Grammatical Complexity as Mediated by Proficiency and Working Memory in L2 Oral Production:

Measuring Syntactic Complexity versus Grammatical Variety

Submitted by

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ABSTRACT

The purpose of the study reported in the present article is to explore whether differences in second language proficiency and working memory capacity affect the grammatical complexity of second language oral performance. Data from a film retelling task were used to analyze the oral grammatical complexity of a group of 91 L1 Catalan/Spanish learners of L2 English from the GRAL group corpus. Syntactic complexity and grammatical variety measures were employed for the analysis. In order to account for text length differences in the narratives, the square root of the denominator was used rather than the denominator itself. Results suggest that, when using this operationalization, both syntactic complexity and grammatical variety measures end up being positively correlated with L2 proficiency. On the other hand, no relationship was found between any of the employed measures and working memory capacity. The results are discussed in the light of previous research on the relationship between second language grammatical complexity and both proficiency and working memory capacity.

KEY WORDS:

Grammatical complexity, syntactic complexity, grammatical variety, second language proficiency, working memory capacity, second language oral performance.

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LIST OF ABBREVIATIONS

SLA = Second Language Acquisition

L1 = First language

L2 = Second language

GRAL = Language Acquisition Research Group

OPT = Oxford Placement Test

Rspan_P = Reading Span Score

SNs = Sentence Nodes

ASU = Analysis of Speech Unit

ENP = Elaborated Noun Phrases

INFC = infinitival clauses

INGC = -ing clauses

WHC = wh-clauses

MDL = frequency of modals

CON = frequency of conditionals

I. INTRODUCTION

Every day different goals instigate millions of people all over the world to learn second languages. These learners may have several different motivations ranging from the desire to know more about different cultures to the need of migrating to richer countries. Notwithstanding, most of them share one thing: they wish to communicate effectively with natives speakers when using a second language, especially through oral production. In order for them to meet these demands, learners usually need to produce speech which is fluent, accurate and complex. During the last two decades there has been an increased interest in the measurement of second language learners' oral production, as encompassing three different dimensions which have been commonly referred to as *fluency*, *accuracy* and *complexity* (CAF).

Pallotti (2009) claims that accuracy can be considered as the more straightforward construct of the triad because it is related to particular language norms. This assumption reveals the fact that accuracy reflects whether learner's production parallels that of native speakers. However, as Wolfe-Quintero, Inagaki and Kim (1998, as cited by Palloti, 2009:592) suggest, 'whether that comparison reveals or obscures something about language development is another question'. In other words, accuracy does not necessarily inform about the interlanguage level of the learner, it is just an indication of whether it conforms to a series of native speaker norms or not. Similarly, second language learners' fluency is also compared against how fluent native speakers are. Fluency is a complex construct in the sense that it can refer to three very different dimensions, i.e. cognitive fluency, utterance fluency, and perceived fluency (Segalowitz, 2010). In fact, even within the most widely explored type of fluency in CAF studies, namely *utterance fluency*, it has been operationalized by decomposing it into several different subdimensions. For instance, Mora and Valls-Ferrer (2012) developed a study in which they employed measures of CAF to investigate the differential effects that formal instruction and a study abroad period had on L2 learners. In order to calculate *fluency* they used ten distinct fluency measures ranging from *words per minute* to *number of pauses per minute*. Finally, the concept and operationalization of complexity is the most controversial of the triad because of its multiple meanings (Pallotti, 2009). In fact, as Pallotti argues, this complication is already found in the way the word *complexity* is used. First, it is employed to describe not only the performance of the learners, but also the conceptual, attentional and memory demands that the

structure of tasks imposes on learners' processing (Robinson, 2001). In addition, even within the frame of performance of second language learners, the word *complexity* designates various features of learners' output, varying from lexical complexity to grammatical complexity. For the purposes of the present study, from the three measures of CAF, attention will be focused on the third dimension of the triad, linguistic complexity, and more specifically, on grammatical complexity.

Probably one of the consequences of these different senses of the same term is the fact that while fluency, accuracy, and, lexical complexity normally seem to discriminate between learners with different proficiency levels, grammatical complexity seems to fail to guarantee this distinction. Frequently, at early stages there is a positive correlation between grammatical complexity and proficiency but, at some point in development, complexity stops increasing and it even decreases at higher levels of proficiency (Palloti, 2009). As a consequence, those studies which have tried to correlate grammatical complexity and proficiency level have normally found that there is no correlation between the two. This, of course, is a crucial problem because the other CAF dimensions, namely L2 fluency, accuracy and lexical complexity have been found to be effective in classifying learners across levels of proficiency. Similarly, studies investigating the relationship between working memory (WM) and grammatical complexity have found that there is no significant relation between the two (e.g. Trebits & Kormos; Gilabert & Muñoz, 2010), while WM has been shown to correlate with lexical complexity. Given that different structures impose different processing demands on learners, it was thought that WM capacity may play role. Since people display individual differences in processing and storage, a series of studies have tried to tag into the relationship of WM and complexity (as well as the other dimensions of CAF).

The main objective of this exploratory study is to find measures of grammatical complexity which may explain differences in relation to two individual differences: proficiency and working memory. The following section is an overview of what grammatical complexity is and how it has been operationalized, and the findings in previous research studies on the relationship between grammatical complexity and both proficiency and working memory. Afterwards, the study is presented and the results are discussed in the light of previous findings. Finally, the conclusions, some limitations and ideas for further research are drawn.

II. BACKGROUND OF THE STUDY

2.1. Grammatical Complexity: Definition and Operationalization

The term *grammar* refers to the linguistic structure of not only clauses and phrases, but also words. For the purpose of language to be meaningful, vocabulary items need to be organized in a specific order and they also need to follow an internally organized order. Otherwise speakers fail to construct sentences and modify lexemes in a way that permits them to communicate effectively with other speakers.

As Bulté and Housen (2012) observe, there is still no generally agreed definition of *complexity* in the second language acquisition (SLA) field. This is probably the reason why many SLA researchers have committed their work to the definition and operationalization of *complexity* as well as on the evaluation and revision of previous uses of this measure. Therefore, it has been proved that there is no clear understanding of the nature of this linguistic dimension and, as a consequence, authors have attempted to provide different definitions which are normally not precise enough. Bulté and Housen (2012) cite different works aiming at describing the construct *linguistic complexity*:

> "[complexity is the] use of more challenging and difficult language… Complexity is the extent to which leaners produce elaborated language"
> (R. Ellis & Barkhuizen, 2005:139)

> "Grammatical and lexical complexity mean that a wide variety of both basic and sophisticated structures and words are available to the learner"
> (Wolfe-Quintero, Inagaki, & Kim, 1998:69,101)

> "Complexity refers to… the complexity of the underlying interlanguage system developed" (Skehan, 2003:8)

Similarly, Skehan (2009) states that more advanced language leads to complexity and to successful performance. This definition is, from our point of view, rather circular, since it introduces other constructs (i.e. *successful performance, advanced language*) which are also misleading and which are not operationalized either. Iwashita (2008), on the other hand, described grammatical complexity as being exclusively a feature of "utterances at the level of clause relations, that is, the use of conjunctions and, in particular, the presence of subordination". This definition,

however, ignores many other operationalizations that are related to grammatical complexity, such as complexification at the phrasal level.

Hence, these examples show how differently and, sometimes, vaguely researchers have characterized linguistic complexity in their studies. In fact, Bulté and Housen (2012) suggest that the inconsistent results that have been found in studies employing *complexity* as a variable may have been caused by the fact that L2 complexity has normally been operationalized and defined in general and, often, circular terms.

As with every construct, linguistic complexity can be analysed from three different levels: the abstract theoretical level, the observational level of language performance, and the operational level (Bulté & Housen, 2012:27-28). Defining complexity (theoretical level), presenting how it is exhibited in real L2 performance (observational level), and how they can be measured (operational level) are crucial factors for the validation of the studies that use complexity measures (Bulté & Housen, 2012). According to Bulté and Housen, there are two main grammatical complexity sources, namely *syntactic* and *morphological* complexity, which can be further subdivided into smaller subcomponents (see Figure 1).

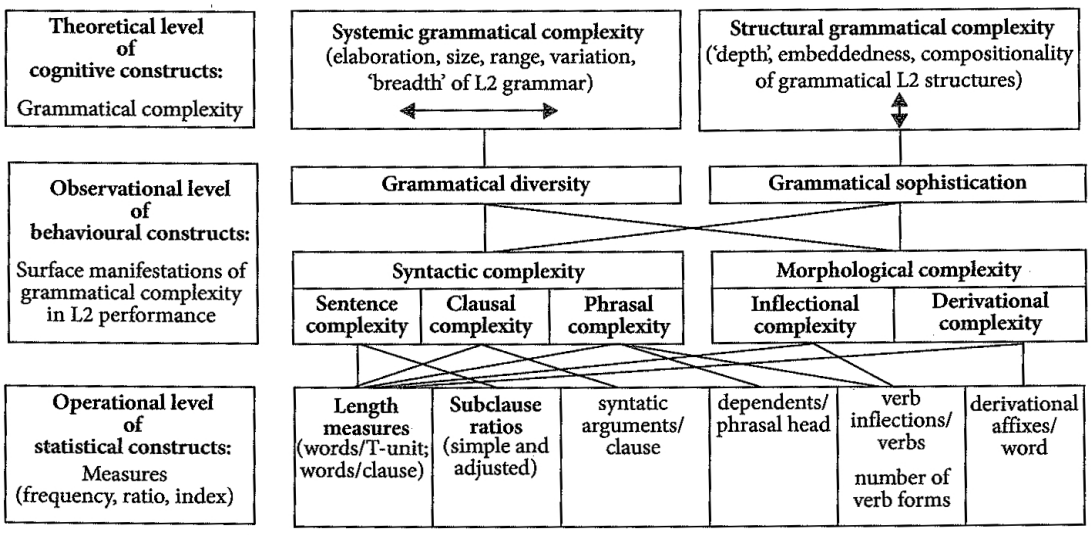

Figure 1: Grammatical complexity at different levels of construct specification (Bulté and Housen, 2012:37)

In their categorization, they link all the measurements together, thus creating a complex web where all the constructs are related to one another (see figure 1). For instance, syntactic complexity and grammatical sophistication, both included within the observational level, are considered to be related to both *systemic grammatical complexity ("elaboration, size, range, variation"*) and *structural grammatical complexity* (*"emdeddedness, compositionality, grammatical structures"*) at the theoretical level. We would like to claim, however, that at the observational level there are two different constructs within grammatical complexity, namely syntactic complexity – related only to structural grammatical level at the theoretical level; and grammatical variety – related only to systematic grammatical complexity at the theoretical level. On the other hand, at the operational level, Bulté and Housen categorize different operationalizations according to the type of grammatical complexity. The two main groups are syntactic and morphological complexity. Syntactic measurements include those that are related to the structure of sentences (e.g. length measurements, subordination measurements). Moreover, they also include a category which they name "*other (± syntactic sophistication)*". This category consists of frequency counts (e.g. frequency of wh-clauses). Similarly the morphological group includes frequencies and varieties. As will be further described in the methodological section, we believe that all frequency lists should be included within one single group because they are fundamentally similar to one another and different from the other structural measurements. As a consequence, in this study a new group with all the frequency measures has been created. Moreover, because this new group contains both morphological and syntactic measures, it will be referred to as *grammatical variety*.

2.1.1. Syntactic Complexity

It is syntactic complexity, as opposed to grammatical variety, that in most previous research has been used as one of the constructs, through a variety of specific operationalizations, to describe the oral outcomes of second language learners. Many of these measurements had already been used in the field of L2 writing. Larsen-Freeman (2009) states that a few years after the birth of SLA research, which is generally agreed to have occurred in the 1970s, Hakuta (1976, as cited in Larsen-Freeman, 2009) already aimed at measuring second language development. This had at that time already been accomplished by researchers investigating how English was acquired as a first language. As Larsen-Freeman (2009) states, these researchers operationalized language

development by calculating the mean length of utterance (MLU), which can obviously be related to grammatical complexity rather than to the other two members of the CAF triad, namely fluency and accuracy, or to lexical variety, which is frequently included within *complexity*. According to Larsen-Freeman (2009), both Hakuta's (1976) and Larsen-Freeman's (1976, as cited in Larsen-Freeman, 2009) requested the creation of an SLA Index of Development. In order to operationalize this construct, Larsen-Freeman (1976) adapted an already employed measurement by Hunt (1970, as cited in Larsen-Freeman, 2009). Hunt had used a T-unit (minimal terminal unit) for the analysis of development of L1 English writers. T-unit represented an independent clause and all the dependent clauses associated to it. As Larsen-Freeman (2009) expounds, the reason why Hunt used T-units instead of MLU is that he acknowledged that even children could write long structures by using only coordinate sentences.

> Some years later, these researchers stated that those measurements that best captured grammatical complexity were clauses per T-unit, number of dependent clauses per T-unit, and also number of dependent clauses per total clauses. Notwithstanding, the first time these CAF measures were referred to as tools for calculating learner's production on tasks, and not to investigate development, was in Skehan (1989). Regarding L2 oral production, it was found that T-units were still problematic for the analysis of oral performance, since T-units referred to those constructions located between two periods. As a consequence, AS-units (Analysis of Speech-units) was established as a measurement which could be used for both oral and written data (Foster, Tonkyn, & Wigglesworth, 2000). Foster *et al.* (2000) defined *As-units* as a mainly syntactic unit and "a single speaker's utterance consisting of an *independent clause*, or *sub-clausal unit*, together with any *subordinate clause(s)* associated with either" (Foster *et al.*, 2000:365).

Table 1 illustrates the variety of approaches of how grammatical complexity has typically been operationalized in previous studies on second language oral performance. This list includes only a sample of studies written during the last two decades and published in main journals.

COMPLEXITY OPERATIONALIZATION	STUDY
• MLU3	**Dewaele & Furnham (1999)** "Personality and speech production: a pilot study of second language learners"
• Clauses / C-unit	**Foster & Skehan (1999)** "The Influence of Task Structure and Processing Conditions on Narrative Retellings"
• Words/ Utterances	**Ortega (1999)** "Planning and focus on form in L2 oral performance"
• Clauses / T-unit	**Yuan & Ellis (2003)** "The effects of pre-task planning and on-line planning on fluency, complexity and accuracy in L2 Monologic Oral Production".
• Coordinate-clause count • Subordinate-clause count	**Collentine (2004)** "The effects of learning contexts of morphosyntactic and lexical development"
• Clauses / AS-unit • Subordinate clauses / Clauses	**Michel, Kuiken, & Vedder (2007)** "The influence of complexity in monologic versus dialogic tasks in Dutch L2"
• Clauses / T-units • Dependent clauses / Clauses • VPs / T-unit • MLU	**Iwashita, Brown, Mcnamara & O'hagan (2008)** "Assessed levels of second language speaking proficiency: How distinct?"
• Clauses / AS-unit • Words / AS-unit	**Tavakoli & Foster (2011)** "Task design and second language performance: The effect of narrative type on learner output"
• SN/ASU	**Gilabert & Muñoz (2010)** Differences in attainment and performance in a foreign language: The role of working memory capacity"
• Clauses / T-units	**Serrano, Llanes & Tragant (2011)** "Analyzing the effect of context of second language learning: Domestic intensive and semi-intensive courses vs. study abroad in Europe"
• Clauses / AS-unit • Clauses (pruned) / AS-unit • Words / AS-unit	**Mora & Valls-Ferrer (2012)** "Oral fluency, accuracy and complexity in formal instruction and study abroad learning contexts"
• Clauses / As-unit	**Foster & Skehan (2013)** "Anticipating a post-task activity: The effects on accuracy, complexity, and fluency of second language performance"
• Clauses / T-unit	**Llanes & Muñoz (2013)** "Age effects in a study abroad context: Children and adults studying abroad and at home"

Table 1. Operationalization of grammatical complexity in studies written from 1999 to 2013

2.1.2. Grammatical Variety

Grammatical variety refers to the range of different specific structures presented in L2 oral productions. Bulté and Housen (2012) introduce a total of forty different task-based learning studies which have used measures of grammatical complexity. Out of the total, eight different studies claim to have used at least one measure of either syntactic sophistication or morphological complexity. In Bulté and Housen (2012), syntactic sophistication is included within syntactic complexity, together with categories such as *coordination, subordination, or clausal*. However, syntactic sophistication differs from the other measurements because it is more a calculation of frequencies of specific grammatical forms than a pure syntactic complexity measurement (e.g. S-nodes/AS-unit). Moreover, what Bulté and Housen (2012) call *morphological complexity* is also a measurement of frequencies of forms (e.g. frequency of tensed forms, frequency of modals). As a consequence, all the measurements classified by Bulté and Housen within both *syntactic sophistication* and *morphological complexity* were considered to form a category which is to be called *grammatical variety* in the present study. Table 2 presents all these measures as well as the studies in they have been (as cited by Bulté & Housen, 2012).

MEASURE	**STUDIES**
Frequency of passive forms	R. Ellis & Yuan (2005)
Frequency of infinitival clauses	Robinson (2007)
Frequency of conjoined clauses	Robinson (2007)
Frequency of Wh-clauses	Robinson (2007)
Frequency of imperatives	Sagarun (2005)
Frequency of auxiliaries	Sagarun (2005)
Frequency of comparatives	Sagarun (2005)
Frequency of conditionals	Sagarun (2005)
Frequency of tensed forms	R. Ellis & Yuan (2005)
Frequency of modals	R. Ellis & Yuan (2005)
Number of different verb forms	Bygate (1996), R. Ellis & Yuan (2004), Yuan & Ellis (2003)
Variety of past tense forms	Foster (1996), Foster & Skehan (1996)

Table2. Studies using grammatical variety measures

2.2. Previous Findings

Grammatical complexity has been used as a dependent measure to gauge language performance of L2 learners in a great number of studies. Frequently, it has been employed together with fluency, accuracy as well as lexical complexity (lexical variety). The main reason why all the dimensions have been typically analysed together in previous studies is that these researchers have tried to explore how these dimensions are interrelated (i.e. how they affect one another). In general, syntactic complexity has been utilized as a dependent and/or as an independent variable. As Butlé and Housen (2012) observe, complexity (understood as cognitive complexity), together with fluency and accuracy, has been used by researchers as an independent variable when their purpose was to show the influence that this dimension had on some feature of either L2 performance or L2 proficiency. On the other hand, it has been employed as a dependent variable when it represented a factor that describes L2 performance, proficiency or development. Butlé and Housen (2012) include that in this case, complexity has been used to see its correlation with other variables such as individual factors or L2-learning context.

2.2.1. Relationship between L2 grammatical complexity and proficiency level

According to Bennati (…:520), proficiency "refers overall to the ability for learners to master and use a second language in different contexts" (Benatti, …:520). According to Stern (1992, as cited in Bennati, …), the four skills, namely listening, speaking, reading, and writing) are still nowadays used as a reference of proficiency. As far as speaking proficiency is concerned, De Jong, Steinel, Florijn, Schoonen and Hulstijn (2012) report that it there are three skills which contribute to it, namely declarative knowledge, speed of access to that knowledge, and pronunciation skills. Similarly, Bygate (1987) states that "a speaker's language proficiency can be seen as a pool of systemic resources and the ability to use them in real contexts" (Bygate, 1987:28). Moreover, he adds that speakers need to exploit all their resources in order to be able to communicate with others under real purposes and constraints.

As far as the relationship between proficiency and linguistic complexity is concerned, Ellis (2009:475) states that *complexity* is "the capacity to use more advanced

language (…) [which] may also involve greater willingness to take risks". By using the term *advanced*, Ellis seems to be implying that proficiency and complexity go hand in hand. Consequently, it may be understood that more complex language is indicative of higher proficiency, since the item *advance* suggests "learned later". In this sense, the definition of complexity does not refer to whether the language produced by learners is made up by more or less parts or items, but to whether it is produced by advanced learners or not. Nevertheless, if this definition were to be considered true, studying how complexity changes over time would not be necessary, since it would always imply a linear progression. However, it has frequently been found that syntactic complexity (as indexed by subordination) increases linearly up to one point, and it then decreases until it stabilizes (Palloti, 2009; Norris and Ortega, 2009).

The same pattern was also found in the field of L2 writing research and, specifically, written performance of German as a second language. Cooper (1976, as cited in Ortega, 2003) advanced a prediction which was called *the developmental prediction*. This prediction was replicated more recently by Wolfe-Quintero *et al.* (1998) in L2 English writing. Both Cooper and Wolfe-Quintero agree on the fact that by measuring grammatical complexity at the subordination level, a non-linear relationship is found with L2 proficiency. The reason why this non-linear relationship is found is, they claim, that learners in advanced proficiency groups do not complexify at the clausal but at the phrasal level. This idea has also been supported by Norris and Ortega (2009) who argue that even though syntactic complexification always increases, it does not increase linearly because it may increase in alternative ways, such as at the phrasal level.

As far as work in oral production is concerned, it has been found that native speakers also complexify at the phrasal, rather than at the clausal level. Eisenberg, Ukrainetz, Hsu, Kaderavek, Justice and Gillam (2008) measured grammatical complexity at the phrasal level in the oral narratives produced by L1 English children. In their study, Eisenberg *et al.* (2008) used *Noun Phrase Elaboration* as a developmental measure in children of different ages (i.e. 5, 8 and 11 year-old children). Results from the study showed that there were substantial developmental changes in the degree of noun phrase elaboration among the different age groups. These results can be matched to the findings from L2 written performance introduced above, since they all maintain that a positive relation exists between phrasal complexification and

proficiency/age (i.e. the more proficient, or older in the case of L1 children, the participants become, the more complex structures they produce at the phrasal level). Consequently, because results from both oral L1 and written L2 production show that with the development of the target language speakers tend to produce more complex structures in the phrasal level, it is probable that oral L2 production also presents such a relationship. Accordingly, our exploratory approach has motivated the use of NP Elaboration in the present study.

2.2.2.Relationship between L2 grammatical complexity and working memory capacity

Working memory (WM) is defined by Baddeley (2000) as the "limited capacity system allowing the temporary storage and manipulation of information necessary for such complex tasks as comprehension, learning, and reasoning" (Baddeley, 2000:418). Nowadays, this is a multicomponent model that has widespread attention in the SLA field, and it is the one which has been adopted in this study.

Because of the fact that working memory is limited, it is assumed that it may constrain L2 oral production. To our knowledge, however, few studies have intended to see whether there is a relationship between working memory capacity and grammatical complexity. Nevertheless, from a theoretical point of view, Levelt's model of L1 speech production (Levelt, 1989, 1993) has been acknowledged as the best model of L1 speech processing and this model considers working memory to play an important role in speech production. Levelt (1993) claims that speaking is an intentional activity since it "serves a purpose the speaker wants to realize" (Levelt, 1993:20) and that intentional activities are located under *executive control*. However, Levelt also explains that not all processing components are under this control, since they belong to automatic processing. These automatic processes are accomplished without awareness and they have their own resources and thus do not interfere with the other processes which take place during language production. On the other hand, controlled processing needs attentional resources and, according to Levelt, speakers can only attend to a limited number of items that may be located in the working memory at a given time. It is for this reason that Levelt argues that while working memory is indispensable during the conceptualization and monitoring of the message, the formulation and articulation of

this message is automatic and, consequently, they do not require the influence of working memory (Levelt, 1993:21).

Nevertheless, in SLA, many different factors have not been automatized yet (Kormos, 2006). Regarding syntactic encoding, Kormos claims that, differently to L1 speakers, L2 learners need a "declarative memory" which stores all the syntactic and phonological rules in the second language. In fact, she states that while these rules are automatized in the L1 (Levelt, 1989), many are not automatic for second language speakers. Nonetheless, only those learners with low proficiency would need to store these rules in a separate region of the brain, while proficient bilinguals do not need to rely on this separate store (Kormos, 2006:169). This lets to an immediate assumption; the more proficient learners' are, the less they would need attention resources in working memory to be able to appropriately apply syntactic rules during L2 production. As a consequence, differences in working memory capacity would be expected to exert less impact on the L2 production of high-proficient than of low-proficient learners, although it would still perform a role in both groups.

As stated by Gilabert and Muñoz (2010), researchers have recently conducted studies with the aim of establishing the relationship that may exist between differences in working memory capacity and learner's L2 performance and development. The main purposes of these studies are to explore the relationship between working memory and oral L2 fluency (Fortkamp, 2000; Mizera, 2006, as cited in Gilabert & Muñoz, 2010); between working memory and development (Payne & Whitney,2002; Payne & Ross, 2005; Kormos & Sáfár, 2008, as cited in Gilabert & Muñoz, 2010); and, finally, between working memory and the three CAF dimensions (Mota, 2003; Trebits & Kormos, 2008; Guará-Tavares, 2009; Gilabert & Muñoz, 2010). For the purposes of the present study, attention is directed to those studies which measured grammatical complexity in relation to working memory.

First, Mota (2003) aimed at establishing the relationship between working memory and measures of CAF. Grammatical complexity was measured in Mota's study by calculating the total number of dependent clauses per minute. In this case, this measurement can be considered more related to fluency than to grammatical complexity. For it to be a measurement of grammatical complexity the number of dependent clauses should have been contrasted to another linguistic unit in the speech

production (e.g. total number of clauses). On the other hand, Trebits and Kormos (2008), investigated the relationship between working memory and measures of CAF from the oral narratives of 21 Hungarian participants learning English as an L2 with a level of proficiency which was reported to be slightly above intermediate level, according to their teachers. Grammatical complexity was measured by calculating the total number of clauses per the total number of AS-units. Results from their study showed that working memory did not influence their participant's oral L2 production, since students with high and low working memory capacity presented no differences in terms of grammatical complexity. Finally, in her study, Guará-Tavares intended to discover whether oral L2 speech performance significantly correlated with learners' working memory capacity. She operationalized grammatical complexity by calculating the total number of clauses per c-unit. Again, she found that there was no relationship between working memory and grammatical complexity.

Furthermore, Gilabert and Muñoz (2010) also attempted to determine whether there was a relationship between working memory capacity and L2 performance. Using comparable participants and the same task that is used in the present study, they found evidence for lack of correlation between working memory and grammatical complexity, since differences in the means in grammatical complexity between the high- and the low-proficient students did not differ significantly. Nonetheless, the researchers used only a syntactic measure to calculate grammatical complexity, namely number of sentence nodes per AS-unit.

Guará-Tavares (2008), trying to see the effects of working memory capacity on fluency, accuracy and complexity, found that there was a correlation between working memory and grammatical complexity. Nevertheless, in this study she tried to find this correlation under pre-task planning condition. This means that, the participants were not under a real situation, since speakers are not normally given time to prepare their speech.

III. THE PRESENT STUDY

After considering previous findings in the literature, the main purpose of the study reported in this article is to determine whether differences in proficiency and working memory have an impact on the grammatical complexity of second language learners. As far as we know, previous research has not aimed at comparing the relationship between syntactic complexity and grammatical variety. Therefore, the first objective of this study is to explore whether there is a correlation between these two dimensions. Moreover, it also targets at determining how the strength of this relationship changes over time. In other words, it aims at discovering how the relationship between syntactic complexity and grammatical variety may evolve with proficiency to unveil whether they either evolve in parallel or whether they progress at different paces. Finally, the last goal of the present study is to establish whether working memory has a role in the correlation. Previous studies on the relationship between working memory and grammatical complexity have frequently found that there is no correlation between the two variables of interest. Nonetheless, these studies explored only syntactic complexity and not grammatical variety. Hence, this study stands as an effort to investigate both these unexplored as well as problematic areas. Accordingly, these are the research questions addressed by the present study:

1. Is there a relationship between syntactic complexity and grammatical variety?
2. How does the relationship between syntactic complexity and grammatical variety evolve with proficiency?
3. Do syntactic complexity and grammatical variety explain differences in second language proficiency?
4. Does working memory capacity explain differences in grammatical variety and/or syntactic complexity?

The first two research questions are exploratory because, to our knowledge, they have never been formulated before, and, hence, the null hypothesis applies (i.e. there is no relationship between the two). As far as the third and fourth research questions are concerned, previous findings lead us to predict that no correlation will be found between syntactic complexity and either L2 proficiency, nor working memory capacity. However, whether or not correlations are found between grammatical variety and

proficiency and/or working memory is an open question, since no directional hypothesis are available on the basis of previous findings.

3.1. Participants

From the initial 97 subjects selected for the study, six were disregarded from the analysis in the present study because they did not complete the proficiency test. Therefore, the final sample consisted of 91 (74 females and 17 males) undergraduate students of English Studies who were L1 Catalan/Spanish bilinguals. They all had been educated in the Catalan system, where L2 English is an obligatory subject. They had been learning English for 10.7 to 53 years (mean of 18.2), and had an advanced level of English. However, the data of only 85 subjects were used to answer the fourth research question, since not all the participants had completed the working memory task.

3.2. Tests

The data analyzed in the present study were collected in 2011 and they belong to a larger BAFIA data set developed by the GRAL (Language Acquisition Research Group) group at the University of Barcelona. Both a personal information and input questionnaire were constructed by the members of this group to obtain information about the participants' linguistic background as well as their previous experience with English. Two different proficiency tests were employed to determine their level of proficiency: a standardized holistic proficiency test called OPT (*Oxford Placement Test*) and two yes-no questionnaires of receptive vocabulary which have proven to strongly correlate with proficiency, namely X-lex (Meara, 2006) and Y-lex (Meara and Miralpeix, 2006).

In order to determine the working memory capacity of the participants, they were required to complete an automated reading span task which had been adapted for both Spanish and Catalan, and also developed by the GRAL group. In this task, participants were presented with eighty sentences, ranging from 8 to 12 words, once at a time, and they had to indicate whether the sentence made sense and to remember its last word. All the sentences were presented in series of 2 to 6 sentences and required

different levels of processing. The words that needed to be recalled had all 3-syllables, belonged to the same frequency band and were not proper names or abstract concepts. The length of the sentence as well as the accuracy, order, and reaction times were taken into account when scoring the performance.

3.3. Main Task

The task that was used to elicit the L2 production of the participant was the retelling of a clip of Charles Chaplin's *Modern Times*. This is a complex scene because of its many different characters and events. (Gilabert and Muñoz, 2010) Participants watched the clip twice, and they were asked to retell the story after they had watched it for the second time. A researcher, who acted as a listener, was present during the participant's narration.

3.4. Measures of Grammatical Complexity

All the narratives used in this study had already been transcribed using CLAN (MacWhinney, 2000) by the GRAL group and they had been coded on three of the syntactic complexity measures used in this study. The already calculated measures were *number of S-Nodes per ASU*, *number of words per S-Nodes* and *number of words per ASU*. In the present study, the data were further analyzed for syntactic complexity using a measure of phrasal complexity named ***Noun Phrase Elaboration*** (based on Eisenberg *et al.*, 2008; Pownall, 2009). Eisenberg *et al.* used four types of elaborated NPs (ordered here according to their results); we created the last type, namely *PREPOST*, for the present study:

a) Simple designating noun phrases (*PRE1*): one pre-noun element (articles, possessive pronouns, demonstratives, quantifiers) before the head noun. E.g.: *the baker*.
b) Simple descriptive noun phrases (*PRE2*): a determiner (when required), one descriptive element (adjective or noun modifier) before the noun head. E.g.: *a married couple*.
c) Complex descriptive noun phrases (*PRE3*): two or more descriptive elements (adjectives, noun modifiers and/or adverbs). E.g.: *the little poor girl*.

d) Complex noun phrases with noun postmodification (*POST*) such as prepositional phrases or clauses. E.g.: *a man who is taking bread into the shop*.

e) Complex noun phrases with both pre- and postmodification (*PREPOST*). E.g.: *this young girl that is walking down the street*.

As far as grammatical variety is concerned, not all the measurements presented in Table 2 above were used in the present study. First, *frequency of conjoined clauses* was not employed because we believed that it was a measure of syntactic complexity rather than of grammatical variety (i.e. obtaining similar results than with a measurement of coordination). Second, after scrutinizing Sigarun (2005), it was acknowledged that the measurements that were applied for this study were selected because participants were instructed to use these grammatical forms. As a consequence, since participants in the present study were not invited to use specific forms, these measurements were eventually excluded. Nonetheless, *frequency of conditionals* was introduced as one of the measurements of grammatical variety because the story that was retold by the participants included a section in which the protagonist imagined a hypothetical life, which would elicit conditional constructions. Third, once the study by R. Ellis and Yuan (2005) was inspected it was found that *frequency of modals* was actually not one of the measurements that were utilized. Notwithstanding, the frequency of modals was still calculated following Bygate (1996), although instead of including it within the measures of number of different verb forms, we decided to use it as a separate variable. Finally, the measures *frequency of passive forms*, *number of tensed forms* and *number of past forms* were included within the measurement of number of different verb forms, following the classifications in Bygate (1996), R. Ellis & Yuan (2004), and Yuan & Ellis (2003). Therefore, the grammatical variety measures employed for the analysis of our data were: *frequency of infinitival clauses*, *frequency of wh-clauses*, *frequency of conditionals*, *frequency of modals*, and *number of different verb forms*. Moreover, we included the measure *frequency of -ing clauses*, since they are often interchangeable with infinitival clauses. These measures are further described below.

3.4.1. Frequency of infinitival and ing- clauses

An infinitival clause (INFC) is a "subordinate clause containing a plain form of the verb. Covers *to*-infinitivals (To err is human) and bare infinitivals (I will go) (Huddleston and Pullum, 2005). We adopted this definition for the coding of our data, although we did not consider verbs after modals to form an infinitival form nor subordinate clauses. In fact, after having scrutinized Huddleston and Pullum (2002) it was found that they considered auxiliary verbs to be heads, not dependents.

In our analysis of INFC, however, we decided to follow the canonical classification (e.g. Quirk, Greenbaum, Leech, Svartvik, 1988), and so auxiliaries such as *will, should* or *have to* were not coded as being followed by infinitival clauses. On the other hand, bare infinitival were those constructions with a main verb followed by a bare VP (e.g. *he's trying to make the police take him*).

Similarly, -*ing* clauses are also subordinate clauses but they include a verb in the -*ing* form (Quirk *et al*., 1988). In other to operationalize this measure, all the clauses with verbs in the –*ing* form (except for those in the continuous form) were coded as -*ing* clauses. Accordingly, sentences such as "Obviously the policeman is not going to pay" was not considered an -*ing* clause as opposed to sentences such as "he starts eating the lunch".

3.4.2. Frequency of wh-clauses

In the present analysis, subordinate *Wh*-clauses were those subordinate constructions that contain a *wh*-word (e.g. *what, how, where*, etc.) but that were not considered relative clauses, since they were already captured in the measure of ENPs. These are the three main *wh*-clauses that were included in the analysis:

- ***Wh*-adverbial clauses (WHCA)**: clauses containing a *wh*-element and functioning as adjuncts of time, place, purpose, result or reason. E.g.: *And when the owner doesn't see her she steals a loaf of bread*.
- ***Wh*-Cleft clauses (WHCC):** subordinate clauses containing a *wh*-word and appearing before the main clause in order to give prominence to a part of the sentence. E.g.: *what she does is try to jump off the van.*

- ***Wh*-indirect interrogative clauses (WHIC):** subordinate clauses which contain a *wh*-word and which are usually employed to report direct questions. E.g.: *he asks her why she's so sad*.

Moreover, two other types of clauses, namely ***it-cleft clauses* (ITCC)** and ***yes-no indirect interrogative clauses* (YNIC)**, were also included in this classification because even though they did not contain a *wh*-word, their structure is closely associated to that of *WHCCs* and *WHICs*, respectively. For example:

- *It has been the girl who has stolen the baguette* (ITCC).
- *Nobody knows if it's been him or her* (YNIC).

3.4.3. Frequency of conditionals and modals

Those sentences which were produced in the conditional voice were counted as being part of *frequency of conditionals*. One example of a conditional construction is the subordinate clause of the sentence "they start imagining how would be like if they were to be married".

On the other hand, the measure *frequency of modals* was coded by tagging all the modals that appeared in the narratives. Modals included the following words: *can*, *could*, *may*, *might*, *must*, *should*, *will*, *would*, *shall*, *ought*, and their negative forms. For example, *I can do the pain of working*.

3.4.4. Number of different verb forms

Following Yuan and Ellis (2003) and Ellis and Yuan (2004) all the verbs found in the narratives were classified according to tense (e.g. present simple, past continuous) and voice (passive or active). Ten different tags were used to code the data: PS (present simple), PC (present continuous), PP (present perfect), TS (past simple), TC (past continuous), TP (past perfect), PSV (passive voice), PCF (present continuous in future time), TCF (present continuous in future time) and FRT (future time).

3.5. Operationalization of All the Measurements

Since the task employed to elicit the data was not time constraint, participants produced outputs of very different lengths. As a consequence, we decided to use the square root

of the number in the denominator rather than the denominator itself in all the measures. By using this technique, we tried to correct for the fact that longer texts would have more probability of presenting shorter constructions. In addition, in short texts, using one of the constructions of interest would represent a bigger percentage of the final number of constructions as compared to using one in longer texts. This mathematical technique is applied in Giraud's index, a measure of lexical variety which has been proved to compensate for text length. Accordingly, these are the measures used in the present study and the operationalization of each one:

- Total number of S-Nodes per total number of ASUs: SNs/$\sqrt{ASU}$
- Total number of number of words per total number of S-Nodes: Words/$\sqrt{ASU}$
- Total number of number of words per total number of ASU: Words/$\sqrt{SNs}$
- (Total number of NPs minus PRE1) per total number of ASU: ENPs/$\sqrt{ASU}$
- Total number of INFs per total number of SNs: INFC/$\sqrt{SNs}$
- Total number of *-ing* clauses per total number of SNs: INGC/$\sqrt{SNs}$
- Total number of *wh-* clauses per total number of SNs: WHC/$\sqrt{SNs}$
- Total number of conditionals per total number of ASUs: CON/$\sqrt{ASU}$
- Total number of modals per total number of words: MDL/$\sqrt{Words}$
- Number of different verb forms: count of total number of grammatical verb forms

3.6. Coding Procedures

Every specific measure was associated with a code (e.g. PS for *present simple*, WHCA for *wh-adverbial clauses*) and these were manually introduced next to the target construction using CLAN (see appendices A-D for an example). Afterwards, the frequencies were extracted using the FREQ function of CLAN.

Finally, an English Philologist coded a random 10% of all the narratives, which were contrasted to the coding by the author of the present study, who also recoded a random 10% of the data. Inter- and intra-rater measures showed an overall inter-rater reliability of 94.4% while intra-rater reliability reached 95.8%.

3.7. Statistical Instruments and Tests

Microsoft Excel was used to extract the entire count provided by CLAN outputs. Afterwards, the data from the excel document was transferred to a document of IBM SPSS Statistics (version 21). SPSS was the program used to carry out all the statistical analyses.

Depending on the kind of distribution that was presented by the data, whether it was normally distributed or not by means of both Kolmogorov-Smirnov and Shapiro-Wilk test of normality, two different types of tests were used in each of our research questions. Pearson correlations were used when both variables were normally distributed while Spearman correlations were applied when at least one of the variables turned out to be non-normally distributed. In order to answer the second research question, our population was divided into two groups by means of K-means Cluster Analysis in SPSS. Finally, SPSS was also used to create the tables used in the results sections, while excel was selected to build all the figures.

IV. RESULTS

The main goal of the present study was to determine whether there was to explore whether differences in proficiency and working memory had an effect on the syntactic complexity and/or grammatical variety of second language learners.

Descriptive statistics of the whole sample of learners that participated in the present study are displayed in table A1 in appendix E, and here the results of the correlations are presented.

4.1. Relation between Syntactic Complexity and Grammatical Variety

The first research question asked whether there was a relationship between measures of syntactic complexity and grammatical variety. Table 3 below shows the correlations that exist between syntactic complexity measures (vertical) and the grammatical variety measures (horizontal).

		$\frac{INFC}{\sqrt{SNs}}$	$\frac{INGC^{(S)}}{\sqrt{SNs}}$	$No.\ of\ verb\ types^{(S)}$	$\frac{WHC}{\sqrt{SNs}}$	$\frac{MDL^{(S)}}{\sqrt{Words}}$	$\frac{CON^{(S)}}{\sqrt{ASU}}$
$\frac{SNs^{(S)}}{\sqrt{ASU}}$	Correlation Coefficient	**.498****	**.416****	**.563****	**.394****	**.139**	**.188**
	Sig. (2-tailed)	.000	.000	.000	.000	.189	.075
	N	91	91	91	91	91	91
$\frac{Words}{\sqrt{ASU}}$	Correlation Coefficient	**.355****	**.316****	**.577****	**.396****	**.128**	**.147**
	Sig. (2-tailed)	.001	.002	.000	.000	.228	.164
	N	91	91	91	91	91	91
$\frac{Words}{\sqrt{SNs}}$	Correlation Coefficient	**.300****	**.319****	**.581****	**.373****	**.111**	**.112**
	Sig. (2-tailed)	.004	.002	.000	.000	.295	.291
	N	91	91	91	91	91	91
$\frac{ENPs}{\sqrt{ASU}}$	Correlation Coefficient	**.239***	**.131**	**.298****	**.112**	**.017**	**.090**
	Sig. (2-tailed)	.023	.214	.004	.289	.874	.396
	N	91	91	91	91	91	91

SNs = *Sentence Nodes*; ASU = *Analysis of Speech Unit*; ENP = *Elaborated Noun Phrases*; INFC = *infinitival clauses*; INGC = *-ing clauses*; WHC = *wh-clauses*; MDL = *frequency of modals*; CON = *frequency of conditionals*; $^{(S)}$ = *non-normally distributed*.

Table 3. Pearson and Spearman correlations between syntactic complexity measures (vertical) and grammatical variety measures (horizontal).

The results from both Pearson and Spearman correlations show that there was a moderate significant correlation between all the syntactic complexity measures (with the exception NP Elaboration) and the frequency of infinitival, *-ing*, and *wh-* clauses and with number of different verb forms. This suggests that those learners who were producing more infinitival, *-ing* and wh-clauses were also significantly producing more S-Nodes and words per AS-unit and more words per S-Nodes. A weak significant correlation was found between NP Elaboration and frequency of infinitival, and *-wh* clauses, which indicated that those who were complexifing their NPs were also producing more infinitival clauses and types of verb forms.

4.2. Syntactic Complexity with Grammatical Variety as mediated by Proficiency

For the purpose of answering the second research question, the sample was split into two different groups: low and high proficient as measured by OPT. Descriptive statistics of these two groups are displayed in tables A2 and A3 in the appendices F and G respectively. Results from the correlations between syntactic complexity and grammatical variety measures presented in tables 4 and 5 below.

		$\frac{INFC}{\sqrt{SNs}}$	$\frac{INGC^{(S)}}{\sqrt{SNs}}$	$No.\ of\ verb\ types^{(S)}$	$\frac{WHC^{(S)}}{\sqrt{SNs}}$	$\frac{MDL^{(S)}}{\sqrt{Words}}$	$\frac{CON^{(S)}}{\sqrt{ASU}}$
$\frac{SNs}{\sqrt{ASU}}$	Correlation Coefficient	**.565****	**.371***	**.559****	**.570****	**.065**	**.257**
	Sig. (2-tailed)	.001	.037	.001	.001	.726	.156
	N	32	32	32	32	32	32
$\frac{Words}{\sqrt{ASU}}$	Correlation Coefficient	**.458****	**.295**	**.515****	**.567****	**.150**	**.136**
	Sig. (2-tailed)	.008	.101	.003	.001	.411	.459
	N	32	32	32	32	32	32
$\frac{Words}{\sqrt{SNs}}$	Correlation Coefficient	**.415***	**.350***	**.531****	**.487****	**.088**	**.044**
	Sig. (2-tailed)	.018	.050	.002	.005	.632	.811
	N	32	32	32	32	32	32
$\frac{ENPs}{\sqrt{ASU}}$	Correlation Coefficient	**.290**	**.001**	**.178**	**.151**	**.306**	**-.013**
	Sig. (2-tailed)	.107	.997	.330	.408	.088	.942
	N	32	32	32	32	32	32

SNs = *Sentence Nodes*; ASU = *Analysis of Speech Unit*; ENP = *Elaborated Noun Phrases*; INFC = *infinitival clauses*; INGC = *-ing clauses*; WHC = *wh-clauses*; MDL = *frequency of modals*; CON = *frequency of conditionals*; $^{(S)}$ = *non-normally distributed*.

Table 4. Pearson and Spearman correlations between syntactic complexity measures (vertical) and grammatical variety measures (horizontal) in the low proficiency group

Overall, all the correlations that were found for the whole group were also found for the low proficiency group, when split by OPT. There are only two correlations that were significant for the whole sample but that are not for either the low or the high proficient group, namely the correlation between frequency of *-ing* clauses and words per ASU and the correlation between ENPs and frequency of infinitival clauses. Moreover, only for the high proficiency group, words per SNs does not correlate anymore with either frequency of infinitival nor *-ing* clauses and there is also no correlation found between number of different verb forms and Elaborated NPs, while it was found for the whole and the low proficiency groups.

		$\frac{INFC}{\sqrt{SNs}}$	$\frac{INGC}{\sqrt{SNs}}$	$No.\ of\ verb\ types^{(S)}$	$\frac{WHC}{\sqrt{SNs}}$	$\frac{MDL^{(S)}}{\sqrt{Words}}$	$\frac{CON^{(S)}}{\sqrt{ASU}}$
$\frac{SNs^{(S)}}{\sqrt{ASU}}$	Correlation Coefficient	**.451****	**.312***	**.569****	**.275***	**.235**	**.101**
	Sig. (2-tailed)	.000	.016	.000	.035	.074	.449
	N	59	59	59	59	59	59
$\frac{Words}{\sqrt{ASU}}$	Correlation Coefficient	**.307***	**.241**	**.603****	**.313***	**.174**	**.106**
	Sig. (2-tailed)	.018	.065	.000	.016	.189	.424
	N	59	59	59	59	59	59
$\frac{Words}{\sqrt{SNs}}$	Correlation Coefficient	**.248**	**.196**	**.589****	**.307***	**.172**	**.094**
	Sig. (2-tailed)	.058	.136	.000	.018	.192	.478
	N	59	59	59	59	59	59
$\frac{ENPs}{\sqrt{ASU}}$	Correlation Coefficient	**.221**	**.078**	**.357****	**.056**	**-.047**	**.090**
	Sig. (2-tailed)	.092	.555	.006	.672	.723	.496
	N	59	59	59	59	59	59

SNs = *Sentence Nodes*; ASU = *Analysis of Speech Unit*; ENP = *Elaborated Noun Phrases*; INFC = *infinitival clauses*; INGC = *-ing clauses*; WHC = *wh-clauses*; MDL = *frequency of modals*; CON = *frequency of conditionals*; $^{(S)}$ = *non-normally distributed*.

Table 5. Pearson and Spearman correlations between syntactic complexity measures (vertical) and grammatical variety measures (horizontal) in the high proficiency group

4.3. Relationship between Proficiency / Working Memory and Syntactic Complexity / Grammatical Variety

In the third and fourth research questions we asked whether there was a correlation between syntactic complexity and proficiency, as measured with OPT, and the collapsed results of Xlex and Ylex, and between syntactic complexity and working memory. Table 6 below shows the existing correlations between both proficiency and working memory with the already calculated measures of syntactic complexity by using the canonical operationalization (without using the square root of the denominators).

		$\frac{SNs}{ASU}$	$\frac{Words^{(S)}}{ASU}$	$\frac{Words}{SNs}$
XandYLex	Correlation Coefficient	**-.170**	**-.117**	**-.076**
	Sig. (2-tailed)	.107	.270	.474
	N	91	91	91
OPT	Correlation Coefficient	**.072**	**-.061**	**-.141**
	Sig. (2-tailed)	.496	.564	.181
	N	91	91	91
Rspan_P	Correlation Coefficient	**-.160**	**-.061**	**-.134**
	Sig. (2-tailed)	.143	.581	.223
	N	85	85	85

OPT = *Oxford Placement Test*; Rspan_P = *Reading Span Score*; SNs = *Sentence Nodes*; ASU = *Analysis of Speech Unit*; $^{(S)}$ = *non-normally distributed*.

Table 6. Pearson and Spearman correlations between the canonical syntactic complexity measures (horizontal) and proficiency (*XandYlex and OPT*) and WM (*Rspan_P*).

Results from both Pearson and Spearman$^{(S)}$ correlations show that there is no correlation between any of the syntactic measures and neither proficiency nor working memory capacity.

However, because we thought that these measures did not correct for text length, we decided to use the square root of the denominator of all the measures and explore whether, by using this operationalization, correlations between the variables could be found. Table 7 below presents the results of these correlations.

		$\frac{SNs^{(S)}}{\sqrt{ASU}}$	$\frac{Words}{\sqrt{ASU}}$	$\frac{Words}{\sqrt{SNs}}$	$\frac{ENPs}{\sqrt{ASU}}$
XandYLex	Correlation Coefficient	**.365****	**.289****	**.337***	**.167**
	Sig. (2-tailed)	.000	.005	.001	.113
	N	91	91	91	91
OPT	Correlation Coefficient	**.287****	**.207***	**.209***	**.168**
	Sig. (2-tailed)	.006	.049	.047	.111
	N	91	91	91	91
Rspan_P	Correlation Coefficient	**.046**	**.050**	**.083**	**-.053**
	Sig. (2-tailed)	.678	.648	.449	.632
	N	85	85	85	85

OPT = *Oxford Placement Test*; Rspan_P = *Reading Span Score*; SNs = *Sentence Nodes*; ASU = *Analysis of Speech Unit*; ENP = *Elaborated Noun Phrases*; $^{(S)}$ = *non-normally distributed*.

Table 7. Pearson and Spearman correlations between the new syntactic complexity measures (horizontal) and proficiency (*XandYlex and OPT*)and WM (*Rspan_P*).

The results above indicate that, when controlled for text length, all the syntactic complexity measures significantly weakly correlate with proficiency as measured by Xlex/Ylex and OPT, except for ENP, which does not significantly correlate with OPT, while it does with the other two complexity measures. Nevertheless, working memory does not significantly correlate with any of the syntactic complexity measures, which indicates that the learners' working memory capacity is not related to linguistic complexity, or at least to syntactic complexity. The results overall suggest that more

proficient learners are in fact complexifying their speech at all these levels, except for NP Elaboration, but that this cannot be seen unless we control for text length.

Finally, table 8 below presents Pearson and Spearman correlations between grammatical variety and both proficiency, as measured by Xlex/Ylex and OPT, and working memory, as measured by the reading span task.

		$\frac{INFC}{\sqrt{SNs}}$	$\frac{INGC^{(S)}}{\sqrt{SNs}}$	$No.\ of\ verb\ types^{(S)}$	$\frac{WHC}{\sqrt{SNs}}$	$\frac{MDL^{(S)}}{\sqrt{Words}}$	$\frac{CON^{(S)}}{\sqrt{ASU}}$
XandYLex	Correlation Coefficient	**.079**	**.366****	**.237***	**.138**	**-.138**	**.101**
	Sig. (2-tailed)	.457	.000	.024	.193	.193	.341
	N	91	91	91	91	91	91
OPT	Correlation Coefficient	**.040**	**.395****	**.109**	**.209***	**-.007**	**.309****
	Sig. (2-tailed)	.707	.000	.306	.047	.946	.003
	N	91	91	91	91	91	91
Rspan_P	Correlation Coefficient	**.126**	**.063**	**.144**	**-.015**	**-.030**	**-.163**
	Sig. (2-tailed)	.252	.568	.189	.894	.782	.136
	N	85	85	85	85	85	85

OPT = *Oxford Placement Test*; Rspan_P = *Reading Span Score*; SNs = *Sentence Nodes*; ASU = *Analysis of Speech Unit*;; INFC = *infinitival clauses*; INGC = *-ing clauses*; WHC = *wh-clauses*; MDL = *frequency of modals*; CON = *frequency of conditionals*; $^{(S)}$ = *non-normally distributed*.

Table 8. Pearson and Spearman correlations between grammatical variety measures (horizontal) and proficiency (*XandYlex and OPT*) and WM (*Rspan_P*).

Results from the correlations presented in table 6 show that XandYlex correlated significantly only with the frequency of *–ing* clauses and of number of different verb forms. Moreover, there is a moderate significant correlation between OPT and frequency of both *–ing* clauses and conditionals, and a weak correlation between OPT and *wh*-clauses. These results suggest that the use of infinitival clauses does not imply higher proficiency since the correlation is not significant. Again, no correlation was found between working memory capacity and any of the grammatical variety measures.

Previous research found that there was a non-linear progression between OPT and grammatical complexity measures. We tried to see the trend of the old measures with the new operationalization as well as of the new measures that have been introduced in the present study. Figures A1-A13 in the Appendices H and I show that, as expected, the progression is much linear if the new operationalization is applied and, for some measures such as Words per S-Nodes it even changes from being a negative progression to being a positive one when the square root of S-Nodes is used. These results will be interpreted and discussed in the following section.

V. DISCUSSION

The study reported in the present article aimed at finding whether differences in second language proficiency as well as working memory capacity could be detected by analyzing the learners' grammatical variety. Previous research with similar goals had found that such relationships did not exist. Regarding proficiency, findings suggested that while low proficient learners seemed to complexify at the sentential and clausal level, more advanced learners would cease complexifying at these level, gearing their attention towards phrasal complexification (e.g. Cooper 1976; Wolfe-Quintero *et al.* 1998; Norris and Ortega; 2009). Likewise, working memory had also been found not to show a relationship with grammatical complexity.

Nevertheless, these studies have generally used subordination indexes, or at least syntactic complexity measures, and not grammatical variety ones, in order to explore such relationships such relationships. Correspondingly, we hypothesized that using syntactic complexity measures would lead us to find no relationships with either proficiency or working memory. Nonetheless, we used grammatical variety calculations, as it is suggested Bulté and Housen (2012), in order to explore whether this correspondence exists when the latter is operationalized by using either a syntactic complexity measure at the phrasal level or different specific grammatical variety measures. Furthermore, when we operationalized our measures, we decided to use the square root of the denominator in the calculations, so that they allowed us to correct for the fact that learners were producing speech outputs of different lengths.

Our research question asked whether a relationship between our syntactic complexity and grammatical variety measures grow simultaneously and in a linear fashion, or whether they evolved at different paces. The results suggest that the syntactic measures that target the sentential or the clausal level are related to all the grammatical variety measures with the exception of the frequency modals and conditionals. The fact that they are related would lead us to think that when learners syntactically complexify their speech at the level of the sentence or the clause, they also use more varied grammatical constructions and forms. We found lack of relationship between syntactic measures and the frequency of modals and conditionals. It can be hypothesized that this finding might have been affected by the task itself. The learners

saw a scene which was part of the imagination of the characters. Some of them correctly interpreted that they were talking about a hypothetical life and so they would use more conditionals and modal verbs. However, other participants interpreted it as part of the whole narration, and they do not use the irrealis mode, using no conditionals and fewer modal verbs. As far as NP Elaboration is concerned, weak correlations were found with infinitival clauses and grammatical verb forms. First, many learners produced constructions such as "then of course he does not have money to pay for it" or "there is a girl who seems to be very hungry". These two sentences would be categorized as both Elaborated NP, specifically "post-modification" and, at the same time, they would contain an infinitival clause. There were other constructions which did not imply both categorizations, however, and in fact this may have yielded weak correlations rather than moderate or strong. On the other hand, those learners who complexified more at the phrasal level also used different grammatical verb forms. It is possible that one measurement implies the other. For instance, producing more infinitival or *-ing* clauses would immediately involve producing also more clauses per AS-unit.

The second research question at related to whether the above relationships changed when groups with different proficiency levels were compared. The results indicate that similar correlations were to be found when splitting our sample. Some of the relationships weakened with proficiency, and so the low proficient group would present lack of significance in some cases (e.g. number of different grammatical verb forms and NP Elaboration). In other cases, the higher the level of proficiency, the stronger the correlation (e.g. infinitival clauses with words per S-nodes).

Our third question targeted the issue of whether grammatical complexity, understood as syntactic complexity or grammatical variety, would reflect differences in the learners' proficiency (OPT scores) and working memory capacity (reading span task). We first used the conventional measurements of syntactic complexity and we found that there was evidence in our data of lack of relationship with both proficiency and working memory. These results were in agreement with previous research which had found that grammatical complexity presented a non-linear progression with respect to proficiency and that working memory was not related to it. Notwithstanding, we made the decision of attempting to compensate for text length by squaring both the ASU and the SNs, since in longer narratives the likelyhood of using single ASUs would increase. With this new operationalization we actually found correlations with all the

syntactic complexity measures (with the exception of ENP) and both OPT and Xlex/Ylex scores. The reason why we did not find a relationship in the case of ENP could have been caused by the fact that sometimes lack of knowledge may also cause learners to complexify more their language. For example, several learners in the present study were producing structures such as "the man of the bakery", while more proficient learners used "the baker". In these cases, the proficient learners' phrase was categorized as PRE1 (not elaborated in the present study) while the NP by the low proficient learner was categorized as elaborated. Regarding the relationship between proficiency (both OPT and Xlex/Ylex and out grammatical variety measures, results suggest that more proficient learners use more *-ing* and *wh*-clauses as well as verb types and conditionals. The reason why we find a correlation between *-ing* clauses and proficiency but not infinitival clauses and proficiency may be related to the fact that these two structures, although similar, are sometimes interchangeable (e.g. *she starts to run* and *she starts running*). Given that the first language of the participants (Catalan/Spanish) build these constructions by means of a main verb plus a preposition and the infinitive form of the verb (*comença a córrer* (Catalan) / *empieza a correr* – Spanish), it may have been the case that low proficient students were more confident in using *to + INF*, since they already master this structure in their first language. Finally, no relation was found between those that used modal verbs and those that did not. It may be the case that all the participants in this study are expected to be able to use them easily because it is learned at a lower stage in acquisition. On the other hand, conditional structures are assumed to require more computation and to be learned later, and that is why we found that it was a correlation between conditionals and proficiency, because only the more proficient learners were confident to use of this construction.

By now we can assume that with proficiency, learners tend to complexify their speech; they produce a syntactically more elaborated and grammatically varied language. From previous research we can claim that this may be caused by the fact that more proficient learners have more availability of attentional as well as linguistic resources, which enable them to assemble complex ideas more efficiently. Consequently, less proficient learners would show a risk-adverse attitude in the sense that, because they are less confident in producing complex structures or forms, they may favor the use of short and less complex. This idea is related to the definition of complexity by Ellis (2009), who relates complexity to willingness to take risks. By

doing that they ensure enough resources to keep a fluent, lexically complex, and accurate speech production.

As far as the relationship between working memory capacity and all the measures used in this study is concerned, results showed that working memory did not affect the degree of grammatical complexity of the learners, neither at the syntactic level and nor in the use of varied grammatical forms and structures. Even though our new operationalization was useful to find a relationship between our measures and proficiency, the same pattern was not found in the case of working memory. Therefore, we could assume that working memory may be related to grammatical complexity when the learners are given time to plan their speech (Guará-Tavares, 2008) but not when they are faced to a task without planning time. Another explanation would be related to what we stated above, that more advanced learners have already automatized their speech and so they would not immediately need attention resources to be able to process and apply syntactic or morphological rules during speech performance. Because all the participants in the present study ranged from intermediate to advanced learners of L2 English, differences in working memory capacity may have not had an impact on their grammatical complexity.

VI. CONCLUSIONS, LIMITATIONS AND FURTHER RESEARCH

Overall, the results of the present study indicate that there is a relationship between proficiency and grammatical complexity when the measures are operationalized in such a way that they compensate for text length. S-nodes and Words per AS-Units as well as words per S-nodes were good indicators of L2 speakers' level of proficiency. The grammatical variety measures that were most effective in explaining differences in proficiency were the frequency *-ing* and *wh*-clauses, number of different grammatical verb forms and frequency of conditional structures. However, even with the use of this new operationalization, working memory seems to not exert any influence in L2 speakers' degree of grammatical complexity.

This study, however, presented number of limitations which should be acknowledged. First, the participants selected for the present study had all roughly the same level of proficiency (i.e. from intermediate to upper-intermediate). As a result, it

may have been the case that some potential correlations were not found because their levels were not different enough. Hence, learners with clearly different proficiency levels could be selected for further research, so as to be able to see whether more differences would lead to more and stronger correlations. Second, once all the transcriptions had been coded, some of the measurements used in the study did not reach enough instances as for them to be included in the statistical analysis. Consequently, many of the analyzed subtypes of measures (e.g. POST and PREPOST for NP Elaboration) were eventually not included in the analysis. A larger sample of participants would have made feasible the use of these finer grained measures, which would in fact tell us more about their relationship with proficiency. Moreover, all the participants shared the same mother tongue (Catalan/Spanish) and were carrying out the task in the same second language (English). Therefore, the measures that have been useful to find an effect of proficiency on grammatical variety may not be suitable for participants with different linguistic backgrounds. Future research could use a population with different first as well as second languages.

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APPENDICES

Appendix A (Coding of Noun Phrase Elaboration)

@UTF8
@Begin

*INV: could you tell me what happened in the first part of the story ?

*SUB: ok there's [///] hmm@p you can see POST a street where there's a bakery hmm@p there's POSTOa woman who's [/] is hmm@p looking into the bakery as she were hmm@p hungry and then hmm@p suddenly there's the [/] POST the man in charge of the bakery POST who is carrying a lot of bread or products I don't know something into PRE1 the bakery and she takes profit of PRE1 this situation <to stool a a> [//] to steal sorry a [/] PRE2 a loaf of bread and runs tries to escape so but PRE1 the thing is that she crashes into Charles Chaplin and hmm@p there's PRE1 a witness POST a woman who witnesses the scene and she [/] she tells POST the man in charge of the bakery who has stolen the [/] PRE1 the bread and there's PRE1 a policeman and they [/] they tell him what has happened but hmm@p Charles Chaplin hmm@p tells them that hmm@p he [/] he is POST the person who stole the [/] the bread so PRE1 the policeman gets Charles Chaplin and PRE1 the woman stays in [/] in PRE1 the street so but PRE1 the thing is that <the witness> [///] POST the woman who witnesses the [/] the thing hmm@p tries to say again to POST the man in charge that [/] that it was POST the woman who stole the bread so the [/] hmm@p the tell PRE1 the policeman what happened and PRE1 the policeman hmm@p takes for granted that is PRE1 the woman and she [//] he takes the [/] PRE1 the woman so Charles Chaplin decides to enter PRE1 a restaurant and he [/] he gots PREPOST two big plates of food and drinks and everything and hmm@p he doesn't want to pay and he [//] PRE1 his purpose is xx to call the [/] PRE1 the policeman and tell him that well he has no money to pay POST the products that he consumed so hmm@p <he has to be> [/] hmm@p he has to be taken into jail so PRE1 the policeman takes him and they go out in PRE1 the street and while PRE1 the policeman is hmm@p calling for [/] for someone to [/] to take Charles Chaplin hmm@p he takes POST profit of the situation and gets PRE1 some cigars and some [/] hmm@p PRE1 some chocolates I think so he shares it [//] them with PRE2 some children and hmm@p again PRE1 the policeman sees that he has hmm@p taken PRE2 some things that he cannot pay so they [/] hmm@p they put Charles Chaplin into PRE1 a lorry <of he policeman> [//] of PRE1 the police and hmm@p the [/] the truck I think it's [/] it's stopped and hmm@p it goes <into the> [/] into PRE1 the truck POST the woman who stole the bread hmm@p so they meet PRE1 each other and it was what Charlot wanted hmm@p in PRE1 the lorry there's PRE2 some drunk people PREPOST some other people who was [/] are going to jail and [/] hmm@p and they [///]

hmm@p there's PREPOST some ambulance or something that crosses <with the this lorry> [///] <with this truck> [/] with this truck and hmm@p they try to escape and they jump off the [/] PRE1 the truck and hmm@p <while they they> [/] while they're <in the> [//] on PRE1 the street PRE1 the policeman is going to wake up but hmm@p <Charlot Chaplin> [//] Charles Chaplin hmm@p beats him and he knocks him so they [///] that's it more or less yes .

*INV: what happened in the second part of the story ?

*SUB: hmm@p they both Charles Chaplin and POST the woman who stole the bread <they are> [/] they are <in a in a> [//] in front of PRE1 a house it seems PRE2 a nice house PRE2 a rich house and <they are> [///] hmm@p they sit <in in the grass> [//] on PRE1 the grass and they look how hmm@p <some people a pair> [///] PRE1 a couple hmm@p just come out of PRE1 the house and they [/] they laugh at them because they are really happy and they're so so I don't know so I don't know the word hmm@p so happy and so rich and and <so so> [///] They [/] hmm@p they hmm@p Charles Chaplin tells [///] asks her how it would be to [/] to live in POST a house like that and she thinks he is going to get into PRE1 a house but it's not <he just> [/] hmm@p he just imagines the [/] PRE1 the scene so you can see POST the scene where they are both in hmm@p in PRE2 the interior of a house of PREPOST a nice house where everything is so natural and they [/] they have lemons from PRE2 the lemon+tree off PRE1 the window and they [/] they have a [/] POST a cow where [//] from where they can get milk and hmm@p there's PRE1 a kitchen she's cooking for him and they're really happy and [/] and PRE1 the moment they're going to [/] eat to cut a [/] PRE2 a big steak then hmm@p it's PRE1 the present they are on PRE1 the grass hmm@p as they were before and she's happy hmm@p thinking of PRE1 the steak and <he tells him> [//] he tells her something like hmm@p I want PRE1 a house even if I have to work for it and they just realize that there's PRE1 a policeman hmm@p <behind before> [//] behind them and they run away again .

@End

Appendix B (Coding of Infinitival and *-ing* Clauses)

@UTF8
@Begin

*INV: Marta could you tell me what happened in the first part of the story ?

*SUB: hmm@p in the first scene there is a woman who seems INFC to be starving and she's staring at a store with breads and I think &Ch [//] Chaplin appears and ah@ no no no wait she decides <to stole a> [//] INFC to steal a [/] a bread but there's a woman who seems INFC to be bored and tells the owner of the store that hmm@p the girl stole the bread and then Chaplin appears and wants INFC to help her and tells the [/] the man and the policeman that hmm@p he was the one who stole the bread and not the girl but then the old lady appears again and tells that it was not Chaplin but hmm@p the woman so they start INGC running and I think Chaplin is released and hmm@p yes no què@s:c més@s:c passa@s:c # I don't remember I just remember Chaplin then goes to a restaurant and she [//] he orders a lot of food he eats the food and then he goes without INGC paying and he tells the policeman INFC to come because he doesn't want INFC to pay and the policeman takes him to the car [?] with the rest of delinquents &=laugh and suddenly the girl appears again the one who stole the bread and I don't know they start INGC talking and the girl decides INFC to run away and <they have> [/] they have an accident and Chaplin tell her that it's [///] <if it want> [//] <if he[?]> [//] if she wants INFC to escape this is the right time because the policeman is [/] is unconscious so they run away together .

*INV: what happened in the second part of the story ?

*SUB: hmm@p after INGC running away hmm@p they sit down INFC to rest for a while next to a beautiful house and he ask her where does she live and she says that she has no place INFC to stay that she doesn't have a home or something like that and the couple who live in [/] in the house hmm@p the man goes to work and the woman stays at home and they Chaplin and the girl start INGC imagining a life together INGC having a house and the next scenes are in the house in their future house and there's a cow &=laugh a very smart cow and she's preparing the meal <while she> [//] while he's waiting to [/] INFC to have his dinner and that's it they have a big piece of meat and then they go back to reality and he decides to [/] INFC to get a home for both of them even if he has to work and then the policeman appears and they run away again .

@End

Appendix C (Coding of *Wh*-clauses)

@UTF8
@Begin

*INT: Jason could you tell me what happened in the first part of the story ?

*SUB: well WHCA when the film starts we see a [/] a girl watching the screen of a breadshop and the man of the breadshop getting some bread from the lorry and WHCA when he gets inside the shop she goes quick and steals a [/] a loaf of bread and goes running but hmm@p <a women> [//] a woman sees her and they all go after her and WHCA when she's running through hmm@p [//] in the street <she smashes> [//] she crushes with Charles Chaplin and the man from the bread and the woman get to them and [/] <and &Char> [//] and the police appears and Charles Chaplin says that he has stolen the [/] the bread and not the [/] the woman and the police takes the [//] Charles Chaplin instead of xx hmm@p but the woman tells to the breadman that it wasn't him <it was her that stole the> [///] WHCC it was the girl that stole the bread and they go and [//] to find the policeman then we see that Charles Chaplin goes to a cafeteria and gets a lot of food <and eats> [/] and eats it hmm@p WHCA when he's going out the cafeteria he [/] he calls the police and the police gets him then WHCA when the police has to make a phone call he starts smoking and gives hmm@p kind of cards <from the &sh> [/] from the [///] smoking things I don't know what to [/] to some kids to play and [/] and then I don't remember now very clear WHCI what it happens hmm@p ah@i yeah the policeman I think takes him to a lorry and puts him Charles Chaplin in a lorry with some other people and WHCA when he's there suddenly the lorry stops and the girl appears he says to her YNI if she remember him about the [/] the bread and [/] and the girl seems very [/] very upset and starts crying then &=laugh # no [/] no I really don't remember now # they go out the lorry and no and +...

*INT: ok so it's the end of the first part yes ?

*SUB: yeah [/] yeah .

*SUB: yeah I'm sorry but I thought at the beginning that I was going to see the image at the same time <I'm sorry> [/] I'm sorry <when you> [/] WHCA when you said to start I thought I was going to see the <yeah yeah> [/] yeah that's why I [/] I oh@i I really wasn't [///] I was looking more for the +...

*INT: what happened in the second part Jason ?

*SUB: well the second part starts with Charles Chaplin and the girl walking through a desert hmm@p road and they sit together in [/] in a grass <near the> [/] near a house and well she starts playing with like a flower and <he tells her where> [//] he ask hers WHCI where she lives and she says anywhere she's from nowhere

and suddenly the [//] a couple go out from the house a husband and a wife it seems they kiss them together and he goes out and Charles Chaplin laughs about the [/] the wife that was so happy with him and with the husband and he tells her that <if she &rememb> [//] YNI if she imagines themselves living in a house too and then we go to the imagination of [/] of Charles Chaplin WHCA where they live together he can get fruit from everywhere in the living+room he [/] he can get hmm@p fruit from a tree or in the kitchen he can get some grapes too and [/] and if he needs some milk he puts a cup outside calls a cow and the cow comes and gets him some milk and [/] and then <they they> [/] they eat some meat together and [/] and then suddenly goes back to the reality WHCA where there are sitting on the grass and she feels hungry thinking about they [/] they [] living together and suddenly a policeman appears and they start running and go yes .

@End

Appendix D (Coding of Grammatical Verb Forms)

@UTF8
@Begin

*INV: so this is the narrative in English with Mireia Casassas .

*INV: so Mireia MDL could please you tell me what happened in the first part of the story ?

*SUB: the first part of the story hmm@p we PS MDL may see a girl walking around and she PS stops by a shop well a breadshop and while the breadmaker PC is bringing the bread inside the shop <she she> [/] she well no [/] no definetely she [/] she PS steals a piece of bread but he [//] she's [/] TS PSV she's got caught from [//] for no [//] by the police hmm@p but hmm@p before that she TP has had crash with Charles Chaplin and finally <he he he> [/] he TS confessed that he PP has been the one who PP has stolen the bread and TS let the girl free well she [/] she finally PS gets free and [//] but one lady that PP has seen all the scene hmm@p PS tells <the truth> [/] the truth to the police but Charles Chaplin finally PC is the one who PC is paying for that and after that more I PS keep going ?

*INV: yeah yeah .

*SUB: and after that well hmm@p after this scene we PS MDL can see that Charles Chaplin PCF is going to have <some dinner> ai@i [//] some lunch hmm@p and [/] and he's [/] PC he's having two trays hmm@p instead of one I PS don't know why and well PC he's having his food and I PS don't remember what else happened right after this hmm@p PC he's paying the bill he PS seems very [/] very nice to everyone and also PC is giving some books or something to two kids that he PS meets on the street and [//] but after that hmm@p the police hmm@p PS catches him and PS PSV he's sent to somewhere I PS don't know because PC is not appearing at the scene hmm@p PS PSV he's sent to like a &sp [//] kind of bus plenty of people well dirty people and not [///] they TS seemed like yeah thieves and burglars and hmm@p fortunately the girl PS appears &wi [//] with shabby clothes and [/] and he PS lets her his seat because he [/] he MDL FTR will sit for [//] instead of him and after that they [//] the [/] the bus and another car or another bus had [//] has [/] PS has a crash and all are [//] PS seems to be like falling on the street and he PS tells PS is your chance to escape go [/] go go and she PS thinks oh PS that's good I PS MDL can go but [/] but finally she PS ask him PS MDL can you join me and I PS think this PS is the last part that we PS see .

*INV: Mireia MDL could you tell me what happened in the second part of the story ?

*SUB: after [/] after +...

*INV: after they escaped .

*SUB: ok they TS escaped and then they PS start sitting <on a kind of> [///] in front of a neighborhood and they PS start flirting because PC he's smiling and PS he's oh oh oh and they TS saw a lovely couple who PC are kissing each other and PC saying goodbye hmm@p who PC are living in the nice house and they PS start hmm@p like making hypothesis and [//] because he PS ask her if [//] <where does where does> [//] where PS do you live and she PS says nowhere and he [//] the boy PS starts dreaming of him and her living in a nice house and living as a traditional couple hmm@p in a bucollic hmm@p scenery with a cow and PC she's doing the dishes and the cooking and ok if I have to work even he PS says emphasizing that hmm@p if I have to work I [/] I CON2 MDL would get you a house and well <&i she> [//] then [/] then she PS seems very &ang [//] hungry I PS mean and <at the> [/] at the very end the police PS comes and they PS go somewhere with the police .

@End

Appendix E (Descriptive statistics of the whole sample)

Table A1. Descriptive statistics of the whole sample

	N	Mean	SD	Minimum	Maximum
$XandYLex$	91	6412.64	1086.63	4150	8900
OPT	91	44.46	6.48	28	56
$Rspan\_P$	85	63.84	18.48	9.33	100
SNs/ASU	91	1.55	.17	1.24	2.33
$Words/ASU$	91	9.18	1.42	5.95	14.27
$Words/SNs$	91	5.93	.67	4.11	8.10
$SNs/\sqrt{ASU}$	91	10.78	2.40	5.09	19.47
$Words/\sqrt{ASU}$	91	63.71	15.26	36.45	120.68
$Words/\sqrt{SNs}$	91	51.28	11.96	29.52	92.35
$ENPs/\sqrt{ASU}$	91	2.29	.78	.43	4.75
$INFC/\sqrt{SNs}$	91	.83	.39	.13	1.90
$INGC/\sqrt{SNs}$	91	.45	.35	0	1.36
$No.\ of\ verb\ forms$	91	4.98	1.28	2	8
$WHC/\sqrt{SNs}$	91	.90	.47	0	2.51
$MDL/\sqrt{Words}$	91	.13	.10	0	.50
$CON/\sqrt{ASU}$	91	.21	.20	0	1.14

OPT = *Oxford Placement Test*; Rspan_P = *Reading Span Score*; SNs = *Sentence Nodes*; ASU = *Analysis of Speech Unit*; ENP = *Elaborated Noun Phrases*; INFC = *infinitival clauses*; INGC = *-ing clauses*; WHC = *wh-clauses*; MDL = *frequency of modals*; CON = *frequency of conditionals*.

Appendix F (Descriptive statistics of the low proficiency group)

Table A2. Descriptive statistics of the low proficiency group

	N	Mean	SD	Minimum	Maximum
$XandYLex$	32	5709.38	746.65	4250	7050
OPT	32	37.31	3.56	28	42
$Rspan\_P$	29	61.24	18.45	9.33	96
SNs/ASU	32	1.55	.15	1.24	1.90
$Words/ASU$	32	9.49	1.52	7.40	14.27
$Words/SNs$	32	6.10	.71	5.10	8.10
$SNs/\sqrt{ASU}$	32	9.83	2.22	5.09	13.67
$Words/\sqrt{ASU}$	32	59.54	13.13	36.45	83.14
$Words/\sqrt{SNs}$	32	47.71	9.76	30.27	67.43
$ENPs/\sqrt{ASU}$	32	2.15	.59	1.28	3.58
$INFC/\sqrt{SNs}$	32	.81	.44	.16	1.90
$INGC/\sqrt{SNs}$	32	.28	.28	0	1.08
$No.\ of\ verb\ forms$	32	4.78	1.36	2	8
$WHC/\sqrt{SNs}$	32	.81	.43	0	1.51
$MDL/\sqrt{Words}$	32	.13	.09	0	.33
$CON/\sqrt{ASU}$	32	.16	.14	0	.56

OPT = *Oxford Placement Test*; Rspan_P = *Reading Span Score*; SNs = *Sentence Nodes*; ASU = *Analysis of Speech Unit*; ENP = *Elaborated Noun Phrases*; INFC = *infinitival clauses*; INGC = *-ing clauses*; WHC = *wh-clauses*; MDL = *frequency of modals*; CON = *frequency of conditionals*.

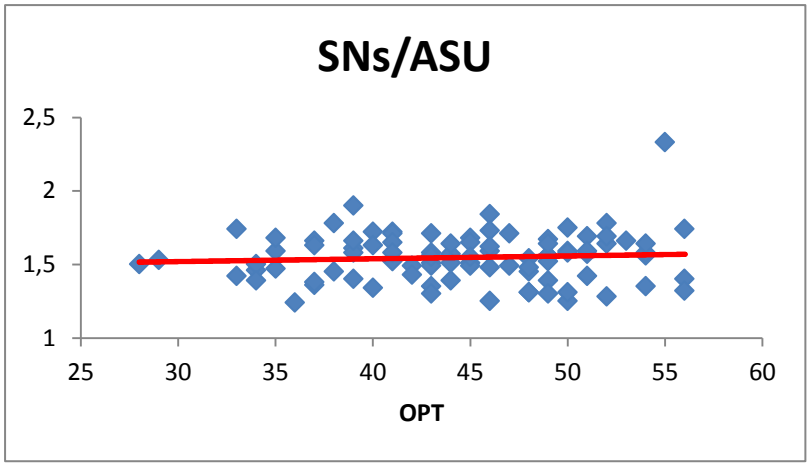
Appendix G (Descriptive statistics of the high proficiency group)

Table A3. Descriptive statistics of the high proficiency group

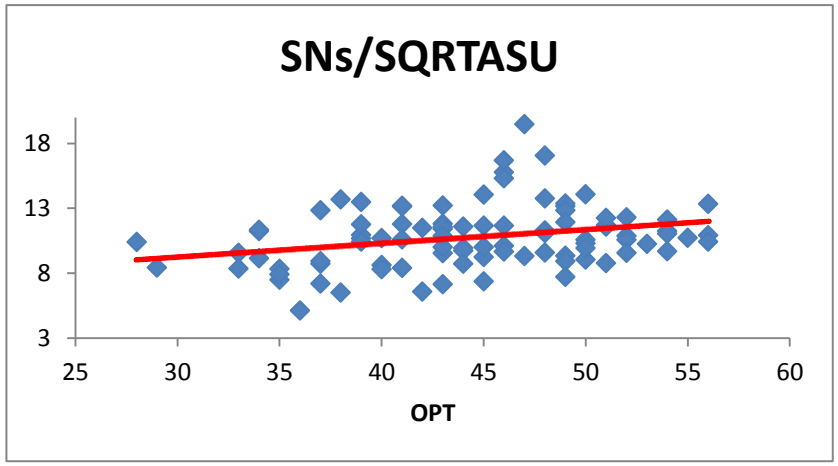
	N	Mean	SD	Minimum	Maximum
$XandYLex$	59	6794.07	1055.16	4150	8900
OPT	59	48.34	3.86	43	56
$Rspan\_P$	56	65.19	18.51	21.33	100
SNs/ASU	59	1.55	.18	1.25	2.33
$Words/ASU$	59	9.01	1.34	5.95	14
$Words/SNs$	59	5.84	.62	4.11	7.06
$SNs/\sqrt{ASU}$	59	11.29	2.35	7.12	19.47
$Words/\sqrt{ASU}$	59	65.98	15.96	38.31	120.68
$Words/\sqrt{SNs}$	59	53.22	12.65	29.52	92.35
$ENPs/\sqrt{ASU}$	59	2.37	.86	.43	4.75
$INFC/\sqrt{SNs}$	59	.84	.37	.13	1.61
$INGC/\sqrt{SNs}$	59	.54	.34	0	1.36
$No.\ of\ verb\ forms$	59	5.08	1.24	2	8
$WHC/\sqrt{SNs}$	59	.95	.48	0	2.51
$MDL/\sqrt{Words}$	59	.13	.11	0	.50
$CON/\sqrt{ASU}$	59	.23	.22	0	1.14

OPT = *Oxford Placement Test*; Rspan_P = *Reading Span Score*; SNs = *Sentence Nodes*; ASU = *Analysis of Speech Unit*; ENP = *Elaborated Noun Phrases*; INFC = *infinitival clauses*; INGC = *-ing clauses*; WHC = *wh-clauses*; MDL = *frequency of modals*; CON = *frequency of conditionals*.

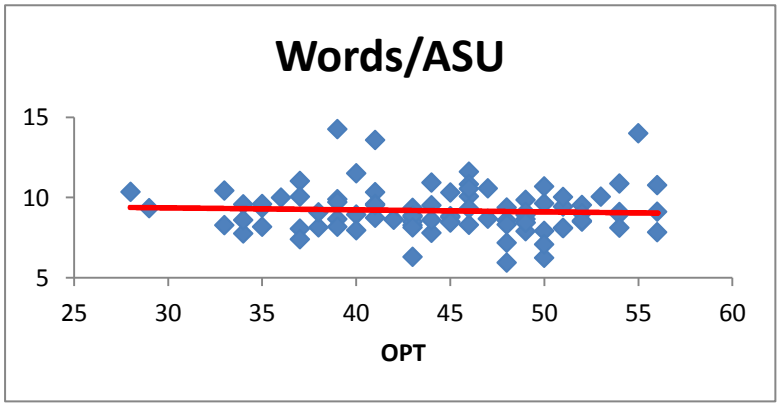
Appendix H (Syntactic Complexity Measures and Proficiency)



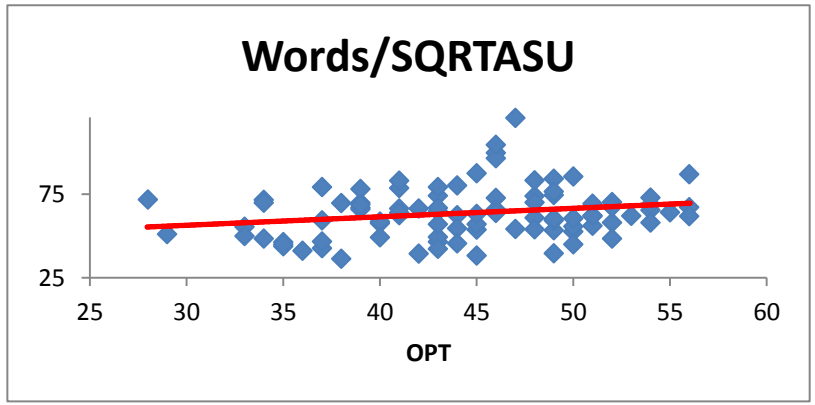
FigureA1. Progression of SNs/ASU with Proficiency as measured by OPT



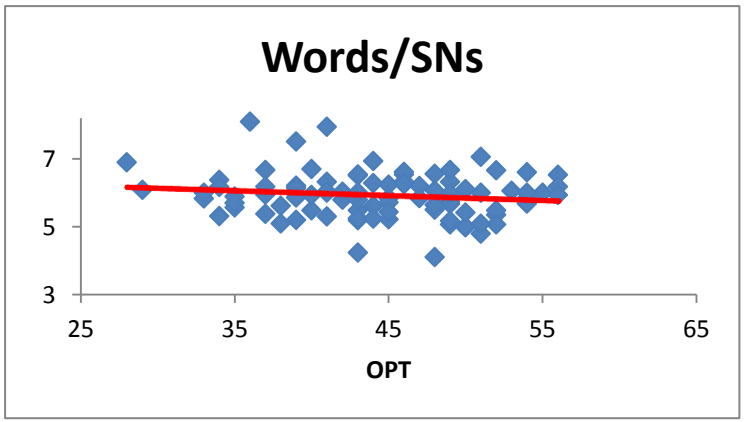
FigureA2. Progression of SNs/√ASU with Proficiency as measured by OPT



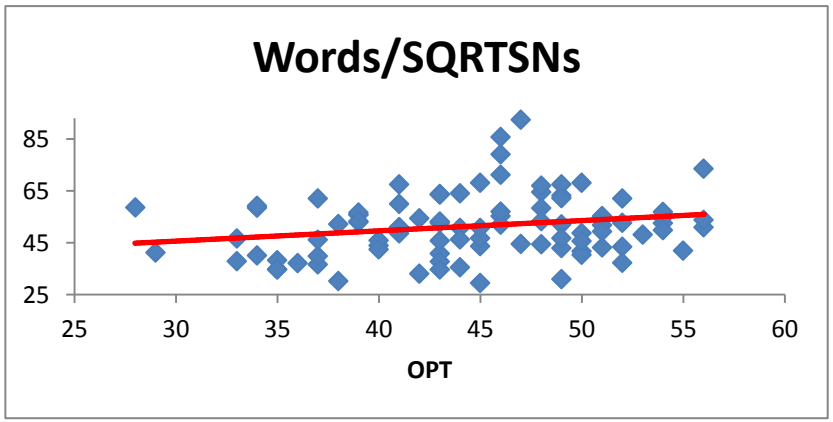
FigureA3. Progression of Words/ASU with Proficiency as measured by OPT



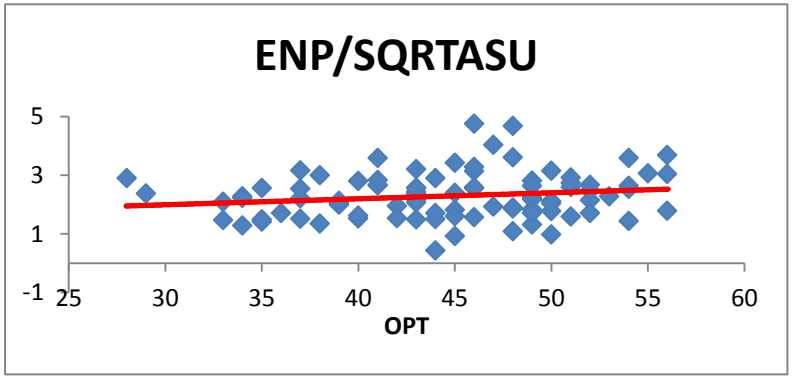
FigureA4. Progression of Words/√ASU with Proficiency as measured by OPT



FigureA5. Progression of Words/SNs with Proficiency as measured by OPT

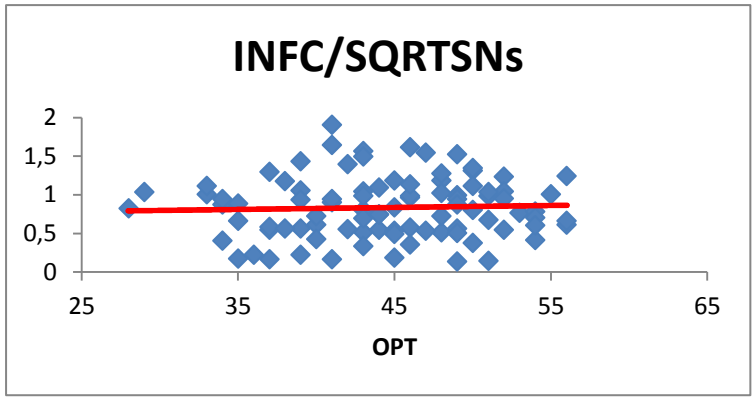


FigureA6. Progression of Words/√SNs with Proficiency as measured by OPT

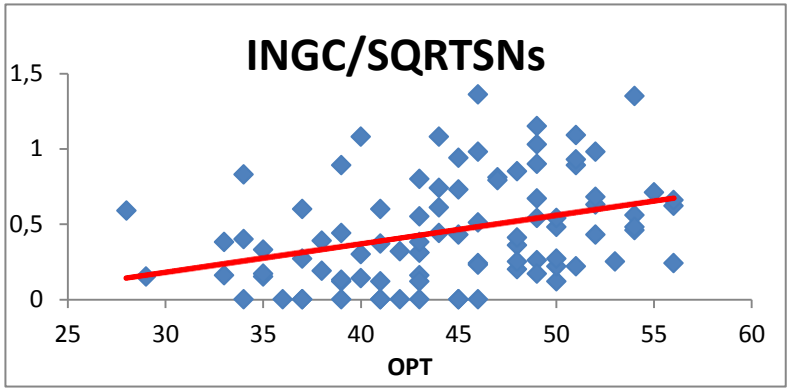


FigureA7. Progression of ENP//√ASU with Proficiency as measured by OPT

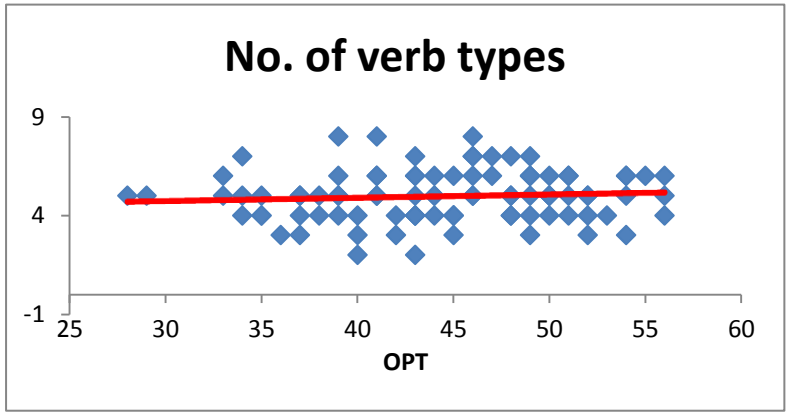
Appendix I (Grammatical Complexity Measures and Proficiency)



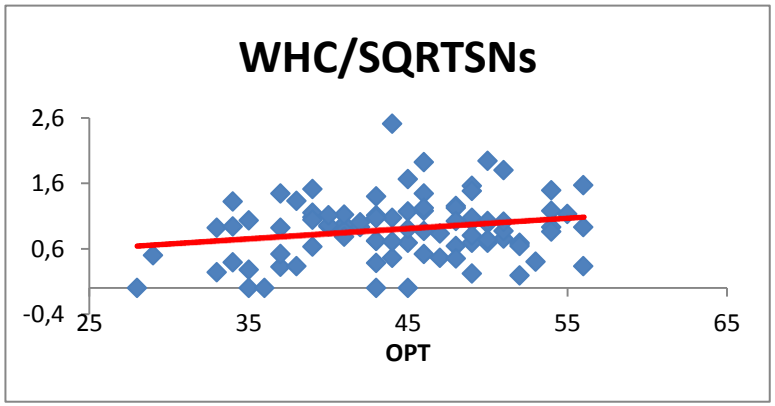
FigureA8. Progression of INFC/√SNs with Proficiency as measured by OPT



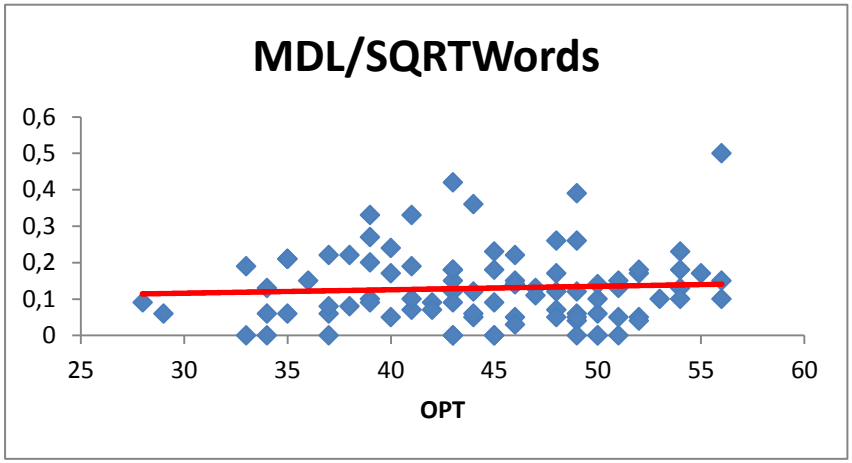
FigureA9. Progression of INGC/√SNs with Proficiency as measured by OPT



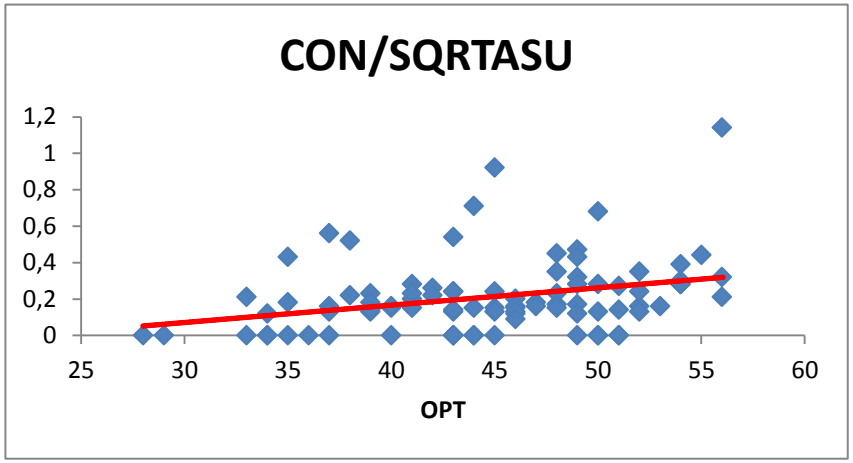
FigureA10. Progression of No. of verb forms with Proficiency (OPT)



FigureA11. Progression of WCH/√SNs with Proficiency as measured by OPT



FigureA12. Progression of MDL/√words with Proficiency (OPT)



FigureA13. Progression of CON/√ASU with Proficiency as measured by OPT