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WORKING MEMORY AND THE PROCESSING OF LINEAR TEXTS AND HYPERTEXTS.

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When discussing about hypertext, there is no consensus in the literature about the effects of linearity/nonlinearity for its processing/comprehension process. Thus, this study tried to investigate this issue making an interface between working memory capacity (WM), and some reading activities taken in a text that was presented in two different modes- as a hypertext and as linear text. Results from this study showed that high-span readers reading the hypertext presented the same performance as low span-readers reading the linear text. One possible explanation for this result is that the hypertext imposed some constraint for processing, affecting readers' performance. However, further research has to be conducted to make more assertive the hypotheses raised here.

Quando o assunto é hipertexto não há um consenso na literatura sobre os efeitos da linearidade/não linearidade para o seu processamento e a sua compreensão. Sendo assim, este estudo procurou estabelecer uma interface entre a capacidade de memória de trabalho e o processamento de um texto apresentado em duas versões: como hipertexto e como texto linear na tentativa de investigar esses aspectos. Resultados obtidos neste estudo demonstraram que os participantes com alta amplitude de memória de trabalho, lendo o hipertexto, tiveram o mesmo desempenho que os participantes com baixa amplitude de memória lendo o texto linear, nas tarefas propostas. Uma possível explicação para tal resultado é que o hipertexto foi um constritor para o processamento, afetando o desempenho dos leitores. Entretanto, devido às limitações desta pesquisa, mais investigações devem ser conduzidas para que as hipóteses aqui levantadas possam ser corroboradas.

Palavras-chave: Memória de trabalho, hipertexto e texto linear.
Key-words: Working memory, hypertexts and linear texts.

Introduction

One of the central issues involving the investigation of hypertexts is the assumption that hypertexts might be more constraining for processing than linear texts. This hypothesis is related to the fact that, hypertexts, differently from traditional texts, may present most information externally to the body of the text, that is, in a nonlinear structure. This characteristic, which at the same time allows more flexibility to the readers who may do a deliberate search for linking information, may also lead to some fragmented representations, hence imposing a greater cognitive burden on working memory which has limited resources for processing and storing information (Baddeley, 1999; Engle, Laughlin, Tuholski & Conway, 1999 among others).

Over the course of the past few years, much research has been conducted to observe the effects of text organization on comprehension (Rouet, Levonen, Dillon & Spiro, 1996; Dillon, 1996, Foltz, 1996; McKnight, Dillon & Richardson, 1990; Tomitch, 2003; 1999-2000, among others). Results from studies conducted by Kintsch and Yarborough (1982) showed that, for example, it is harder for the readers to answer questions about the topics of texts when paragraphs were randomly ordered (Kintsch & Yarborough, 1982). Similarly, retrieving the main ideas is found more constraining in texts that are poorly structured or lacked organization (Dee-Lucas & Laking, 1990; Kieras, 1980; Kintsch & Yarborough, 1982). However, despite conclusions obtained from various experiments, some aspects such as the ones related to the effects of linearity for processing remain controversial, and many questions still remain unanswered.

The aim of this work is to explore the effects of text linearity/nonlinearity on the reading comprehension process, considering the individual differences in working memory capacity. For this purpose, an interface between working memory (WM) and a text presented in two different versions (a hypertext and a linear text) were built. The experiment considered the following aspects:

a) Working memory is involved in “the control, regulation, and active maintenance of task-relevant information in the service of complex cognition…” (Miyake & Shah, 1999, p 450).

b) The limitations of working memory.

c) The individual differences in processing.

d) The correlation between L1/L2 WM capacity and performance in complex cognitive tasks (L1/L2).

e) Linarity/nonlinearity in texts- the disruptive nature of hypertexts may represent a processing constraint, as opposed to linear texts.

f) The schemata readers may need for using computers may also represent a restrain for processing.

In order to achieve the aforementioned aim, this work seeks to investigate the following questions:

1) Considering the two types of text proposed (hypertext and linear text), and also considering participants' working memory spans, is performance on both types of texts (hypertext and linear texts) equivalent in all the activities proposed?

2) Do L1/L2 WM reading span tests have the same efficacy in predicting L2 reading performance, as measured by the reading span tests applied?

The hypotheses raised from these questions are:

a) Considering the two types of text structures (a linear text and a hypertext), it may be expected that performance on activities related to L2 linear texts would be less constrained, and accordingly superior, than performance on activities related to L2 hypertexts.

b) L2 *proficiency* may also be a source of working memory constraint, hence, L2 working memory span tests should be better predictors of L2 performance than L1 working memory span tests.

1.0 Method

In order to investigate and answer the research questions proposed in this work, an experiment was conducted at a university in Santa Catarina. The first part of the experiment assessed participants' working memory capacity (L1 and L2) by means of modified versions of the reading span test (Daneman & Carpenter, 1980), and the operation-word span test developed by Turner and Engle (1989). The second part aimed at investigating participants' reading comprehension, mainly their ability to notice the *contradictions* explicitly stated in the two texts (hypertext and linear text).

1.1 Participants

In order to conduct the pilot study, six participants, enrolled in the Graduate Program in English Language and Literature- Letras at a Brazilian University were invited. Two of the

participants were male and four were female. Their ages ranged from 26 to 34 years. All the participants were native speakers of Brazilian Portuguese, and speakers of English as a foreign language. All participants were proficient in English, and thus, it was assumed that they would have experience in reading different types of texts such as academic articles, dissertations, abstracts, reviews, and books in general.

1.2 Instruments

1.2.1 The reading span tests

Considering that the participants in this study were Portuguese speakers, and also to avoid floor effect due to task difficulties, in this experiment two different versions of the original reading span test developed by Daneman and Carpenter (1980) were applied- one in Portuguese and one in English. These modified versions were developed and tested by Torres (2003) (see Appendices A and B). Both reading span tests consisted of 42 sentences, which were presented on a computer screen. As explained by Torres (2003), in the *Portuguese adaptation*, sentences were taken from some Brazilian popular magazines, and sentences were controlled for length so as to be as long as the sentences in the original English version (around 12 words each sentence). However, since this test was taken in their native language, there was no control for syntactic complexity. On the other hand, *in the English version applied*, sentences were shorter, and syntactically simpler than in the original reading span test, taking into account that participants were Brazilians. In order to control for processing, a grammatical judgment (correct/incorrect) was added to the task to ensure processing (Torres, 2003; Fortkamp, 2000; Turner & Engle, 1989, among others).

1.2.2 The written text

In the present study, two expository texts, one taken from the National Geographic Magazine called “Why are we so fat”, and one taken from the internet called “Gastrointestinal Surgery for Severe Obesity” (Appendix H) were adapted for the creation of a new text. These two original articles talk about aspects related to the causes and effects of obesity, and explain what can be done to control such condition. They were selected because (1) the subject matter was considered to be of general interest for the potential participants, (2) shared the same subject, (3) were authentic passages, (4) shared the same degree of difficulty, (5) required minimal

background knowledge, and (6) had logical rhetorical ordering of ideas. Hence, some of the important information provided by the original articles was preserved, *and additional fictional information, including characters and events*, were created specially for the purpose of this study.

In order to assist in the observation of the relation between participants' working memory capacities, and their performance in the reading comprehension activities, some *contradictions* were created (Appendix E). The process of detecting contradictions is very challenging for working memory, because it requires processing beyond sentence and word levels, to the integration of the passage as a whole (Kamas & Reder, 1995). Besides, as Kamas and Reder (1995) explain "in order to detect a contradiction within a passage, *both of the contradictory propositions must be part of working memory at the same time*" (p. 186) (stress added). Thus, in this experiment, the contradictions were also developed as possible means to verify the correlations between participants' working memory spans and their performance in the tasks proposed. In order to facilitate processing, headings and logical connectives (organizational devices) were used in both types of text (hypertext and linear text).

The hypertext consisted of three nodes, and a central body. The nodes were placed on the right side of the screen. The participants were asked to read the three nodes, in any other they wanted to make the linking. The central body and the nodes of the hypertext were linear because, as McKnight (1996) explains, hypertexts that preserve a certain degree of linearity makes it easier for processing. An expert in computer programs developed the design of the hypertext for the computer presentation.

1.2.3 The recall of propositions

After reading the text proposed, each student had to recall it for further analysis. For helping the researcher to establish which propositions could be essential for constructing the gist, three reading teachers, in addition to this researcher, assisted in the classification of the main propositions. Each teacher was asked to read the text thoroughly and write down his/her results. Propositional analysis allowed the scoring of the information retained in long term memory, by each participant, related to his/her understanding of the text (Suh & Trabasso), that is, the way each participant established the semantic relations (meaning) among concepts.

1.2.4 The reading comprehension analysis- the written questions

The comprehension of micropropositions and macropropositions in the text were also investigated by a questionnaire answered by the participants (see Appendix C). *For all participants, the questions were presented on a paper format*. The questions tried to explore: (a) literal comprehension (also including questions which required only the reorganization of information explicitly stated in the text); (b) inferential comprehension, that is, reading between the lines for the construction of the situation model; (c) awareness of the cognitive operations, that is, of how the participants perceived their own readings (for example, "how difficult was for you to read the text?"). For investigating literal comprehension, a multiple-choice test (textually explicit question) with 12 questions was elaborated. Each question had five alternatives with only one correct answer. For observing inferential comprehension, two textually implicit questions were posed. Finally, in order to scrutinize participants' cognitive awareness, 5 reading awareness questions were designed. According to Pearson and Johnson (1978) textually explicit questions refer to the ones found in the text. Textually explicit questions are those which also derive from prior knowledge.

1. 3 Procedures

The experimental procedures comprised three different phases. The first phase aimed at investigating participants' working memory spans. The second phase intended to observe how the participants understood the text. Finally, the last phase was planned to explore reading comprehension.

1.3.1 Working memory capacity measures

The experimental procedures comprised *different phases*. In the *first phase*, to assess individual differences in working memory capacity, participants were required to individually read aloud some sentences presented on a computer screen (see Appendices A and B), one at a time, and to judge whether they were grammatically possible or not. Individual sentences were displayed at a rate of 9 seconds, in the middle of the screen (Torres, 2003). The number of the sentences increased in length, starting from 2 and extending to 5. After reading each sentence,

participants had to make a *grammatical judgment* (correct/incorrect) aloud and they should try to recall the final word of each sentence, such as: "His younger brother roll and rock a in guitar band" (incorrect), and "At the top of the tree sat a small bird" (correct). In these cases the words recalled should be *band* and *bird*.

Subjects received credit for recalling a word *only* if they had also made the right decision about the grammaticality of the sentences presented. For each word recalled in the same order of presentation, participants received one point, as already applied in some studies (Tomitch, 2003; Fortkamp, 2000; Turner & Engle, 1989; Daneman & Green, 1986; Daneman & Carpenter, 1983). Participants were classified as high or low-spans according to their scores on the reading span tests on a scale ranging from 1 to 42. They were divided into two groups: the ones who recalled 19 or less (less than 50%) correct words were classified as low-span participants, and participants who recalled more than 20 correct words were considered high-spans. The labels low and high-spans are relative to the present sample. This classification (high/low-spans) was an adaptation of Torres's (2003) work.

1.3.2 The propositional analysis

The *second phase* was planned to investigate participants' reading comprehension. For both types of text the procedures were basically the same. First, individually, and at his/her own pace, the participant was asked to silently, carefully and attentively read a text designated to him/her (these aspects were emphasized due to the length of the text, and also to its concentration of information) (see Appendix D). Hypertext readers had the text presented on a computer screen. The participant was allowed to *read only once*. Second, after finishing reading, he/she was asked to recall everything he/she could remember from the text. Propositions, as explained by Kintsch (1998) "make explicit those aspects of the meaning of a text that are considered most directly relevant to how people understand a text" (p.49), and they are consisted of several other *atomic* propositions (van Dijk & Kintsch, 1983). The recalls were transcribed and used for scoring the propositions. The scores were investigated using an adapted version of van Dijk and Kintsch (1983), developed by Tomitch (2003), and tested at the Reading Laboratory at UFSC (Appendix F). Thus, in this study, following Tomitch's (2003) procedures, the first step was to identify the central proposition (propositions) of each sentence, and then the modifiers or attributes which

could modify the central proposition. A parenthesis was placed before any attribute which could create a new proposition, that is, which could modify the central proposition. The recalls were matched with the proposionalized text for the number of (atomic) propositions recalled in each case (Tomitch, 2003).

1.3.3 The reading comprehension analysis- the written questions

The last phase comprised a written comprehension activity. In this phase, the participant (from the hypertext and the linear text) received comprehension questions that should be answered *without referring back to the text*, either to confirm or check the answers. These two activities, the verbal recall and the comprehension questions, aimed at investigating the situation model generated by the participants (Appendix C).

Different types of questions comprised the written test. In the multiple-choice tests, for each correct answer participants received one point. The total they could get was 12. For scrutinizing the inferential comprehension two questions were proposed. For each correct answer participant received one point. The total they could get was 2. Thus, these two types of questions were scored following the same procedures. Finally, for investigating participants' cognitive awareness about their own reading processes, five questions were elaborated (see Appendix C). These questions were not scored because they were only meant to observe if the participants were able to notice the contradictions in the text, without asking them explicitly this question (Have you noticed any contradiction in the text?). Asking this question directly could have led them to different reactions (answers) from those they produced while answering the questionnaire.

The statistical analysis of the data was carried out using the SPSS software. The Pearson Product Moment Coefficient of correlation (*r*), a parametric test was the analytic procedure carried out in order to assess whether, and to what extent the relationship between processes were statistically significant.

2.0 Results

This section presents results of the statistical analysis, and the descriptive analyses made to address the hypothesis and research questions of the present investigation, followed, in the next section, by the discussion of the findings reported here.

Table 3.1 below reports the statistical analysis for the correlation between the reading span tests (L1/L2), and the scores obtained by the participants in the reading activities proposed.

Table 3.1 The Pearson Product Moment Correlation between the Reading Span Tests (L1/L2), and the scores obtained by the participants in the reading activities

	L1 RSPAN	L2 RSPAN	READING
RST L1	1.00	. 74	. 70
RST L2	. 74	1.00	. 86*

***** p < .05.

N=6

As can be seen above, correlation between L1 and L2 WM reading span tests did not reach statistical significance, according to the Pearson Correlation procedures: r (6) = .74, p >.05. Similarly, the correlation between the L1 working memory span tests and the reading activity was not statistically significant: r (6) = .70, p >.05. Nevertheless, a significant correlation was obtained between L2 reading span tests and the reading activities: r (6) = .86, p <.05. The consistency of the data obtained between the working memory span tests and the reading activities was replicated using analysis of variance. Results are provided in Table 3.2.

Table 3.2 below displays the statistical results for the reading spans tests as predictors of participants' reading performance.

Table 3.2 Analysis of the L2 WM reading span tests as predictors of the reading performance

Model	Sum of squares	df	Mean square	F	Sig
1 Regression	32. 797	1	32. 797	11. 013	.029
Residual	11. 912	4	2. 978		
Total	44. 708		5		

N=6

Table 3.2 summarizes the results of the analysis between the L2 WM reading span tests as predictors of reading performance (Predictors: (constant) L2 RSPAN – Dependent variable: Reading). As it can be noticed, the statistical correlation is significant: F (5) = 11, 013, p < .05

showing that, in this study, the reading span tests in L2 were good predictors of participants performance in the reading tasks proposed.

Table 3.3 shows the descriptive statistics for the correlation between the WM span tests and the participants' performance in the L2 reading activity.

Table 3.3 Analysis of the L1 WM reading spans as predictors of L2 reading performance

Model	Sum of squares	df	F	Sig
1. Regression	21. 878	21. 878	3. 833	. 122a
Residual	22. 831	5.708		
Total	44. 708			

N= 6

As it can be observed in table 3.3, a statistically significant correlation was not found between L1 WM span tests and the L2 reading performance: F (5) = 3.833, p > .05. Thus, in this study, unlike from the L2 reading span tests, the L1 reading span tests were not good predictors of the L2 reading tasks proposed.

Table 3.4 displays the descriptive statistics – the Mean (M), and the standard deviation (SD) – for the L1 and L2 working memory span tests.

Table 3.4 Descriptive statistics for the reading span test in L2 and L1

	L2 reading span tests	L1 reading span tests
M	19.5000	20.5000
SD	6.1887	4.23208

N = 06

Table 3.4 shows that variation in the working memory span tests was larger prominent among participants in the L2 WM span tests, suggesting that the different levels of proficiency in English might have interfered in processing, thus affected performance.

Table 3.5 displays the descriptive statistics– the Mean (M), and the standard deviation (SD) – for the L2 RST and the reading activities.

Table 3.5 Descriptive statistic for the L2 RST and the reading scores obtained from the tasks proposed

	L2RST	Reading scores obtained
M	20,5000	13.4167
SD	4,2308	2.8882

N = 06

Results from table 3.5 show that the standard deviation of the L2 reading span test was more important than the standard deviation of the performance in the reading activities, in other words, although participants presented a reasonable difference in their working memory spans, this difference seem to be minimized in their performance in the tasks proposed, as results show (2.8882).

Table 3.6 below presents participants' individual scores obtained from the reading span tests, the written activities proposed, and also their scores obtained from the recall of propositions.

Table 3.6 Participants' scores obtained from the WM span tests, the written tests, and from their recall of propositions

Results from working memory span tests	Scores from the written tests (total number 14)	Scores from the propositions recalled (total number 26)
Part 4 – high-span (hyper)	8,5	09
Part 2 – high-span (hyper)	8,0	06
Part 3 – low-span (linear)	7,0	06
Part 6 – low-span (linear)	6,5	05
Part 1 – low-span (linear)	7,0	07
Part 5 – low-span (hyper)	4,5	04

Table 3.6 presents a quantitative analysis, which consists of the results of the reading span tests, numbers of propositions recalled by the participants, and their scores obtained from the written exercises (the questionnaire they had to answer). As it can be noticed by the results

above, from the three participants reading hypertexts two were considered high-span readers, and one a low-span reader. Participants reading linear texts were all low-spans readers. The results of the scores obtained by the participants, as table 3.6 shows, ranged from 8,5 to 4,5. However, considering the total number of the participants, the standard deviations in the scores obtained were not important (2.882- as already presented in table 3.5 above).

Table 3.7 below displays the results of the reading awareness questions, which consists of the subjective comments made by the participants in relation to their reading processes, concerning aspects such as the vocabulary, and the hypertext and linear text structures.

Table 3.7 Results of the answers obtained from the reading awareness questions

	Reading awareness questions				
	Type of texts	How difficult was it for you to read the text?	Was the vocabulary…?	How did your reading flow?	Was the structure of the text:
Part 4	Hypertext	*A little difficult*	Easy	*With difficulty*	Easy
Part 2	Hypertext	Easy	Easy	*With difficulty*	Very easy
Part 5	Hypertext	Easy	*A little difficult*	Easily	Easy
Part 3	Linear	Easy	Easy	Very easily	Very easy
Part 6	Linear	Easy	Easy	Easily	Very easy
Part 1	Linear	Very easily	Easy	Very easily	Very easy

Table 3.7 displays the subjective comments made by all the participants in relation to their own reading process. These questions aimed at investigating if readers were able to notice that the text was contradictory, without explicitly asking them this question (Did you notice that the text you read had many contradictions?). The answers obtained were the following:

For the question ("How difficult was it for you to read the text? Very difficult, difficult, a little difficult, easy") the majority of the participants agreed that it was *easy*, however, participant 1 (high-span- reading a hypertext) answered that it was *a little difficult*. In the next question (Was

vocabulary: very difficult, difficult, a little difficult, easy?) the majority of the subjects considered it *easy*, nevertheless, participant 5 (low-span – reading a hypertext) answered that it was *a little difficult*. The following question (How did the reading flow?) was regarded as *effortless* for most of the participants, however, two subjects 4 and 2 (hypertext readers, with high-span scores), considered the flow of reading *difficult*. All participants considered the structure of the texts *undemanding* (Was the structure of the text very difficult, difficult, easy, very easy?).

None of the participant, answering those questions above (Table 3.7), acknowledged the existence of *contradictions*. Only during the verbal recall, participants 4 and 2 (high spans) mentioned to have noticed one contradiction each (the surgery is risky/*the surgery is not risky* and it is very easy to treat severe obesity/ *severe obesity can be easily treated*, respectively).

Hypertexts contexts, with their own characteristics, seem to impose a higher cognitive load on readers, as already discussed. When reading a hypertext, readers have to remember their current location, make decisions about what information to link, keep track of the previous pages visited, understand the semantic relations among units, and integrate them to form a coherent mental representation of the text. These tasks may impose a burden on working memory, which has limited resources to cope with the activities proposed, especially in L2.

In order to investigate the aspects aforesaid, this study examined *two hypotheses*: (1) Hypertexts, due to their disruptive nature, may consume more attentional resources from WM than linear texts, being more cognitively demanding, especially in L2 activities. Therefore, considering the two types of structures- the linear text structure and a hypertext structures, it may be expected that performance on activities related to L2 linear text would be less constraining, and hence superior, than activities performed in L2 hypertext, especially for low-span readers. (2) The second hypothesis was that L2 *proficiency* may be a source of working memory constraint, thus, L2 working memory span tests should be better predictors of L2 performance than L1 working memory span tests. In order to investigate these issues the two following questions were addressed:

1) Considering the two types of text proposed (hypertext and linear text), and also considering participants' working memory spans, was performance on both types of texts (hypertext and linear texts) equivalent?

The statistical findings presented in this section show that high and low-span readers reading different types of text (linear text and hypertexts) *performed similarly* (considering standard results obtained, as already shown). However, due to the limitations of this exploratory study (discussed on page 45), which do not allow any assertive conclusions, it cannot be assumed here that the performance of the high-span readers reading hypertexts was affected by some possible constraints imposed by the hypertext on their working memory resources. On the other hand, I believe, this hypothesis cannot be discharged either. Thus, further research needs to be conducted to corroborate this assumption, mainly in activities related to the reading of hypertext in EFL.

2) Do L1/L2 working memory span tests have the same efficacy in predicting L2 reading performance?

As it was shown in table 3.1, no significant statistical correlation was obtained between L1 and L2 working memory span tests, or between L1 working memory span tests, and the reading activities. Nevertheless, a *significant* statistical correlation was obtained between L2 working memory span tests and the reading activities. Thus, in this experiment, the results indicate that L2 WM reading span tests may be better predictors of L2 performance, compared to L1 WM reading span tests. Proficiency in a second language seems to impose some constraints on working memory, directly affecting processing, and L2 WM reading span tests seem to provide more effective data to predict such phenomena. Nevertheless, an investigation with a much larger group would be necessary to corroborate this finding.

4.0 Discussion

There was no statistically significant correlation between L1/L2 WM reading span tests, as it can be observed in table 3.1. This aspect may signal to the fact that, although the group was very homogeneous in relation to their L1 WM capacities (they were all master candidates at the Letras course), their proficiency in English varied, possibly affecting their processing efficiency. This aspect may corroborate Berquist's (1997) claims that "the biological capacity of WM is fully formed in L1 adult subject, variations among individuals in L2 WM capacity is best defined as efficiency of processing rather than a fixed capacity" (p. 468). On the other hand, while no correlation was found between L1 WM span tests, and the reading activities, strong correlations were observed between L2 WM span tests, and the reading activities (r (6) = .83 < 0.5).

Results aforesaid might also suggest that L2 proficiency may be considered a critical factor in processing, constraining working memory capacity, especially for less proficient readers. Lack of knowledge in the L2 may slow down processing speed, thus, parsing, decoding, literal comprehension, and inferential comprehension, for example, might demand additional control of attention (Engle et al., 1999,) in order to avoid, among other aspects, information decay (Baddeley & Logie, 1999), which may directly affect comprehension.

Regardless of the fact that there was a correlation between the L2 WM span test and the reading activities, it is interesting to notice (see Table 3.5 above) that the standard deviation among the scores obtained from participants' performance in the reading comprehension activities was not expressive (2. 88). That is, high-span participants scored close to low-span participants. One possible explanation for this result may be the text itself, considering that the standard deviation in the L2 WM span tests was more significant (6. 188). In other words, it could be hypothesized that the hypertext read by the two high-span readers (Participants 4 and 2) might have, in some way, diminished their processing efficiency. This assumption may be corroborated by the fact that both of them (Participants 4 and 2) endorsed that their flow of reading was difficult (see Table 3.7). However, these participants acknowledged that vocabulary and structure were easy. Thus, it could be supposed that interruptions in the flow of information presentation might have demanded more effort for understanding the hypertext.

Another aspect that deserves some comments is related to *participant 5* (a hypertext reader). Although he/she was classified as a low-span reader, her/his performance was much inferior than the other low-spans readers reading linear texts. A possible explanation, again, is that since participant 5 read a hypertext, the disruptive nature of the hypertext might have increased the burden on his/her WM for processing, mainly considering that he/she is a low-span reader.

In relation to the reading awareness questions (subjective comments made by the participants), it is important to emphasize that the text developed for this experiment was very demanding for processing/comprehension, regardless of being considered easy by the participants in terms of structure and vocabulary. Two main reasons made the reading tasks challenging: First, the one inherent to the text itself, which was the great variety, and amount of information to be processed. Second, the condition allowing participants to read only once. These characteristics reflected in the participants' performance, as results seem to indicate. Thus, high-span subjects

(Participants 4 and 2) were the only participants who noticed the contradictions- participant 4 noticed one, and participant 2 noticed one of the six contradictions stated in the texts (the surgery is risky/*the surgery is not risky*, and severe obesity can be easily treated/ *it is very difficult to treat severe obesity*).

The detection of contradictions, as explained by Kamas and Reder (1995) is very demanding for working memory:

> In order to detect a contradiction within a passage, *both of the contradictory propositions must be part of working memory at the same time*. If the activation of the first concept has decayed so that it is no longer in working memory, it cannot be compared to the second, and thus, no contradiction will be noted (p. 186) (stress added).

Thus, high-span participants, having a higher capacity for controlling attention, seemed to have been able to hold the relevant information in their working memories long enough to inhibit the contradictions when they appeared, contrary to the low-span participants (Baddeley & Loggie, 1999; Engle et al., 1999, Hasher & Zacks, 1988). However, they were only capable to notice one out of six explicitly stated contradictions. One possible explanation for such performance was that in the hypertexts the contradictions were presented in different nodes, which might have increased the burden on working memory, preventing the participants from holding more contradictory propositions long enough to compare them. Finding contradictions also requires deep processing, that is, going beyond the superficial features of texts (Kamas & Reder, 1995), integrating micro and macropropositions. Low-span readers, with a limited processing efficiency, and poor attentional control seemed to have been more affected in such endeavor.

Finally, the appropriate provision of the theme and the title to the texts shows that the majority of the participants were able to construct the appropriate gist. On the other hand, nearly everyone seemed to lack the ability to select, and store most of the relevant information from the microstructure, necessary for answering the literal questions proposed, as indicated by the results displayed on table 3.7. This result can be explained by the length of the text, which might have made the activities proposed more challenging.

4.0 Conclusion

Results from this study demonstrated that high-span readers reading hypertexts presented similar scores to those obtained by low-span readers reading linear texts, thus showing close performance. However, and as already said, this finding cannot corroborate the assumption that hypertexts are more cognitively demanding for processing than linear texts, due to the limitations of this study (few participants). Nevertheless, this previous result added to the fact that the lowest scores in all activities was obtained from a low-span hypertext reader may signal to the fact that hypertext environments might present some variables which might influence readers' processing, and these variables are worth investigating.

Another important characteristic raised in this work was the fact that computer systems may also represent a significant constraint for some readers, who do not have specific schemata for using them. This aspect could as well represent a cognitive load on processing. Two hypertext readers, as already seen, acknowledged that the flow of reading was difficult, although they considered the structure of the text easy. This aspect might signal to possible constraints in reading/processing from the screen, which in turn, might have affected comprehension.

Finally, it is important to emphasize that despite all the arguments raised in this work, differences in the processing of linear texts and hypertexts, if any, were not possible to be established yet. Nevertheless, considering that, to my knowledge, there are no studies correlating measures of readers' working memory capacities to their performance on tasks involving hypertexts and linear texts, and in view of the results and the hypotheses raised here, I believe further investigation can shed new light to this field of investigation.

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