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Rioplatense Spanish Speaking Schoolchildren with and without Language Difficulties: Syntactic and Lexical Aspects

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Abstract

Two groups of schoolchildren, one of 6 to 8 and the other of 9 to 12 years old, participated in a comprehension test of complex syntactic structures and maintained individual interviews. It was hypothesized that the processing of high-cost syntactic structures, such as reversible passives, relatives and partial questions, is especially difficult for children with language deficits.

The aim of the study was twofold: to recognize possible comprehension difficulties with the implementation of a test battery, and to evaluate to what extent comprehension difficulties allow us to predict distinctive lexical characteristics in the oral speech production of participants.

Regarding the first goal, the implementation of the test allowed us to distinguish three groups: children without comprehension difficulties; children that overcame initial difficulties in a second test carried out two years later; and children who did not overcome the difficulties and were considered at risk of Specific Language Impairment. Regarding the second goal, the results suggest that traditional lexical diversity measures remain at similar values in children with and without difficulties regardless of age. More specific measures did allow establishing group differences. The most notable difference was found in verbs: young and old children without comprehension difficulties produced significantly more different verbs than the groups with difficulties, while there were no significant differences between groups with comprehension problems.

Taken together, the results indicate that 10.43% of the total participants had comprehension problems, of which a third were also evaluated and diagnosed by professionals outside this investigation. The remaining two-thirds went unnoticed in the family and/or school environments. Furthermore, measurements of lexical diversity support the idea that deficient syntactic comprehension predicts lexical impoverishment, in particular, at the production of verbal predicates.

Altogether, the results obtained suggest that schoolchildren with temporary or permanent comprehension problems could be making strategic use of language tending to minimize processing costs in their oral speech productions.

Keywords: *Specific Language Impairment; Language Processing; Syntactic Comprehension; Lexical Diversity; Verbal Predicates*

Abbreviations

SLI: Specific Language Impairment; DLD: Developmental Language Disorder; MINC: Integrated Model of online Computing; MP: Minimalist Program; MABILIN: Módulos de Avaliação de Habilidades Linguísticas (Language Skills Assessment Modules) DSyn: Syntactic Delay; SynSLI: Syntactic Specific Language Impairment; TTR: Type/Token Ratio; D: Diversity of Vocabulary; MLUw: Mean Length of Utterances

in Words; NDW: Number of Different Words (Types); TNW: Total Number of Words (Tokens); TNN: Total Number of Nouns; TNV: Total Number of Verbs; SD: Standard Deviation

Introduction

It has been observed that language difficulties are a factor that can influence the learning, behavior and emotions of young children and that this influence can manifest itself stronger in older children and adolescents [1]. However, most studies on language (for both typical and atypical individuals) have focused on the period that covers the first 4 or 5 years of life. Regarding the school-aged, there is a remarkable lack of research [2]; older children and adolescents are often the 'forgotten group' [3]. Mendoza [4] points out that language problems in young children are perceived as such and can turn to be a manifestation of more deep, specific or generalized disorders. However, over time children improve their discursive skills and sustain more communicative interactions. If scholarly or behavioral difficulties arise, they are attributed to learning disorders or behavioral disorders, leaving aside the possibility that they are due to underlying linguistic difficulties [4].

Thus, language deficit is often considered a preschool condition, and although it has been conceptualized as a relatively pure language disorder, the condition is quite heterogeneous, with wide-ranging and far-reaching sequelae, i.e. language impairment may not be as clearly distinguishable as the classical definitions entail. The most widely used label for language deficits is Specific Language Impairment (SLI); it is characterized as a language developmental disorder in the absence of clear neurological, sensory-motor, non-verbal cognitive or socio-emotional deficits, which can affect both expressive and receptive language [5,6]. Recently, however, it has been described as a Language Development Disorder (LDD), a less strict characterization, oriented to include cases of language problems with social, economic and emotional sources as well [7]. Therefore, current research suggests that the picture is more complex, at least from a clinical perspective, and that the traditional characterizations need revision.

The causes of language problems are multiple and there is great variability between individuals, which makes a complex issue the detection of cases (and their possible treatments). As risk factors that can result in language difficulties there have been pointed out: those of a biological nature (e.g. male sex individuals more affected than female ones, and families with a background on language difficulties); of a cognitive nature (basically associated with low attention span and memory limitations); and of environmental nature (e.g. parental education and socioeconomic status). These factors can also be combined [8]. In this sense, studies on language difficulties of environmental origin due to factors such as violence, home chaos, food insecurity or emotional instability, are relatively scarce [9]. Research mainly in the English language indicates that schoolchildren who had language difficulties during their childhood continue to show problems primarily in the processing of syntax [10] and in the extension and depth of lexicon knowledge [11]. In addition, their spontaneous productions often lack complex syntactic structures [12]. Even those children who seem to have overcome difficulties before entering school, although they tend to have good comprehension skills, may experience language-related difficulties at the institution [13].

Another aspect complicating the scenario, in addition to the multicausality and the diversity of labels to refer to language problems, is that of the method or instrument used to define whether there are difficulties and/or poor performance in one or more language domains (i.e. standardized type tests). It is a theoretically and empirically intricate topic that is beyond the scope of this paper. However, given the current perspectives raised by the Minimalist Program (MP) [14,15] in generative grammar concerning a better understanding of what a syntactic computation is (technically called derivation), various accounts have been provided to explain the patterns of language impairment [5,16]. These proposals range from theoretical approaches more oriented to linguistic knowledge itself to psycholinguistic approaches addressing the ways of access to and use of such knowledge. In the latter tendency, the Integrated Model of online Computation (Modelo Integrado de Computação online, since now MINC) [17,18] proposes that the computations carried out in the linguistic cognitive system when comprehending (and producing) certain types of sentences can overload the syntactic processing system in particular discursive contexts. Specifically, the sentences requiring canonical order to be altered due to discursive needs are those that impose the greatest demands on memory. For instance, if during a conversation a speaker uses a passive voice of the type Mary was congratulated by Anne, there the canonical order has been altered (i.e. Anne congratulated Mary). Among others, this type of syntactic structures, according

to the MINC, have a high processing cost making them difficult to comprehend (and produce) for children in general, and especially for those with linguistic deficits. Sufficient empirical evidence supports the idea that some passive, relative and partial interrogative structures entail high processing costs, as stated by the MINC [19].

The scenario presented by the aforementioned research is affected by a lack of studies on language difficulties in schoolchildren/adolescents, especially about cases where there haven't been alerts, or weren't given due attention during early childhood. In school, many children who experience language problems, whether caused by cognitive/biological or environmental factors, do not usually have evident symptoms, although they struggle daily to be successful in school tasks requiring sophisticated degrees of linguistic ability. Language difficulties are sometimes overcome with time, but they can persist and result in negative social, emotional, academic, and occupational throughout life consequences [20]. In this article, we report the results of a comprehensive assessment of language comprehension skills on school-aged children, performed to identify possible occurrences of comprehension difficulties in the syntactic domain. In addition, a follow-up of those children who presented problems in the evaluation was carried out to determine whether the difficulties were overcome with time or not. On the other hand, students who did not present difficulties and also those who scored low in the comprehension test participated in semi-controlled interviews to verify to what extent impairment in syntactic comprehension can be a predictor of alterations on the lexical component of production.

The article is organized as follows: first, the working hypothesis, the objectives of the study and the characteristics of the processing model are made explicit; secondly, the method of evaluating syntactic comprehension skills is described, and the seven measurements used to outline the characteristics of school children's lexical production get explained; the results of the lexical diversity measurements are presented afterwards; then the results of the measurements are discussed, and in the end, a conclusion is offered.

Hypothesis and Objectives

The assumed working hypothesis was that linguistic processing dependent on high-cost computational operations presents difficulties in comprehending complex sentences in school children and can be particularly hard for children with some type of linguistic deficit. The aforementioned processing cost can be characterized in relation to the type of operation carried out and its implications on the working memory [18] and also concerning the effect of a third intervening element located between the two terms involved in the syntactic relationship, when this third element has certain syntactic properties [21]. The notion of processing cost will be explained in the following section.

The goal of inquiry was twofold. In the first place, from the implementation of a test battery, were identified those children whose syntactic performance was below the pattern corresponding to their age group. In addition, after two years the test battery was applied again to the children who had low performance, in order to determine if they had overcome the initial difficulties 'on their own' or if those persisted. In the second place, based on the distinction between children with and without difficulties, it was evaluated whether diverse measures of lexical diversity allow establishing differences between groups. Furthermore, the analysis of lexical categories of the open class, specifically of nouns and verbs, was considered relevant, since they carry most of the semantic and conceptual information and act as an important interface between lexicon and syntax [22].

The real-time processing model

The MINC [17,18] incorporates computational operations characterized in the PM [14,15] as a requirement for the grammatical codification of the clauses for processing in comprehension and production; such operations are merge, movement (copying) and agreement. They apply to lexical entries retrieved from the mental lexicon. From a psycholinguistic perspective, it is assumed that those lexical units will be maintained in working memory prior to syntactic computation. In production, the result of the interaction between semantic/formal features present in the lexical items and conceptual-intentional systems is what will motivate the selection of items to be retrieved from the lexicon. In the case of comprehension, the phonological features of the lexical items (which make up the structures heard) permits access to the formal features in order for those items to be analyzed (parsing process). In other words, in production, the linguistic computation starts from a set of lexical items selected based on a communicative intention and concepts to be transmitted,

while in comprehension, the speaker's intention and the concepts are recovered as the linguistic structure is analyzed and systematically interpreted, setting the references.

Two relevant characteristics are prominent in the MINC: i) a mixed top-down/bottom-up syntactic computing system directly related to the distinctive characteristics of the functional elements of the lexicon which semantic-formal features encode referential properties and illocutionary force, being thus related to the intentional systems and those lexical elements which semantic-formal features would be more directly related to the conceptual systems; and ii), two types of movement are distinguished: the online movement (i.e. insertion of temporally sequenced copies), demanded by discourse needs, with measurable computational cost, and movements related to the canonical order (i.e. insertion of simultaneous copies), fixed during the process of language acquisition, without computational cost.

Therefore, it is assumed in the MINC that the selection of functional nodes, guided by a speech intention, gives rise to a derivation of top-down syntactic objects (Complementizer Phrases, Tense Phrases and Determiner Phrases) which are coupled to derivations of bottom-up syntactic objects from lexical nodes linked to the content of the conceptualized message. The computational cost in the case of sentence comprehension is thus linked, on the one hand, to the recognition of formal features present in the statement and, on the other hand, to the presence or absence of movements (or generation of copies) demanded by the discourse. A distinction is then made between syntactic structures that do not require a high demand of resources for their processing and therefore facilitate their rapid acquisition, such as simple matrix clauses, like structures with the Subject-Verb-Object canonical order (SVO) from Spanish; and syntactic structures of high computational cost originated by speech demands such as those already mentioned passives, in particular, if they are reversible.

However, the authors point out, the sentences that are derived from canonical ordering entail the execution of algorithms each time they must be processed depending on the different situations of discourse. It is in this sense that the model allows predicting that certain sentences will be mastered before others during the typical acquisition of a language and that some of these structures increase comprehension problems when there are difficulties in syntactic processing, which could be a sign of SLI/DLD alert. Finally, it should be remarked that not all structures that involve syntactic movement (sequenced copies, in real-time computing) entail processing difficulties to the same degree. In this sense, it has been found [23] that the presence of an intervening element between the moving element and its copy can be a source of greater demand, either due to the distance between the moving element and its original position (causing an overload in memory) or because the features from the interposing element are largely shared with those belonging to the other two elements involved in the operation, i.e. the moving element and its copy.

Materials and Methods

Participants

374 children belonging to primary schools from Santa Fe city (Argentina), divided into two age groups: one of 180 younger children (6 to 8 years old, mean 7.2, SD = .6); and another of 194 older children (9 to 12 years old, mean 10.4, SD = .7). They were assessed in the comprehension of syntactic structures. Participants were selected with parental consent by the adults in charge, from children whose ages were within the stipulated ranges, and who, in the opinion of the teachers, were in a position to carry out this form of test (they did not present apparent nor diagnosed hearing or neurological difficulties). In this way, children with some type of disability that impeded the implementation of the instrument were excluded. The children belonged to families with a middle or low socioeconomic status. Articulatory and/or phonological skills were not formally assessed. However, all participants had intelligible speech.

Material

Syntactic structures comprehension test

For the evaluation regarding comprehension, was used the syntactic module of MABILIN, a test battery for the assessment of linguistic abilities originally designed for Brazilian Portuguese [24]. An adaptation for Rioplatense Spanish was employed [25]. The Rioplatense Spanish adaptation allows a more reliable assessment in the local context than the use of the usual instruments generally translated from the English language (see Silveira [26] for a critical view on the use of standardized tests).

This module consists of a picture identification task with three different sections according to syntactic structures. In section 1, the task contains reversible active, reversible passive and non-reversible passive structures; section 2 comprises relative sentences (with extraction of subject and object) in the object, and questions with who or what and what + N; section 3 of the module consist on relatives (with extraction of subject and object) in the subject (with transitive or intransitive matrix verb). There are 8 sentences per condition, which are presented orally along with three images displayed on a computer screen: the target (correct action/thematic role assignment); and two distractors corresponding to predictable errors. The order of presentation is random, and the computer automatically records the children's response. The result obtained by MABILIN for each participant is the score obtained (i.e. number of correct answers with maximum = 8) in each of the thirteen conditions. These results were compared with the values considered limit by condition (i.e. 2 SD below the mean) and by age group. The limit values for correct answers by condition for children speaking Rioplatense Spanish were obtained from the study by Dotti, Corrêa, Rivera, Benassi and Formichelli [39].

As expected, regardless of age, the most demanding structures were: reversible passives (e.g. The dancer is adorned by the girl.); object questions (with who or what + N) (e.g. Who did the clown kiss?/What giraffe did the ballerina decorate?); object relatives at the object (e.g. Point to the lion that the tiger grabbed.); and object relatives at the subject (e.g. The bear that the tiger grabbed lifts a rock.).

Of the total of 374 participants, 39 (10.43%) scored 2 standard deviations below the mean in at least one experimental condition (mild and moderate cases were registered, and no severe cases). Of these 39 children, 30 belonged to families with a middle socioeconomic status and 9 to families with a low socioeconomic status. Children with a middle socioeconomic status were assessed with the MABILIN test a second time two years later (children with a low socioeconomic status could not be reassessed due to different causes). 19 of the 30 reassessed children scored this second time within the normal range, and it was considered that they suffered a temporary delay in the syntactic domain that was overcome with time (hereinafter SynD Group). Meanwhile, the remaining 11 children showed the same difficulties as in the first test. This second group was considered to be the most likely to be at risk for syntactic SLI (hereinafter SynSLI Group). It should be clarified that 5 of these 11 children were evaluated by registered professionals, independently of the present investigation, and diagnosed as having SLI before or during the period this study lasted.

Lexical diversity measures

In order to assess the lexical characteristics of spontaneous speech, audio-recorded interviews were conducted with all participants. Different activities were proposed as stimuli: a) narration of a story from the display of sheets with images shown by the interviewer; b) acted interview with the 'celebrity child'; c) narration of the plot of a movie or series the child liked; d) construction of a short story from drawings of characters and actions presented at random by the interviewer; e) telling a story based on the display of pictures from classic fairy tales; f) free conversation.

It was decided to transcribe 110 of the interviews carried out with children of middle socioeconomic status: 30 from the children who presented difficulties in the comprehension test and another 80 who were randomly selected among those children who did not show difficulties. Excessively short interviews, with little cooperation from the children or with technical audio problems were ruled out. Whereof in the end a total of 97 interviews were transcribed and coded under the CHAT system of the CHILDES database [27].

At transcription work, the speech samples were first segmented into sentences and then each sentence was coded. The limits of the statements were determined ignoring prosodic signals, based on purely syntactic criteria. Grammatical segmentation is easier to apply consistently and less ambiguously than segmentation using intonation and prosodic cues [28]. The general definition of a statement was a matrix clause together with its subordinate clause when any. Main clauses linked by coordinate conjunctions were considered separate sentences, obeying the general rule of one main sentence per utterance. For instance, She got into her car/and I think she sped off, were considered as two different statements. Interjections, pauses with sounds (e.g. 'eh', 'mmm') and/or sentence fragments were transcribed and encoded in a differentiated way.

In order to obtain greater reliability in the segmentation and coding labor, each interview was transcribed by a member of the team and examined in two subsequent instances by two other different members together with the audio recordings.

The transcripts were divided into two age groups, younger and older children; 19 transcripts corresponded to the SynD Group, 11 to the SynSLI Group and the remaining 67 to the Control Group, distributed according to table 1.

Group	Control	SynD	SynSLI
Younger Children	n = 36 92.9 (9.4)	n = 14 90.6 (7.0)	n = 5 92.6 (9.8)
Older Children	n = 31 135.1 (12.9)	n = 5 128.8 (17.9)	n = 6 128.6 (22.1)

Table 1: *Distribution of groups by age and speech characteristics.*

Note: The numerical values correspond to the average age in months. In parentheses: SD.

Seven measures were used: TTR, D, MLUw, NDW, TNW, TNN, TVN. The CLAN program [27] ignored the aforementioned pauses with sound and sentence fragments, on the automatic calculation of these measures, taking into account only complete and intelligible sentences.

Each measure is briefly described below.

TTR: The type-token ratio, a measure of linguistic production derived from a spontaneous speech sample, is perhaps one of the most widely used in research and clinic, although it isn't exempt from criticism [29]. It represents the ratio between the number of different words (NDW) or types present in a language sample and the total number of words (TNW) or tokens in that same sample (it ranges between the values 0 to 1). It has been recommended as a means of quantifying the semantic skills of children in order to identify a language disorder and/or describe the strengths and weaknesses of children with language learning difficulties [30]. However, TTR and MLU have their limitations, joint contrast is recommended or comparisons with other measures [31]. For example, it is generally recognized that TTR is highly influenced by sample size [32]. With the increase in the number of sentences in a sample, the words tend to be repeated and the TTR decreases [33]. One of the solutions that has been proposed and that is used in this study is to consider a fixed portion of statements to calculate the TTR [34]. Specifically, the first 100 statements expressed by each child in their transcript (approximately 5 minutes of audio) were left out, and the subsequent 100 were taken into account.

D: More recently, the D measure was proposed to overcome the drawbacks imposed by the TTR [35]. It predicts the potential reduction of lexical diversity in longer texts and, consequently, allows the comparison of texts of different lengths. The measure is based on a probability model to track the decrease in TTR as the number of tokens increases. The higher the D value, the greater the lexical diversity. In this research, therefore, all the statements of each child were used (with the exceptions described above) for the automatic calculation of the D measure.

MLUw: The Mean Length of Utterance in words is another frequently used measure that can be obtained from spontaneous speech. Its calculation formula consists of dividing the total number of words (functional and lexical) by the total number of sentences produced. Its main objective is to obtain a rough estimate of the syntactic abilities of both typically developing children and those with language difficulties. A significant correlation has been obtained between the MLUw measure and age in children, adolescents and adults, in different languages [36]. Kemper and Summer [37], for instance, point out that the MLUw (among other measures) is similar in young people and older adults, although in young people this measure tends to increase if lexical pauses such as 'right', 'you see', 'you know', among others, are taken into account. For this reason, this form of pause is excluded in this study. Gutiérrez-Clellen, Restrepo, Bedore, Peña and Anderson [38] point out that the MLUw (among others) is a measure that should be used with caution, mainly in relation to possible conclusions about the individuals' grammatical development. As noted before, the authors suggest that any language assessment instrument should be employed together with other measures, for the results obtained can be compared and complemented.

NDW: The number of different words (types) provides a measure of semantic proficiency [31]. In this study, the various occurrences of a lemma are considered as different words, for example, 'run', 'ran' and 'running' count as three different words. The NDW measure was calculated based on 100 utterances (in the same way as TTR).

TNW: The total number of words used in a spoken text (tokens) represents a more global linguistic ability, which includes skills such as speed of speech, the ability to formulate expressions (as well as motor-speech skills in young children). Kelly and Habers [39] suggest that the TNW appears to be a more informative index than the TTR. Given that in the present study the speech samples are comparable in size, it was considered pertinent to incorporate this measure covering the full text.

TNN and TNV: The total numbers of nouns and verbs correspond to the different types (not tokens, though they are called "total number" they refer to the "total number of different nouns/verbs") used in each transcription and were calculated with the CLAN subprogram freq. In both categories, each variant of the same lemma was counted (e.g. 'casa' [house] and 'casita' [little house] were counted as two different nouns). In the case of verbs, simple forms (e.g. 'compró' [bought]) and compound forms (e.g. 'pudimos comprar' [we were able to buy]) were counted as different; copulatives were not computed.

Process

During the sampling within the schools' buildings, each child interacted individually with a member of the team, in a space away from the classrooms (except for five cases in which speech pathologists participated in their clinics).

First, the syntactic structures comprehension test (MABILIN) was carried out, which lasted between 30 and 40 minutes. The student was sitting in front of the computer and next to him was the adult who was manipulating it. The adult read a sentence and the child pointed out, among the images that appeared on the screen, the one that, in her opinion, matched with the sentence heard. The computer automatically recorded the answers (right hits).

In a second moment, after a short break, each child participated in an interview conducted by the same person who administered the test. The interviewers implemented sample collection methods that could encourage participants' verbal production, including: (a) following the children's interests during the conversation; (b) limiting the interviewers' interventions; (c) using comments and open-ended questions when interacting; (d) changing the stimuli if the child lost interest.

Each interview lasted approximately 20 minutes.

Results and Discussion

The non-parametric Kruskal-Wallis test was used to compare the means of each of the seven measure between study groups (Control, SynD and SynSLI). The results are presented in table 2 for Younger Children and in table 3 for Older Children. On the other hand, when there were significant differences ($p < .05$) in any of the seven measures, the Mann-Whitney U test was used to make pairwise comparisons. The analyses were carried out with the statistical package InfoStat [40].

Results

Younger children group

The more traditional measures (TTR, D and LMUw) did not show significant differences between groups. Among the alternative measures, there were differences in NDW, with more quantity in Control than in SynD ($p = .02$) and than in SynSLI ($p = 0.01$); the difference between SynD and SynSLI was at the limit of significance ($p = .06$) with more in SynD. In the NTW there were differences in favor of Control with respect to SynD ($p = .03$) and with respect to SynSLI ($p = .01$); no significant difference between SynD and SynSLI. Regarding TNN, there were significant differences, with more Ns in Control than in SynD ($p = .03$) and than in SynSLI ($p = .02$); the difference between

SynD and SynSLI was at the limit of significance (p = .06) with more for SynD. Regarding TNV, there were differences in favor of Control in relation to SynD (p = .03) and SynSLI (p = .01); there were no differences between SynD and SynSLI.

These results suggest that, at first glance and according to the TTR and D measures, younger children, with a mean age of 7.5 years, do not differ between study groups due to the volume and variety of words used. Nor do they differ in the number of words used per sentence (LMUw). However, children in the SynSLI group use markedly fewer different words (NDW), i.e. the expressive lexicon, as might be expected, is less rich than in typically developing children, and also than in children suffering from a temporal delay in their syntactic processing abilities.

When speaking, Control children usually use a much higher total word count (TNW) than the other two groups. In more detail, the results reveal that the number of different nouns in types (TNN) of the controls is on average higher than in the other two groups; furthermore, the SynD group produces more different nouns than children on SLI alert, although the difference is not significant.

Something similar happens with different verbs. Control children express themselves using a greater variety of verbs than the other two groups; however, the difference between the groups with difficulties is not statistically significant.

The general table shows that children who did not have problems in the comprehension test produced sentence structures with similar extensions (in number of words), but with greater lexical diversity than children who did have difficulties. The most consistent differences compared to controls are found in the SynSLI group. The latter use a smaller variety of words (lexical and functional), use fewer words to express themselves throughout their speech and have a more restricted variety of nominal and verbal types.

The profile of the SynD group is less clear. They are not differentiated from the other groups by the LMUw measure. They have a less rich expressive lexicon than controls, but somewhat more elaborate than SynSLI children. They used a lower total of words in their interviews than the Control, but that does not differ from the SynSLI group. Regarding nouns, they used fewer different nouns than the controls, but more than the SynSLI group (close to the significance p-value). Finally, they used fewer different verbs than Control and an amount that did not differ from the SynSLI group.

In summary, the Control and SynSLI groups, in this age group, present more extreme productive lexicon characteristics, while children with syntactic delay share lexical characteristics of both groups.

Measure	Control group	SynD Group	SynSLI Group	p
TTR	0.42 (0.03)	0.42 (0.03)	0.43 (0.03)	*
D	71.3 (10.2)	70.1 (9.3)	63.2 (6.3)	*
MLUw	4,59 (0,63)	4,63 (0,99)	3,68 (0,31)	*
NDW	55.9 (6.0)	50.0 (2.5)	36.2 (11.8)	.04
TNW	1615.1 (571.3)	1094.2 (982.9)	1116 (198.8)	.03
TNN	150.6 (36.8)	130.2 (61.0)	100.0 (42.3)	.04
TNV	130.4 (31.8)	106.1 (58.3)	85.2 (26.8)	.04

Table 2: *Means and SD by type of measure in younger children.*

Note: (*) = p > .05.

Older children group

TTR, D, MLUw, NDW and TNN measures did not show significant differences in this age group. There were differences in favor of Control in TNW used in the transcripts compared to SynSLI (p = .01) but not compared to SynD; there were no significant differences between SynSLI and SynD. And there were differences in the TNV with a greater amount for Control compared to SynSLI (p = .04) but without differences with respect to SynD; there were no significant differences between SynSLI and SynD.

These results suggest that, in general terms, in older children, with an average age of 10.5 years, the differences between the three compared groups tend to decrease. The differences are notable in the total number of words used during each interview and in the different verb forms produced.

The Control group compared to the SynD group no longer shows significant differences, but there are departures compared to children at risk of SLI. When comparing both groups with difficulties, there are no significant differences, although a greater total volume of words is observed in children with SynD. Regarding the number of different verbs that Control children express, this does not differ from that of SynD, and it does differ from that of children with suspected SLI. SynD children produced more verbs than the SynSLI group, although the difference was not significant.

In summary, leaving aside the standard measures (TTR, D, LMUw) that do not allow recognizing differences, at this age group it is observed that the groups got balanced in terms of the number of different words (lexical and functional) and different nouns. The outstanding differences are in the TNW used and in the TNV, in favor of Control, over SynSLI, while for SynD these same measures got values between those of the other two groups.

Measure	Control group	SynD Group	SynSLI Group	p
TTR	0.42 (0.03)	0.45 (0.03)	0.43 (0.03)	*
D	80.3 (7.9)	81.1 (8.6)	80.5 (9.7)	*
MLUw	5.45 (0.8)	5.17 (0.71)	4.53 (0.8)	*
NDW	55.6 (6.2)	55.6 (5.8)	65.3 (3.6)	*
TNW	2475 (753.8)	2081.8 (926.2)	1548.6 (895.9)	.04
TNN	176.8 (31.3)	176.4 (60.0)	154.6 (38.9)	*
TNV	181.7 (31.2)	143.0 (62.8)	124.6 (13.2)	.02

Table 3: *Means and SD by type of measure in older children.*
Note: (*) = p > .05.

Comparison of younger children vs. older children

Each of the seven measures was compared between age groups by study group (Control, SynD and SynSLI), using Mann-Whitney U test, as shown in table 4. No differences were found in TTR, D and LMUw. There was a difference in the NDW in favor of older SynSLI (p = .02), but not with respect to Control and SynD. Regarding the TNW, there were significant differences with a greater amount in older controls (p = .001), not so in the other two groups. The TNN increased significantly in the older children both in Control (p = .03) and in SynSLI (p = .01), but not in SynD. Finally, the TNV also increases significantly with age both in the Control group (p = .001) and in children with suspected SLI (p = .04).

Measure	Group	Younger Children	Older Children	p
TTR	Control	0.42 (0.03)	0.42 (0.03)	*
	SynD	0.42 (0.03)	0.45 (0.03)	*
	SynSLI	0.43 (0.03)	0.43 (0.03)	*
D	Control	71.3 (10.2)	80.3 (7.9)	*
	SynD	70.1 (9.3)	81.1 (8.6)	*
	SynSLI	63.2 (6.3)	80.5 (9.7)	*
MLUw	Control	4.59 (0.63)	5.45 (0.8)	*
	SynD	4.63 (0.99)	5.17 (0.71)	*
	SynSLI	3.68 (0.31)	4.53 (0.8)	*

NDW	Control	55.9 (6.0)	55.6 (6.2)	*
	SynD	50.0 (2.5)	55.6 (5.8)	*
	SynSLI	36.2 (11.8)	65.3 (3.6)	.02
TNW	Control	1615.1 (571.3)	2475 (753.8)	.0001
	SynD	1094.2 (982.9)	2081.8 (926.2)	*
	SynSLI	1116 (198.8)	1548.6 (895.9)	*
TNN	Control	150.6 (36.8)	176.8 (31.3)	.03
	SynD	130.2 (61.0)	176.4 (60.0)	*
	SynSLI	100.0 (42.3)	154.6 (38.9)	.01
TNV	Control	130.4 (31.8)	181.7 (31.2)	.001
	SynD	106.1 (58.3)	143.0 (62.8)	*
	SynSLI	85.2 (26.8)	124.6 (13.2)	.001

Table 4: *Means and SD by type of measure between age groups.*
Note: (*) = p > .05.

In general, these results suggest an increase in volume and variety in the use of words in older Control children, although older children with SLI alert also show, at least in part, a greater lexical diversity compared to younger schoolchildren. Meanwhile, the SynD group does not present significant differences between age groups in any of the measures, although the indices tend, in general, to increase with age.

Discussion

The first objective of the present study was to recognize possible cases of schoolchildren with syntactic comprehension difficulties, starting from the hypothesis that, according to the Integrated online Computing Model, MINC [17,18], certain syntactic structures imply a high cost of processing in children with linguistic deficits (SLI/DLD). 10.43% (39 of 374) of the students scored 2 points of SD below the mean in at least one of the 13 conditions of the MABILIN test. 30 of these 39 children (i.e. those belonging to families of middle socioeconomic status) were administered the test again two years after the first evaluation. It was found that 19 of these 30 schoolchildren were able, on this occasion, to pass the test without having had any kind of additional specific help or intervention. In this sense, it was considered that they had suffered a temporary delay related to their syntactic processing capabilities. The remaining 11 children maintained comprehension difficulties, and it was considered that they were at risk of being SLI carriers. This means that, of the total of 374 children tested with the MABILIN, leaving aside the children of low socioeconomic status who could not be reevaluated, approximately 5% had temporary difficulties (SynD Group), while about 3% were on SLI alert (SynSLI Group). This last value is within the limits recorded in other languages (See [41]).

These results refer us to the 'forgotten group', mentioned by Reed [3]. There were schoolchildren with comprehension problems and, as mentioned above, only 5 of them had SLI clinical diagnosis made outside this investigation. In other words, most of the cases with difficulties went unnoticed. What the test revealed is that there were children who, for some cause (or combination of factors), had serious difficulties comprehending one or more of the thirteen types of complex sentences in the test, at ages close to 7.5 years and even at 10.5, when typically developing children tend to master them around 6 years of age. Other studies also indicate difficulties in comprehending this type of structure in the acquisition of the mother tongue [27] and especially in children diagnosed with SLI [28].

Although the results obtained here with the MABILIN battery test are restricted to the area of syntactic comprehension, this can have an impact on the different activities of the child/adolescent that are mediated by language. During the life of children in school, in a more or less progressive form, considerable cognitive, physiological, emotional, social and educational changes take place. Language also evolves, and language changes are affected and affect other areas of development [3].

In this sense, complex structures such as the passive periphrastic, relatives and partial interrogatives are not uncommon in school environments. Current research has renewed the debate regarding to what extent the processing cost is due exclusively to the type of syntactic structure, and how much linguistic aspects, not specifically syntactic, but semantic, lexical, contextual or related aspects that could interfere in the processing of the speech to which a speaker is most usually exposed. Thus, it has been proven that semantically reversible sentences (e.g. The girl is hugged by the grandmother.) take longer to be interpreted than in non-reversible cases (e.g. The gift is received by the girl.). This is because the thematic role of agent is usually assigned to the first constituent of the structure as a heuristic strategy instead of performing a complete parsing (see [44] for typically developing children; [45] for adults and grammatical patients; [46] for people with Alzheimer's disease; [31] for subjects with SLI). Other interfering factors that act during the processing of a sentence are the accessibility of a phrase within a complex sentence and the discursive context within which the sentence is uttered. Such is the case of relatives of the type The nanny [sent by the agency] is adored by the children, in which the linguistic material nested in the subject (between square brackets) may contain a noun phrase whose referent may be difficult to access, or which can introduce a new referent in the communication. In both cases, their comprehension becomes more problematic [47,48].

The use of the language in a certain community is also relevant when it comes to evaluating processing costs. Recent research indicates that the frequency with which certain words and sentences are used in the surrounding speech influences, at least in part, the acquisition and understanding of language [49,50]. For instance, numerous studies coincide in pointing out that object relatives are more difficult to understand than subject relatives, whether they are embedded in the object or in the subject. However, experimental and corpus studies suggest that, if the type of object relative that the participants say and listen the most is used in a test, the referred object-subject asymmetry disappears both in children [51] and in adults [52]. Fox and Thompson [53], in a corpus study for English, observed that object relatives were significantly more frequent than subject ones when, for example, the antecedent was inanimate (The problem [I have] is my skin is oily).

Now, how can these extra-syntactic factors influence the understanding of complex sentences?

In general terms, according to the MINC conception, in the comprehension of sentences it is assumed that a representation of segmented and recognized lexical elements is temporarily kept in a processing window and the computational system acts on those items; also it is assumed that they correspond roughly, to prosodic and syntactic units, probably phases, in Chomsky's sense [54]. That is, the acoustic signal of speech is segmented and the lexemes (the phonological forms of the lexical items) are recognized, from which the lexical access is produced, as a search of the lemmas (containing syntactic-semantic information) corresponding to the segmented lexemes begins in the mental lexicon. Once the set of lexical pieces necessary for computation has been recovered, the computational system acts on the formal features contained in them and generates the corresponding hierarchical structures. Lexical access is thus a precondition for the lexical pieces to be merged, a crucial condition since it is a moment during processing permeable to interference factors such as the frequency of use of items in the communication of a community, effects of priming with the preceding discourse, or the more or less complex form of the segmented items.

On the other hand, apart from these pre-syntactic interferences, that is, that can occur before the syntactic computational process, some can occur during the processing itself. Complex structures require that certain linguistic material, e.g. the nucleus antecedent noun phrase in the case of relatives, must be temporarily held in working memory, while sentence processing continues from left to right in search of a suitable element to which this phrase can be associated. Something similar happens with partial interrogatives, in which the operator (wh-element) is 'listened' at the beginning of the structure, but it must be kept in working memory until it is related to the place of extraction where a copy of that element receives a thematic role mark. As long as the processor retains these elements (and the reference is fixed in the case of the antecedent in relatives), the structure is vulnerable to interference, which in turn also depends on the distance between the antecedent and the place of extraction, and on the size of the retained operator (i.e. who vs. what + N). Having a retained element, occupying memory resources, can make this element have to compete with other previously heard noun phrases, or with another type of syntactic structure with which the speaker is more familiar.

This type of interference, which acts by overloading the working memory, can impair the understanding of children with SLI. But it can also hinder comprehension for children who do not have SLI (as seems to be the case for the SynD group in the present study).

The human language processing system is robust enough that most children comprehend almost all types of structures with virtually no difficulty by age 6. However, related factors, which have been studied, such as the biological characteristics of each individual and environmental ones can destabilize the working memory system and therefore verbal comprehension [55]. Among the biological factors, considered more stable, there are aspects of the personality, such as being introverted, which could reduce memory capacity [56,57] as well as neurosis [58]. On the other hand, environmental causes, in general, considered less stable, temporary and reversible, could also be found at the base of a deficient comprehension. For instance, it has been suggested that negative emotions or lack of motivation can generate 'worrying thoughts' that drain resources from the phonological loop [55] and that prolonged anxiety and stress can negatively influence verbal memory in young children [59]. Also, similar to the case of anxiety, diet seems to affect the phonological loop, but not because of weight loss or caloric restrictions, but because of intrusive thoughts associated with the behaviors required by the diet itself [60]. The kind of nourishment is also relevant to the working memory system. The negative effects of a lack of sugar (glucose), dairy, protein, carbohydrates and fat have been examined. However, the results depend on the proportions, amounts ingested and age [55]. Certain psychoactive substances (e.g. alcohol, marijuana) can reduce the ability to care and maintain, plan, and update information, also depending on the amounts and frequency of ingestion [61,62].

Finally, it should be noted that the duration of the effects of environmental factors on working memory can be chronic or acute and that it is not yet known with certainty what mechanisms underlie certain harmful factors such as, for instance, lack of sleep [55].

The second objective of this work, based on the distinction between children with and without syntactic comprehension difficulties was to evaluate whether different measures related to the lexicon allow establishing group differences.

The first thing that stands out is that no significant differences were observed in three traditional measures such as TTR, D and MLUw, neither between the study groups (Control, SynSLI and SynD) of the same age range nor when comparing each of these measures between younger and older children.

Regarding TTR, a general measure of lexical diversity that includes both lexical and functional categories, similar results were obtained in Watkins, Kelly, Habers and Hollis [29], where no differences were found between children with SLI and children of typical development. As these authors argue, the fact that children with and without difficulties have similar results, calls into question the usefulness of this measure as an indicator of limited semantic skills or poor lexical access [30,63]. The existing literature suggests that children with SLI have problems in the early acquisition of the vocabulary and that these are prolonged during the school stage [6]. The children participating in the present study, as in the case of Watkins [29], probably had difficulties to which the traditional TTR measure was simply not sensitive.

The D measure, a mathematically more sophisticated quantification of lexical diversity than TTR, calculated on all the statements of each student, although it shows an increase in the averages of older children compared to younger children, did not constitute a significant difference. Studies that have used this measure carried out in different languages (English, Dutch, French, Icelandic, Hebrew, Swedish and Spanish) obtained similar results [64-67]. In these investigations about the oral speech and the writing of children, adolescents and adults, it was observed that typically developing individuals from approximately 7 to 11 or 12 years of age have similar D values, and that there is a significant increase only in later ages. On the other hand, this measure did not show differences between groups with and without difficulties within each age group.

That is, children with syntactic comprehension difficulties (SynSLI and SynD groups in the present study) appear to be as competent in the use of the lexicon measured by D as their typically developing peers, at least in spontaneous speech. This homogeneity could be due to the considerable control that the speaker has over the topic, and therefore over the lexicon used in a spontaneous conversation, unlike what can occur in tasks in which the lexicon is manipulated mainly by others (See [68] for a similar argument in 3-to-7-year-olds). In sum, the results obtained support the view that many children with SLI/DLD are more competent in the use of the lexicon in spontaneous speech than in their morphosyntactic abilities [69].

The MLUw is a measure that indicates approximately the syntactic complexity in production. The longer the sentences, the more likely it is that complex structures are being used that contain, e.g. subordinates, infinitive complements or prepositional phrases. The

comparative MLUw results obtained here show that small and large typically developing children use a very similar average number of words per sentence (between 4 and 6), which suggests that at these ages there is a mismatch that contrasts with the notable increases generally experienced by infants between the ages of 2 and 5. Similar results were obtained by Kemper, Rice and Chun [70] in the narratives of English-speaking children aged 5 to 10 years. These authors noted that there were almost no significant variations in LMUw in the entire period between the mentioned ages. It should be noted that the MLUw values are somewhat higher in the study by Kemper., *et al*. [70] for English, which may be due to the exclusive use of narratives, a complex, decontextualized type of discourse that usually requires a more diverse vocabulary and more complex structures than conversation. Another factor that can influence is the language employed since Spanish is a pro-drop language while English is not.

On the other hand, in the present study, children with comprehension difficulties (SynD and SynSLI groups) also had MLUw values that did not present significant differences between them and, more strikingly, compared to the Control group. In other words, the children participating in this research mostly used sentences of between 4 or 6 words to express themselves. Another generalization of interest is that, although children with difficulties increased their MLUw over time (although not significantly), the MLUw index was always somewhat below that of the controls. Similar results were obtained by Rice, Smolik, Perpich, Thompson, Rytting and Blossom [36] in a study with English-speaking children between 3 and 9 years of age. They noted that there were greater differences in MLUw between children with SLI and control peers between 3 and 7 years of age, but that after that age the differences in this measure, although they did not disappear, remained constant.

What we have so far, leaving aside the TTR measure that raises doubts about its adequateness to characterize the groups addressed here, is that, at first glance and in general terms, the children/adolescents with and without difficulties who participated in the interviews appear to have a fairly similar speech in the course of their schooling. The salient characteristics are the use of relatively short sentences and a very similar vocabulary richness.

However, the NDW measure, the number of different words in 100 sentences, one of the components of TTR (i.e. TTR = NDW / TNW), showed the first significant difference between groups. Younger children at risk for SLI and the SynD use markedly fewer different words than the Control group. For their part, SynD children had a greater diversity of words than SynSLI. In contrast, older children did not show such differences between study groups, and there were no important changes with age. Miller [31] and Watkins [29] found similar results in typically developing children and children with SLI, i.e. differences are marked only at younger ages. In other words, the abilities to express ideas and concepts that the NDW measure evaluates are greater for control children at the beginning of schooling, and then these abilities improve in groups with difficulties until they resemble that of controls.

The other component of TTR was TNW (total number of words produced), in this case, computed over the totality of each text. In younger and older children, the controls produced more words than the groups with difficulty, while the latter did not differ from each other in both age groups. The NTW measures obtained here, following the statements of Miller [31] and Watkins [29], suggest that typically developing children have greater processing capacity than children with language difficulties. That is, they process faster. This does not mean that they speak faster, but rather that they can compute syntactic structures with greater fluency in comprehension and production.

Taking together the NDW lexical diversity and TNW lexical productivity measures, the general picture indicates that the participants in this study without comprehension difficulties have a similar vocabulary diversity in both age groups, although they manage to improve their lexical productivity with age; as for children with difficulties, they improve with age their expressive semantic capacities, although not of processing.

More specific measures such as TNN and TNV (total number of different nouns and verbs, in types) yielded interesting results. The group of typically developing younger children used significantly more different nouns and verbs than their troubled peers. However, in older children the most notable difference between groups with and without comprehension difficulties was in the verbs. In other words, when there were deficiencies in syntactic comprehension, there were also comparatively lower verb production rates. These results are in

line with previous studies that indicate the difficulty of children with SLI/DLD regarding quantities and/or morphological and argumental characteristics in verb production [71-74].

A comment about verbs and processing difficulties in the SynD group: the results presented suggest that control children use significantly more different verbs than children with syntactic comprehension problems. This is not surprising for children on alert or diagnosed with SLI. However, approximately 5% of all children tested (children in the SynD group) had temporary syntactic comprehension problems and a mean TNV that did not differ from that of the SynSLI group.

The present study does not permit us to know how long the period lasted during which SynD children were affected. That is, these children/adolescents may have had a slower language development than usual before the first test, or a typical development and suffer a temporary delay between both tests. In the first case, the fact that they did not present difficulties in the second test suggests that they were able to acquire language skills that perhaps they did not possess. And in the second case, that they were able to recover skills they already possessed. It is possible that, at least in part, relatively prolonged exposure to certain environmental factors, such as those discussed above (family problems, nutrition, intrusive thoughts, etc.), have been interfering with sentence processing.

From the perspective of the processing model adopted here (MINC [17,18]), the abstract structures that are assembled in working memory to produce and comprehend sentences have verbal predicates as fundamental pieces, given the syntactic and semantic information these contain. As follows from the preceding, maintaining certain types of structures in memory requires an amount of resource that can be increased depending on the type of verb (e.g. a verb with more arguments requires more memory resources), but above all depending on the degree of complexity of the structures to be processed, such as in the case of the sentences that make part of the comprehension test applied.

The children of the SynD group, in school life, in the face of the demands imposed by the various daily activities, could be making strategic use of language in general and of verbs in particular, as has been observed in cases with SLI. To what extent SynD children may be using strategies to minimize the cost of processing is an open question. There is evidence that schoolchildren in alert of SLI, speakers of Brazilian Portuguese, a language typologically close to Spanish, prefer to use instead of an interrogative of the type Que boné seu filho quer? (What cap does your son want?) a simpler form with a pronominal subject such as Qual boné ele quer? (Which cap does he want?). This second structure implies lower processing cost to the extent that the intervening element between the displaced operator (i.e. qual boné) and its original position, is a referential pronoun (i.e. ele) instead of a full phrase (i.e. seu filho) [75]. Additionally, Dotti & Formichelli [74] presented evidence that children with SLI who speak Rioplatense Spanish use significantly more verbs with a single argument and significantly fewer verbs with three arguments compared to typically developing children. In any case, the fact that syntactic comprehension difficulties in children with SynD allow predicting a dependence on strategies to minimize the cost of processing in production, as has been observed in children with SLI, is an empirical question to be explored.

Conclusion

The results of this study suggest that a percentage close to 10% of children and adolescents at school age, without a history of pathologies (neurological, auditory or cognitive) that can explain language problems, have syntactic comprehension difficulties. Such may constitute an SLI alert, or else, indicate the existence of temporary difficulties that can be overcome over time without necessarily extra specific interventions taking place meanwhile. In both cases, as has been pointed out in other studies, this type of difficulty usually goes unnoticed by the family environment, therapists and/or educators.

Regarding oral productions in conversational contexts, it was observed a speech with similar characteristics in terms of traditional measures of lexical diversity and sentence length. That is, regardless of age and whether there were comprehension problems, the students presented a homogeneous diversity of words (lexical and functional categories), expressed mostly in relatively short sentences (between 4 and 6 words).

The differences between study groups were more notable in the group of younger children in more specific measures of lexical diversity. Typically developing children, in sharp contrast to individuals with an alert of SLI, produced more words and a greater variety

of nouns and verbs. Meanwhile, participants considered with syntactic delay (SynD group), although they had a somewhat higher average production of nouns than children at risk of SLI, did not differentiate by the number of verbs.

In the age group of older children, it was observed that the groups were balanced since there were no significant differences in five of the seven measures carried out. The control children far outperformed the groups with difficulties in the number of total words produced and the number of different verbs they used in their conversations. Both groups with difficulties did not differ here in terms of the number of verbs produced.

Finally, by comparing the different measures by age group, and leaving aside the traditional measures (TTR, D and MLUw), children without comprehension problems improve their general performance, as expected. Children on SLI alert also improve in some aspects, such as the number of different nouns and verbs. Meanwhile, the group with syntactic delay presents a less clear profile, that is, although older children improve the averages of the measures with respect to younger children, they do not do so significantly.

Altogether, despite the apparent general homogeneity in the conversational speech of schoolchildren, this study supports the idea that a high cost of processing as characterized in the MINC, allows predicting that poor performance in comprehension will be crucially reflected in restricted use of verbal predicates.

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