

# THE ACQUISITION OF A SYNTACTIC STRUCTURE IN L2 SPEECH: THE ROLE OF WORKING MEMORY CAPACITY

## LA ADQUISICIÓN DE UNA ESTRUCTURA SINTÁCTICA EN EL HABLA DEL L2: EL PAPEL DE LA CAPACIDAD DE MEMORIA OPERATIVA

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### ABSTRACT

The study investigated whether working memory capacity is related to the acquisition of a syntactic structure as it emerges in L2 speech. Following Information Processing Theory L2 speaking is conceptualized as a complex skill requiring both automatic and controlled processes for its execution. Controlled processes require attention, which is limited in working memory. L2 speech production and acquisition are explained in terms of the interplay of controlled and automatic processes as well as in terms of the operation of a dual code cognitive system made up of a rule-based and a memory-based system. Working memory is assumed to be involved in the execution of controlled processes operating in the rule-base system, which, in turn, are assumed to be at least partially responsible for the acquisition of a syntactic structure in L2 speech. Overall results show that working memory capacity is related to the acquisition of a syntactic structure in L2 speech. Linguistic accounts of L2 processing are used to complement and explain the acquisition of the syntactic structure. Results are discussed in terms of the linguistic and psycholinguistic complexity of the syntactic structure investigated in relation to working memory capacity, processing of form versus processing of meaning, the acquisition of a rule by the rule-based system, L1 and L2 linguistic variations and constraints in L2 speech production.

*Keywords:* Working memory, acquisition of syntactic structure, L2 speech.

## RESUMEN

En este estudio se analiza si la capacidad de memoria operativa está relacionada con la adquisición de una estructura sintáctica en el habla del L2. Partiendo de la Teoría del Procesamiento de Información, el habla en L2 es vista como una habilidad compleja que requiere procesos automáticos y controlados para su ejecución. Los procesos controlados necesitan una atención que en la memoria operacional es limitada. La producción y adquisición del habla en L2 es explicada a través de la operación de un sistema cognitivo doble, compuesto por un código basado en la regla y otro basado en la memoria. La memoria operacional está involucrada en la ejecución de los procesos controlados que operan en el sistema basado en la regla y que, por su parte, son parcialmente responsables de la adquisición de una estructura sintáctica en el habla del L2. En términos generales, los resultados de la investigación muestran que la capacidad de la memoria operacional está relacionada con la adquisición de una estructura sintáctica en el habla del L2. Un aporte lingüístico del procesamiento en L2 también es utilizado para complementar y explicar la adquisición de esa estructura sintáctica, con lo que se lleva a cabo una discusión de los datos desde una perspectiva de la complejidad lingüística y psicolingüística de la estructura investigada. La discusión también abarca el procesamiento de la forma versus el procesamiento del significado, la adquisición de una estructura por el sistema basado en la regla, variaciones lingüísticas en L1 y L2 y, finalmente, las limitantes de la producción del habla en L2.

*Palabras clave:* Memoria operacional, adquisición de una estructura sintáctica, habla en L2.

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## 1. INTRODUCTION

Among the many abilities that learners must develop in the course of L2 acquisition, speaking is the one which represents the greatest challenge for adult learners to master. Due to the difficulty associated with learning to speak a second language fluently on one hand, and its importance on the other, the present study represents an attempt to better understand L2 learning in general, and the processes involved in L2 speech acquisition in particular.

Information processing theory has been used as a framework to study both L2 acquisition and speaking in a systematic way for over two decades now (Fortkamp, 2008). A basic tenet of this approach is that human beings process information under the constraints of a limited capacity cognitive system –working memory– which functions as a computational arena, fueled by limited cognitive resources (attention) that support both the execution of various symbolic computations and the maintenance of intermediate products generated by these computations (Just & Carpenter, 1992; Miyake & Friedman, 1998). In this framework, working memory is treated as the theoretical construct that refers to the system

or mechanism underlying the maintenance of task-relevant information during the performance of a cognitive task (Miyake & Shah, 1999: 1) and its capacity is believed to be limited.

The earliest reference to limitations in this system was associated with short-term memory and became known as the *Magical Number Seven* introduced by Miller (1956), who noticed that the memory span of young adults was around seven elements or chunks. More recently, Cowan (2001) proposed that working memory capacity is about four chunks in young adults and fewer in children and old adults. Working memory capacity is usually assessed in terms of complex span tests which are dual-tasks comprising a memory span measure and a concurrent processing task. Measures of working memory capacity are strongly related to performance in other complex cognitive tasks such as reading comprehension and problem solving, and with measures of intelligence quotient (Miyake & Shah, 1999).

Within information processing theory, the construct of working memory has been used to explain human processing and there is evidence that individual differences in working memory capacity constrain a number of cognitive processes in first and second language comprehension and production. In the field of second language (L2) acquisition and processing, performance on working memory tasks has been shown to correlate with performance in various skills, including reading, writing, and grammar and vocabulary acquisition and development (for a recent review of literature, see Juffs & Harrington, 2011). To a lesser extent, individual differences in working memory capacity have also been examined in L2 speech performance (Bergsleithner, 2007; Daneman & Green, 1986; Daneman, 1991; Finardi, 2008; Finardi, 2010a; Fortkamp, 2000; Guara-Tavares, 2008; Mizera, 2006; O'Brien, Segalowitz, Collentine & Freed, 2006; Prebianca, 2010; Weisheimer, 2007; among others). Overall these studies show that individuals with larger working memory capacity tend to outperform those with smaller working memory capacity in L2 processing and, in the case of speaking, in aspects such as fluency, accuracy, complexity and weighted lexical density.

According to the aforementioned studies, working memory capacity plays an important role in the processes involved in L2 speech production and development. Based on this evidence, the present study goes a step further to suggest that working memory capacity may also play a role in the processes involved in L2 speech *acquisition*. More specifically, this study investigates whether working memory capacity is involved in the acquisition of a syntactic structure as it emerges in L2 speech. In order to do so, it seeks to understand the role of working memory capacity in two phases of the acquisitional process, which include the retention of a syntactic rule in L2 speech and the acquisition proper. For the sake of this study, retention is assumed to reflect the use of the form of the syntactic structure investigated whereas acquisition is assumed to reflect the use of the form and meaning together, in a communicative context. Retention is operationalized

as the production of the syntactic rule in L2 speech in a focused (Ellis, 2003) and immediate task test in which the target language structure cannot be circumvented, whereas acquisition is operationalized as the production of the syntactic structure in a communicative task test where other structures are possible.

Most accounts of L2 acquisition do not emphasize the role of L2 speech production as a potential variable to trigger acquisition (for a comprehensive review see Ellis, 2008). Among the rare accounts of L2 acquisition that include speaking (for example, Bialystok, 1982; 1991), Skehan's (1998) proposal for L2 learning was selected for this study because of the importance of (speech) production for acquisition in his view of L2 learning. According to Skehan (1998), L2 learners are driven by a focus on meaning. Drawing on Swain (1985), Skehan claims that production (for him, through tasks) is necessary to force the learner to focus on form, syntacticalizing language.

Skehan's view of L2 learning is rooted in dual-process theories of mind which conceptualize our cognitive system as being subdivided into: a memory-based system responsible for synthesis and a rule-based system responsible for analysis (Skehan, 1998). In the case of language use and acquisition, according to Skehan, the memory-based system is responsible for synthesizing language, producing, for example, formulaic language, and the rule-based system is responsible for syntacticalizing language, computing, for instance, grammar rules. For Skehan, production is the means through which learners engage in cycles of analysis and synthesis of language, thus adding items to and transferring from the memory-based and the rule-based system, thus using one system or another depending on processing conditions. The rule-based system (which is the focus of this study) is responsible for computations and requires attention, which is assumed to be limited in working memory.

Although previous studies (Bergsleithner, 2007; Finardi, 2008; Finardi & Prebianca, 2006; Guara-Tavares, 2008; O'Brien *et al.*, 2006; Prebianca, 2010; Weissheimer, 2007) have demonstrated that individual differences in working memory capacity can account for performance in L2 speech production, the relationship between working memory capacity and L2 speech development, to the best of our knowledge, is still in its infancy, with only few studies contributing insights (Finardi, 2010a; Finardi & Weissheimer, 2009; Weissheimer, 2007; Weissheimer & Mota, 2009).

We draw on existing research on working memory capacity and L2 speech production to advance the proposal that this system may also be involved in the retention and acquisition of a syntactic structure in L2 speech. In order to do that, the retention and acquisition of a syntactic structure will be viewed as the production of a syntactic rule by the rule-based system (Skehan, 1998), which operates by means of controlled processes in working memory.

Notwithstanding the psycholinguistic assumption that at least some aspects of an L2 can be learned in adults like other skills (McLaughlin, 1987), this study

acknowledges the fact that cognitive theories are but one way of explaining L2 learning and thus psycholinguistic accounts of L2 acquisition are complemented by linguistic accounts of L2 processing. In the present study we assume that cognitive variables (such as working memory capacity) play an important role in the retention and acquisition of a syntactic structure in L2 speech, but we also acknowledge the possibility that variables such as the linguistic complexity of the structure being learned and parameter resetting<sup>1</sup> in the L2 (White, 1983) may also affect the acquisition of a syntactic structure in L2 speech.

## 2. METHOD

In this study working memory was assumed to comprise the system responsible for storing and processing information online during the performance of complex cognitive tasks (Miyake & Shah, 1999) and limitations in this system were assumed to reflect the efficiency with which individuals can perform the task-specific ability of orally producing sentences (Daneman, 1991; Daneman & Carpenter, 1980; Fortkamp, 2000). Working memory capacity was assessed by means of the speaking span test based on Daneman (1991) and adapted to L2 (Weissheimer, 2006).

The English (L2) target language structure investigated was agreeing with sentences using the formula (*So+aux+I* and *Neither+aux+I*). This structure is assumed to be a complex linguistic structure because it requires verb movement for processing as well as parameter resetting<sup>2</sup> in L2 for acquisition (White, 1991). The retention of this syntactic structure is instantiated in this study as the production of the target language structure (*So+aux+I* and *Neither+aux+I*) in an immediate, focused task test (Ellis, 2003), which requires the use of this specific linguistic structure in obligatory contexts. Acquisition is instantiated as the production of the target language structure in an unfocused, delayed task test, in which other linguistic structures are possible (see the Appendices). The production of this grammar rule in L2 speech production is assumed to take place in the rule-based system (Skehan, 1998) by means of controlled processes which require attention and thus are limited by working memory capacity.

After a pretest aimed at assessing L2 proficiency and knowledge of the target language structure, forty-six adult learners of English as a foreign language (EFL) were selected to participate in the study. These participants had studied English for one semester and results of the pretest showed they did not know the target language structure.

<sup>1</sup> According to White (1983), learners at the initial stages of L2 acquisition are likely to show the effect of the L1 parameter in their L2 processing.

<sup>2</sup> That is, changing the parameter used in L1.

Brazilian Portuguese, the participants' L1, differs from English (L2) in the use of the syntactic structure investigated. Whereas in Portuguese agreement is usually achieved by repeating the main verb in a sentence as in (*A– Eu falo espanhol. B – Eu também falo.*), in English the speaker has to undergo a different syntactic computation to produce the target language structure so as to agree with a sentence, using an auxiliary verb which agrees with the main verb heard in the prompt as in (*A– I speak Spanish. B– So do I.*). In Portuguese agreement follows the canonical order of subject and verb whereas in English this form is used in the prompt but not in the structure used to agree. Moreover, in English there is an encapsulation of the idea expressed in the prompt in the particles *So* and *Neither*, which are placed at the front of the phrase. This agreement structure in English also requires the substitution of the main verb and verb inversion, whereas in Portuguese none of this is necessary.

The study is mainly quantitative since statistical procedures are used to answer the hypotheses raised, although interviews with the participants were also carried out to collect data for the qualitative analysis and data triangulation. The general research question of whether there is a relationship between working memory capacity and the retention and acquisition of a syntactic structure in L2 speech was answered mainly with Pearson correlations. This research question generated three hypotheses:

Hypothesis 1: Participants' performance in the retention test will be more accurate than in the acquisition test.

Hypothesis 2: There is a positive and statistically significant correlation between L2 speaking span test scores and accuracy scores in the retention test. Higher spans are more accurate in the retention test than lower spans.

Hypothesis 3: There is a positive and statistically significant correlation between L2 speaking span test scores and accuracy scores in the acquisition test. Higher spans are more accurate in the acquisition test than lower spans.

Three instruments of data collection were used in this study: two to assess target language use (one for retention and one for acquisition) and one to assess working memory capacity. All the tests were administered individually and interviews with the participants were carried out after each test. The target language tests comprised two speaking tests –one focused and one unfocused– to test target language retention and acquisition, respectively. The target language tests were piloted in a previous study (Finardi, 2007; Finardi, 2010b) yielding positive results about the relationship between working memory capacity and the processing that was assumed to take place in the acquisition of the target language structure.

The target language test for retention was a focused test and required participants to agree with a trigger sentence spoken by the researcher using the formula (*So+aux+I* or *Neither+aux+I*). A treatment (instruction focused on form) was administered to all the participants before the retention test. After the treatment, each participant was tested and interviewed individually. With each participant, the researcher read aloud 10 trigger sentences, with which the participant had to agree using the formula learnt in the treatment. For instance, if the researcher said *I love chocolate*, participants had to agree using *So do I*, regardless of the fact that they might not like chocolate.

The target language structure test for acquisition was similar to the retention test in the sense that it also consisted of 10 sentences (similar to but not the same as the retention test), but it differed from the retention test in that now participants were required to agree or disagree with the sentences heard using any structure they wanted to do so. Because participants could use other grammatical structures to agree or disagree with the trigger sentences this was an unfocused, communicative test. The reason why we wanted participants to agree or disagree with the sentences heard was to make sure that they were processing both meaning and form to answer the questions correctly. Moreover, so as to assume that acquisition had taken place it was necessary to verify the production of the target language structure in a communicative context and not in a focused test in which the target language structure is unavoidable.

The working memory test, based on Daneman (1991), was adapted to English as an L2 (Weissheimer, 2006). The test was piloted in Finardi (2007). The speaking span test consisted of 60 unrelated words organized in five sets of 2, 3, 4, 5 and 6 words which were presented individually on a computer screen for one second. Participants were required to read the words silently, trying to memorize them. The words were then followed by question marks in the screen signaling the number of sentences that participants were required to make. When all the words in the set had been presented, participants saw the question marks and tried to make sentences orally. Participants were instructed to make one sentence per word read. The sentences should be in a grammatically correct form and should follow the order in which the words were presented.

After the pretest to select participants, the three tests –retention, acquisition and working memory– were administered, in this order, with a two-week interval between each test. Each test yielded two scores, one strict and one lenient. The strict score considered only correct sentences (regarding form, meaning and order) and assigned one point for each answer whereas the lenient score considered partially correct answers and assigned half a point for each answer. A summary of the variables created in this study is presented next: RS (retention strict), RL (retention lenient), AS (acquisition strict), AL (acquisition lenient), L2 S (L2 speaking span strict), L2 L (L2 speaking span lenient).

The results of the tests were submitted to three raters who were familiar with the scoring procedures of the speaking span test. Correlations were run among the scores determined by the three raters and a decision was made to accept only strong correlations (above .7).

### 3. RESULTS

Hypothesis 1 predicted that the performance in the retention test (where participants had to process only the form of the structure) would be more accurate (because the test was less demanding) than the performance in the acquisition test (in which participants had to process both the form and meaning). The means of these tests are presented in Table I.

**Table I.** Descriptive statistics for the retention and acquisition tests.

	N	Minimum	Maximum	Mean	Std. Deviation
retention strict	46	1.0	9.0	6.10	2.121
retention lenient	46	3.5	9.5	7.76	1.413
acquisition strict	46	1.0	9.0	5.02	2.380
acquisition lenient	46	1.5	9.5	6.25	2.270

Valid N (listwise). 46

So as to verify whether the difference in performance in the retention and acquisition tests was statistically significant, a series of parametric paired samples *t*-tests were run. Results of these tests can be seen in Table II and show that the difference in performance between the retention and acquisition tests was statistically significant, thus confirming hypothesis 1.

**Table II.** Paired samples *t*-tests between retention and acquisition tests.

	Paired Dif Mean	t	df	Sig. (2-tailed)
Pair 1 retention strict - acquisition strict	1.08	3.69	45	.001*
Pair 2 retention lenient - acquisition lenient	1.54	5.46	45	.000*

N=46

\* Correlation is significant at the 0.01 level (1-tailed).

Hypothesis 2 predicted that there would be positive and statistically significant correlations between scores of the L2 SST and the retention test (focused). Table

III shows that hypothesis 2 is confirmed. Though weak, there were positive and statistically significant correlations between the L2 SST and the retention test.

**Table III.** Correlation coefficients between averages in L2 SST and retention test.

	average L2 strict	average L2 lenient
retention strict	.275*	.264*
retention lenient	.283*	.289*

N=46

\* Correlation is significant at the 0.05 level (1-tailed).

Hypothesis 2 also predicted that individuals rated as higher spans would be more accurate in the retention of the target language structure than lower spans. So as to check this hypothesis, the L2 SST scores calculated by rater 1 (R1)<sup>3</sup> were converted into nominal variables using the tertile split extreme groups design in which the sample is divided in three and the middle range is ignored. High span individuals were coded as 1, intermediate span individuals were coded as 2 and ignored in the analysis, and low span individuals were coded as 3. Independent samples *t*-tests were run between the retention test and the L2 SST nominal scores to check if this difference was statistically significant. Results of the *t*-tests can be seen in Table IV and show that the means for the performance in the retention test did not vary significantly for high (N=16) and low (N=11) span participants. The difference in performance between the two groups was not statistically significant for the retention strict test  $t(25) = 1.86, p > .05$  but it was for the retention lenient test  $t(25) = 2.08, p < .05$ , that is, higher spans retained more the target language structure than lower spans but this difference was not statistically significant in the case of the retention strict test.

**Table IV.** Independent samples t-tests between L2 SST strict nominal and retention test.

	L2 nominal strict	N	Mean	Std. Deviation	Std. Error Mean
retention strict	high	16	6.8	1.834	.458
	low	11	5.5	1.572	.474
retention lenient	high	16	8.5	1.263	.316
	low	11	7.5	1.214	.366

Independent Samples Test

<sup>3</sup> Rater 1 was responsible for administering the tests and collecting the data and thus was selected as the main rater for having a more direct contact with the data.

Continuation Table IV.

		t-test for Equality of Means		
		t	df	Sig. (2-tailed)
retention strict	Equal variances assumed	1.86	25	.074
retention lenient	Equal variances assumed	2.08	25	.047

So as to check if this difference was also statistically significant for the lenient scores of the L2 SST, another set of independent *t*-tests was run between the retention test and the L2 SST with lenient scores. Results can be seen in Table V which shows that the means for the two groups were not very different. There is a positive and statistically significant relationship between working memory capacity in L2 and the retention of a syntactic structure in L2 speech and, although the means for the higher spans were higher than the means for the lower spans in the retention test, the difference in their performance was not statistically significant in the case of the lenient score of L2 SST and the retention strict score.

**Table V.** Independent samples *t*-tests between the L2 SST lenient nominal and the retention test.

	L2 nominal lenient tertile	N	Mean	Std. Deviation	Std. Error Mean
retention strict	high	16	6.62	1.668	.417
	low	9	5.88	2.315	.772
retention lenient	high	16	8.43	1.153	.288
	low	9	7.66	1.581	.527

Independent Samples Test

		t-test for Equality of Means		
		t	df	Sig. (2-tailed)
retention strict	Equal variances assumed	.92	23	.367
retention lenient	Equal variances assumed	1.4	23	.174

The most important question pursued by this study was materialized in hypothesis 3 which predicted that there would be positive and statistically significant correlations between scores of the L2 SST and scores in the acquisition test. Table VI shows the results of these correlations and indicates that there were positive and statistically significant correlations between scores on the L2 SST and the acquisition test.

**Table VI.** Correlation coefficients between L2 SST (rater 1) and acquisition test.

	acquisition strict	acquisition lenient
L2 SST strict	.584**	.688**
L2 SST lenient	.404**	.565**

N=46

\*\* Correlation is significant at the 0.01 level (1-tailed).

Hypothesis 3 also predicted that individuals rated as higher spans would be more accurate in the acquisition test than lower spans. So as to verify this hypothesis, independent samples *t*-tests were run between the acquisition test and the nominal variables of the L2 SST strict scores. Results can be seen in Table VII which shows that there was a statistically significant difference in performance between the high (N=16) and low (N=11) span individuals in the acquisition test.

**Table VII.** Independent samples t-tests between L2 SST strict nominal and acquisition test.

	L2 nominal strict tertile	N	Mean	Std. Deviation	Std. Error Mean
acquisition strict	high	16	6.31	1.887	.472
	low	11	2.90	2.119	.639
acquisition lenient	high	16	8.06	1.340	.335
	low	11	4.18	2.040	.615

Independent Samples Test

		t-test for Equality of Means		
		t	df	Sig. (2-tailed)
acquisition strict	Equal variances assumed	4.38	25	.000
acquisition lenient	Equal variances not assumed	5.54	25	.000

In order to check whether this difference was also statistically significant for the lenient scores of the L2 SST, another set of independent samples t-tests was run. Results can be seen in Table VIII which shows that when calculated with nominal lenient scores, higher span individuals (N=16) performed better in the acquisition test than lower (N=9) span individuals as shown by their means. Hypothesis 3 predicted that higher spans would be more accurate than lower spans in the acquisition test. Results of the *t*-tests show that higher spans did in fact

perform better than lower spans in the acquisition test but this difference was only statistically significant for the acquisition lenient score, thus, the second part of hypothesis 3 is not confirmed.

**Table VIII.** Independent samples t-tests for L2 SST lenient nominal and acquisition test.

	L2 lenient	N	Mean	Std. Deviation	Std. Error Mean
acquisition strict	high	16	6.12	1.708	.427
	low	9	3.77	2.991	.997
acquisition lenient	high	16	7.93	1.237	.309
	low	9	4.77	2.991	.997

  

Independent Samples Test				
t-test for Equality of Means				
		t	df	Sig. (2-tailed)
AS	Equal variances not assumed	2.16	23	.053
AL	Equal variances not assumed	3.02	23	.013*

Acquisition Strict – AS, Acquisition Lenient - AL

\* Correlation is significant at the 0.05 level.

Taken together, results of the study show that the acquisition test was more cognitively demanding than the retention test and that working memory capacity is related to the acquisition of a syntactic structure in L2 speech. In the discussion that follows, this relationship is explained in terms of the cognitive and linguistic processing required for the production and acquisition of the target language structure.

#### 4. DISCUSSION

The main objective of this study was to investigate whether working memory capacity was related to the retention and acquisition of a syntactic structure in L2 speech. Drawing on information processing theory and dual process theories, we assumed that the acquisition of a syntactic rule by the rule-based system would require controlled processes and attention, which are limited in working memory capacity. Moreover, based on linguistic accounts of language processing (for example White, 1992), we assumed that the target language structure investigated (agreeing with *So+aux+I* and *Neither+aux+I* in short responses in L2 speech) would be complex (due to verb movement and agreement) and difficult to acquire

since the processing of this language structure by Brazilian Portuguese speakers might involve parameter resetting (White, 1983). Based on these assumptions, we hypothesized that working memory capacity scores would correlate with scores in the retention and acquisition tests.

The first hypothesis predicted that participants' performance in the retention test would be more accurate than in the acquisition test. The acquisition test required participants to process the sentences heard for meaning and form, which made it more demanding than the retention test. In the retention test, participants were required to process the sentences heard mainly for form. The fact that participants were more accurate in the retention test than in the acquisition test may be taken as evidence for the idea that the type of computation required to provide a formula is less cognitively demanding than processing strings of information both semantically and syntactically. It is now widely accepted in SLA research that learners' attentional resources are shared between processing of meaning and processing of form of the input they are exposed to. VanPatten (1990 and elsewhere), for instance, has consistently argued that post-critical period learners tend to prioritize meaning, thus leaving fewer resources available to attend to form. Likewise, Skehan (1998, for instance) argues that, because of limits in processing and attentional capacity, learners are affected by trade-off effects between accuracy and fluency. In the case of the retention test adopted in the present study, the processing of meaning was minimized, thus optimizing accurate performance.

The second hypothesis concerned the relationship between working memory capacity and the retention of a syntactic structure in L2 speech and predicted a positive and statistically significant correlation between scores in the L2 speaking span test and the retention test. Moreover, it predicted that higher spans (individuals with more working memory capacity) would retain more the target language structure when compared to lower spans. There were positive and statistically significant correlations between scores in the L2 SST and the retention test, but the difference in performance of high and low span individuals in the retention test was only statistically significant for the lenient scores (which assigned half a point for partially correct sentences) of the retention test and the strict scores (which assigned one point for sentences which were both grammatically correct and in the correct order or presentation) of the L2 SST. These results may be explained by the variability of scoring criteria for the lenient scores of the L2 SST (Finardi, 2010a) and the little room for variability in the case of the strict scores of the retention test. Recall that three raters were used in the study and that in the SST participants had to make grammatically correct sentences with the words that appeared in the computer screen in the right order of presentation. The lenient score of the SST allowed variability in scoring criteria since participants were free to produce any sentence with the word given, whereas in the retention test the possibility of sentence production was limited to short sentences such as *So do*

*I* or *Neither do I*. Had results been derived by scores produced by another rater (instead of rater 1 used for all the nominal variables), this hypothesis would have been confirmed.

Hypothesis 3 predicted a positive and statistically significant correlation between scores of the L2 working memory capacity test and scores in the acquisition test with higher spans acquiring the target structure more than lower spans. This hypothesis was confirmed, but given the strength of association between these two variables (working memory capacity and the acquisition of L2 speech) it is possible to suggest that other variables are involved in the acquisition of the target language structure. Perhaps the linguistic complexity of the target language structure investigated and parameter resetting in L2 are also at play. We now turn to this issue.

The processing of the target language structure investigated is assumed to be cognitively complex –because it involves computation related to the processing of form and meaning, simultaneously and linguistically complex– because it involves verb movement (White, 1992) and auxiliary verb ellipsis. Cross linguistic analyses (for example, Gass & Schachter, 1989) suggest that the processing of a target language structure may be even more complex for L2 speakers whose L1 does not involve auxiliary movement in agreement, as is the case of the Brazilian Portuguese speakers in this study. In Portuguese (L1) agreement involves main verb repetition and does not require auxiliary verb ellipsis or movement. Previous linguistic accounts of L2 processing (for example Flynn, 1987, 1989), suggest that L2 learners use principles of syntactic organization in L1 acquisition for the construction of the L2 grammar. Where principles involve parameters, L2 learners in early stages of acquisition (as is the case of the participants in this study) recognize a match or a mismatch in the values of these parameters between the L1 and the L2. When L1 and L2 values differ, L2 acquisition is disrupted as learners must assign new values to cohere with the L2 grammar. When values match, L2 is facilitated. In the case of the present study parameter resetting was required in order for the target structure to be acquired. This task of assigning new values seems to have been affected by individual differences in working memory capacity: those learners with a greater ability to process and maintain information simultaneously were also more able to realize the computation involved in the processing of the target structure.

## 5. CONCLUSION

The main objective of this study was to investigate the extent to which working memory capacity was related to the retention and acquisition of a syntactic structure in L2 speech. Based on information processing theory, more specifically, dual-process theories, it was assumed that the acquisition of a syntactic rule by the rule-

based system would use controlled processes and attention, which in turn were assumed to be limited in working memory capacity. Moreover, based on linguistic accounts of language processing, it was assumed that the target language structure investigated (agreeing with *so+aux+I* and *neither+aux+I* in short responses in L2 speech), would be complex (due to verb movement and agreement) and difficult to acquire since the processing of this language structure by Portuguese speakers involved parameter resetting. Although the evidence produced by the study represents preliminary evidence that individual differences in working memory capacity are related to the acquisition of a syntactic structure as it emerges in L2 speech, it still remains to be seen whether this capacity can be expanded (and if so how) and how it can be best measured (Juffs & Harrington, 2011).

One pedagogical implication that stems from the present study concerns the teaching of complex syntactic structures. System capacity must be taken into consideration since it affects how learners process form and meaning simultaneously. In this sense, research on L2 processing, especially that related to instructed second language acquisition (VanPatten, 2007), can shed light on the relationship between acquisition problems and system capacity. Regarding the role of individual differences in working memory capacity, recent studies have investigated the effects of training on working memory capacity (see, for instance, Shipstead, Redick, & Engle, 2012). In L2 acquisition, Weissheimer (2007) suggests, and we agree, that one way to help learners overcome their limitations in working memory capacity is to teach strategies to lexicalize language. That suggestion is also aligned with Skehan's (1998) view of L2 production as being a movement from the memory-based system (which does not require computation and runs on automatic processes) to the rule-based system (which requires attention and controlled processes) and vice-versa, thus allowing learners to produce lexicalized or syntacticalized language, depending on processing conditions. If learners have a repertoire of lexicalized language to enable fluency, they may use their limited cognitive resources to produce more complex or accurate language. When learners lexicalize certain aspects of language, they can devote their attentional resources to process other aspects of language (syntax being one) that may not be lexicalized.

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## Appendices

### Pretest

Instruction (given in L1) – Complete the sentences with So + aux + I or Neither + aux + I.

- 1) I work near here. \_\_\_\_\_
- 2) I can't speak Japanese. \_\_\_\_\_
- 3) I've got a dog. \_\_\_\_\_
- 4) I can cook very well. \_\_\_\_\_
- 5) I'll stay in next weekend. \_\_\_\_\_
- 6) I don't like cats. \_\_\_\_\_
- 7) I didn't go out last night. \_\_\_\_\_
- 8) I've been to Camboriú. \_\_\_\_\_
- 9) I won't study tonight. \_\_\_\_\_
- 10) I haven't got an MP3 player. \_\_\_\_\_

### Focused Test – Retention

Instruction ( L1) – Agree with the following sentences using So + aux + I or Neither + aux + I.

- 1) I'm Brazilian.
- 2) I don't like cats.
- 3) I went out last night.
- 4) I'm not an astronaut.
- 5) I didn't see a film yesterday.
- 6) I love chocolate.
- 7) I can speak Portuguese fluently.
- 8) I have a black car.
- 9) I can't speak Chinese.
- 10) I don't have a cat.

### **Unfocused Test – Acquisition**

Instruction (L1) – Agree or disagree with the sentences heard.

- 1) I don't have a million dollars.
- 2) I've already been to Canasvieiras.
- 3) I can speak four languages.
- 4) I can't speak Chinese.
- 5) I'm not Brazilian.
- 6) I can't speak Portuguese.
- 7) I'm going to travel tonight.
- 8) I don't have friends.
- 9) I'm going to take a shower tomorrow.
- 10) I don't study Russian.