Working memory capacity and attention to form and meaning in EFL reading[1]

Capacidade de memória de trabalho e atenção à forma e significado em leitura de inglês como língua estrangeira

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Abstract: This article reports a Master thesis study that aimed at investigating, in a population of high school students of English as a foreign language (EFL), the relationship between individual differences in working memory capacity (WMC) and learners' simultaneous attention to form and meaning in reading. Sixty-one participants were submitted to five data collection sessions which comprised two working memory tests, three retrospective questionnaires, a task used to assess attention to form and meaning, and a feedback session. Data revealed, in general terms, that attention to form and meaning in L2 reading is affected by individual differences in WMC, since these differences were shown to determine efficient performance in the task of paying attention to form and meaning while reading in a population of EFL high school students.

Keywords: Working memory; Attention to form and meaning; Reading

Resumo: Este artigo reporta um estudo de mestrado que teve por objetivo investigar, em uma população de estudantes de ensino médio de inglês como língua estrangeira, a relação entre diferenças individuais na capacidade de memória de trabalho (CMT) e a atenção desses aprendizes à forma e significado em leitura. Sessenta e um participantes foram submetidos a cinco sessões de coleta de dados que compreenderam dois testes de memória de trabalho, três questionários retrospectivos, uma atividade usada para avaliar atenção à forma e significado, outro questionário e uma sessão de *feedback*. Os dados revelaram, em termos gerais, que a atenção à forma e ao significado em leitura em L2 é afetada pelas diferenças individuais na CMT, já que essas diferenças parecem determinar o desempenho eficiente na atividade de prestar atenção à forma e ao significado durante a leitura de uma população de estudantes de ensino médio de inglês como língua estrangeira.

Palavras-chave: Memória de trabalho; Atenção à forma e significado; Leitura

Introduction

Working memory (WM) plays an important and indispensable role in human cognition. Daily cognitive tasks, such as reading, calculating, solving problems, frequently entail various steps with intermediate results that ought to be maintained temporarily in mind so as one can solve the task successfully. WM is the theoretical construct that has been used in cognitive psychology to refer to the integrated system that temporarily stores and manipulates information during the performance of a cognitive task (BADDELEY e HITCH, 1974). Several studies have found positive correlations between WM and performance in language comprehension tasks (DANEMAN e CARPENTER, 1980, 1983; DANEMAN e GREEN, 1986; MIYAKE, JUST e CARPENTER, 1994; TOMITCH, 2003A, 2003B; TURNER e ENGLE, 1989; to mention but a few) and most of them were carried out in the participants' mother tongue, generally English. Just a few studies, however, have investigated the relationship between WM and L2 language tasks involving skills

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such as reading and speaking (ALPTEKIN e ERÇETIN, 2009; 2010; BERGSLEITHNER, 2010; FINARDI, 2009; FONTANINI et al., 2005; FORTKAMP, 2000; PREBIANCA, 2009; TORRES, 2003; WEISSHEIMER, 2007). Therefore, it is believed that there is broad field to investigate the relationship between WM and comprehension of English as a foreign language (EFL).

Attention, as well, despite being a matter of interest for scholars in the areas of psychology, linguistics and neuroscience is an ill-defined construct. For some it is the mind control to focus on a specific thought or thing, for others, it involves the difficulty experienced in trying to deal with two or more activities at the same time (PASHLER, 1992; SCHMIDT, 2001). Nevertheless, it is a general consensus that some people are more capable of paying attention to something or some things for a specific period of time than others. A central issue for research resides in the role of attention in reducing and controlling the flow of information (TOMLIN e VILLA, 1994).

The role of attention in second language acquisition (SLA) has been extensively studied. Theoretical models postulate an important role for attention in foreign language development (ROBINSON, 1995; SCHMIDT, 1990, 2001; TOMLIN e VILLA, 1994, VANPATTEN, 1994). It is known that during language acquisition, the learner goes through widespread and pervasive cognitive changes. The learner is overwhelmed by the incoming L2 input, and attention serves to bring order to the chaos by sorting out that input, sometimes succeeding in helping and, at other times, overwhelming the learner. Unlike native speakers, L2 learners ought to develop the ability to comprehend, and comprehension in real time may tax the computational resources available for processing (VANPATTEN, 2007). The Input Processing model, proposed by VanPatten, assumes that L2 learners process information for meaning first, and as these learners are limited-capacity processors, form competes with meaning for attentional resources during moment-by-moment processing for comprehension. Attention to form at the expense of meaning may result in decrements in comprehension. Research results from VanPatten (1990, 1994, 2007), Greenslade, Bouden and Sanz (1999), Wong (2001), Leow, Hsieh and Moreno (2008) and Bailer and D'Ely (2009) show that available attentional resources are limited and compete for certain aspects of the input during processing. Results differ, therefore, pointing out to some issues that need to be clarified in order to improve the way input processing and attention are understood.-

Thus, up to the knowledge of these researchers, no studies have investigated the relationship, if there is any, between working memory capacity (WMC) and attention to form and meaning in L2 reading. In order to contribute to this context, the main objective of the present study is to investigate, in a population of EFL high school students, the relationship between individual differences in WMC and the learners' simultaneous attention to form and meaning. More specifically, this study aims at investigating (i) whether there is, if any, correlation between WMC and the ability of sustaining attention to form and meaning while reading and; (ii) whether the type of attentional control, namely meaning and form, has a differential effect on reading comprehension.

1 Brief review of literature

1.1 *On reading and WM*

The present study views reading as a complex cognitive process, not just as a final product to be analyzed (TOMITCH, 2008). As well, reading is considered "the interaction between text and reader" (AEBERSOLD e FIELD, 1997: 15). Since each reader assigns meaning(s) to the written symbols in the text and taking into account his/her own personal characteristics such as motivation, aptitude, WMC, background knowledge, influences by the family and the cultural environment, reading comprehension differs from one reader to the other.

As mentioned in the introduction, WM maintains, stores and manipulates information in the short term for cognitive tasks such as language comprehension, learning and reasoning. It is known as 'an arena of computation' where storage and processing compete for capacity in the system. Considering the great storage and processing demands required in the process of reading, the question that remains is how the reader is able to construct a meaningful representation of the text (TOMITCH, 2003a). Daneman and Carpenter (1980:450) explain that, while reading,

> the reader stores pragmatic, semantic and syntactic information from the preceding text and use it in disambiguating, parsing and integrating the subsequent text. Information can become part of working memory through several routes: it may be perceptually encoded from the text; it may be sufficiently activated so that it's retrieved from long-term memory; finally, it may be the output of a comprehension process. Information can be also lost from working memory, since its capacity is assumed to be limited.

Several studies have found correlations between WMC and aspects of L1 reading, as in vocabulary learning from context (DANEMANe GREEN, 1986); inference generation of different types (DANEMAN e CARPENTER, 1983; to mention one); resolution of lexical ambiguities (MIYAKE, JUST e CARPENTER,

1994); adjusting processing and strategies to fit reading purposes (LINDERHOLM e VAN DEN BROEK, 2002); strategy implementation for reading expository text (BUDD, WHITNEY e TURLEY, 1995); and text structure (TOMITCH, 2003a; 2003b). Regarding L2, few studies have investigated the relationship between WMC and tasks, such as reading comprehension (ALPTEKIN e ERÇETIN, 2009; to mention one); main idea construction in L1 and L2 (TORRES, 2003); inferential comprehension in reading (ALPTEKIN e ERÇETIN, 2010); writing performance (BERGSLEITHNER, 2010); speech production (FORTKAMP, 2000; PREBIANCA, 2009; FINARDI, 2009); speech development (WEISSHEIMER e MOTA, 2009); and several skills (FONTANINI et al., 2005).

In this realm, Just and Carpenter (1992: 122) proposed a computational theory called "Capacity Constrained Comprehension" that shows how WMC constrains comprehension. They state that "both processing and storage are mediated by activation and that the total amount of activation available in working memory varies among individuals". When the resource demands of the task exceed the available supply, processing slows down, partial products are generated and performance is affected. Higher spans display more residual capacity to store the words to be remembered in the span task, for the reason that they are more efficient at retrieving information from long term memory and at allocating their resources to meet the demands of the task. Furthermore, they present advantages in comprehension and "their extra capacity could also provide the resources to permit better induction of word meanings and hence better vocabulary acquisition" (1992: 146).

1.2 *On attention to form and meaning*

In the SLA literature, the role of attention has been a matter of interest as well as the interaction of attention to form with attention to meaning. The former is employed to aid in the comprehension of the meaning and the latter, to aid in the psycholinguistic processing of the components of the utterance. According to Leow, Hsieh and Moreno (2008), form may be defined as an item that includes both lexical and linguistic features. The premise underlying these constructs is that processing of meaning and form require of the learner conscious attentional effort, "then tasks involving both simultaneously will, by exceeding total attentional capacity, result in degradation of comprehension when form receives the greater emphasis of conscious effort" (TOMLIN e VILLA, 1994: 186).

Motivated by the perspective that attention is effortful and capacity limited, VanPatten (2007) postulated the input processing (IP) model, which is a model of what happens during comprehension that may subsequently interact or affect other processes and of how learners connect or do not connect particular forms with particular meanings. According to him, input processing can be considered a byproduct of comprehension, since learners should be able to make the appropriate form-meaning connections during the act of comprehension. He argues for a process-oriented approach to attention that "focuses on how learners allocate attention during on-line processing" (VANPATTEN, 1994: 28).

VanPatten (1990) proposed that form and meaning may compete for attentional resources during moment-by-moment processing. As learners are driven to get meaning while comprehending rather than trying to understand how the message is encoded, he postulated that learners will tend to process input for meaning before they do so for form. In addition, as learners are limited-capacity processors and comprehension consumes plenty of resources, the model claims that in the early and intermediate stages of L2 acquisition, learners may not be able to pay conscious attention to form in the input, as native speakers may be.

VanPatten (1994) assumes that the limited attentional resources are directed first at the elements that carry meaning, as content words, lexical items, meaningful morphology, tense and aspect inflections. In short, learners are directed primarily to "lexicon, and only later, when the cost comes down, towards communicatively redundant formal features of language" (SCHMIDT, 2001: 13). According to VanPatten (1989: 414), "learners have difficulty in attending to form which does not contribute substantially to the meaning of the input regardless of type of input". Only when comprehension has been automatized that learners will have resources available to allow them to focus on the form of the message. In addition, when the learner performs a task that is automatized, it does not interfere with the other task being performed concurrently (NORMAN e SHALLICE, 1986). The same does not hold true when the tasks demand controlled processing, when a higher level of attention is demanded. In this case, participants in experimental conditions directed to attend to form while also processing input for meaning may experience decrements in comprehension. Leow, Hsieh and Moreno (2008: 667) state that

> if learners are limited capacity processors, then simultaneous attention to both meaning and form should result in a cognitive overload that impacts negatively on comprehension. This is also tied to language experience. Comprehension will be more effortful for beginning and intermediate students because they will need to employ more attentional resources to make those form-meaning/function connections.

Research within the information-processing framework follows VanPatten's (1994) recommendation that it should involve a simultaneous focus on meaning and form and be tied to research on comprehension. As Wong (2001) also recommended, it needs to tackle under what conditions learners can attend to form and meaning at the same time and if so, what kind of forms. Studies that have investigated the effects of attentional conditions regarding L2 simultaneous attention to form and meaning in comprehension (VANPATTEN, 1990; GREENSLADE, BOUDEN e SANZ, 1999; WONG, 2001; LEOW, HSIEH e MORENO, 2008; BAILER e D'ELY, 2009) present inconclusive results. Although there might be some methodological limitations (as reviewed by LEOW, HSIEH e MORENO, 2008), it can be stated that during input processing, available attentional resources are limited and compete for certain aspects of the input. Results point that attention to grammatical forms negatively affects text comprehension, whereas attention to lexical items does not impair comprehension significantly.

In this context, the present study seeks to investigate the effect of different types of attentional condition (meaning/form) on reading comprehension in a Brazilian high school EFL population, as well as investigating the relationship between WM and attention to form and meaning.

2 Method

2.1 *Research questions and hypotheses*

In order to pursue the aforementioned objectives, the present investigation attempts to answer the following research questions: (RQ1) Is there a correlation between WM, measured by the RST and the OSPAN, and the ability to sustain attention between meaning and form while reading, measured by scores on the answers to a comprehension task and a form recognition task?; and (RQ2) Does type of attentional control (meaning/form) have a differential effect on EFL high school students' reading comprehension?

Based on the literature, the hypotheses of this study are as follows: 1) WMC may be related to the ability to sustain attention to form and meaning in L2 reading; 2) WMC may affect comprehension, with higher span individuals performing better than lower spans; 3) higher spans may be better able to sustain attention to form and meaning while reading; 4) the individuals who just attend to meaning should perform better at comprehension than the ones who attend to form and meaning simultaneously.

2.2 *Research design, instruments and procedures*

The design of this study includes a pilot study, conducted with 9 participants and the final study with 61 participants. Institutions, participants and their parents signed a consent form in the first session. In the second and third sessions, participants performed two WMC tests, followed by retrospective questionnaires. In this study, the psychometrical correlational approach (JUST e CARPENTER, 1992) is used, as the interest relies on understanding how WM tasks predict individual differences in cognitive skills – in this case, reading. To control for order effects, half of the sample performed the Reading Span Test, henceforth, the RST (DANEMAN e CARPENTER, 1980) before the Operation-Word Span Test, henceforth the OSPAN (TURNER e ENGLE, 1989), while the other half performed the OSPAN before the RST, in their Portuguese versions (adapted from TOMITCH, 2003A; PREBIANCA, 2009, respectively). The two tests were chosen, since they reflect different views. The RST reflects the *task-specific view* of WM (DANEMAN e CARPENTER, 1980), in that an individual's capacity varies according to the efficiency in relation to the processes correlated with a particular task while the OSPAN follows the *general view of WMC* (CONWAY e ENGLE, 1996), which considers WMC independent of task nature, as individual differences have implications for any task that is attention demanding and requires controlled effortful processing.

Then, tests scores were used to divide the sample into two groups of balanced WMC. The control group, with 30 participants, had to read a text ("What did you do all day?" from AMOS, PRESCHER e PASQUALIN, 2005: 51) in 7 minutes, answer 11 discursive questions designed to assess reading comprehension, answer a retrospective questionnaire whereas the experimental group, with 31 participants, read the same text and performed a form recognition task (highlighted all occurrences of past tense verb forms from the text) in the same 7 minutes, answered the comprehension questions and a questionnaire. The retrospective questionnaires were designed with the objective of unveiling participants' perceptions and impressions while performing the tests, but for the sake of this article, the data gathered by means of questionnaires will not be analyzed and reported here. The tests/tasks were applied in four different sessions and the participants were offered a fifth meeting in which they received feedback on their performance. In addition, participants were rewarded for their willingness and readiness to come to each meeting. For details regarding the pilot study, instruments and procedures, you may check Bailer, Tomitch and D'Ely (2011).

The data collected were submitted to statistical tests so that a careful analysis of the research results could be carried out. The analysis was done through the environment SEstatNet[3] and the software STATISTICA 10.0 Trial; and comprised descriptive statistics, correlational analyses, non-parametric and reliability tests.

2.3 *Participants*

Sixty-one Brazilian students of English as a foreign language enrolled in high school composed the pool of participants of the present study. The institution was *Colégio Universitário*, a private school in Gaspar (Santa Catarina/Brazil). The cohort consisted of 20 learners enrolled in the 1st year high school, 26 in the 2nd year high school and 15 in the 3rd year high school. Participants were 36 males and 25 females, ages ranging from 14 to 17 with an average of 15,4 years. The present sample had the characteristics of a regular classroom and therefore, it is supposed to include a variety of proficiency levels. The study was conducted apart from the class schedule, according to the participants' available time schedule. Meetings lasted about 30 minutes each and were conducted during the months of March and May of 2011.

3 Results and discussion

3.1 Working memory tests results

Table 1 displays the statistics for the data collected by means of the RST and the OSPAN. Although there is not much agreement in the field concerning the definition of high and low spans, it was decided to classify participants according to the literature. For the RST, higher spans are the ones who scored 3.5 and above in the RST, and lower spans the ones who got 3.0 or below (TOMITCH, 2003a). For the OSPAN, higher spans are the ones who scored a standard deviation (4.5) above the mean (33.7) (PREBIANCA, 2009). This way, higher spans are the ones who scored 38 and above, and lower spans, the ones who got 37 or below.

From the pool, in the RST, the majority of participants are lower spans (48), since only 13 may be considered higher spans. In the OSPAN, the pattern is similar; as 12 participants may be classified as higher spans, while the remaining 49, as lower spans.

Table 1 – Working memory tests: statistics

	RST_S	OSPAN_S
Mean	2.62	33.70
Standard Deviation	1.11	4.59
Minimum-Maximum	0-6	20-42
Spearman's Coefficient r_s	*29* (*p* value = *.01*)	

Source: Bailer (2011).

As regards the correlation between the scores on the two tests, it is statistically significant at $\alpha = .05$ but weak (.29), since the value explains less than 10% of the covariation (r^2). Researchers expect to find a high or even a moderate correlation between the two tests, but possibly due to the nature of the tests and the population investigated in this study, a significant but not high correlation was found, meaning that both tests seem to measure the same construct. Methodologically speaking, Conway et al. (2005) point out that WM span tests have proven to be both reliable and valid measures of WMC.

In the case of this study, the differences between performance on the two tests may rely on the fact that the OSPAN was much easier than the RST. As Conway and Engle (1996: 587) point out: "individual differences will only reveal themselves in tasks that force the subject to engage in controlled effortful processing". Perhaps the point is that the OSPAN did not demand as much attention as the RST. Following the literature, WM is needed under attention-demanding circumstances. Possibly due to their age and profile, our participants may be more efficient in calculus than in reading. As stated by Daneman and Green (1986: 17), "the capacity of working memory will vary as a function of how efficient the individual is at the specific processes demanded by the task to which working memory is being applied".[3]

3.2 *Comprehension scores*

Cronbach's alpha was run so as to check the internal consistency of the reading measure: the comprehension questions. This coefficient of reliability can vary from 0 to 1, the closer to 1, the better. Cronbach's alpha for the items of the comprehension exercise used in this investigation is .86, indicating that the task is reliable to measure comprehension in the population of this study.

Table 2 – Scores on the Comprehension Exercise

	Sample	Control Group	Experimental Group
Number of participants	61	30	31
Mean	7.66	6.21	9.08
Standard Deviation	2.79	2.87	1.85
Minimum-Maximum	2-11	*t-Student measure = -4.62* (*p* value = *0.0*)	

Source: Bailer (2011).

Table 2 presents the descriptive statistics for the whole sample performance as well as the performance of the two groups and the comparison between them. The whole sample mean (7.66) may be considered high, indicating that the participants of this study are good

[3] SEstatNet: Sistema Especialista para o Ensino de Estatística na Web. Available at http://www.sestatnet.ufsc.br/

L2 readers. And although the text seemed to be suitable to the participants' schooling level, it may be inferred, from the participants' performance on the comprehension questions, that some participants read the text in a bottom-up fashion, since they maybe wasted too much of the given time devoting themselves to decoding the words at the expense of higher order processes, thus, resulting in low performance in the comprehension exercise.

When comparing performance of both groups, it can be noted that the control and experimental conditions, respectively focus on meaning and focus on form, tend to produce different results in terms of comprehension, measured by the answers to the comprehension questions. This difference is statistically significant in the population investigated and reveals that participants allocated in the experimental group displayed better results in terms of comprehension than the ones allocated in the control group. Participants from the experimental condition might have benefited from the instruction given – highlight all the verbs in the simple past you encounter and read for meaning –, as opposed to the control participants who were instructed just to read for meaning. It is important to bear in mind that verbs are content words, therefore crucial for the understanding of the passages. And although there was the effort to keep an eye on the formal aspects, it might have fostered their processes to comprehend the passage.

3.2.2 Comprehension scores & WM scores

As regards the WM tests, the comprehension scores only correlate significantly with the RST scores (Spearman's Coefficient $r_s = .37$ at p value $= .00$). This result may be explained because reading is a complex cognitive process and just the RST seems to predict reading performance in the sample investigated. Despite the fact that both WM tests are supposed to measure the same construct and predict a variety of complex cognitive activities, the OSPAN scores, in this population of high school students, did not correlate with reading in the L2 (Pearson's Coefficient $r = .00$ at p value $= .49$). The OSPAN may require a different line of reasoning, more mathematical; and for the population investigated, it was much easier than the RST, revealed by the high mean.

As the comprehension scores only correlated with the RST scores (.37, a weak but significant correlation), statistics were run taking into consideration the performance of higher and lower spans in the comprehension exercise. According to Table 3, the difference between higher and lower spans is significant, corroborating the view that individuals differ in functional capacity, "in the processes they have for maximally utilizing their limited capacities" (DANEMAN e MERIKLE, 1996: 423).

Table 3 – Comprehension scores according to WMC

	Higher spans	Lower spans
N (total = 61)	13	48
Sum of ranks	557	1334
Mann-Whitney U	*158* (*p* value = *.00*)	

Source: Bailer (2011).

Checking whether the higher spans of the experimental group outperformed the lower spans of the same condition reveals that the difference between groups is statistically significant (see Table 4). This result indicates that in the small sample of the experimental group, it may be claimed that higher spans are more capable of performing two activities at the same time (reading and highlighting verbs) than lower spans, besides performing better at comprehension.

Table 4 – Experimental group comprehension scores according to WMC

	Higher spans	Lower spans
N (total = 31)	9	22
Sum of ranks	184.5	311.5
Mann-Whitney U	*58.5* (*p* value = *.00*)	

Source: Bailer (2011).

3.3 *Form recognition scores, correlations with comprehension and WM scores*

Participants from the experimental group were required to perform the form recognition task while reading the text for meaning. This task was devised with the purpose of assessing whether the participants from the experimental condition could pay attention to form while reading the text. There were 32 verbal past forms (regular and irregular) throughout the text and participants were supposed to highlight the forms they encountered. The 31 participants who performed this activity presented scores ranging from 13 to 32 with a mean of 26.3 and a standard deviation of 5.8. Due to the high occurrence of correct forms, it may be concluded that participants could indeed pay attention to form while reading, irrespective of being higher or lower spans.

When correlated with the scores on the comprehension exercise, the form recognition task scores correlate well (Pearson's Coefficient $r = .58$ at p value $= .00$), reinforcing the idea that participants could pay attention to form and meaning while reading. Therefore, it can be claimed that participants in this study did indeed pay attention to the target forms while processing for meaning, as Leow, Hsieh and Moreno (2008) found.

When correlated with the scores on the WM tests, the form recognition scores only correlate with the RST scores (Spearman's Coefficient $r_s = .40$ at p value $= .01$). The results for the correlations with the OSPAN are not

statistically significant (Pearson's Coefficient *r=.07* at *p* value=*.34*). As formerly stated, the RST scores correlated because the form recognition task involves reading while the OSPAN did not, since it seems to not predict reading performance in the sample investigated.

As the scores on the form recognition task only correlated with the RST scores, statistics were run to check whether WMC affected performance in the experimental group (Table 5). It may be claimed that the higher span participants could highlight more right forms than the lower spans. This way, the higher spans were more capable of highlighting forms, verbs, and reading for meaning simultaneously than the lower spans who have less WMC available to perform the two activities.

Table 5 – Form recognition task scores according to WMC

	Higher spans	Lower spans
N (total = 31)	9	22
Sum of ranks	197.5	298.5
Mann-Whitney U	*45.5* (*p* value = *.00*)	

Source: Bailer (2011).

4 Final Remarks: limitations, suggestions for future research and pedagogical implications

The present research had as main objective to investigate, in a sample of high school students of English as a foreign language, the relationship between individual differences in WMC and the learners' simultaneous attention to form and meaning. Results indicate that, in general terms, attention to form and meaning in reading is affected by individual differences in WMC.

The answer to the *first research question* – Is there is a correlation between WM and the ability to sustain attention between meaning and form while reading? – is partially positive, that is, there is a positive correlation between WMC, as measured by the RST, and the ability to comprehend a narrative text. In addition, there is a correlation between the scores on the RST and the highlighted occurrences of simple past. The same did not hold true for the correlation between WM by the OSPAN and the scores on the answers to the comprehension task and the form recognition task, especially because the OSPAN did not work as a predictor of reading performance.

Possibly, the correlations among the RST and OSPAN scores with the comprehension exercise scores reflect the nature of the two WM tests. In the sample investigated, performance on comprehension did only correlate significantly with the RST scores. As already mentioned, the RST follows the *task-specific view* whereas the OSPAN, the *general capacity hypothesis*. Daneman and Merikle (1996: 430), in their meta-analysis of 77 studies, concluded that to achieve the best predictive validity, "the working-memory measure should include a verbal process component *and* a verbal storage component". Maybe that is the case for our study, because the RST components are verbal while the OSPAN elements involve math calculus and verbal processes. Hence, it may be claimed that, in the sample investigated, the RST can be used to predict reading performance while the OSPAN cannot.

Our findings do support the claim that higher spans perform better at comprehension than lower spans, following Just and Carpenter (1992) in that performance on language comprehension tasks varies as a function of WMC. In addition, the results do provide evidence that higher spans have more ability to sustain attention to form simultaneously to meaning, measured by highlighted occurrences of simple past verbal forms.

The answer to the *second research question* – Does type of attentional control (meaning/form) have a differential effect on EFL high school students' reading comprehension? – is positive, that is, the type of attentional control (meaning/form) indeed has a differential effect on EFL high school students' reading comprehension. This finding runs counter to Leow, Hsieh and Moreno's study (2008), whose results revealed no significant difference in comprehension between conditions, consequently, no differential effect on comprehension.

It was expected that the participants who have just attended to meaning (control condition) should have performed better at comprehension than the ones who have attended to form and meaning simultaneously (experimental condition), especially because more attentional resources might have been needed to make the form-meaning connections. In the present investigation, participants in the experimental condition were instructed to highlight verbs, which are content words, crucial for the understanding of meaning. Contrary to what was initially expected, it was found that the experimental group outperformed the control group in the comprehension exercise. Hence, paying attention to form did not result in detrimental effects for comprehension; instead, it may have fostered processing to comprehend the text. It was found that requiring readers to attend to items that were important for understanding the meaning of the passage did not negatively affect comprehension, as Wong did (2001) and partially supported by Leow, Hsieh and Moreno (2008). In the case of the present study, these words were crucial for the understanding of the message, and attending to them, had a positive impact on comprehension.

Although in this study think-aloud protocols were not used, it can be speculated that the task of identifying the verbs might not have been challenging enough to hinder attentional resources. Half of the verb forms were regular forms, and their recognition might have been done

on a very automatic fashion. As it is known, automatic processes require little attention while controlled processes require attention as well as interfere with other processes that require it (SCHMIDT, 2001). The case for this study might be that the participants recognized the regular simple past tense verbs automatically and just had to actively pay attention to the irregular forms. It would be interesting to pre-test participants' knowledge about the target form in future studies.

It may be claimed that the command given to the experimental group served as a strategy for the participants. Following Olshavsky (1977: 656), strategy is "a purposeful means of comprehending the author's message". Reading comprehension strategies demand reader attention and effort and are focused on the goal of constructing meaning. As the forms participants were required to select carry both form and meaning, having this strategy at hands, participants could understand better the text, its details, and the task did not become as demanding as expected. In addition, the fact that participants assumed a behavior under the instructions may reveal that the participants of this study are good readers, as they could convert the instruction into a strategy and benefit from this. Therefore, the experimental group might have profited from that, as opposed to the control group, who was instructed to read the text and do not pay attention to anything else.

It is important to bear in mind that the text was a narrative and certainly, participants' knowledge about the structure of a story may have helped participants from both groups to attend to details such as the answers to the classical questions who, where, when, what and how. The control group participants did not have such a good result in comprehension maybe because they were instructed just to read for meaning; they had the 7 minutes to read the text and could employ any strategy as they wished or even could choose to employ none.

In sum, the results of this investigation speak in favor of a complex relationship between WMC and attention to form and meaning in reading in the L2. In the population investigated, higher spans exhibit better performance on comprehension and are more able to cope with the task of recognizing past tense verbs while reading a text for meaning. As well, paying attention to form and meaning tend to produce better results in comprehension than just paying attention to meaning. The instructions given to the participants, the choice of these forms, the level of automaticity participants' display in identifying these forms and the level of proficiency in the L2 might have played a role in these results. In addition, this study brings evidence for the task-specific view of WMC. This study attempted to shed some light on these issues and found a very complex relationship between the key constructs in the population investigated. Nevertheless, further research is needed to investigate the relationship among different measures of WMC and attention to form and meaning in L2 reading, especially with different proficiency levels, age groups and dealing with different linguistic forms.

As for pedagogical implications, teachers should be aware that individual differences in WM are present and play a role in learning and performance. As well, the results from this study showed that there will always be attention to form while reading, especially when dealing with linguistic features that carry meaning. It means that readers go to a text for meaning but still keep an eye on the formal aspects, on specific forms that call their attention. Pedagogically speaking, teachers should prepare learners with vocabulary and grammar for them to understand the meaning of the texts they read and also bring topics that they are familiar with, which might be a way to enhance comprehension. Besides, controlling the level of text difficulty and providing students with exercises that focus on formal aspects may end up being positive for fostering learners' comprehension. In addition, teaching reading strategies and providing students with an aspect to focus, an objective to read, as this study did, has shown to lead to better comprehension. As Schmidt (2001) pointed out, providing a strategy for focusing attention or for sustaining attention while doing something else results in deeper processing, and in the case of this investigation, results in superior comprehension. Moreover, it is of paramount importance to make learners aware of their role as readers, how strategic they can be. As Tomitch (2008) indicate, teachers should provide students with tools so that students/readers can have free access to texts they might choose, be it to acquire knowledge about a certain subject, entertainment, but in short, their growth as integrated and performing parts of the society they live in.

References

AEBERSOLD, J. A.; FIELD, M. L. *From reader to reading teacher:* issues and strategies for second language classrooms. New York: Cambridge University Press, 1997.

ALPTEKIN, C.; ERÇETIN, G. Assessing the relationship of working memory to L2 reading: Does the nature of comprehension process and reading span task make a difference? *System*, v. 37, p. 627-639, 2009.

ALPTEKIN, C.; ERÇETIN, G. The role of L1 and L2 working memory in literal and inferential comprehension in L2 reading. *Journal of Research in Reading*, v. 33, n. 2, p. 206-219, 2010.

AMOS, E.; PRESCHER, E.; PASQUALIN, E. What did you do all day? *Challenge.* São Paulo: Moderna, 2005. v. único. p. 51.

BADDELEY, A. D.; HITCH, G. J. Working memory. In: BOWER, G. H. (Ed.). *The psychology of learning and motivation:* Advances in research and theory. New York: Academic Press, v. 8, p. 47-89, 1974.

BAILER, C.; D'ELY, R. C. S. F. Attention to form and meaning in reading – a 9th year EFL research. Poster presented at the *XI English teacher convention of the Brazilian Southern States,* UFSC, 2009. (unpublished)

BAILER, C.; TOMITCH, L. M. B.; D'ELY, R. C. S. F. O planejamento como processo dinâmico: a importância do estudo piloto para uma pesquisa experimental em linguística aplicada. *Revista Intercâmbio*, v. 24, p. 129-146, 2011.

BAILER, C. *Working memory capacity and attention to form and meaning in EFL reading*. Dissertação (Mestrado em Letras) – Pós-graduação em Letras/Inglês e Literatura Correspondente, Universidade Federal de Santa Catarina, Florianópolis, 2011.

BERGSLEITHNER, J. M. Working memory capacity and L2 writing performance. *Ciências & Cognição*, v. 15, n. 2, p. 2-20, 2010.

BUDD, D.; WHITNEY, P.; TURLEY, K.J. Individual differences in working memory strategies for reading expository text. *Memory & Cognition*, v. 23, n. 6, p. 735-748, 1995.

CONWAY, A. R. A.; ENGLE, R. W. Individual differences in working memory capacity: More evidence for a general capacity theory. *Memory*, v. 4, p. 577-590, 1996.

CONWAY, A. R. A; KANE, M. J.; BUNTING, M. F.; HAMBRICK, D. Z.; WILHEIM, O.; ENGLE, R. W. Working memory span tasks: a methodological review and user's guide. *Psychonomic Bulletin & Review*, v. 12, n. 5, p. 769-786, 2005.

DANEMAN, M.; CARPENTER, P. A. Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior*, v. 19, n. 4, p. 450-466, 1980.

DANEMAN, M.; CARPENTER, P. A. Individual differences in integrating information within and between sentences. *Journal of Experimental Psychology: Learning, Memory and Cognition,* v. 9, p. 561-583, 1983.

DANEMAN, M.; GREEN, I. Individual differences in comprehending and producing words in context. *Journal of Memory & Language*, v. 25, p. 1-18, 1986.

DANEMAN, M.; MERIKLE, P. M. Working memory and language comprehension: a meta-analysis. *Psychonomic Bulletin & Review*, v. 3, n. 4, p. 422-433, 1996.

FINARDI, K. R. *Working memory capacity and the acquisition of a syntactic structure in L2 speech.* Tese (Doutorado em Língua Inglesa e Linguística Aplicada) – Pós-graduação em Letras/Inglês e Literatura Correspondente, Universidade Federal de Santa Catarina, Florianópolis, 2009.

FONTANINI, I.; WEISSHEIMER, J.; BERGSLEITHNER, J. M.; PERUCCI, M.; D'ELY, R. Memória de trabalho e desempenho em tarefas de L2. *Revista Brasileira de Linguística Aplicada*, v. 5, n. 2, p. 189-230, 2005.

FORTKAMP, M.B.M. *Working memory capacity and L2 speech production: an exploratory study.* Tese (Doutorado em Língua Inglesa e Linguística Aplicada) – Pós-graduação em Letras/Inglês e Literatura Correspondente, Universidade Federal de Santa Catarina, Florianópolis, 2000.

GREENSLADE, T.; BOUDEN, L.; SANZ, C. Attending to form and content in processing L2 reading texts. *Spanish Applied Linguistics,* v. 3, p. 65-90, 1999.

JUST, M. A.; CARPENTER, P. A. A capacity theory of comprehension: Individual differences in working memory. *Psychological Review*, v. 99, p. 122-149, 1992.

LEOW, R. P.; HSIEH, H.; MORENO, N. Attention to form and meaning revisited. *Language Learning*, v. 58, n. 3, p. 665-695, 2008.

LINDERHOLM, T.; VAN DEN BROEK, P. The effects of reading purpose and working memory capacity on the processing of expository text. *Journal of Educational Psychology*, v. 94, n. 4, p. 778-784, 2002.

MIYAKE, A.; JUST, M. A.; CARPENTER, P. A. Working memory constraints on the resolution of lexical ambiguity: maintaining multiple interpretations in neutral contexts. *Journal of Memory and Language*, v. 33, p. 175-202, 1994.

NORMAN, D. A.; SHALLICE, T. Attention to action: willed and automatic control of behavior. In: DAVIDSON, R. J.; SCHWARTZ, G. E.; SHAPIRO, D. (Eds.). *Consciousness and self regulation.* New York: Plenum Press, 1986. v. 4, p. 1-18.

OLSHAVSKY, J. E. Reading as Problem Solving: an investigation of strategies. *Reading Research Quarterly*, v. 12, n. 4, p. 654-674, 1977.

PASHLER, H. Attentional limitations in doing two things at the same time. *Current Directions in Psychological Science*, v. 1, n. 2, p. 44-48, 1992.

PREBIANCA, G. V. V. *Working memory capacity, lexical access and proficiency level in L2 speech production.*Tese (Doutorado em Língua Inglesa e Linguística Aplicada) – Pós-graduação em Letras/Inglês e Literatura Correspondente, Universidade Federal de Santa Catarina, Florianópolis, 2009.

ROBINSON, P. Attention, Memory, and the "Noticing" Hypothesis. *Language Learning*, v. 45, n. 2, p. 283-331, 1995.

SCHMIDT, R.W. The role of consciousness in second language learning. *Applied Linguistics,* v. 11, n. 2, p. 129-158, 1990.

SCHMIDT, R. W. Attention. In: ROBINSON, P. (Ed.). *Cognition and second language instruction.* Cambridge: University Press, 2001. p. 3-32,

TOMITCH, L. M. B. *Reading:* text organization perception and working memory capacity. Florianópolis: PGI/UFSC-ARES, 2003a.

TOMITCH, L. M. B. A capacidade de memória de trabalho e a ilusão da compreensão em leitura. *Fragmentos*, v. 24, p. 117-129, 2003b.

TOMITCH, L. M. B. (Org.). *Aspectos cognitivos e instrucionais da leitura.* Bauru, SP: EDUSC, 2008.

TOMLIN, R. S.; VILLA, V. Attention in cognitive science and second language acquisition. *SSLA,* v. 16, p. 183-203, 1994.

TORRES, A.C.G. *Working memory capacity and reader's performance on main idea construction in L1 and L2.* Tese (Doutorado em Língua Inglesa e Linguística Aplicada) – Pós-graduação em Letras/Inglês e Literatura Correspondente, Universidade Federal de Santa Catarina, Florianópolis, 2003.

TURNER, M.L.; ENGLE, R.W. Is working memory capacity task dependent? *Journal Memory and Language*, v. 28, p. 127-154, 1989.

VANPATTEN, B. Can learners attend to form and content while processing input? *Hispania*, 72, n. 2, p. 409-417, 1989.

VANPATTEN, B. Attending to form and content in the input: an experiment in consciousness. *SSLA*, v. 12, p. 287-301, 1990.

VANPATTEN, B. Evaluating the role of consciousness in second language acquisition: terms, linguistic features & research methodology. In: HULSTIJN, J. H; SCHMIDT, R. (Eds.). Consciousness in second language learning. *AILA review*, v. 11, p. 27-36, 1994.

VANPATTEN, B. Input processing in adult second language acquisition. In: VANPATTEN, B.; WILLIAMS, J. (Eds.). *Theories in second language acquisition* – an introduction. New Jersey: LEA, 2007. p. 115-136.

WEISSHEIMER, J. *Working memory capacity and the development of L2 speech production – an exploratory study.* Tese (Doutorado em Língua Inglesa e Linguística Aplicada) – Pós-graduação em Letras/Inglês e Literatura Correspondente, Universidade Federal de Santa Catarina, Florianópolis, 2007.

WEISSHEIMER, J.; MOTA, M. B. Individual differences in working memory capacity and the development of L2 speech production. *Issues in Applied Linguistics*, v. 17, n. 2, p. 93-112, 2009.

WONG, W. Modality and attention to meaning and form in the input. *SSLA*, v. 23, p. 345-368, 2001.

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