat** and after that a cylinder is rolled which takes the fat out…

It is interesting to note that S1 was able to correct himself without any further access to the text, since whole text recall was done immediately after recall of the last paragraph. According to Gambrell, Koskinen and Kapinus (1991), free recall involves 'verbal reconstruction of text acquired information' (p.356) and leads readers to elaborate and organize the information which has just been read by focusing their attention on the text as a whole. What possibly happened to S1 was that during verbalization of the whole text, he recapitulated the information which had been presented and by putting all this information together he was able to elucidate doubts he probably had.

And the last better reader (S3) did not mention the predictive signal, but like S1 above, she referred to the structure of the paragraph ('they explain how…'). From her recall of the predicted items, it is not clear whether she understood the second step as she made no reference to the use of the ultrasound:

S3: (comment made during recall of the paragraph containing Prediction) Here they explain how the surgery is developed. First they inject water and a bunch of other things there which I don't know their names… I mean … I know… but memorizing like this is difficult … And afterwards… to make the region swell… when **the fat cells explode** … they roll a kind of

cylinder there… for the fat to go out in liquid form.

(comment made during recall of the whole text) … Here they talk about the surgery, an incision is made where there is more fat… they inject some substances… **and the fat cells explode and change into liquid** then they roll a cylinder and take the fat out in liquid form.

S3 did refer to the fact that the fat cells explode, but from her recall it is not clear whether they explode because of the ultrasound or because of the drugs which make them swell. In fact, during the retrospective interview, S3 said that the text didn't flow very well, she gave it a 4 on the difficulty scale and another 4 on the familiarity scale. She commented that what had made the text difficult was the technical vocabulary – medical terms. Like S6, mentioned above, S3's reported difficulties were also confirmed by her recall protocol: she had the lowest score on the recall of the paragraph containing Prediction (50% lower than four other better readers) and the lowest score on whole text recall.

As to the weaker readers, only one subject (S7) did not mention the predictive signal. However, like the two better readers mentioned before (S1/S3), S7 referred to the structure of the paragraph ('they explain in detail how…'). She was the only weaker reader who recalled all three predicted items correctly:

S7: (comment made during recall of the paragraph containing Prediction) Here they explain in detail how the liposuction with ultrasound is developed… they use distilled water to make the region with fat swell… and an anesthetic… and then they use this device… by means of ultrasound… which transforms the fat into liquid… and then they roll a cylinder on top… for the liquid to come down to the incision… to be expelled from the body…

(comment made during recall of the whole text) … In the third

paragraph, they say they use anesthetics… distilled water … to make the place swell… and after having used the ultrasound … when the fat became liquid… they use a cylinder… on top… for the fat to be expelled through the incision.

The other five subjects recalled the predictive signal correctly, but were not able to recall all the predicted items correctly (S18/ S9/S10/S11/S12):

S8: (comment made during recall of the paragraph containing Prediction) Here the three steps of… liposuction with ultrasound are mentioned. First they put sodium bicarbonate and anesthetics… and then… they put a … it must be a pipe… in the incision and then…and that **they widen the skin a little to make it easier**… ant then they roll a cylinder so that this material is expelled.

(comment made during recall of the paragraph containing Prediction) This surgery is made in several steps… an injection with distilled water and anesthetics is given…and then **a cylinder is rolled to unmake the fat cells… and this canula is introduced … to take the excess of fat out.**

(comment made during recall of the whole text) It is developed in three steps… the first an injection with… distilled water and.. anesthetics is given … **a cylinder is rolled, it dilutes the liquid… this ultrasound canula, it takes the excess of fat out… the fragments which remained …then it becomes liquid…**

S10: (comment made during recall of the paragraph containing Prediction) And this surgery with ultrasound… it is… through an equipment … they spot the fat and the fat is bombarded. And with that… the fat is undone… **with the incision it disappears.**

(comment made during recall of the whole text) This last part… it is developed in three steps. The first step is… they give injections where the person has fat, so that it swells… and then they put the device… and the fat cells are blown…an then **the device which makes the incision… it changes into liquid.**

S11: (comment made during recall of the paragraph containing Prediction) … It is developed in three steps… the surgeon gives an injection of bicarbonate and anesthetics, this is to make the… adipose tissue… swell, then with the ultrasound… with … I don't know with what he … he … with the ultrasound **it spreads** (ela se espalha), only the fat cells and after that then with a cylinder … **they roll a cylinder and it becomes liquid.**

S12: (comment made during recall of the paragraph containing Prediction) This type of lipoaspiration is developed in three steps… then he puts the three steps… **I'm not going to say because I don't remember…**

(comment made during recall of the whole text) … And this type of surgery… is developed in three steps… **I know an injection with distilled water is given .. that I remember…**

A summary of the results for the recall of better and weaker readers in relation to the predictive signal and the predicted items is presented in Table 9:

TABLE 9 – Better vs weaker readers' recall of the predictive signal and the predicted items – Complete Prediction

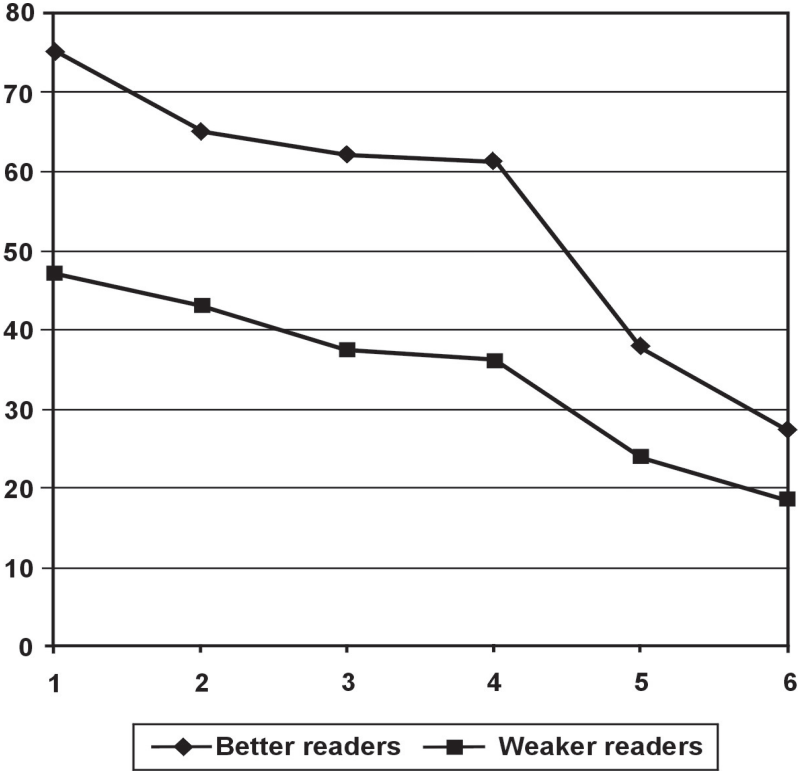
	BETTER READERS						WEAKER READERS					
	1	2	3	4	5	6	7	8	9	10	11	12
PREDICTIVE SIGNAL		X		X	X	X		X	X	X	X	X
PREDICTED ITEM 1	X	X	X	X	X	X	X	X	X	X	X	X
PREDICTED ITEM 2	X	X		X	X		X			X		
PREDICTED ITEM 3	X	X	X	X	X		X	X				

Results show that the third hypothesis was partially confirmed. Although both better and weaker readers tended to recall the predictive signal - 'three steps' - there was a difference between them in terms of the recall of the three predicted items. Whereas four better readers recalled all three predicted items correctly, only one weaker reader (S7) was able to do so.

As mentioned in the beginning of this section, the prediction pair described the liposuction surgery with ultrasound in reasonably great detail. The enumerable in the predictive signal - 'steps' - implied that a 'sequence' of events would be described in a given order. The signals which preceded each of the three predicted items - 'first', 'next' and 'last' confirm this Prediction. Results presented above suggest that better readers recognized and were more able to follow the sequence to organize recall of the predicted items: whereas five of them reproduced the same sequence as that used by the author (S1/S2/S3/S4/S5), only three weaker readers did so (S7/S8/S11). Furthermore, from the five better readers who reproduced the sequence, four of them correctly recalled all the predicted items (S1/S2/S4/S5), whereas only one of the three weaker readers who reproduced the sequence was able to do so (S7).

Regarding the number of propositions recalled for the paragraph containing Prediction, there was also a statistically significant difference between the two groups (Student T= 2.47, df= 10, p= 0.03); i.e., better readers recalled significantly more propositions (55.14%) than weaker readers (30.05%) (see Figure G). The analysis of the recall protocols, as presented before, revealed that most weaker readers had problems in understanding the individual propositions in the predicted items of the Prediction pair, which described the new surgery. In addition, four of the weaker readers rated the text as moderately difficult and pointed to 'vocabulary' as the source of difficulty; three weaker readers also rated the subject of the text as moderately unfamiliar.

Figure G - Better vs weaker readers' recall of the paragraph containing Complete Prediction (%)



According to Just and Carpenter (1992), processing a sequence of sentences, within the capacity limitations of working memory, is possible because of some mechanisms which reduce the demands for processing and storage. As described earlier, context is given by Just and Carpenter as the mechanism which can facilitate processing. Among the mechanisms which reduce the demands for storage, they include the following: only the most recent propositions remain activated, as well as only the most relevant aspects of prior knowledge; each new word or phrase tends to be interpreted as

soon as it is encountered; after higher level structures have been built, lower level representations may be deactivated. It is possible that the unfamiliarity with the vocabulary and subject of the text affected weaker readers' performance in this text. First, they might not have been able to benefit from the context provided in the text which could have helped them interpret the stream of input; i.e., they probably failed to activate the relevant 'concepts, relations and schemas' (Just & Carpenter) which could help them process the incoming sentences; second, they might not have been able to interpret each incoming word or phrase immediately, having to wait for more input to do so; third, since they could not access referential meaning immediately, the formation of higher level structures had to be postponed until more input arrived, leading to a need for storage of more surface information. Failure in the mechanisms described above might have overwhelmed working memory by increasing the demands for processing and storage to an unmanageable level, leading to a decrease in performance.

4.2.2.2 Hypothesis 6

There is a relationship between reading ability and readers' capacity to notice distortions in terms of the text organizing mechanism of Prediction; i.e., readers who are able to comprehend and recall more of a text are also able to perceive when the text fails to completely fulfill the expectations set up by the writer in the predictive member of the Prediction pair.

Distorted prediction

For this investigation on distorted prediction, a text entitled "O cerco a Michelangelo" (The siege to Michelangelo) (*Veja*, 1992) was used. The text contains three paragraphs and, as was the case with the complete Prediction text, the Prediction pair is located in the last paragraph (see Appendix E for the whole distorted text). The first paragraph presents the problem posed by the Michelangelo

virus which, according to the text, could destroy al computer files on the sixth of March of 1992. The second paragraph defines computer viruses, elaborates specifically on the problem presented and introduces the solution in general terms ('Most people took the necessary precautions…'). The last paragraph elaborates on the antivirus vaccines which are given as a solution to the presented problem. Again, the predictive member of the Prediction pair contains a numeral - 'three'- and an enumerable - 'types'- as follows: 'There are at least three types of vaccination programs against the computer virus'. Then, breaking expectations, the predicted member describes only two types of vaccination programs, as follows: '**one of them** looks for the virus tracking each one of the filed programs, the invader is found and exterminated. **A second type** only localizes the clandestine and the user has to make use of another specific program to do away with the microinvader'. The distortion in this text was the omission of the third element in the predicted member of the pair, the third type of antivirus vaccine – 'and a third type prevents the virus from entering the machine'. The Prediction pair is immediately followed by negative evaluation about antivirus vaccines - 'The Norton vaccine, against 700 viruses, costs the equivalent to 200 dollars in Brazil'.

The reasoning behind the methodology used in this study – distortion of one of the predicted items – is that if the reader perceives the distortion, i.e., if he/she explicitly says the text failed to mention the 'third type of antivirus vaccine', it can only be because he/she had kept the predictive signal 'three' in working memory, which implies that he/she was using the text mechanism of prediction to organize the flow of information in working memory.

In terms of better readers, only one of the six subjects explicitly mentioned that there was a distortion, in a comment made during the recall of the whole text. However, his protocol shows that he became confused and tried to make up for the text by adding a third type of vaccine from memory (S1):

S1: There are three types… the text only describes two… I don't know whether the third type is the one which destroys … one which finds and destroys, another which only finds … and another which destroys… there are three…

Since S1 had kept the numeral 'three' from the predictive signal and could only retrieve two predicted items, he seemed to have drawn upon two alternatives to solve the impasse: first, 'it is a failure in the text itself' ('the text only describes two'…) but he seemed confused and did not sustain this affirmation and drew upon another alternative - 'It's a failure in my memory' ('I don't know whether'…) and thus made up his hypothesis ('…the third type is the one which destroys'), a probable inference from the two types mentioned. Guided by this hypothesis, he started the search in his memory for the three items: retrieved the first type ('one which finds and destroys'), retrieved the second type (another which only finds), and then retrieved his 'educated guess' as actually being mentioned in the text ('and another which destroys'), thus opting for the second alternative - 'my memory may have deceived me' (there are three'…).

S1 engaged in what Bartlett (1932, as cited in Ashcraft, 1994) describes as 'an effort after meaning' or what is called today 'reconstructive memory' (Ashcraft, 1994; Anderson, 1995) or 'reconstructive changes' (Searleman & Herrmann, 1994), which is defined as 'the tendency in recall or recognition to include ideas or elements that were inferred or related to the original stimulus but were not part of the original stimulus' (Ashcraft, 1994, p.681). Searleman and Herrmann point out that it may often be very difficult to determine exactly where a particular inference occurred, at encoding or retrieval. However, in the case presented above, it seems likely that it occurred during retrieval. One reason which points to this interpretation is that during immediate recall of the paragraph containing the distorted Prediction, S1 recalled the predictive signal 'three' and the two predicted items effectively mentioned, without

adding the third missing item from memory nor referring to the distortion:

S1: … He describes three types of vaccines against the virus, sold in Brazil…One looks for the virus and destroys the virus… There is another type that only looks for the virus, then one has to use another program to destroy the virus … and then the price is also discussed…

It was only during whole text recall that he became confused and added the third missing item.

Three other better readers did not make any explicit comments about the distortion but replaced the numeral 'three' in the predictive signal with 'several' (S4/S5), or with 'two' (S3/S4), or ignored the predictive signal and mentioned the predicted items only (S3); but all three subjects recalled correctly the two predicted items effectively mentioned:

S3: (comment made during recall of the paragraph containing Prediction) There is a type of vaccine… which you put… in a diskette and it already finds and destroys… and the other vaccine you put and it finds the virus, but you would have to bring another program in… to destroy that type of virus.

(comment made during recall of the whole text) … there are two types… one of the vaccines … finds and destroys the virus… the other vaccine… it finds it and you have to use another program against that virus… to terminate it.

S4: (comment made during recall of the paragraph containing Prediction) … these vaccines have several forms of action… one of them detects the invader, the virus in this case and… terminates it… another type only detects the invader but another program is needed to terminate this invader…

S5: (comment made during recall of the paragraph containing Prediction) … there are several types of vaccines… one finds

and destroys the virus and another only finds it and one has to resort to other… methods… to destroy the virus…

Like S1 mentioned above, these three better readers were also involved in some kind of reconstruction during retrieval. For them, the predicted items had a 'retroactive interference' in their memory for the predictive signal. Ashcraft (1994) describes 'retroactive interference' as a type of interference in which 'newer material interferes backward in time with your memory for older items' (p.154).

One better reader recalled the predictive signal but not the predicted items (S2):

S2: (comment made during recall of the paragraph containing Prediction) … There are three types… which are expensive…

Only one of the better readers kept the predictive signal - 'three types'- and recalled the two predicted items mentioned in the text without making any comments about the distortion (S6):

S6: (comment made during recall of the paragraph containing Prediction) There are at least three types of vaccines… one vaccine… it tracks the whole… filed program… looking for the virus and when it finds it destroys it. Another vaccine only finds the place where the virus is and the user has to use another type of vaccine to… do away with it.

(comment made during recall of the whole text) … there are at least three types and that… one tracks the whole… the whole program looking for the virus and when it finds it … destroys it, another only finds the virus and the user has to… resort to another device to destroy…

One possible explanation for S6's recall is that she might erroneously have taken 'at least' in the predictive signal as an indication that the author would need to provide 'a number of ' examples and not necessarily the 'three'. In fact, she was the only

reader who recalled the expression 'at least'; she included it in both paragraph recall and whole text recall.

In terms of the weaker readers, none of them made explicit comments about the distortion. One subject, however, replaced the numeral 'three' in the predictive signal with 'two' (S7):

S7: (comment made during recall of the paragraph containing Prediction) This one is talking about the antivirus vaccines… that there are two… one tracks the whole program and is able to terminate with the virus… and the other only finds it and… another person has to look for another program… which exterminates it.

Only one of the other five weaker readers recalled the predicted items correctly. She made up for the text by replacing the predictive signal - 'three types' - with a demonstrative - 'these' - plus an open set noun - 'vaccines' (S11):

S11: (comment made during recall of the paragraph containing Prediction) … these vaccines… from these vaccines one finds the invader, they are made with magnetic diskettes and… they find the invader and destroy, others only find and the user has to… has to find an specific mean to… eliminate it…

(comment made during recall of the whole text) … and these vaccines are magnetic diskettes which… introduced in the computer they find the virus and destroy and others… simply find and the use… finds… specific means to eliminate it…

Three other weaker readers only made reference to the existence of antivirus vaccines and recalled general information, without actually describing the two types mentioned (S8/S9/S12) :

S8: (comment made during recall of the paragraph containing Prediction)… The second here talks about… **the antivirus vaccines, which are expensive..**

S9: (comment made during recall of the paragraph containing Prediction) Then some… users… they got a … diskette which is… **the antivirus… then it eliminates all the existent viruses in the computer…** it cleans … it doesn't let this virus damage what is written, what is recorded.

(comment made during recall of the whole text) … To fight that… magnetic tapes were recorded and… **users make that for various types of virus…**

S12: (comment made during recall of the paragraph containing Prediction) Oh My God… let me see… A diskette is used… and this diskette… **there is a vaccine against the virus, which is the antivirus… and it is introduced and eliminated, the virus**… the only thing is that it's very expensive…

(comment made during recall of the whole text)…There is an **antivirus vaccine which is introduced in the computer … and it goes tracking, taking out… and it goes searching and eliminates the virus…**

Finally, the other weaker reader recalled the predictive signal - 'three types', but was not able to recall the two predicted items effectively mentioned (S10):

S10: (comment made during recall of the paragraph containing Prediction) … there are <u>three types</u> of vaccines against the virus… <u>one</u> which the person adopts… and the virus is found inside the computer and destroyed… and <u>another type</u> **that the viruses can be killed through diskettes**. Now, I think it is the virus itself which is the story (história) programmer…

S10 recalled the first type 'apparently' correctly; apparently because when he tried to recall the second type, he was not able to and he brought in information ('… another type that the viruses can be killed through diskettes') implying that this was a characteristic

peculiar to the second type of vaccine. This suggests that he did not understand a basic premise in relation to all antivirus vaccines, at least as described in the text: '… all of them sold in the form of magnetic diskettes for computers'. Actually, S10 did not refer to the mode of action of the second type of antivirus vaccine ('it only localizes the clandestine and the user has to make use of another specific program to do away with the microinvader').

A summary of the results related to the recall of the predictive signal and the predicted items is shown in Table 10.

TABLE 10 – Better vs. weaker readers' recall of the predictive signal and the predicted items - Distorted Prediction

	BETTER READERS						WEAKER READERS					
	1	2	3	4	5	6	7	8	9	10	11	12
PREDICTIVE SIGNAL (L)	X	X				X				X		
PREDICTIVE SIGNAL (R)			X	X	X		X					
OPEN SET NOUN (VACCINE)								X	X		X	X
PREDICTED ITEM 1	X		X	X	X	X	X	X	X	X	X	X
PREDICTED ITEM 2	X		X	X	X	X	X				X	
PREDICTED ITEM 3 (M)	X											

(L) = literal recall of the predictive signal
(R) = replacement of the predictive signal
(M) = attempt to provide from memory

Results indicate that the fourth hypothesis was not confirmed. In fact, neither better nor weaker readers explicitly reported the distortion. However, all better readers referred to the predictive signal, either by recalling exactly what was mentioned in the text - 'three types' (three better readers) or by replacing the predictive signal to suit the predicted items (three better readers), whereas only two weaker readers did so. Furthermore, five of the six better readers recalled the two predicted items effectively mentioned in the text, whereas only two weaker readers were able to do so.

The fact that four of the six better readers 'reconstructed' the Prediction mechanism indicates that it had some importance in the organization of information in memory and it suggests that they were using the mechanism of Prediction to organize the flow of information during reading. A possible explanation for the fact that they did not report the distortion is that although they might have attended to the numeral 'three', working memory became so busy processing the incoming input that the numeral was just displaced with the subsequent flow of processing.

An explanation for such results may be that the type of Prediction used in this study organized the text at the micro level and was not crucial to the understanding of the text as a whole. Actually, at the macro level, the text was organized in terms of Problem/Solution with the problem being 'the Michelangelo virus which would attack on the sixth of March and could destroy all files in the computer'; 'the antivirus vaccines' were given by the text as a solution to the problem. Therefore, the specification of the 'types of vaccines' with their modes of action would then be a response to the problem at the macro level. It could be that better readers were more concerned with identifying the solution given by the text and concentrated their attention on the open set noun - 'vaccines' (related to the predictive signal) – and their modes of action (predicted items), thus not giving full attention to the numeral 'three', since it was not so important in terms of the macrostructure of the text. Possible evidence for this comes from the pattern of recall shown by better readers: they tended to replace the enumerable in the predictive signal to match the predicted items effectively mentioned and tended to recall the two predicted items.

The pattern of results shown by weaker readers may indicate that they might have gone through a different process: they tended to disregard the predictive signal and pick up one of the predicted items and use it as general information for the topic of the paragraph. This may indicate that they were not using the mechanism of

Prediction, or if they were attempting to use it, they were so affected by task demands that much of the information was displaced while reading, which led them to maintain only a sense of what was going on in the paragraph.

The recall protocols suggest that weaker readers (also lower span) were more affected by the task of maintaining global coherence and processing the paragraph containing the distorted Prediction. As already mentioned before, whereas five of the six higher span readers correctly recalled the two predicted items effectively mentioned, only two lower span readers did so. Actually, weaker readers retained much less information from the paragraph containing Prediction (Student T= 3.03, df= 10, p= .01) (see Figure H) and also from the whole text (Student T= 4.8, df= 10, p= .0007) (see Figure I) than better readers. During the retrospective interview, except for one weaker reader (S8), who considered the text as very easy and totally familiar, all others reported having difficulties with the subject of the text. In fact, of all five texts used in Experiment 2, this was the one which received, from weaker readers, the highest rating in terms of difficulty and the second highest rating in terms of unfamiliarity with the subject. As opposed to Text 4 (complete Prediction), this time the reported difficulties were not specifically related to vocabulary, but to lack of familiarity with the subject.

Figure H - Better vs weaker readers' recall of the paragraph containing Distorted Prediction (%

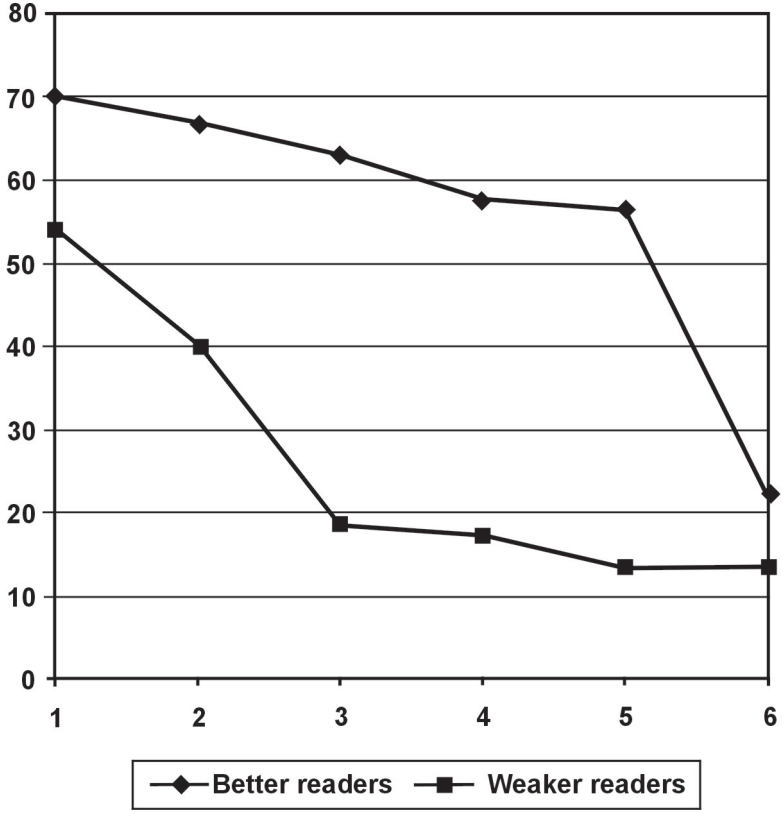
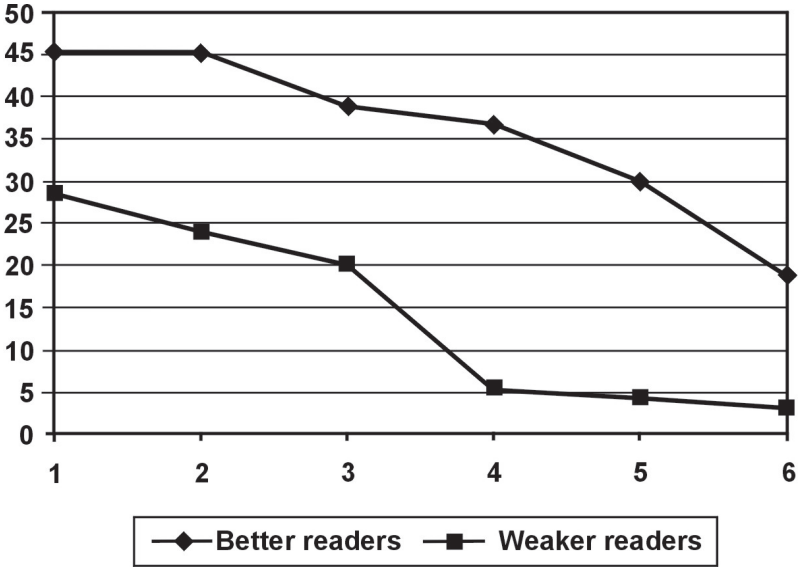


Figure I - Better vs weaker readers' recall of the text containing Distorted Prediction (%) - Whole Text Recall



As already observed in the discussion of Hypothesis 5, context is a mechanism which can reduce processing demands (Just & Carpenter, 1992). According to Just and Carpenter, the stored context provides for the preactivation of relevant 'concepts, relations and schemas' necessary for comprehension. Weaker readers might have benefited less from the context provided in the text, since the subject was unfamiliar, thus overwhelming working memory with storage and processing of the succeeding sentences.

4.2.3 Hypothesis 7 – Problem/Solution vs. Prediction

Distortions in terms of the Problem/Solution pattern will have a greater negative effect on recall than the distortion related to Prediction.

Better readers

What motivated the present hypothesis was the fact that Problem/Solution was used as a macroorganizer and Prediction as a microorganizer. Therefore, distortions of the Problem/Solution structure could affect processing at the macrolevel and thus produce a deficit in comprehension and recall of the whole text. Distortions of the predicted items, on the other hand, involved the omission of one proposition which played a role at a local level – a single paragraph – thus not expected to affect processing at the macrolevel.

Regarding better readers, there was not a significant difference in terms of Whole Text Recall of the complete Prediction Text as compared to the distorted one (Student T= .5, df= 10, p= .62); i.e., the distortion of the predicted items did not affect better readers' recall of the whole text (see Figure J). Similarly, no difference was found in terms of better readers' recall of the complete and the distorted paragraph (Student T= -.0967, df= 10, p= .92) (see Figure K).

Figure J - Better readers' recall of the Complete vs Distorted Prediction Texts (%) - Whole Text Recall

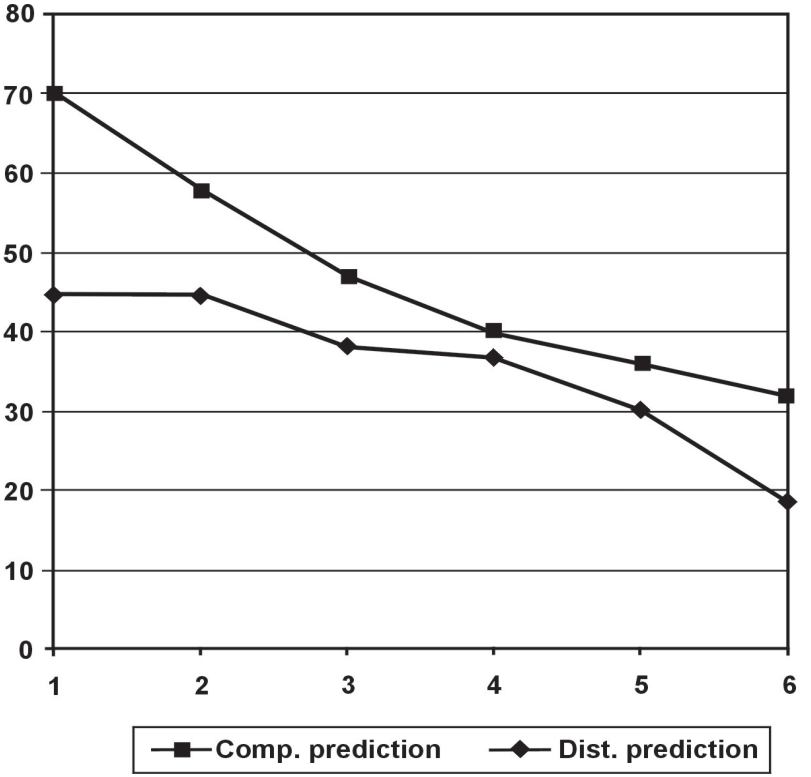
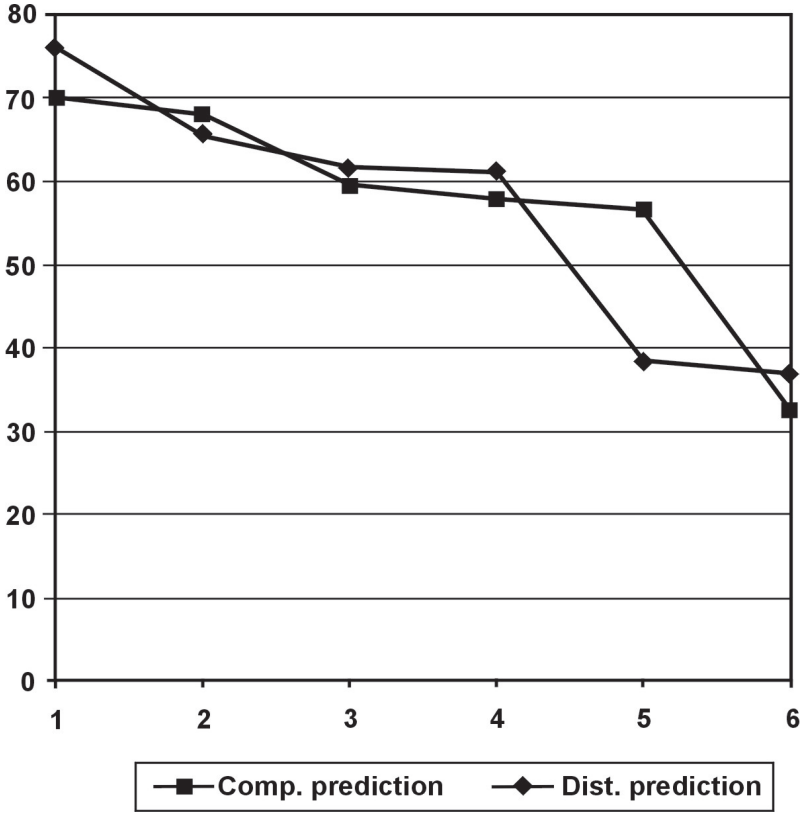


Figure K - Better readers' recall of the paragraphs containing Prediction - Complete vs Distorted

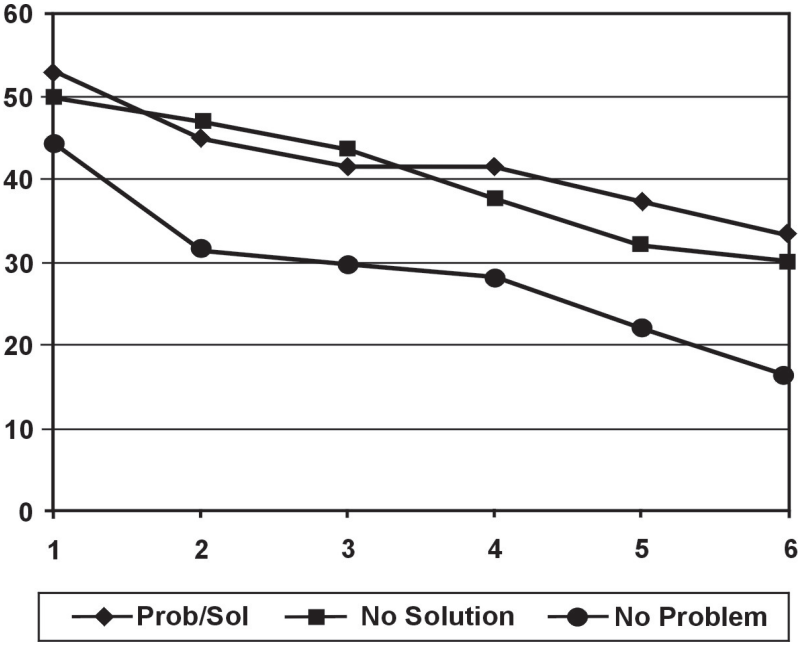


In terms of the Problem/Solution pattern, results from the ANOVA performed on the data show a statistically significantly difference in better readers' recall of the three texts, both in terms of Total Paragraph Recall – TPR ($F= 6.45$; $df= 2.15$; $p< .05$) and also in terms of Whole Text Recall – WTR ($F= 4.45$; $df= 2.15$; $p< 0.05$). In terms of TPR, Tukey's Honestly Significant Difference (HSD) test showed that there were two significant comparisons: 'complete Problem/Solution vs. 'no problem' and also 'no solution' vs.

'no problem'. Regarding WTR, the only significant comparison was between the 'complete Problem/Solution' and the 'no problem' text.

As shown by Figure L, the text which seemed to pose more difficulty in terms of recall was the 'no problem' one; i.e., the distortion of the problem section might have affected better readers' recall of the whole text. As already mentioned in the discussion of Hypothesis 4 ('no problem' text), this was the only text where there was no difference in terms of recall between better and weaker readers and also the only text where there was no significant correlation between working memory span and recall. Contrary to expectations, there was no difference between better readers' recall of the 'complete Problem/Solution' and the 'no solution' text (see Figure L); i.e., the distortion of the solution section did not affect better readers' recall of the text.

Figure L - Better readers' recall of the Problem/ Solution pattern (%) - Whole Text Recall



One possible explanation for these results is that all texts used in this study were of a journalistic nature. It is not uncommon within the journalistic world to present a particular problem and refer to it throughout the whole text without actually suggesting a solution to the presented problem – the function of the text can still be perceived as to inform and make people aware of a certain problem. Although better readers considered the text as being disconnected, badly written, badly organized and incomplete, they made comments which indicate that they tried to activate the schema - '(non-) recycling ' or 'waste' - when reading the text and thus were probably able to process the text from that perspective:

S1: (comment made during the evaluation questionnaire – when asked about the author's objective) I think it was to give examples of… products which are wasted and not recycled… are thrown away… things which could be reused… he talked about the products which are not being recycled.

S2: (comment made during recall of the whole text) First it talks about… the extinction, the shortage… of natural fuels… and that there is a lot of waste of many things…

(comment made during the evaluation questionnaire – when asked about the author's objective) It was… to show that… recycling is a cheaper means … that there are a lot of good things thrown away which could be used… I understood… but I think he could have been more… direct, because he didn't mention… at any moment in the text… the name… recycling, he just induced, gave examples…

S4: (when asked about the author's objective) Talk about waste…about the environment in general, about pollution.

S5: (comment made during recall of the whole text) The text, in general… talks about industrialized products, about the waste, how glass… can be recycled but most… people ignore this fact, and throw glass away… break it… waste…

(comment made during the evaluation questionnaire – when asked about the author's objective) Show that … there is a lot of waste, humanity wastes a lot…

S6: (comment made during recall of the whole text)… and says that … many things are wasted, that we could … recycle these things like glass… that it is always wasted… that instead of producing several cars… we could recycle, some cars..

(comment made during the evaluation questionnaire – when asked about the author's objective) He says many things are wasted, I think this was the objective.

The activation of the relevant schema probably guided readers in making the necessary inferences to build a coherent representation of the text and thus recall more information at the end.

One question that can possibly be raised is 'why weren't better readers also able to activate an appropriate schema for the 'no problem' text?'. A possible answer for this question is that the 'no problem' text was ambiguous; no single interpretation to what was being discussed could be readily given. The vagueness of the lexical items, 'drama', 'emergency', electronic indicators', 'difficulties of a geographical nature', probably did not allow readers to trigger or confirm the 'pollution' schema or any other plausible schema.

The 'no solution' text, on the other hand, although apparently talking about a different subject in each paragraph: 'manufactured goods', 'automobiles', 'silver' and 'glass', more readily allowed for bridging inferences across paragraphs. Lexical signaling for the 'non-recycling' or 'waste' schema was more salient: '… end up in the scrap-heap…', '…evaporates…', '… wasted'.

In terms of better readers, it can be said that the fifth hypothesis was confirmed; i.e., better readers seemed to encounter more problems with the distortions in terms of the Problem/Solution pattern, especially with the distortion related to the problem section, than with the distortion related to Prediction. This seems plausible

since the texts used in this study contained the Problem/Solution as a macrolevel organizer and Prediction as a micro organizer.

Weaker readers

As shown by Figure M, weaker readers' recall of the whole text containing distorted Prediction was significantly lower that their recall of the whole text containing complete Prediction. However, there was no statistically significant difference between their recall of the complete and the distorted paragraph (see Figure N). The results suggest that weaker readers seemed to have more difficulties with Text 5 - 'distorted Prediction' than with Text 4- 'complete Prediction', but the problems they may have encountered were not necessarily related to the distortion, but to text difficulty and unfamiliarity. As already mentioned in the discussion of Hypothesis 6, weaker readers gave Text 5 the highest rating in terms of difficulty and the second highest rating in terms of unfamiliarity with the subject.

Figure M - Weaker readers' recall of the Complete vs Distorted Prediction texts (%) - Whole Text Recall

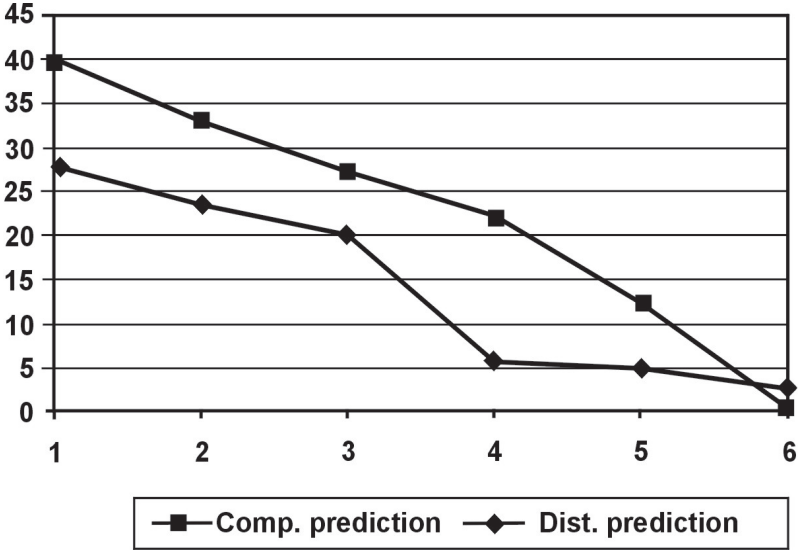
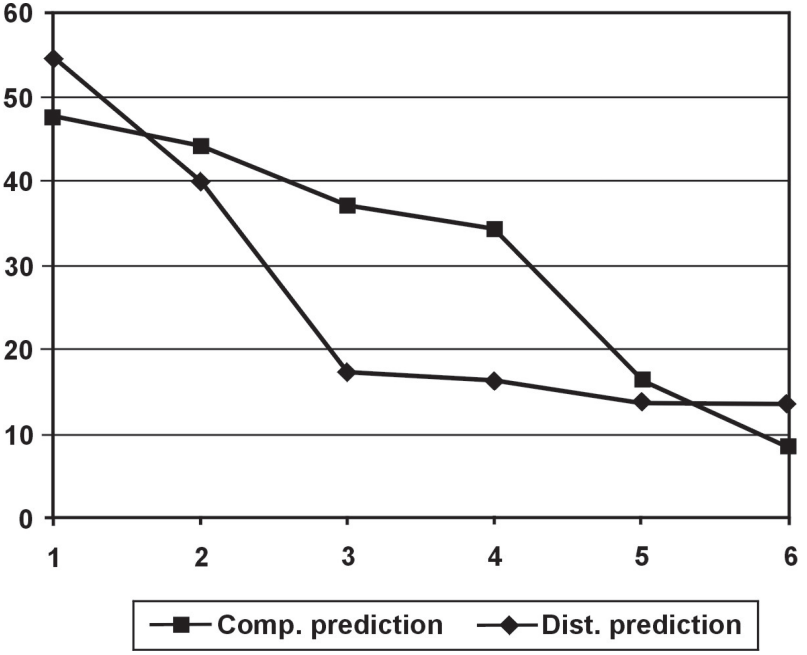
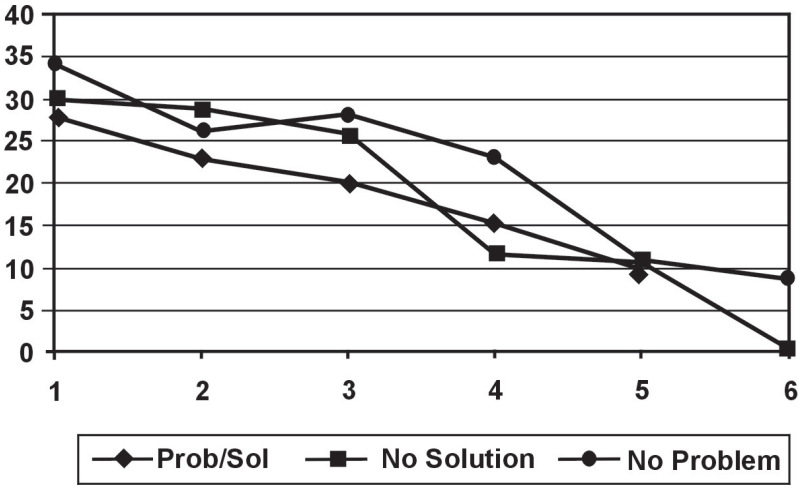


Figure N - Weaker readers' recall of the paragraphs containing Prediction (%)- Complete vs Distorted



In relation to the problem/Solution pattern, results from the ANOVA revealed no statistically significant difference in their recall of the three texts - 'complete Problem/Solution', 'no solution' and 'no problem' ($F= .47$; $df= 2.15$; $p> .05$) (see Figure O). They recalled little information in all situations. This finding is compatible with those in the literature of working memory research. Lower span readers perform so poorly without a load (complete text) that their performance has little room to deteriorate in the presence of a load (distorted texts). Higher span readers, on the other hand, who in the absence of a load have more capacity for processing, show a greater detriment in performance in the presence of an extra load (Turner & Engle, 1989; King & Just, 1991; Just & Carpenter, 1992).

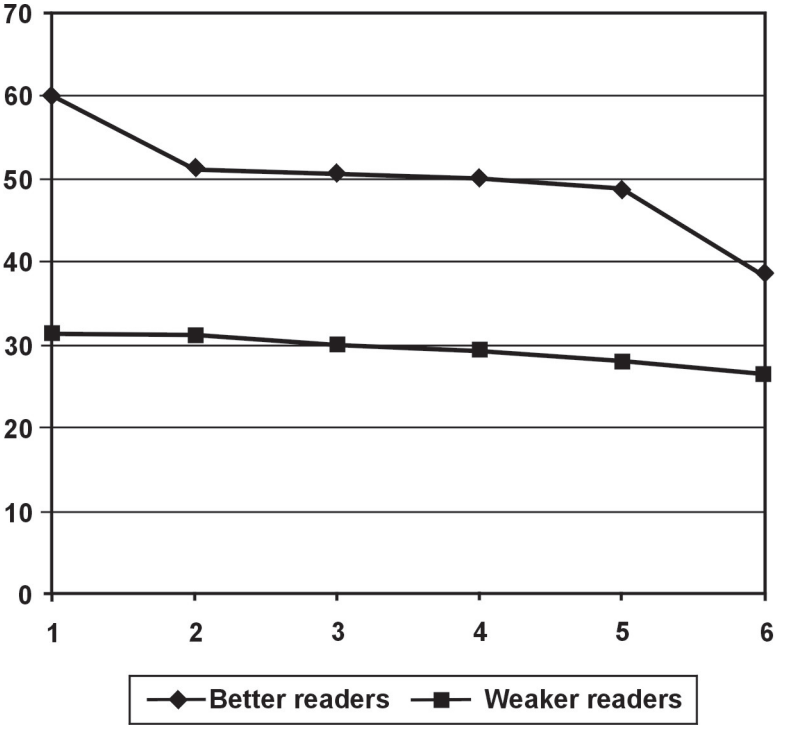
Figure O - Weaker readers' recall of the Problem/ Solution pattern (%) – Whole Text Recall



Therefore, regarding weaker readers, it can be said that the fifth hypothesis was not confirmed. First, though they recalled less information from the distorted Prediction text than from the complete Prediction one, this was probably not due to the distortion, since their recall of the complete and distorted paragraphs was the same, but to lack of familiarity with the subject, as suggested by the comments they made. Second, they recalled as little information from the complete Problem/Solution text as from the distorted ones.

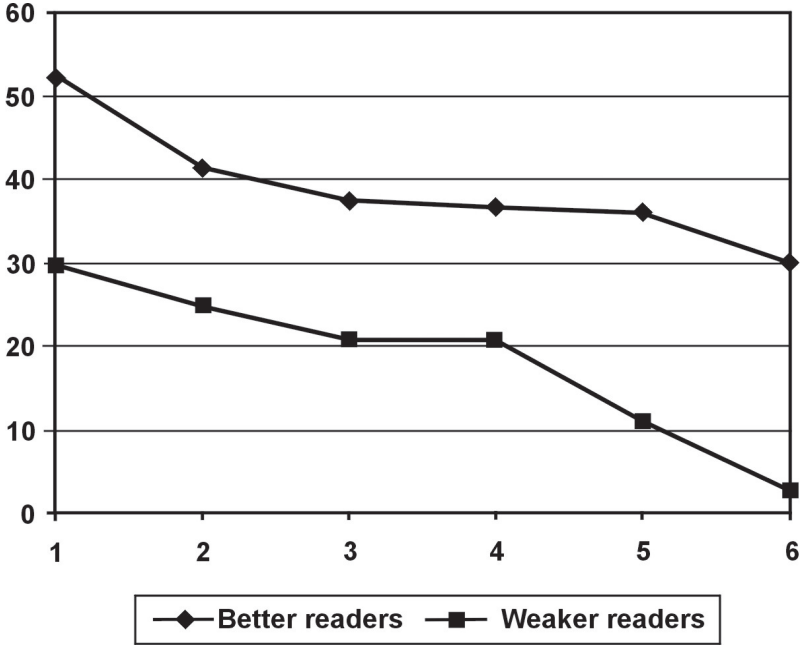
Regarding the average for the recall of all five texts, weaker readers recalled significantly less information than better readers. In terms of the Average for Total Paragraph Recall (ATPR), results from the T-Test show that the null hypothesis, that is, that the difference between means would not be significant, is rejected (Student T= 6.87, df= 10, p= .00004). Better readers had a significantly higher average for Total Paragraph Recall for all five texts than weaker readers, as shown by Figure P.

Figure P - Average of Total Paragraph Recall (%) of all five texts (Complete Problem/Solution, Distorted Solution, Distorted Problem, Complete Prediction and Distorted Prediction) – Better vs weaker readers



The same applies for the Average for Whole Text Recall (AWTR). In this case, both groups scored lower (see Figure Q) than for ATPR above, but the difference between means was still statistically significant (Student T= 4.12, df= 10, p= .002).

Figure Q - Average of Whole Text Recall (%) of all five texts (Complete Problem/Solution, Distorted Solution, Distorted Problem, Complete Prediction and Distorted Prediction) – Better vs weaker readers



Besides recalling less information, weaker readers also had more comprehension problems concerning all texts, complete and distorted, and also provided more elaborations which deviated from the information given in the text, as already observed before. They also tended to make more vague references – by providing referring items without mentioning their specific referents, and/or by replacing a word or sentence or even a group of sentences with a general word or phrase – possibly trying to make up for their lack of understanding of the information given in the text (brackets indicate the problem in each case):

S7: (comment made during recall of the first paragraph – Text 1) Here it is saying that… computers would have to be in environments with air conditioning… central… and asks whether allergic people already know that there… let's say so… is a good place for **them** [no referent] to grow.

(comment made during recall of the last paragraph – Text 1) Here it says that there is another country which is worried… with this type of … bacteria… which are inside where the air conditionings have to be… they are already **producing something in that sense** [substitution for 'producing filters to attenuate the reproduction of germs'] … and that our country here still… how can I say… is launching **something** [substitution for 'filters']… but it is new in this sense…

(comment made during recall of the whole text – Text 1)… they manufacture… I don't know… **a certain material** [substitution for 'filters'] … to put in the air conditionings…

S9 (comment made during recall of the paragraph containing Prediction – Text 5) Then some … users… they got a… diskette which is …**the antivirus… then it eliminates all the existent viruses in the computer** [substitution for the two types of vaccines mentioned in the text]… it cleans… it doesn't let this virus damage what is written, what is recorded.

In the present study, weaker readers were more likely to fail to detect the distortions in each case. In spite of this, they still reported that the texts flowed well, were well organized, complete, and easy to understand. Weaker readers engaged in what Epstein, Glenberg and Bradley (1984) describe as 'the illusion of knowing', which is defined by them as a failure to detect a contradiction in a text, followed by an overassessment of comprehension.

It is certainly the case that textual factors contribute to the phenomenon of 'illusion of knowing', described by Epstein et al. In

this study, the distortions of the problem/solution structure made the texts become vague and disconnected, as all the explicit information related to the section to be distorted was either turned implicit or simply omitted. This way the language in the texts must have contributed to the 'illusion of knowing', since much of the information was presupposed and implicit, allowing for a number of inferences to be made. However, if textual factors were the only contributors to this phenomenon, similar results should have appeared uniformly across the protocols of both better and weaker readers. This was not the case. Weaker readers exhibited 'the illusion of knowing' much more often than better reader. Therefore, the results in this study point to the existence of readers factors which contribute to the 'illusion of knowing'.

The following factors may account for this phenomenon. Weaker readers tended to apply either overly bottom-up or overly top-down strategies to process the texts, thus missing the point intended by the writer (the experimenter who had introduced the distortions), but keeping a feeling that they had comprehended the texts. An overly bottom-up strategy may take the reader to understand individual propositions, but not the relationships among them. An overly top-down strategy, on the other hand, may allow for the construction of a macrostructure, although inaccurate or incomplete.

On the whole, the findings in the present study corroborate those of other related research in the area of reading comprehension: weaker readers are also poor comprehension monitors (August, Flavell & Clift, 1984; Duffy, Roehler, Meloth, Vavrus, Book, Putnam & Wesselman, 1986; Dewitz, Carr, & Patberg 1987; Dole, Duffy, Roehler & Pearson, 1991, among many others).

CHAPTER 5

FINAL CONSIDERATIONS, LIMITATIONS AND IMPLICATIONS

5.1 Final considerations

The purpose of the present study was twofold: 1) to investigate whether there is a correlation between the Reading Span Test (Daneman & Carpenter, 1980) and two measures of reading ability: free recall and answers to questions about important information in the text; and 2) to investigate better and weaker readers' awareness of two text organizational aspects (Problem/Solution – Hoey, 1979 and Prediction – Tadros, 1985) and their ability to use these textual aspects to organize the flow of information processing in working memory.

In relation to the first objective, results revealed that working memory span correlated significantly with the ability to answer questions about important information in the text and also with the number of propositions recalled from all complete and distorted texts, except the 'no problem' text, as already observed. These results corroborate those found in other related studies and are congruent with the argument that an individual's ability to process language is constrained by his/her working memory capacity, with high span individuals being less affected by task demands than low span individuals (Daneman & Carpenter, 1980, 1983; Just & Carpenter, 1992, among many others).

In relation to the second objective, regarding the Problem/Solution structure, three measures were used to assess awareness: first, readers' use of the same structure as the author's to organize recall; second, response to interview question about the structure; and third, perception of the distortions of the structure. In terms of

the 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 questions 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 or indirectly, whereas weaker readers tended not to spot the distortions and only make vague references, not knowing exactly what the distortion was in each case. The results from 'use of structure' and 'perception of the distortions' corroborate those in the literature of text structure research: better readers are more aware of text structure than weaker readers (van Dijk & Kintsch, 1983; Taylor & Samuels, 1983; Meyer, Brandt & Bluth, 1980; Carrell, 1984, 1992; Roller, 1990, and others).

The fact that some weaker readers were more able to refer to the structure as 'Problem/Solution' but were not able to use the structure to organize their recall and were also not able to perceive the distortions was explained as possibly indicating that they possess declarative knowledge (Anderson, 1993, 1995; Paradis, 1994) of the structure. Procedural knowledge is related to working memory capacity, as already observed before, and would prevent weaker readers from being able to use the structure while reading, thus overloading the system with the storage and processing of text information. The distinction drawn in this study between declarative and procedural knowledge of the Problem/Solution structure may have an implication for the studies on text structure awareness. As previously mentioned, the type of assessment which is considered more cognitively demanding is a probe question about the structure

(Richgels et al., 1987; Carrell, 1992). However, the results of the present study suggest that being able to talk about the Problem/ Solution structure using signal words does not necessarily imply that readers will use the structure while reading. Therefore, the results obtained here point to the need for a distinction between 'awareness' and 'use' of structure. A probe question about the structure may indicate a reader's 'declarative knowledge' of the structure (awareness) but may not reveal his/her 'procedural knowledge' of the structure (actual use).

Regarding the text mechanism of Prediction, neither better nor weaker readers reported the distortion of the predicted items. However, better readers tended to reconstruct the Prediction pair so that predictive and predicted items would still match, whereas weaker readers tended to ignore the predictive signal and use one of the predicted items as the topic of the paragraph. This might indicate that better readers are more aware of the mechanism or at least more able to use it during their reading to organize the input information. This is reinforced by the fact that during recall of the paragraph containing complete Prediction, better readers tended to follow the same sequence as the author's to organize their recall of the predicted items, whereas weaker readers tended not to be able to do so. The fact that better readers did not report the distortion may be due to its role in the text. It organized the text at the microlevel, not affecting the discourse as a whole.

The results of the present study reveal differences in the performance of better (higher span) and weaker (lower span) readers while processing complete and distorted texts. As observed in the review of the literature, individual differences in working memory capacity can be explained by two hypotheses: total capacity and processing efficiency (Just & Carpenter, 1992). The total capacity hypothesis posits that individuals vary in the amount of activation they have available for storage and processing, therefore high span readers exhibit a better performance in language tasks because they

would have more activation to support the two functions. The processing efficiency explanation posits that individuals vary in the efficiency of their mental processes; therefore, high span readers' better performance in language tasks would be due to the fact that their mental processes do not consume all the available capacity in working memory and thus leave more capacity for storing the intermediate products. The results obtained in this study revealed differences between the two groups in terms of the use of text structure during reading; therefore, the results are congruent with the processing efficiency explanation. However, this does not rule out the possibility that high span readers' better performance was also due to more activation available to support processing and storage.

According to Just and Carpenter (1992), differences in processing efficiency should be manifested independently of the total demand of the task, whereas differences in total capacity or activation should be more apparent in times of high demand. In the present study, the distorted texts ('no solution' and 'no problem') may have been more demanding than the complete text where the structure was complete (as already observed, the language in the distorted texts was vague and ambiguous, and a large amount of inferencing was required for readers to round off the discourse). Therefore, the processing efficiency explanation would be favored if there would be differences in the performance of the two groups in both the complete and the distorted texts. The total capacity explanation, on the other hand, would be favored if there were differences in the performance of the two groups only in the more demanding situations. Quantitative results showed that higher span readers performed better than lower span readers in the 'complete Problem/Solution' and also in the 'no solution' text, but there was no difference between the two groups in terms of the 'no problem' text. Now, qualitatively speaking, weaker readers' performance in the 'complete Problem/Solution' text was better than their performance in the distorted texts – they did not

provide so many unwarranted inferences as they did in the distorted texts. Thus, the quantitative results in this study favor the processing efficiency explanation. However, qualitative results indicate that the total capacity explanation is not rejected. Therefore, the results in the present study support both explanations.

The rationale for the present study came mainly from two studies on working memory capacity: Daneman and Carpenter (1980; 1983). The main assumption behind those studies is that processing efficiency accounts for the relationship between working memory capacity and reading comprehension; i.e., better readers perform better in reading tasks because they have more efficient reading skills. However, research on working memory capacity has advanced a great deal since then and what has been found more recently is that even when two groups are equated for procedural knowledge, i.e., when two groups are equally proficient at a particular process, there may still be differences in their performance in reading tasks (Just & Carpenter, 1992; Engle, Cantor & Carullo, 1992). Such findings are explained in terms of differences in activation available to support processing and storage. In the present study, results indicated systematic differences in the performance of better and weaker readers in terms of both comprehension and recall of the complete and distorted texts. The two groups were also found to differ in terms of use of text structure during reading. These findings thus suggest that there is a difference in processing efficiency. 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 while reading in contexts of high demands? As mentioned before, the results of the present study tend to support the processing efficiency explanation but do not refute the possibility that differences in activation also account for the relationship between capacity and task performance. 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.

5.2 Limitations of the study and recommendations for further research

In this section I present the limitations and difficulties encountered throughout the development of the study, and make recommendations for further research.

1 – NUMBER OF SUBJECTS – The twelve subjects who participated in this study represent a small sample in the whole population of better and weaker college readers; thus, no generalizations can be made about the processes of better and weaker college readers in general.

2 – TEXT ORGANIZATIONAL ASPECTS (1) – The text in which all the information belonging to the solution section was omitted was still regarded as complete by some readers. This could be due to the fact that being a journalistic text, it could still have the function of making readers aware of a problem without necessarily being committed to presenting a solution. Further research could make use of other types of texts which contain the Problem/Solution structure but where a solution is naturally expected (e.g., advertisements).

3 – TEXT ORGANIZATIONAL ASPECTS (2) – As mentioned earlier, the text mechanism of Prediction (in the sense in which the term is being used here) can organize the text at both the local level and the global level. This study used only texts which contained local level Prediction. It is possible that global level Prediction will play a more important role during the process of reading and will, thus, be more used by readers in maintaining the flow of information in working memory.

4 – TEXT ORGANIZATIONAL ASPECTS (3) – This study investigated the role of two text organizational aspects, namely

Problem/Solution and Prediction, in organizing the flow of information processing in working memory. There are other types of patterns which need investigation, e.g., matching relations, logical sequence relations (Winter, 1986), among other types.

5 – TEXT ORGANIZATIONAL ASPECTS (4) – This study investigated only one type of Prediction, namely Enumeration (Tadros, 1985). There are other categories which need investigation, e.g., Advance Labeling, Reporting, Recapitulation, Hypotheticality and Question (in Tadros's terms).

6 – PROCEDURE – The use of computer technology (King & Just, 1991; MacDonald, Just & Carpenter, 1994) to present texts may allow for a more complete analysis of the reading process. First, reading times per word or sentence can be measured. Second, it allows for a more direct control of rereadings. These are two important aspects which were not accounted for in the present study.

5.3 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 information. 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, as already observed in the review of literature, research has indicated that reading comprehension can be facilitated by teaching text structure. Pehrsson and Denner (1988), to mention further research, 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 & 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 over-assess 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 over-assesses 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 take the reader to acquire information at the

microstructure level, while leading him/her 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 & Patberg, 1987; Dole, Duffy, Roehler & 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 & Brennan, 1983; Richgels, McGee, Lomax & 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, 1996) 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 & 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 & Carpenter, 1992; Engle, Cantor & 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 & Carpenter, 1992,) and researchers agree that poorly learned processes demand resources from working memory (Just & Carpenter, 1992; Engle, Cantor & 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 successful reading comprehension.

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APPENDIX A

Instructions given during data collection

All subjects received written instructions in Portuguese before each part of the experiment (see the corresponding translation at the end of each part).

I – General instructions at the beginning of the experiment

Você vai participar de um estudo sobre memória e leitura. O estudo consta de três partes com objetivos específicos. Na primeira parte, você lerá um texto, tentará escrever tudo o que se lembrar do mesmo e então responderá perguntas de compreensão geral sobre o que você leu. Na segunda parte, você lerá frases soltas, fora de contexto e tentará reter a última palavra de cada uma delas. Na terceira parte, você lerá alguns textos e comentará sobre sua leitura dos mesmos. A primeira e a segunda parte serão desenvolvidas neste primeiro encontro e a terceira parte num encontro posterior.

You will participate in a study about memory and reading. The study is divided into three parts and each one has a specific objective. In the first part, you will read a text, write down everything you can remember from it and then you will answer general comprehension questions about what you read. In the second part, you will read unrelated sentences and try to retain the last word of each one of them. In the third part, you will read some texts and comment on your reading of them. The first and second parts will be carried out in this first encounter and the third part on a subsequent date.

II – Instructions for the reading proficiency test

Você receberá um texto de uma página. Leia-o silenciosamente. O tempo para a leitura será de quatro minutos. Após a leitura, o texto será recolhido e você receberá uma folha em branco. Tente escrever tudo o que você se lembrar do texto. Use frases completas. Ao terminar, essa folha será recolhida e você receberá outra contendo perguntas de compreensão geral sobre o mesmo texto. Responda às perguntas de acordo com o que você leu.

You will receive a one page text. Read it silently. You will have four minutes to read the text. After reading, the text will be collected and you will receive a blank sheet of paper. Try to write down everything you can remember from the text. Use complete sentences. When you have finished, this sheet of paper will be collected and you will receive another containing general comprehension questions about the same text. Answer the questions according to what you read.

III – Instructions for the reading span test

Uma série de frases será apresentada a você através de fichas. Cada vez que uma dessas fichas for mostrada, leia a frase em voz alta e tente memorizar a última palavra da frase. As frases foram divididas em grupos, separados por uma ficha em branco. Cada vez que uma ficha em branco for mostrada, busque na memória e diga em voz alta todas as últimas palavras daquele grupo, exatamente na ordem em que foram mostradas. O número de frases em cada grupo vai aumentando progressivamente. Para que você possa entender o procedimento, será feito um treinamento inicial.

A series of sentences will be presented to you in cards. Each time a card is shown to you, read the sentence aloud and try to memorize the last word of that sentence. The sentences were divided in groups, separated by a blank card. Each time a blank card is shown, try to retrieve from your memory all the last words from that group and say them out loud, exactly in the same order as they

were presented. The number of sentences in each group will gradually increase during the course of the test. You will be given practice before the actual procedure.

IV – Instructions for the pause protocol procedure (Adapted from Cavalcanti, 1989)

Esta parte do experimento consta da leitura de cinco textos. Durante a leitura de cada um dos textos, observe o seguinte procedimento:

1 – Leia o texto silenciosamente. O objetivo da leitura é uma compreensão geral do texto.

2 – O texto deve ser lido **silenciosamente**; contudo, essa leitura silenciosa deve ser interrompida quando você:

2.1 – detectar uma ***pausa** (não importa a duração) durante a leitura

***Pausa** – momento em que a atividade de leitura é interrompida e você nota que está, por exemplo, pensando sobre um problema que encontrou ou sobre alguma coisa que tenha chamado sua atenção.

2.1.1 – Quando a leitura for interrompida devido à ocorrência de uma pausa, por favor

a – localize a pausa no texto, isto é, leia em voz alta a palavra, expressão ou oração que a ocasionou.

b – comente sobre a razão da pausa, isto é, se resultou de algum problema encontrado na leitura ou de algo que lhe chamou a atenção.

2.2 – chegar ao final de cada parágrafo. (Um ponto vermelho foi colocado no final dos parágrafos como lembrete).

2.2.1 – Quando terminar de ler cada parágrafo, por favor

a – fale sobre o que acabou de ler, isto é, sobre o conteúdo do parágrafo.

b - comente sobre o que estava pensando enquanto lia o parágrafo.

Obs: Se a pausa requer a solução de um problema antes que você possa continuar a leitura, por favor tente pensar em voz alta enquanto tenta resolvê-lo.

3 – Continue a ler o texto e a falar sobre ele até o final.

4 – Tente ler como se você estivesse sozinho.

5 – A sessão será gravada.

6 – Será feito um treinamento inicial.

V – Instruções pós-leitura

Por favor, tente verbalizar tudo o que você se lembrar do texto. Tente usar frases completas.

(Adapted from Cavalcanti, 1987)

This part of the experiment involves the reading of five texts. While reading each of the texts, try to observe the following procedure:

1 – Read the text silently. The reading purpose is general comprehension.

2 – The text should be read **silently;** however, this silent reading should be interrupted whenever you:

2.1 – detect a ***pause** (no matter how short) during your reading.

***Pause –** moment when the reading activity is interrupted and your find yourself, for instance, thinking about a problem encountered, or about something that might have caught your attention.

2.1.1 – whenever your reading is interrupted because a pause is occurring/has occurred, you are asked to:

a – locate the pause in the text, i.e., read aloud the word, expression or sentence that caused it.

b- comment upon the reason for the pause, e.g., if it resulted from something that called your attention or from any kind of problem encountered.

Note: If the pause demands solving a problem before reading is resumed, please try to think aloud while working towards a solution.

2.2 – get to the end of each paragraph. (A red dot has been placed at the end of a paragraph as a reminder).

2.2.1 – When you finish reading each paragraph, you are asked to:

a – talk about what you will have just read, i.e., about the content of the paragraph.

b- comment upon what you will have been thinking about while reading the paragraph.

3 – Continue reading the text and talking about it until the end.

4 – Try to read as if you were on your own.

5 – The session will be tape-recorded.

7 – You will be given practice before the actual experiment.

V – Post reading instructions

a- Please try to recall everything you can remember from the text you just read. Try to use complete sentences.

APPENDIX B

Sentences for the reading span test

1 - O intelsat-6 foi lançado em 1990, mas nunca funcionou – ficou numa órbita **errada**. (13 palavras – *Veja*, 20 de maio, 1992, p.63).

2 - A iniciativa deve partir da própria pessoa interessada em ter um corpo bonito e **saudável**. (15 palavras – Veja SC, 15 de abril, 1992, p.4).

3 - A igreja do bispo extorque dinheiro dos fiéis, que são obrigados a fazer doações compulsórias nos **cultos**. (17 palavras – ***Veja*, 3 de junho, 1992, p.33).**

4 - As bactérias degradam as emulsões coloridas do filme, criando imagens que podem ser definidas como **futuristas.** (16 palavras – *Superinteressante*, fevereiro de 1992, p.14).

5 - A padronização agrícola, para atender aos consumidores, ameaça a diversidade biológica do mundo **vegetal.** (14 palavras – *Superinteressante*, julho de 1992, p.10).

6 - O governo desistiu de limitar a importação de carros, conforme proposta defendida pela Secretaria Nacional da *Economia*. (17 palavras – *Folha de S. Paulo*, 6 de setembro 1992).

7 - Para realizar as atividades cerebrais do pensamento, os neurônios tiram energia do oxigênio e da **glicose.** (16 palavras – *Superinteressante*, maio de 1992, p.17).

8 - O processo de fabricação é o problema que aflige a maior parte dos pequenos **empresários**. (15 palavras – *Folha de S. Paulo*, 29 de novembro de 1992).

9 - Cerca de 250 milhões de pessoas, ao redor do mundo, se encontram na mais profunda **depressão**. (16 palavras – *Superinteressante*, setembro de 1992, p.57).

10 - O presidente francês tem um câncer na próstata que pode ser tratado com **medicamentos**. (14 palavras – *Folha de S. Paulo*, 17 de setembro de 1992).

11 - Uma manifestação estudantil ontem em Brasília foi marcada por atritos com a polícia **militar**. (14 palavras – *Folha de S. Paulo*, 17 de setembro de 1992).

12 - Mostra a capacidade do homem em transformar coisas simples em obras de arte, através da **dedicação**. (16 palavras – *Superinteressante*, setembro de 1992, p.3).

13 - A expressão refere-se à tentativa de conciliar o progresso com a preservação da **natureza**. (14 palavras – *Veja*, 3 de junho, 1992, p.34).

14 - Uma proteína do amendoim ajudou células retiradas de tumores do intestino grosso a se reproduzirem em **laboratório.** (17 palavras – *Folha de S. Paulo*, 17 de setembro de 1992).

15 - Pesquisa do Sebrae aponta que o novo salário mínimo deve provocar uma onda de **demissões.** (15 palavras – *Folha de S. Paulo*, 17 de setembro de 1992).

16 - Se o Brasil pretende ir ao espaço sem pedir licença, não pode dispensar um programa de **foguetes.** (17 palavras – *Superinteressante*, setembro de 1992, p.10).

17 - O médico deve levar em conta a idade, número de filhos e saúde do **paciente.** (15 palavras – *Folha de S. Paulo*, 17 de setembro de 1992).

18 - Soube que o marido não ganhou o direito de protestar contra o abandono em momento tão **delicado**. (17 palavras – *Superinteressante*, setembro de 1992, p.4).

19 - Nós pedimos para o mundo falar e a mensagem soou alta, clara e extraodinariamente **perfeita**. (15 palavras – *Veja*, 3 de junho, 1992, p.98).

20 - A obra custou caro demais, a utilidade é incerta e o resultado final, **polêmico.** (14 palavras – *Veja*, 23 de setembro, 1992, p.60).

21 - É a primeira vez que se consegue em órbita a ovulação e fertilização de espécies **animais.** (14 palavras – *Veja*, 23 de setembro, 1992, p.61).

22 - Os fabricantes de microcomputadores estão criando produtos com novas tecnologias, a preços mais **atraentes**. (14 palavras – *Folha de S. Paulo*, 23 de setembro de 1992).

23 - Pesquisadores descobrem que o antílope das pradarias norte-americanas é o mais resistente dos mamíferos **terrestres.** (17 palavras – *Superinteressante*, julho de 1992, p.37).

24 - O neandertal tinha testa curta e grossa, mandíbula forte, de queixo curto, e seus ossos eram **pesados.** (17 palavras – *Superinteressante*, julho de 1992, p.37).

25 - Depois de rejeitar acordo em plebiscito, a Dinamarca quer alterar a tendência de centralismo da unificação **Européia**. (17 palavras – *Folha de S. Paulo*, 23 de setembro de 1992).

26 - Às vésperas do fim da reserva da informática, cresce a pressão por novos privilégios e **favores**. (16 palavras – *Veja*, 23 de setembro, 1992, p.80).

27 - Seu público eram as pessoas que olham muito para a pechincha e pouco para a **qualidade.** (16 palavras – *Veja*, 23 de setembro, 1992, p.83).

28 - O Brasil reforça sua presença no milionário clube da telefonia celular com o anúncio de novos **editais**. (17 palavras – *Veja*, 23 de setembro, 1992, p.85).

29 - Quando o cineasta dá rédea solta ao puro amor pelas imagens, o filme arrebata os **sentidos**. (16 palavras – *Folha de S. Paulo*, 23 de setembro de 1992).

30 - Na catarata, a vítima perde a visão gradualmente porque as células do cristalino tornam-se mais **opacas.** (16 palavras – *Superinteressante*, fevereiro de 1992, p.9).

31 - É difícil acreditar no acidente que interrompeu a arrancada do trem voador japonês, rumo às rotas **comerciais**. (17 palavras – *Superinteressante*, fevereiro de 1992).

32 - Os conservadores usaram e abusaram das teses de perversidade, da futilidade e da **ameaça**. (14 palavras – *Folha de S. Paulo*, 23 de setembro de 1992).

33 - Elas mostraram sinais de rotas das caravanas de mercadores, que levaram os pesquisadores à **cidade**. (17 palavras – *Superinteressante*, junho de 1992, p.10).

34 - Cartão-postal sob suspeita: radiação eletromagnética das antenas na Avenida Paulista pode afetar a saúde **humana.** (16 palavras – *Superinteressante*, junho de 1992).

35 - O investidor pode estar procurando a segurança do ouro, um investimento tradicional, neste momento de crise **política**. (17 palavras – *Folha de S. Paulo,* 23 de setembro de 1992).

36 - As fêmeas dos escorpiões só deixavam os abrigos dez vezes por ano, no **máximo.** (14 palavras – *Superinteressante,* agosto de 1992, p.8).

37 - Não se vê um único exemplar das cem carpas japonesas que vivem no lago **artificial**. (15 palavras – *Veja*, 23 de setembro de 1992, p.35).

38 - Os satélites ajudam os oceanógrafos a descobrir a temperatura da água em diversos locais do **planeta.** (16 palavras – *Superinteressante*, agosto de 1992, p.5).

39 - Nos casos de históricos de vida sedentária, evitar esportes anaeróbicos que exigem melhor condicionamento **físico.** (16 palavras – *VIP EXAME*, junho de 1992, p.19).

40 - Catástrofes à parte, a maior atração da viagem são a própria Galáxia e seus incríveis **habitantes.** (16 palavras – ***Superinteressante***, agosto de 1992, p.24).

41 - O computador mostrou que, mesmo sem se quebrarem, alguns capacetes transmitem muita energia mecânica para a **cabeça.** (17 palavras – *Superinteressante,* agosto de 1992, p.30).

42 - A saúde instável de Miterrand serviu como outro elemento psicológico do ataque de nervos do **mercado**. (16 palavras – *Veja*, 23 de setembro de 1992).

43 - É a primeira vez que o Brasil vende tênis em quantidades expressivas no **exterior.** (14 palavras – *Veja*, 23 de setembro de 1992, p.84).

44 - O resto é luz do céu, claridade que desce da lua prateando a superfície **gelada**. (15 palavras – *VIP EXAME*, junho de 1992, p.44).

45 - O IBGE lançou um Atlas que mostra trezentas e três espécies animais ameaçadas de **extinção.** (15 palavras – *Folha de S. Paulo*, 23 de setembro de 1992).

46 - O equipamento tem memória que permite dar ao usuário detalhes sobre eventuais defeitos em processos **industriais**. (16 palavras – *Folha de S. Paulo*, 23 de setembro de 1992).

47 - Os bosques de mangues, regados pelas marés, garantem comida farta para a fauna dos **oceanos.** (15 palavras – *Superinteressante*, maio de 1992, p.25).

48 - Hoje, quando o planeta é visto de cima pelos satélites, seus contornos não têm mais **segredo.** (16 palavras – *Superinteressante*, maio de 1992, p.34).

49 - Mesmo sem saber o índice de queda nas vendas, desvalorizou as ações da **empresa.** (14 palavras – *Veja*, 23 de setembro de 1992, p.86).

50 - Para os oitenta milhões de telespectadores brasileiros, a televisão significa lazer acessível e **barato.** (14 palavras – *Veja*, 23 de setembro de 1992, p.92).

51 - É preciso desmontar os motores em terra para prever as falhas, trabalho que consome tempo e **dinheiro.** (17 palavras – *Superinteressante*, julho de 1992, p.10).

52 - O paciente precisa de ressuscitação cardiorrespiratória o mais rápido possível, feita por pessoas **treinadas.** (14 palavras – *Folha de S. Paulo*, 28 de setembro de 1992).

53 - Segundo Senna, a chuva fez com que o desgaste dos pneus fosse excessivo na **corrida.** (15 palavras – *Folha de S. Paulo*, 28 de setembro de 1992).

54 - O povo com certeza irá ocupar as ruas para mostrar aos deputados o que querem seus **eleitores**. (17 palavras – *Folha de S. Paulo*, 28 de setembro de 1992).

55 - O telefone celular pode ser usado em qualquer ponto da cidade coberto por uma **célula.** (15 palavras – *Folha de S. Paulo*, 28 de setembro de 1992).

56 - Grandes quantidades de sal tornam a água mais pesada ou densa, diminuindo, em conseqüência, seu **volume.** (16 palavras – *Superinteressante,* julho de 1992, p.17).

57 - Como seres civilizados, deixamos as cavernas nas últimas glaciações, no início da Idade da Pedra **Polida.** (16 palavras – *Superinteressante*, agosto de 1992, p.73).

58 - A desvalorização é o que mais dói no orgulho nacional e no bolso de suas **vítimas.** (16 palavras – *Veja*, 23 de setembro de 1992, p.78).

59 - É quase impossível ter um critério justo, e a decisão acaba ficando nas mãos da **burocracia**. (16 palavras – *Veja*, 23 de setembro de 1992, p.81).

60 - Os efeitos do sal na pressão das artérias depende de outros minerais no **organismo**. (14 palavras – *Superinteressante,* fevereiro de 1992, p.15).

Words to be retained

1-errada
2- saudável

3- cultos
4- futuristas

5- vegetal
6- economia

7- glicose
8- empresários
9- depressão

10- medicamentos
11- militar
12- dedicação

13- natureza
14- laboratório
15- demissões

16- foguetes
17- paciente
18- delicado
19- perfeita

20- polêmico
21- animais
22- atraentes
23- terrestres

24- pesados
25- Européia
26- favores
27- qualidade

28- editais
29- sentidos
30- opacas
31- comerciais
32- ameaça

33- cidade
34- humana
35- política
36- máximo
37- artificial

38- planeta
39- físico
40- habitantes
41- cabeça
42- mercado

43- exterior
44- gelada
45- extinção
46- industriais
47- oceanos
48- segredo

49- empresa
50- barato
51- dinheiro
52- treinadas
53- corrida
54- eleitores

55- célula
56- volume
57- Polida
58- vítimas
59- burocracia
60-organismo

APPENDIX C

Reading ability test

O delicioso paradoxo francês

Pesquisa redime iguarias gordurosas

Notícia boa: o foie gras da França, o fenomenal e caríssimo fígado de ganso engordado artificialmente, faz bem à saúde. Imaginava-se que sua elevada taxa de gordura provocasse problemas cardiovasculares. Essa tese pode vir abaixo com um estudo do respeitado Instituto Nacional de Saúde e Pesquisa médica da França. Um grupo de médicos de Lyon divulgou recentemente um estudo de dez anos sobre os hábitos alimentares e a taxa de mortalidade na Região Sudoeste da França, especialmente na Gascogne, área responsável pela produção de 80% de todo o fígado de ganso consumido no planeta. Esses franceses ingerem gordura como poucos – e fazem dela a base de sua alimentação. No entanto, os dados colhidos pela Organização Mundial da Saúde, utilizados pelo instituto de pesquisa francês, revelam que a cidade de Toulouse, por exemplo, possui uma das taxas mais baixas de mortalidade por problemas de coração em toda a Europa. A cada ano, em um grupo de 100.000 pessoas entre 35 e 44 anos, há ali apenas 33 mortes por ataque cardíaco. Nos Estados Unidos esse patamar é de 96. "Percebemos que a composição química da gordura do foie gras é muito mais próxima do óleo de oliva do que da manteiga. Ela contém uma grande proporção do chamado colesterol bom, inofensivo ao organismo", diz o médico Serge Renaud, um dos responsáveis pelo estudo.

Os especialistas chamam de "paradoxo francês" o baixo índice de mortalidade por problemas cardíacos em um país que se come à vontade e a gordura é a rainha da mesa. Os americanos, fanáticos pelo controle do colesterol, ficaram loucos com o resultado da

pesquisa gaulesa. Agora, patrocinam estudos complementares para verificar se é mesmo o foie gras ou a boa vida do sudoeste francês que explica o paradoxo.

*Veja***,** 29 de janeiro, 1992.

Nome:.....
Data:____/____/____

I- Responda às seguintes questões, de acordo com o texto que você acabou de ler:

1- Qual foi a grande descoberta com relação ao fígado de ganso? O que se acreditava anteriormente?

2- Qual foi o objetivo do estudo realizado na região sudoeste da França? Que variáveis foram relacionadas?

3- Por quê foi escolhida essa região?

4- Quais foram os resultados encontrados?

5- Como esses resultados foram explicados no texto?

6- Qual é a dúvida levantada pelos americanos, com relação a esses resultados?

APPENDIX D

Scores on the reading ability measures

SUBJECTS	RECALL	QUESTIONS	AVERAGE
1	31.75	68.75	50.25
2	35.13	87.50	61.31
3	38.51	87.50	63.00
4	37.16	100.00	68.58
5	58.78	81.25	70.01
6	32.43	75.00	53.71
AVERAGE	**38.96**	**83.33**	**61.14**

TABLE D.1 –Better Readers' Scores on the Reading Ability Tests (%)

SUBJECTS	RECALL	QUESTIONS	AVERAGE
7	20.94	50.00	35.47
8	29.05	43.75	36.40
9	20.94	50.00	35.47
10	11.48	12.50	11.99
11	19.59	31.25	25.42
12	20.27	37.50	28.88
AVERAGE	**20.37**	**37.50**	**28.93**

TABLE D.2 – Weaker Readers' Scores on the Reading Ability Tests (%)

APPENDIX E

Texts used in experiment 2

I – Problem/Solution (complete text)

Mal pelo ar

Ar condicionado central, sala acarpetada, portas e janelas fechadas, o ambiente ideal para os computadores. Mas, os alérgicos já sabem: o território é dos fungos e bactérias, microorganismos que encontram o habitat ideal para a sua proliferação na câmara úmida dos grandes sistemas de ar condicionado.

A contaminação do ar tem relação direta com a ocorrência de doenças. A manifestação mais comum é a alergia. As pesquisas mostram que os funcionários que trabalham em edifícios fechados, sob ar condicionado central, queixam-se de doenças numa proporção até duas vezes maior do que a dos indivíduos que trabalham em ambientes abertos. O stress, que caracteriza o trabalho sedentário dos escritórios, ajuda a diminuir a resistência do sistema imunológico e abre as portas do organismo para a entrada dos micróbios.

Como os computadores têm de funcionar em ambientes refrigerados, os fabricantes americanos de computadores recomendam a instalação de filtros nos grandes sistemas de ar condicionado para evitar a multiplicação dos micróbios. No Brasil esta preocupação ainda é nova. A importadora Uniqemi acaba de lançar no país um filtro desse tipo, chamado Panguard – uma tira de plástico saturada de agentes químicos que se diz capaz de atenuar a reprodução dos germes dentro dos tubos do ar - condicionado central.

*Veja***,** 11 de março, 1992.

II - Problem/solution (no solution text)

* All the words and sentences in brackets are part of the original text and signal the 'SOLUTION', and were thus omitted or replaced in the distorted version (underlining indicates words which were replaced).

Reciclagem

A produção de bens industrializados nos custa muito mais caro do que poderia parecer à primeira vista. Tem ficado cada vez mais evidente que as fontes naturais de energia, como o petróleo, o gás natural e o carvão estão se esgotando; que a destruição das florestas tropicais e subtropicais contribui para o aumento do "efeito estufa", além de causar a extinção de numerosas espécies animais e vegetais; e o meio ambiente vem sendo perigosa e irreversivelmente poluído pelos detritos industriais.

Todos os anos fabricam-se cerca de 30 milhões de automóveis no mundo inteiro. No mesmo período, vários milhões de modelos antigos acabam nos depósitos de sucata. [Imensas quantidades de metais úteis podem ser retiradas desses carros, e muitas de suas peças reaproveitadas, com e até sem recondicionamento. Depois de extraídas as partes aproveitáveis, as carcaças são fundidas e vendidas como matéria prima.]

A prata, na forma de sais de cloro e bromo, entra na constituição de filmes e papéis fotográficos e de chapas de radiografia. Durante a fabricação desses produtos, parte dos sais evapora e se desperdiça [é recapturada, voltando à linha de produção. Os banhos empregados na revelação de filmes e papéis fotográficos também contêm sais de prata em solução. Por isso, todo laboratório fotográfico revende seus banhos usados a empresas que os processam para retirar a prata].

Uma substância de largo emprego industrial e muito desperdiçada (corresponde a cerca de 10 por cento do lixo doméstico nas cidades) é o vidro. [Os recipientes que acondicionam

produtos de consumo doméstico podem, em sua maior parte, ser reaproveitados diretamente, quando voltam intactos às fábricas de origem – como no caso dos refrigerantes; ou podem ser partidos e os cacos misturados com vidro novo, derretido, num forno].

*Revista Literária Globo***,** outubro de 1992

III – Problem/solution (no problem text)

* All the words and sentences in brackets signal the 'PROBLEM' and were thus either omitted or made vague in the distorted version (underlining indicates substitution of the original word or expression which appears in brackets).

[Ar irrespirável]

[Poluição] Recorde pára a Cidade do México

Os 20 milhões de moradores da Cidade do México, que formam o mais formidável formigueiro humano da América Latina, viveram um drama na terça-feira da semana passada. [A poluição atmosférica atingiu a taxa de 800 micogramas de ozônio por métrico cúbico de ar – um índice quatro vezes maior que o considerado aceitável pela Organização Mundial da Saúde. A cidade de São Paulo, na pior crise que já viveu, no final dos anos 70, amargou apenas 500 micogramas de ozônio]. As autoridades da capital mexicana foram obrigadas a tomar medidas inéditas para acabar com o sufoco. As escolas foram fechadas e milhões de estudantes tiveram que ficar em casa. As mais de 200 indústrias instaladas nas redondezas da capital mexicana foram obrigadas a reduzir em 75% a sua produção. Os automóveis [responsáveis pela liberação de 80% dos gases tóxicos em suspensão no ar] também foram proibidos de circular. Pelo menos 1.2 milhão de veículos ficou na garagem. A operação deu certo. Na quarta-feira, [parte dos gases tóxicos se

dispersou e] a emergência foi levantada. "As medidas eram necessárias, mas apenas aliviaram os sintomas da questão [poluição]", diz o especialista [ecologista] mexicano Homero Aridjis. "O que nós precisamos é de propostas [soluções] a longo prazo".

Para resolver o drama [problema] mexicano, houve quem apresentasse [propusesse] na semana passada propostas [soluções] mirabolantes, como a instalação de indicadores eletrônicos [100 ventiladores gigantes, capazes de forçar a circulação do ar e a dispersão dos gases tóxicos,] em todas as residências e escolas.

O drama da Cidade do México é resultado de um desmazelo que atormenta boa parte das metrópoles do planeta, sobretudo as de terceiro mundo: o crescimento urbano desordenado. [As cidades se enchem de automóveis e de indústrias poluentes sem que ninguém avalie previamente o impacto.] A questão [O problema] da Cidade do México é mais grave ainda porque há também uma dificuldade de ordem geográfica. [Ela se situa num planalto cercado de montanhas que impedem a dispersão dos poluentes].

Veja, 25 de março, 1992

IV – Prediction (complete text)

Sopro de beleza

Aparentemente uma intervenção cosmética, a lipoaspiração, a operação que suga mecanicamente gorduras localizadas, é uma cirurgia séria. Chega-se a perder mais de meio litro de sangue durante a sucção da gordura. Um novo tipo de cirurgia plástica acaba de desembarcar no Brasil para concorrer com a lipoaspiração e leva a vantagem de provocar uma perda mínima de sangue. É a lipoaspiração com ultra-som.

A cirurgia é feita com o auxílio de um equipamento, introduzido através de uma incisão na região onde há excesso de gordura, que emite ondas de ultra-som. As ondas bombardeiam apenas as células

gordurosas, que se rompem. Em estado líquido, a gordura é expulsa para fora do corpo através da incisão.

A nova cirurgia é desenvolvida em três etapas. Primeiro o cirurgião aplica uma injeção de água destilada, bicarbonato de sódio e anestésicos na região do corpo onde há excesso de gordura. O objetivo é inchar o tecido adiposo para facilitar a operação. Em seguida uma cânula de ultra-som é introduzida. A cânula emite ondas numa freqüência que provocam o rompimento apenas das células gordurosas. Por último, a região onde o ultra-som foi aplicado é pressionada por um rolo. A gordura, em estado líquido após o rompimento das células, verte para a incisão. A perda de sangue é seis vezes menor do que numa lipoaspiração comum.

Veja, 26 de agosto, 1992

V – Prediction (distorted text)

* The sentence in brackets in the last paragraph is part of the original text and is the third element of the predicted member of the prediction pair and hence was omitted in the distorted version.

O cerco a Michelangelo

Um vírus enlouqueceu milhões de usuários de computadores na sexta-feira passada. Não era uma doença de verdade, mas um vírus de computador. Seu nome, Michelangelo, uma homenagem ao artista renascentista italiano. Ele invadira a memória de milhões de computadores pessoais do tipo PC (o mais popular do planeta) e prometia destruir todos os seus arquivos no dia 6 de março.

Os vírus são simplesmente instruções clandestinamente colocadas nos programas e que fazem os computadores executar funções malucas – como apagar informações valiosas gravadas em sua memória. Eles só apresentam seus sintomas em situações específicas. No caso de Michelangelo, a situação especial era uma efeméride – dia 6 de março, 517° aniversário do mestre italiano. A paranóia entre os usuários foi maior que os danos previstos e acabou

dando bons resultados para os vendedores de equipamentos de segurança contra vírus. A maioria das pessoas se preveniu e o vírus não teve força para instituir o caos eletrônico nos terminais.

Alguns usuários recorreram às vacinas antivírus. Existem pelo menos três tipos de programa de vacinas contra o vírus de computador – todas elas vendidas na forma de disquetes magnéticos para computador. Uma delas procura o vírus rastreando cada um dos programas arquivados. O invasor é encontrado e anulado. Uma outra apenas localiza a presença do clandestino. O usuário tem que recorrer a um outro programa específico para dar cabo do microinvasor. [Uma terceira variante impede a invasão do vírus barrando sua entrada na máquina.] O problema de todas as vacinas é o seu preço elevado. A vacina Norton, contra 700 vírus, custa o equivalente a 200 dólares no Brasil.

*Veja***,** 11 de março, 1992

APPENDIX F

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 so, 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 ( )

APPENDIX G

An example of the recall protocols produced by one subject and their respective scoring in terms of propositions recalled

I – Text used in the reading ability test: "O delicioso paradoxo francês"

O delicioso paradoxo francês

Através de pesquisas feitas sobre os hábitos alimentares dos franceses, nos últimos dez anos, mostram que a iguaria fígado de ganso (engordado artificialmente) não traz problemas cardiovasculares, como era de se esperar, pela alta taxa de gordura que possui, isto porque, ficou comprovado que sua gordura está mais próxima do azeite de oliva que da manteiga.

Através de levantamentos feitos na cidade que produz a iguaria, constatou-se que de cada 100.000 pessoas com idade entre 33 e 44, apenas 36 morreram de problemas do coração, enquanto nos Estados Unidos a taxa é de 96 pessoas.

Os americanos, tão preocupados com a taxa de colesterol, não se conformam e estão fazendo pesquisas complementares para saber se é a gordura do fígado de ganso que não faz mal ou é a boa vida que os franceses do sudoeste da França têm que explica o paradoxo.

Propositional scoring:

(X) O delicioso (X) paradoxo (X) francês

( ) Pesquisa ( ) redime (X) iguarias ( ) gordurosas

( ) Notícia ( ) boa: ( ) o foie gras ( ) da França, ( ) o fenomenal e ( ) caríssimo (X) fígado de ganso (X) engordado (X) artificialmente, (X) faz (X) bem (X) à saúde. (X) Imaginava-se que (X) sua (X) elevada (X) taxa (X) de gordura (X) provocasse (X) problemas cardiovasculares. ( ) Essa tese ( ) pode vir abaixo ( ) com um estudo ( ) do respeitado ( ) Instituto ( ) Nacional ( ) de Saúde ( ) e Pesquisa ( ) médica ( ) da França. ( ) Um grupo ( ) de médicos ( ) de Lyon ( ) divulgou ( ) recentemente (X) um estudo (X) de dez anos (X) sobre os hábitos alimentares ( ) e a taxa ( ) de mortalidade ( ) na Região ( ) Sudoeste (X) da França, ( ) especialmente ( ) na Gascogne, (X) área (X) responsável (X) pela produção ( ) de 80% ( ) de todo (X) o fígado de ganso ( ) consumido ( ) no planeta. ( ) Esses franceses ( ) ingerem ( ) gordura ( ) como poucos - ( ) e fazem ( ) dela ( ) a base ( ) de sua alimentação. ( ) No entanto, ( ) os dados ( ) colhidos pela ( ) Organização Mundial da Saúde, ( ) utilizados ( ) pelo instituto de ( ) pesquisa ( ) francês, ( ) revelaram que ( ) a cidade de Toulouse, ( ) por exemplo, ( ) possui ( ) uma das taxas ( ) mais ( ) baixas ( ) de mortalidade ( ) por problemas de coração ( ) em toda a Europa. ( ) A cada ano, (X) em um grupo (X) de 1000.000 pessoas ( ) entre 35 e (X) 44 anos, ( ) há ali (X) apenas (X) 33 mortes (X) por ataque (X) cardíaco. (X) Nos Estados Unidos (X) esse patamar (X) é de 96. ( ) "Percebemos que ( ) a composição ( ) química (X) da gordura (X) do foie gras (X) é muito mais próxima (X) do óleo de oliva (X) do que da manteiga. ( ) Ela contém ( ) uma grande ( ) proporção ( ) do chamado colesterol bom, ( ) inofensivo ( ) ao organismo", ( ) diz o médico ( ) Serge Renaud, ( ) um dos responsáveis ( ) pelo estudo.

( ) Os especialistas ( ) chamam ( ) de "paradoxo francês" ( ) o baixo ( ) índice ( ) de mortalidade ( ) por problemas cardíacos ( ) em um país ( ) que se come ( ) à vontade ( )

e a gordura ( ) é a rainha da mesa. (X) Os americanos, (X) fanáticos (X) pelo controle (X) do colesterol, (X) ficaram loucos ( ) com o resultado ( ) da pesquisa ( ) gaulesa. (X) Agora, (X) patrocinam (X) estudos (X) complementares (X) para verificar (X) se é mesmo (X) o foie gras (X) ou a boa vida (X) do sudoeste (X) francês (X) que explica (X) o paradoxo.

II – Texts used in the mais experiment

Text 1: "Mal pelo ar"

Paragraph 1 recall

S: Aqui fala sobre ar condicionado... e o local ideal para se ter computadores, que seriam salas fechadas né... sem ar nenhum, sem ventilação... sem muita incidência de sol, mas que... as pessoas que entendem um pouquinho já saberiam que essas salas são perfeitas pra fungos e bactérias.

Propositional scoring:

(X) Ar condicionado ( ) central, (X) sala ( ) acarpetada, ( ) portas ( ) e janelas (X) fechadas, (X) o ambiente (X) ideal (X) para os computadores. (X) Mas, (X) os alérgicos (X) já sabem: (X) o território (X) é dos fungos (X) e bactérias, ( ) microorganismos ( ) que encontram ( ) o habitat ( ) ideal ( ) para a sua proliferação ( ) na câmara ( ) úmida ( ) dos grandes ( ) sistemas ( ) de ar condicionado.

Paragraph 2 recall

S: Aqui fala sobre a contaminação do ar... que pessoas que trabalham em prédios fechados, com ar condicionado central, os médicos dizem que eles se queixam duas vezes mais de incidências né... de

doenças... principalmente de alergia, do que as pessoas que trabalham num ambiente aberto.

Propositional scoring:

(X) A contaminação (X) do ar ( ) tem relação ( ) direta ( ) com a ocorrência ( ) de doenças. (X) A manifestação (X) mais comum (X) é a alergia. ( ) As pesquisas ( ) mostram (X) que os funcionários (X) que trabalham (X) em edifícios (X) fechados, (X) sob ar condicionado (X) central, (X) queixam-se (X) de doenças (X) numa proporção (X) até duas vezes maior (X) do que a dos indivíduos (X) que trabalham (X) em ambientes (X) abertos. ( ) O stress, ( ) que caracteriza ( ) o trabalho ( ) sedentário ( ) dos escritórios, ( ) ajuda ( ) a diminuir ( ) a resistência ( ) do sistema imunológico ( ) e abre ( ) as portas ( ) do organismo ( ) para a entrada ( ) dos micróbios.

Paragraph 3 recall

S: Aqui fala que os computadores têm que se ser instalados né... o local de trabalho seria com... ar condicionado central, e que os americanos adotam um filtro... pra não ter tanta incidência de micróbios né... Mas que aqui no Brasil essa preocupação ainda é muito pequena, mas já existe uma empresa que está trabalhando com esse... já está importando... esse filtro.

Propositional scoring:

(X) Como os computadores (X) têm de funcionar (X) em ambientes (X) refrigerados, ( ) os fabricantes (X) americanos ( ) de computadores ( ) recomendam (X) a instalação (X) de filtros ( ) nos grandes ( ) sistemas ( ) de ar condicionado (X) para evitar (X) a multiplicação (X) dos micróbios. (X) No Brasil (X) esta preocupação (X) ainda é nova. (X) A importadora ( ) Uniqemi (X) acaba de lançar ( ) no país (X) um filtro

(X) desse tipo, ( ) chamado Panguard - ( ) uma tira de ( ) plástico ( ) saturada ( ) de agentes ( ) químicos ( ) que se diz ( ) capaz ( ) de atenuar ( ) a reprodução ( ) dos germes ( ) dentro ( ) dos tubos ( ) do ar condicionado ( ) central.

Whole text recall

S: Fala sobre o ar refrigerado né... que as empresas que trabalham com computadores, geralmente as salas são muito fechadas e com ar refrigerado central né... ambiente próprio para a proliferação de bactérias... E os médicos dizem que as pessoas que trabalham com janelas fechadas assim... com ar refrigerado central... esse tipo de coisa... têm muito mais incidências a doenças como a alergia, do que as pessoas que trabalham em ambientes abertos ... Aqui no Brasil, não existe a preocupação ainda de se colocar filtro no ar condicionado central, como existe nos Estados Unidos. Esse filtro diminui a produção de bactérias... Mas já existe uma empresa que está lançando no mercado esse filtro.

Propositional scoring:

(X) Ar condicionado (X) central, (X) sala ( ) acarpetada, ( ) portas ( ) e janelas (X) fechadas, (X) o ambiente (X) ideal (X) para os computadores. ( ) Mas, ( ) os alérgicos ( ) já sabem: ( ) o território ( ) é dos fungos (X) e bactérias, ( ) microorganismos ( ) que encontram (X) o habitat (X) ideal (X) para a sua proliferação ( ) na câmara ( ) úmida ( ) dos grandes ( ) sistemas ( ) de ar condicionado.
( ) A contaminação ( ) do ar ( ) tem relação ( ) direta ( ) com a ocorrência ( ) de doenças. ( ) A manifestação ( ) mais comum (X) é a alergia. ( ) As pesquisas ( ) mostram (X) que os funcionários (X) que trabalham (X) em edifícios (X) fechados, (X) sob ar condicionado (X) central, (X) queixam-se (X) de doenças (X) numa proporção (X) até duas vezes maior (X) do que a dos indivíduos (X) que trabalham (X) em ambientes

(X) abertos. ( ) O stress, ( ) que caracteriza ( ) o trabalho ( ) sedentário ( ) dos escritórios, ( ) ajuda ( ) a diminuir ( )a resistência ( ) do sistema imunológico ( ) e abre ( ) as portas ( ) do organismo ( ) para a entrada ( ) dos micróbios.
( ) Como os computadores ( ) têm de funcionar ( ) em ambientes ( ) refrigerados, ( ) os fabricantes (X) americanos ( ) de computadores (X) recomendam (X) a instalação (X) de filtros ( ) nos grandes (X) sistemas (X) de ar condicionado (X) para evitar (X) a multiplicação (X) dos micróbios. (X) No Brasil (X) esta preocupação (X) ainda é nova. (X) A importadora ( ) Uniqemi (X) acaba de lançar ( ) no país (X) um filtro (X) desse tipo, ( ) chamado Panguard - ( ) uma tira de ( ) plástico ( ) saturada ( ) de agentes ( ) químicos ( ) que se diz ( ) capaz ( ) de atenuar ( ) a reprodução ( ) dos germes ( ) dentro ( ) dos tubos ( ) do ar condicionado ( ) central.

Text 2: " Reciclagem"

Paragraph 1 recall

S: Aqui fala a respeito dos bens industrializados... que a sua fabricação é muito mais cara do que as pessoas imaginam... e que as reservas naturais como o petróleo, o gás natural e coisas assim... estão se esgotando... E a destruição das florestas tropicais e sub-tropicais está causando a extinção de várias espécies animais e vegetais.

Propositional scoring:

(X) A produção (X) de bens (X) industrializados (X) nos custa (X) muito (X) mais (X) caro (X) do que poderia parecer (X) à primeira vista. ( ) Tem ficado ( ) cada vez ( ) mais ( ) evidente (X) que as fontes (X) naturais ( ) de energia, (X) como o petróleo, (X) o gás natural ( ) e o carvão (X) estão se

esgotando; (X) que a destruição (X) das florestas (X) tropicais (X) e subtropicais ( ) contribui ( ) para o aumento ( ) do "efeito estufa", ( ) além de (X) causar (X) a extinção (X) de numerosas (X) espécies (X) animais (X) e vegetais; ( ) e o meio ambiente ( ) vem sendo ( ) perigosa ( ) e irreversivelmente ( ) poluído ( ) pelos detritos ( ) industriais.

Paragraph 2 recall

S: Aqui fala que durante um ano são construídos mais de 30 milhões de carros em todo o mundo... e que muitos carros... modelos mais antigos... vão pra sucata... pro lixo.

Propositional scoring:

(X) Todos os anos (X) fabricam-se (X) cerca de 30 milhões (X) de automóveis (X) no mundo (X) inteiro. (X) No mesmo período, (X) vários (X) milhões (X) de modelos (X) antigos (X) acabam (X) nos depósitos (X) de sucata.

Paragraph 3 recall

S: Aqui fala que a prata e o vidro estão sendo utilizados em processo de ... (silêncio)... esqueci... em papéis de fotografia... raio x ... durante o processo de elaboração ... parte evapora... uma coisa assim.

Propositional scoring:

(X) A prata, ( ) na forma ( ) de sais ( ) de cloro ( ) e bromo, (X) entra (X) na constituição ( ) de filmes (X) e papéis fotográficos ( ) e de chapas de (X) radiografia. (X) Durante a fabricação (X) desses produtos, (X) parte ( ) dos sais (X) evapora ( ) e se desperdiça.

Paragraph 4 recall

S: Aqui fala que uma substância muito utilizada e... está sendo desperdiçada né... que é mais ou menos 10% de todo o lixo... seria o vidro.

Propositional scoring:

(X) Uma substância (X) de largo (X) emprego ( ) industrial (X) e muito (X) desperdiçada (X) (corresponde (X) a cerca (X) de 10 por cento (X) do lixo ( ) doméstico ( ) nas cidades) (X) é o vidro.

Whole text recall

S: Primeiro fala da reciclagem... fala que a indústria gasta muito mais dinheiro pra produzir esses produtos industrializados do que a gente imagina... E que as reservas naturais estão se esgotando... e que a destruição das florestas tropicais e sub-tropicais ... estão... se extinguindo com a destruição... está se extinguindo grande parte dos animais e vegetais e produzindo o efeito estufa... Aí tem um que fala do carro velho... que durante um ano são produzidos 30 milhões de carros e que nesse período milhões de automóveis viram sucata... Outro fala da prata que ta sendo utilizada na radiografia, na foto... e que na hora da elaboração, os sais se evaporam... Acho que é isso.

Propositional scoring:

(X) A produção (X) de bens (X) industrializados (X) nos custa (X) muito (X) mais (X) caro (X) do que poderia parecer (X) à primeira vista. ( ) Tem ficado ( ) cada vez ( ) mais ( ) evidente (X) que as fontes (X) naturais ( ) de energia, ( ) como o petróleo, ( ) o gás ( ) natural ( ) e o carvão (X) estão se esgotando; (X) que a destruição (X) das florestas (X)

tropicais (X) e subtropicais (X) contribui ( ) para o aumento (X) do "efeito estufa", ( ) além de (X) causar (X) a extinção (X) de numerosas (X) espécies (X) animais (X) e vegetais; ( ) e o meio ambiente ( ) vem sendo ( ) perigosa ( ) e irreversivelmente ( ) poluído ( ) pelos detritos ( ) industriais. (X) Todos os anos (X) fabricam-se (X) cerca de 30 milhões (X) de automóveis ( ) no mundo ( ) inteiro. (X) No mesmo período, ( ) vários (X) milhões (X) de modelos ( ) antigos (X) acabam ( ) nos depósitos (X) de sucata.
(X) A prata, ( ) na forma ( ) de sais ( ) de cloro ( ) e bromo, (X) entra (X) na constituição ( ) de filmes ( ) e papéis fotográficos ( ) e de chapas (X) de radiografia. (X) Durante a fabricação (X) desses produtos, ( ) parte (X) dos sais (X) evapora ( ) e se desperdiça.
( ) Uma substância ( ) de largo ( ) emprego ( ) industrial ( ) e muito ( ) desperdiçada ( ) (corresponde ( ) a cerca ( ) de 10 por cento ( ) do lixo ( ) doméstico ( ) nas cidades) ( ) é o vidro.

Text 3: "Recorde pára a Cidade do México"

Paragraph 1 recall

S: Aqui fala sobre a cidade mexicana... com 200 milhões de habitantes... que é a mais... o formigueiro da América Latina... e as autoridades tiveram que tomar algumas medidas... acho que pelo fato da poluição ... então as escolas foram fechadas... os alunos ficaram em casa... os carros forma proibidos de circular... mais de 1 milhão e 200 mil carros ficaram sem circular... e as indústrias também... pararam... Mas que isso está longe de resolver o problema, foi apenas uma aliviada.

Propositional scoring:

( ) Os 20 milhões ( ) de moradores (X) da Cidade do México, (X) que formam (X) o mais formidável (X) formigueiro ( ) humano (X) da América Latina, ( ) viveram ( ) um drama ( ) na terça-feira ( ) da semana passada. (X) As autoridades ( ) da capital ( ) mexicana (X) foram obrigadas (X) a tomar (X) medidas ( ) inéditas (X) para acabar (X) com o sufoco. (X) As escolas (X) foram fechadas e ( ) milhões (X) de estudantes ( ) tiveram (X) que ficar (X) em casa. ( ) As mais ( ) de 200 ( ) indústrias ( ) instaladas ( ) nas redondezas ( ) da capital mexicana ( ) foram obrigadas ( ) a reduzir ( ) em 75% ( ) a sua produção. (X) Os automóveis (X) também foram (X) proibidos de circular. ( ) Pelo menos 1.2 milhão de veículos ficou na garagem. ( ) A operação ( ) deu certo. ( ) Na quarta-feira, ( ) a emergência ( ) foi levantada. "As medidas ( ) eram necessárias, mas apenas aliviaram ( ) os sintomas da questão", ( ) diz ( ) o especialista ( ) mexicano ( ) Homero Aridjis. ( ) "O que nós precisamos ( ) é de propostas ( ) a longo prazo".

Paragraph 2 recall

S: Pra resolver o problema mexicano as pessoas propuseram colocar... é... instalar... indicadores eletrônicos nas casas e escolas...

Propositional scoring:

(X) Para resolver (X) o drama (X) mexicano, (X) houve (X) quem apresentasse ( ) na semana passada ( ) propostas ( ) mirabolantes, (X) como a instalação (X) de indicadores (X) eletrônicos ( ) em todas (X) as residências (X) e escolas.

Paragraph 3 recall

S: Aqui fala a respeito da Cidade do México... diz que o que ta ocorrendo hoje é um desmazelo que acontece em quase todas as

cidades... as grandes metrópoles do terceiro mundo... que é a ... (silêncio)... que é a desorganização... o crescimento desorganizado... acho que é mais ou menos isso...

Propositional scoring:

( ) O drama (X) da Cidade do México ( ) é resultado ( ) de um desmazelo ( ) que atormenta ( ) boa parte (X) das metrópoles ( ) do planeta, ( ) sobretudo (X) as de terceiro mundo: (X) o crescimento ( ) urbano (X) desordenado. ( ) A questão ( ) da Cidade do México ( ) é mais grave ainda ( ) porque há também ( ) uma dificuldade ( ) de ordem geográfica.

Whole text recall

S: Aí fala sobre o problema da Cidade do México... que deve ser a poluição... e que eles tiveram que tomar uma atitude um pouco drástica ... fecharam as escolas... os estudantes ficaram em casa... os carros foram proibidos de circular... as indústrias também tiveram que parar um pouquinho de jogar a fumacinha delas no ar né... e que houveram bons resultados né... tanto que já tá tudo ok né... o pessoal já tá circulando de novo né... Só que isso não resolveu o problema... só aliviou... e a Cidade do México hoje né... é como uma outra grande metrópole do terceiro mundo... que não há um crescimento organizado... e eles ainda têm um problema de localização geográfica.

Propositional scoring:

( ) Os 20 milhões ( ) de moradores (X) da Cidade do México, ( ) que formam ( ) o mais ( ) formidável ( ) formigueiro ( ) humano ( ) da América Latina, ( ) viveram ( ) um drama ( ) na terça-feira ( ) da semana passada. (X) As autoridades ( ) da capital ( ) mexicana (X) foram obrigadas (X) a tomar (X) medidas (X) inéditas ( ) para acabar ( ) com o sufoco. ( ) As

escolas ( ) foram fechadas ( ) e milhões (X) de estudantes (X) tiveram (X) que ficar (X) em casa. ( ) As mais ( ) de 200 (X) indústrias ( ) instaladas ( ) nas redondezas ( ) da capital mexicana (X) foram obrigadas (X) a reduzir ( ) em 75% (X) a sua produção. (X) Os automóveis (X) também foram (X) proibidos (X) de circular. ( ) Pelo menos ( ) 1.2 milhão ( ) de veículos ( ) ficou na garagem. (X) A operação (X) deu certo. ( ) Na quarta-feira, ( ) a emergência ( ) foi levantada. "As medidas ( ) eram necessárias, (X) mas apenas (X) aliviaram ( ) os sintomas (X) da questão ", ( ) diz ( ) o especialista ( ) mexicano ( ) Homero Aridjis. ( ) "O que nós precisamos ( ) é de propostas ( ) a longo prazo".
( ) Para resolver ( ) o drama ( ) mexicano, ( ) houve ( ) quem apresentasse ( ) na semana passada ( ) propostas ( ) mirabolantes, ( ) como a instalação ( ) de indicadores ( ) eletrônicos ( ) em todas ( ) as residências ( ) e escolas.
( ) O drama (X) da Cidade do México (X) é resultado ( ) de um desmazelo ( ) que atormenta ( ) boa parte (X) das metrópoles ( ) do planeta, ( ) sobretudo (X) as de terceiro mundo: (X) o crescimento ( ) urbano (X) desordenado. ( ) A questão (X) da Cidade do México ( ) é mais grave ainda (X) porque há também (X) uma dificuldade (X) de ordem geográfica.

Text 4: "Sopro de Beleza"

Paragraph 1 recall

S: Aqui fala sobre a lipoaspiração ... que é uma... tipo uma cirurgia né.. que a pessoa faz pra perder gordura né... Mas que você perde muito sangue durante a operação... e que agora tá desembarcando no Brasil um novo tipo de lipoaspiração que é a lipoaspiração com ultra-som... você já não perderia tanto sangue... leva essa vantagem.

Propositional scoring:

( ) Aparentemente ( ) uma intervenção ( ) cosmética, (X) a lipoaspiração, ( ) a operação (X) que suga ( ) mecanicamente (X) gorduras ( ) localizadas, (X) é uma cirurgia ( ) séria. (X) Chega-se (X) a perder (X) mais ( ) de meio litro (X) de sangue (X) durante a sucção (X) da gordura. (X) Um novo (X) tipo (X) de cirurgia ( ) plástica (X) acaba (X) de desembarcar (X) no Brasil ( ) para concorrer ( ) com a lipoaspiração (X) e leva (X) a vantagem (X) de provocar (X) uma perda (X) mínima (X) de sangue. (X) É a lipoaspiração (X) com ultra-som.

Paragraph 2 recall

S: A cirurgia é feita através de uma incisão ... no local onde tem as gorduras que você quer perder... e essas gorduras... elas saem em forma de líquido.

Propositional scoring:

(X) A cirurgia (X) é feita ( ) com ( ) o auxílio de ( ) um equipamento, ( ) introduzido (X) através (X) de uma incisão (X) na região (X) onde (X) há (X) excesso (X) de gordura, ( ) que emite ( ) ondas ( ) de ultra-som. ( ) As ondas ( ) bombardeiam ( ) apenas ( ) as células gordurosas, ( ) que se rompem. (X) Em estado líquido, (X) a gordura é expulsa ( ) para fora ( ) do corpo ( ) através da incisão.

Paragraph 3 recall

S: Aqui eles explicam como é feita a cirurgia. Primeiro eles aplicam água e mais um monte de coisas lá que eu não sei o nome.... quer dizer... até sei né... mas gravar assim é que é difícil.. Aí depois que... pra inchar a região né... quando as células gordurosas explodem ... sei lá... desmancham... eles passam tipo um rolo ali... que é pra gordura sair em forma de líquido.

Propositional scoring:

( ) A nova ( ) cirurgia ( ) é desenvolvida ( ) em três ( ) etapas. (X) Primeiro (X) o cirurgião (X) aplica ( ) uma injeção (X) de água destilada, ( ) bicarbonato ( ) de sódio ( ) e anestésicos ( ) na região ( ) do corpo ( ) onde há ( ) excesso de ( ) gordura. (X) O objetivo (X) é inchar (X) o tecido adiposo ( ) para facilitar ( ) a operação. ( ) Em seguida ( ) uma cânula ( ) de ultra-som ( ) é introduzida. ( ) A cânula ( ) emite ( ) ondas ( ) numa ( ) freqüência ( ) que provocam ( ) o rompimento ( ) apenas ( ) das células gordurosas. ( ) Por último, (X) a região ( ) onde o ultra-som ( ) foi aplicado (X) é pressionada (X) por um rolo. (X) A gordura, (X) em estado líquido (X) após (X) o rompimento ( ) das células, (X) verte ( ) para a incisão. ( ) A perda ( ) de sangue ( ) é seis vezes ( ) menor ( ) do que numa lipoaspiração ( ) comum.

Whole text recall

S: O texto fala da lipoaspiração, que é uma cirurgia pra gente perder gordura né... e fala que durante a lipoaspiração, o paciente perde muito sangue. Então pra concorrer com esse tipo de cirurgia, tá chegando no Brasil a lipoaspiração ultra-som... a vantagem é que você perde 6 vezes menos sangue do que na lipoaspiração comum. Aí fala a respeito da operação, que é feita uma incisão onde tem a parte de mais gordura... eles aplicam umas substâncias e as células gordurosas se rompem e se transformam em líquido... daí eles passam um rolo e tiram a gordura em forma de líquido.

Propositional scoring:

( ) Aparentemente ( ) uma intervenção ( ) cosmética, (X) a lipoaspiração, ( ) a operação (X) que suga ( ) mecanicamente (X) gorduras ( ) localizadas, (X) é uma cirurgia ( ) séria.

(X) Chega-se (X) a perder (X) mais ( ) de meio litro (X) de sangue (X) durante a sucção (X) da gordura. (X) Um novo (X) tipo (X) de cirurgia ( ) plástica (X) acaba (X) de desembarcar (X) no Brasil (X) para concorrer (X) com a lipoaspiração ( ) e leva ( ) a vantagem ( ) de provocar ( ) uma perda ( ) mínima ( ) de sangue. (X) É a lipoaspiração (X) com ultra-som.
(X) A cirurgia (X) é feita ( ) com ( ) o auxílio de ( ) um equipamento, ( ) introduzido (X) através (X) de uma incisão (X) na região (X) onde (X) há (X) excesso (X) de gordura, ( ) que emite ( ) ondas ( ) de ultra-som. ( ) As ondas ( ) bombardeiam ( ) apenas (X) as células gordurosas, (X) que se rompem. ( ) Em estado líquido, ( ) a gordura é expulsa ( ) para fora ( ) do corpo ( ) através da incisão.
( ) A nova ( ) cirurgia ( ) é desenvolvida ( ) em três ( ) etapas. (X) Primeiro (X) o cirurgião (X) aplica ( ) uma injeção ( ) de água destilada, ( ) bicarbonato ( ) de sódio ( ) e anestésicos ( ) na região ( ) do corpo ( ) onde há ( ) excesso de ( ) gordura. ( ) O objetivo ( ) é inchar ( ) o tecido adiposo ( ) para facilitar ( ) a operação. ( ) Em seguida ( ) uma cânula ( ) de ultra-som ( ) é introduzida. ( ) A cânula ( ) emite ( ) ondas ( ) numa ( ) freqüência ( ) que provocam ( ) o rompimento ( ) apenas ( ) das células gordurosas. (X) Por último, (X) a região ( ) onde o ultra-som ( ) foi aplicado (X) é pressionada (X) por um rolo. (X) A gordura, (X) em estado líquido (X) após (X) o rompimento ( ) das células, (X) verte (X) para a incisão. (X) A perda (X) de sangue (X) é seis vezes (X) menor (X) do que numa lipoaspiração (X) comum.

#Text 5: "O cerco a Michelangelo"

Paragraph 1 recall

S: Aqui fala a respeito de um vírus ... o Michelangelo né... deve ser

uma homenagem ao pintor italiano... e que invadiu as memórias dos computadores... e que provavelmente iria destruir todas as memórias no dia 6.

Propositional scoring:

(X) Um vírus ( ) enlouqueceu ( ) milhões ( ) de usuários ( ) de computadores ( ) na sexta-feira passada. ( ) Não era ( ) uma doença ( ) de verdade, ( ) mas ( ) um vírus ( ) de computador. (X) Seu nome, Michelangelo, (X) uma homenagem (X) ao artista ( ) renascentista (X) italiano. (X) Ele invadira (X) a memória ( ) de milhões (X) de computadores ( ) pessoais ( ) do tipo PC ( ) (o mais popular ( ) do planeta) (X) e prometia (X) destruir (X) todos (X) os seus arquivos (X) no dia 6 de março.

Paragraph 2 recall

S: Aqui diz que ... vírus são informações colocadas nos... disquetes, nos programas... informações clandestinas, então esse vírus manda, por exemplo, apagar informações que você colocou no computador, que são super valiosas pra você... superimportantes.. Esse vírus se chamava Michelangelo, porque... ele iria atacar no dia do aniversário do Michelangelo né... numa data específica... no dia 6. Mas as pessoas ficaram assustadas com o fato né... e quem acabou lucrando foi o ... as empresas que trabalham com programas antivírus... com programas de segurança... Então o vírus de Michelangelo não teve tanta incidência assim como...

Propositional scoring:

(X) Os vírus (X) são ( ) simplesmente (X) instruções (X) clandestinamente (X) colocadas (X) nos programas (X) e que fazem (X) os computadores (X) executar (X) funções ( ) malucas – (X) como apagar (X) informações (X) valiosas

(X) gravadas (X) em sua memória. ( ) Eles só ( ) apresentam ( ) seus sintomas ( ) em situações ( ) específicas. (X) No caso de Michelangelo, (X) a situação (X) especial (X) era ( ) uma efeméride – (X) dia 6 de março, ( ) 517° (X) aniversário (X) do mestre ( ) italiano. (X) A paranóia (X) entre (X) os usuários (X) foi (X) maior que (X) os danos (X) previstos (X) e acabou (X) dando (X) bons (X) resultados (X) para os vendedores (X) de equipamentos (X) de segurança (X) contra vírus. ( ) A maioria ( ) das pessoas ( ) se preveniu ( ) e o vírus ( ) não teve ( ) força ( ) para instituir ( ) o caos ( ) eletrônico ( ) nos terminais.

Paragraph 3 recall

S: No terceiro parágrafo fala que alguns usuários recorrem à vacina... de computador que são vendidas em forma de disquetes magnéticos. Existe um tipo de vacina né... que você coloca né... num disquete e ela já localiza o vírus e destrói... e a outra vacina você coloca e ela localiza o vírus, mas você teria que entrar com outro programa né... pra destruir aquele tipo de vírus. O único problema das vacinas é que são muito caras. Uma vacina que destrói, por exemplo, 700 vírus, vacina de Norton, custa mais ou menos 200 dólares aqui no Brasil.

Propositional scoring:

(X) Alguns (X) usuários (X) recorreram (X) às vacinas ( ) antivírus. ( ) Existem ( ) pelo menos ( ) três ( ) tipos ( ) de programa ( ) de vacinas ( ) contra ( ) o vírus (X) de computador – ( ) todas elas (X) vendidas (X) na forma (X) de disquetes (X) magnéticos ( ) para computador. (X) Uma delas (X) procura (X) o vírus ( ) rastreando ( ) cada um ( ) dos programas ( ) arquivados. ( ) O invasor ( ) é encontrado (X) e anulado. (X) Uma outra ( ) apenas (X) localiza ( ) a presença ( ) do clandestino. (X) O usuário (X) tem que (X) recorrer (X) a um (X) outro (X) programa (X)

específico (X) para dar cabo (X) do microinvasor. (X) O problema (X) de todas (X) as vacinas (X) é o (X) seu preço (X) elevado. (X) A vacina Norton, (X) contra (X) 700 vírus, (X) custa (X) o equivalente (X) a 200 dólares (X) no Brasil.

Whole text recall

S: O texto fala a respeito do vírus de computador... o Michelangelo... que iria atacar os computadores no dia 6... dia 6 porque era aniversário do Michelangelo... O vírus é... são informações clandestinas colocadas na memória do computador... que manda ele... dão ordens pros computadores apagarem os programas ... é... determinadas informações que você colocou e que são muito importantes né... Então as pessoas ficaram com um pouco de medo... de perderem os programas e... compraram uns outros programas contra... o vírus... Então não teve tanta incidência quanto as pessoas achavam que iria ter no dia 6 né... porque o remédio pro vírus de computador... anulou o programa do Michelangelo. Fala também que outras pessoas que acham melhor usar vacinas... antivírus... elas são compradas em disquetes magnéticos... aí existem dois tipos... Uma das vacinas... ela localiza e destrói o vírus... a outra vacina ela localiza e você tem que usar um outro programa contra aquele vírus... pra acabar com ele... só que as vacinas são muito caras... A vacina de Norton... que destrói 700 vírus custa mais ou menos 200 dólares aqui no Brasil.

Propositional scoring:

(X) Um vírus ( ) enlouqueceu ( ) milhões ( ) de usuários (X) de computadores ( ) na sexta-feira passada. ( ) Não era ( ) uma doença ( ) de verdade, ( ) mas ( ) um vírus ( ) de computador. (X) Seu nome, Michelangelo, ( ) uma homenagem ( ) ao artista ( ) renascentista ( ) italiano. (X) Ele invadira (X) a memória ( ) de milhões (X) de computadores ( )

pessoais ( ) do tipo PC ( ) (o mais popular ( ) do planeta) ( ) e prometia ( ) destruir ( ) todos ( ) os seus arquivos (X) no dia 6 de março.
(X) Os vírus (X) são ( ) simplesmente (X) instruções (X) clandestinamente (X) colocadas (X) nos programas (X) e que fazem (X) os computadores (X) executar (X) funções ( ) malucas – (X) como apagar (X) informações (X) valiosas (X) gravadas (X) em sua memória. ( ) Eles só ( ) apresentam ( ) seus sintomas ( ) em situações ( ) específicas. ( ) No caso de Michelangelo, ( ) a situação ( ) especial ( ) era ( ) uma efeméride – ( ) dia 6 de março, ( ) 517° (X) aniversário (X) do mestre ( ) italiano. ( ) A paranóia ( ) entre ( ) os usuários ( ) foi ( ) maior que ( ) os danos ( ) previstos ( ) e acabou ( ) dando ( ) bons ( ) resultados ( ) para os vendedores ( ) de equipamentos ( ) de segurança ( ) contra vírus. (X) A maioria (X) das pessoas (X) se preveniu (X) e o vírus (X) não teve (X) força (X) para instituir ( ) o caos ( ) eletrônico ( ) nos terminais.
(X) Alguns (X) usuários (X) recorreram (X) às vacinas (X) antivírus. ( ) Existem ( ) pelo menos ( ) três ( ) tipos ( ) de programa ( ) de vacinas ( ) contra ( ) o vírus ( ) de computador – ( ) todas elas (X) vendidas (X) na forma (X) de disquetes (X) magnéticos ( ) para computador. (X) Uma delas (X) procura (X) o vírus ( ) rastreando ( ) cada um ( ) dos programas ( ) arquivados. ( ) O invasor ( ) é encontrado (X) e anulado. (X) Uma outra ( ) apenas (X) localiza ( ) a presença ( ) do clandestino. (X) O usuário (X) tem que (X) recorrer (X) a um (X) outro (X) programa (X) específico (X) para dar cabo (X) do microinvasor. (X) O problema (X) de todas (X) as vacinas (X) é o (X) seu preço (X) elevado. (X) A vacina Norton, (X) contra (X) 700 vírus, (X) custa (X) o equivalente (X) a 200 dólares (X) no Brasil.

five texts following the Pause Protocol Procedure (Cavalcanti, 1987, 1989). 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 for each of the text organizational aspects being investigated, Problem/Solution and Prediction, and also read three distorted texts, containing 'no solution', 'no problem' and 'distorted prediction' respectively. Regarding the first experiment, significant correlations were obtained between the Reading Span Test and the two measures of reading ability. In relation to the second experiment, results indicate that better readers (also with a higher memory capacity) were better able to perceive and use the two-text organizational aspects than weaker readers (also with a lower memory capacity). Furthermore, in general, better readers were able to comprehend and recall more from the texts than weaker readers. Results are analyzed in the light of other studies about text structure awareness and about the relationship between working memory capacity and reading comprehension. The author suggests that processing efficiency is an important component in the relationship between working memory capacity and reading comprehension.

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