8

Assessment of reading fluency and comprehension of sentences in discourse

In order to assess the participants' reading ability of the target costly structures (object WH+N questions (OWH+N) and object relative clauses (ORC)) in discourse, a new experiment was designed and conducted. The same students who took part in experiment 3 participated in the present one.

Those structures were included in narrative texts in order to verify whether the SI group, who has difficulty in reading these sentences fluently and comprehending them in isolation, face similar difficulties when processing them in discourse, which may affect the overall comprehension of a text. The texts presented the target structures both along the narratives and in critical questions following them, which were intended to evaluate the main information conveyed by the text.

Having in mind the *intervention hypothesis* (cf. chapter 3), the present experiment also investigated whether or not the structural properties of the intervenient element (the subject of the WH+N and of the ORC) affect the reading abilities investigated. For each structure, the *intervening element* was an independent variable: full nominal phrase (cf. examples 1 below) and pronoun (cf. examples 2).

- Examples 1: Which animal has <u>your friend</u> adopted?
  The animal that <u>my friend</u> has adopted was a turtle.
- Examples 2: Which animal has <u>he</u> adopted?
  The animal that <u>he</u> has adopted was a turtle.

Their reading abilities were assessed based on *reading rate*, *reading accuracy*, *prosody* and *reading comprehension*.

8.1.
The reading fluency and comprehension of sentences in discourse task

A self-paced oral reading task, followed by a comprehension task, was conducted. Participants should read some stories fragment-by-fragment on a computer screen, pressing a key at a computer keyboard to continue. After reading each story, they should answer three comprehension questions (1 distractor and 2 critical questions) related to it.

8.1.1
Experimental design

- Independent variables

For each type of structure (OWH+N and to ORCs), the independent variables were:

- Group (SI; CT);
- Structure of the intervening element (full nominal phrase; pronoun);

- Dependent variables

As in the previous experiment, different dependent variables were stipulated for each reading aspect:

- Reading rate – *reading time* per sentence type and *number of words per minute*;
- Reading accuracy – *number of words read correctly per minute* (WCPM) and *number of disfluencies*;
- Prosody – *number of sentences with proper pitch contour* and *number of sentences with no intrasentential pauses* longer than 0,25 seconds;

- Reading comprehension – *number of correct responses* for the comprehension task.

8.1.2
Method

- Participants

The 12 subjects (mean age: 12; 4 girls) from the *SI* group and 12 subjects (mean age: 12; 4 girls) from the *CT* group previously tested for their abilities to read fluently and to comprehend isolated sentences participated in this experiment.

- Material

Eleven small stories were created (2 for training; 6 for testing and 3 distractors) containing the syntactically demanding structures investigated. Each participant read a total of 6 object WH+N questions and 6 object relative clauses within the stories. Each story was followed by a distractor question and by two critical questions: an object WH+N question and a YES/NO question involving an object relative clause. Six lists were prepared, so that each participant was not presented to the same story in different experimental conditions. An example of the stories with the target structures underlined and the critical questions are presented below (see Appendix 3 for all the stories).

Example of the stories and the critical questions

Pedro é um menino muito bondoso. Ele sempre tenta ajudar quem precisa.
No último sábado, Pedro convidou seu primo Daniel e o amigo dele, Cauã, para uma feira de animais.
Pedro passou mal e acabou não podendo ir à feira. Mas Daniel e Cauã foram e cada um deles adotou um animal diferente.
No dia seguinte, Pedro soube que Cauã tinha adotado um animal.
Pedro encontrou Daniel e perguntou: "Que animal seu amigo adotou?"
Daniel respondeu: "Meu amigo adotou um cachorro."
Pedro logo falou: "Já sei! O cachorro vai dormir no quintal!"
Daniel então disse: "Isso mesmo. Mas eu também adotei um animal."

Pedro curioso tentou adivinhar: "Acho que você adotou um gato!"
Daniel riu e falou: "Errou! O animal que eu adotei foi uma tartaruga!"
A tartaruga vai dormir debaixo da cama do Daniel.

Critical questions:
- Cauã, amigo de Daniel, adotou um animal. Que animal o amigo de Daniel adotou?
- Daniel também adotou um animal. O animal que ele adotou vai dormir debaixo da cama?

Pedro is a very kind boy. He always tries to help people.
Last Saturday, Pedro invited his cousin Daniel and his friend, Cauã, to an animal fair.
Pedro felt sick and ended up not being able to go to the fair. But Daniel and Cauã went there and each one of them adopted a different animal.
The next day, Pedro heard that Cauã had adopted an animal.
Pedro met Daniel and asked him: "Which animal did your friend adopt?"
Daniel replied: "My friend adopted a dog."
Pedro said: "Let me guess! The dog will sleep in the yard!"
Daniel then said: "That's right, but I also adopted an animal."
Peter got curious and tried to guess: "I think you adopted a cat!"
Daniel laughed and said: "You're wrong! The animal that I adopted is a turtle!"
The turtle will sleep under Daniel's bed.

Critical questions:
- Cauã, Daniel's friend, has adopted an animal. Which animal did Daniel's friend adopt?
- Daniel has also adopted an animal. Will the animal that he adopted sleep under his bed?

Figure 17: Example of the stories and the critical questions.

- Apparatus

A DELL Inspiron 15 laptop and the computer program LINGER were used in this experimental activity. A Panasonic MP3 player was necessary to record the subjects' production, which was analyzed using the software Praat.

- Procedure

The students were invited to take part in a different reading task, now involving texts, and all of them agreed to participate. The experimenter explained they were supposed to read some stories fragment-by-fragment on a computer screen. They should press a key at the computer keyboard to get the next

fragment. After reading the whole story, they should answer three comprehension questions (1 distractor, 1 critical question with an object WH+N interrogative sentence, and 1 critical YES/NO question involving an object relative clause) related to it[1]. After the instruction, they took part in a training session that included 2 stories. All participants could cope with the task, which took from 10 to 25 minutes and was conducted in an isolated room at their schools.

8.1.3
Reading rate

Similarly to the analysis conducted on the previous test (the reading fluency and comprehension of isolated sentences task), two measures were considered, in order to examine *reading rate*. At first, *reading time* per sentence type was measured. It was defined by the latency between the presentation of the test sentences on the computer screen and the pressing of a key at the computer keyboard by the student after reading aloud such sentence. Then the *number of words read per minute*[2] for each type of structure was analyzed.

8.1.3.1
Results

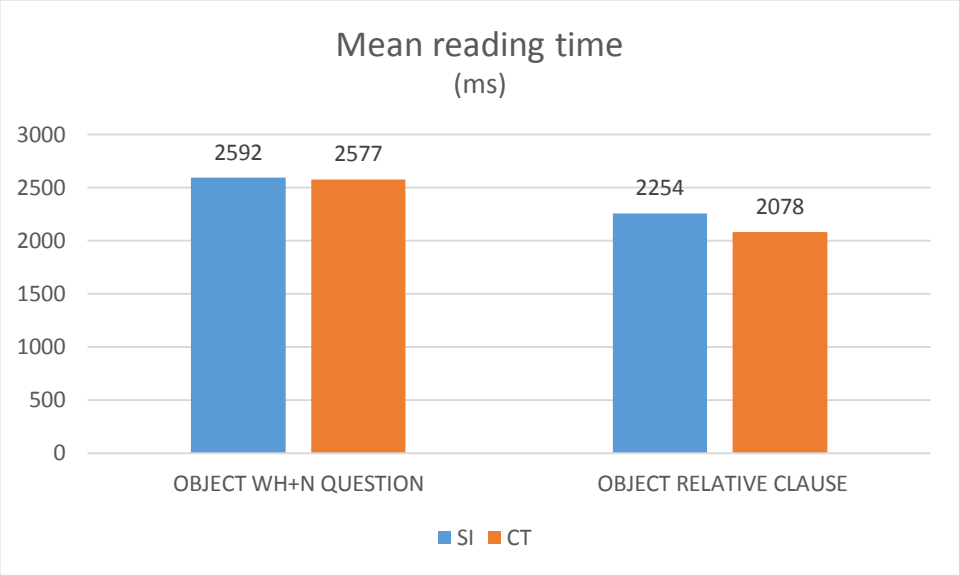
For each sentence type, the effect of group was analyzed by means of one-tailed t-tests. No significant effect of group was obtained for *reading time*. The results are presented below:

- Object WH+N questions: t (1,22) = 0.12 p= .48
- Object relative clauses: t (1,22) = 1.92 p= .17

[1] In order to examine whether implicit prosody can facilitate oral fluency reading and comprehension, two types of tasks were conducted. Half of the participants in each group read the texts aloud and then answered the comprehension questions. While the other halves initially read the texts silently, then they read the same texts aloud and, after that, they answered the comprehension questions. This procedure was intended to verify whether prior silent reading would facilitate oral fluency and comprehension. However, the final number of participants was small for this analysis.

[2] All words were considered in this analysis.

The following graph (33) shows the mean *reading time* of SI and CT groups for each type of structure.

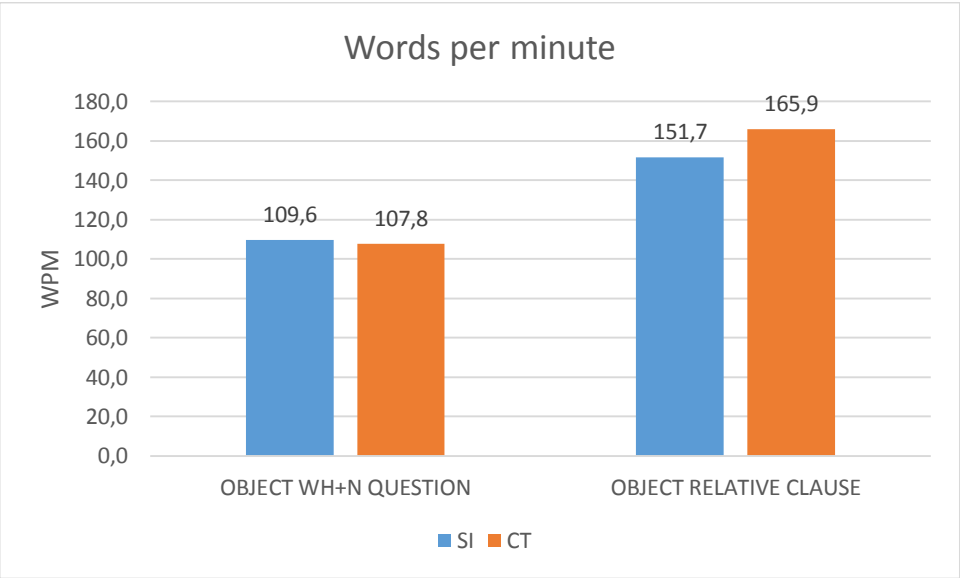


Graph 33: Mean reading time (ms).

There was no significant effect of group for *number of words per minute*, as well.

- Object WH+N questions: t (1,22) = 0.42 p=.42
- Object relative clauses: t (1,22) = 2.06 p=.16

Graph 34 exhibits the *number of words read per minute* of both groups for each type of structure.



Graph 34: Number of words per minute.

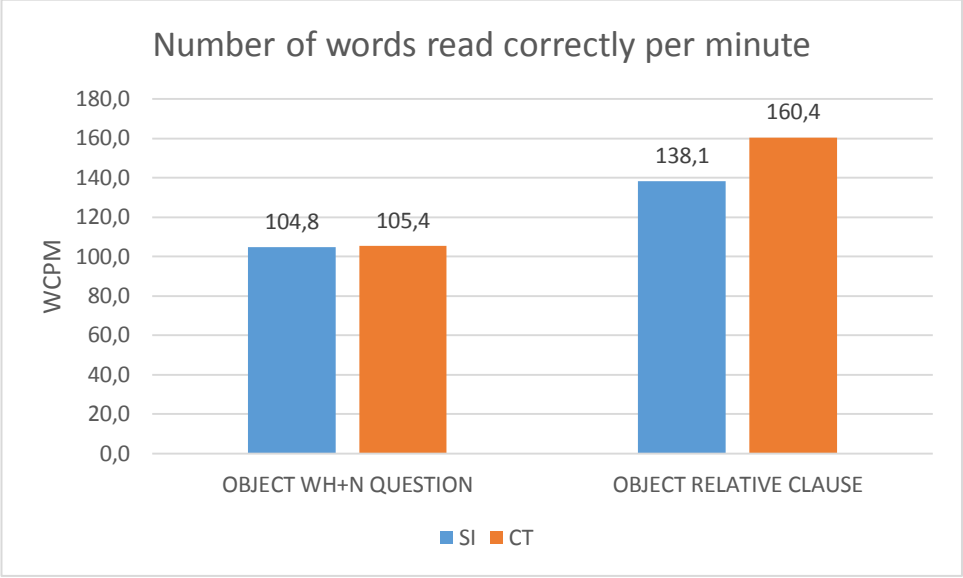
These results indicate that the syntactic impairment detected in the oral and reading comprehension of the highly costly structures does not affect the reading rate of these sentences in discourse.

8.1.4
Reading accuracy

For this assessment, only the sentences inserted in the narratives, not the final critical questions were analyzed. Two measures were considered: (i) the *number of words read correctly per minute*[3] (WCPM) for each type of structure; and (ii) the *number of disfluencies*. The six categories of errors examined (1- word repetition; 2- word omission; 3-word addition; 4-misread words; 5-self-corrections; 6- hesitations) were the same from the previous experiment.

8.1.4.1
Results

Graph 35 presents the performance of both SI and CT groups for each type of structure as far as *number of words read correctly per minute* is concerned.



Graph 35: Number of words read correctly per minute.

[3] All words were considered for this analysis.

There was no significant effect of group for *number of words read correctly per minute* (WCPM), though for object relative clauses, the difference approached significance. The results are exhibited below:

- Object WH+N questions: t (1,22) = 0.12 p=.48
- Object relative clauses: t (1,22) = 2.9 p=.08

The breakdown of reading disfluencies of both groups per sentence type is shown on the following table (5).

TYPE OF DISFLUENCY	OBJECT WH+N QUESTION		OBJECT RELATIVE CLAUSES	
	SI	**CT**	**SI**	**CT**
Word repetition	-	-	1 (1,39%)	1 (1,39%)
Word omission	-	-	6 (8,33%)	1 (1,39%)
Word addition	2 (2,78%)	-	2 (2,78%)	-
Misread words	1 (1,39%)	-	1 (1,39%)	-
Self-corrections	7 (9,72%)	5 (6,94%)	15 (20,83%)	5 (6,94%)
Hesitation	6 (8,33%)	3 (4,17%)	15 (20,83%)	8 (11,11%)
Total	**16 (22,22%)**	**8 (11,11%)**	**40 (55,56%)**	**15 (20,83%)**

Table 5: Breakdown of reading disfluencies.
n=72 (Total of sentences read per group)

The figures in Table 5 show that the SI group committed more mistakes than the CT group. A significant effect of group was obtained for *number of disfluencies* for object relative clauses (t (1,22) = 6.00 p<.003), and for object WH+N questions, the difference approached the significance level (t (1,22) = 3.04 p=.07).

It seems that the number of disfluencies was affected by the syntactic impairment detected in the oral and reading comprehension of isolated sentences. As for *number of words read correctly per minute*, although the effect of group did not reach the level of significance for object relative clauses the means are in the predicted direction. Syntactic impairment as initially detected seems, therefore, to have some impact in reading accuracy.

8.1.5
Prosody

As in the previous experiment, two features were examined for the prosodic analysis: (i) pitch contour and (ii) intrasentential pauses longer than 0,25 seconds, both identified on the spectrographs provided by the software Praat. The patterns of pitch contour based on the oral reading of two fluent adult readers (one male/one female adult) were taken as reference for the analysis of the oral reading data. See examples below.

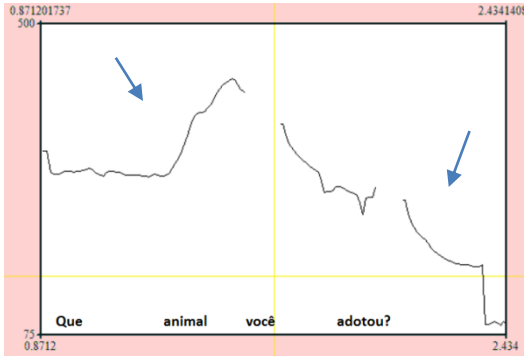


Figure 18: Example of WH+N interrogative with proper pitch contour.

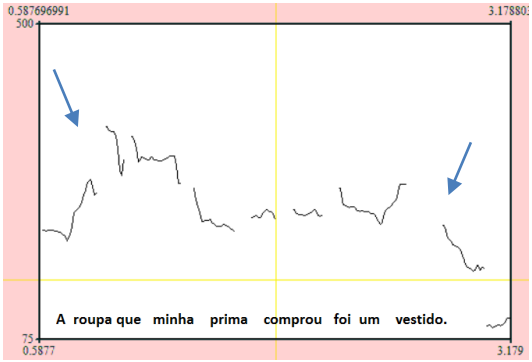


Figure 19: Example of ORC with proper pitch contour.

8.1.5.1
Results

The following figures (20 and 21) present the examples of inappropriate pitch contours.

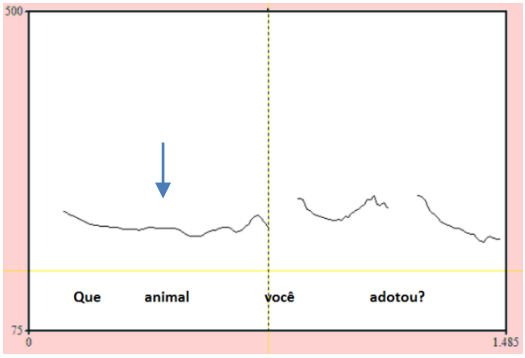


Figure 20: Example of WH+N interrogative with inappropriate pitch contour.

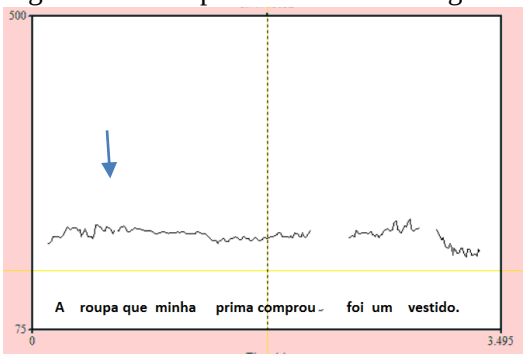
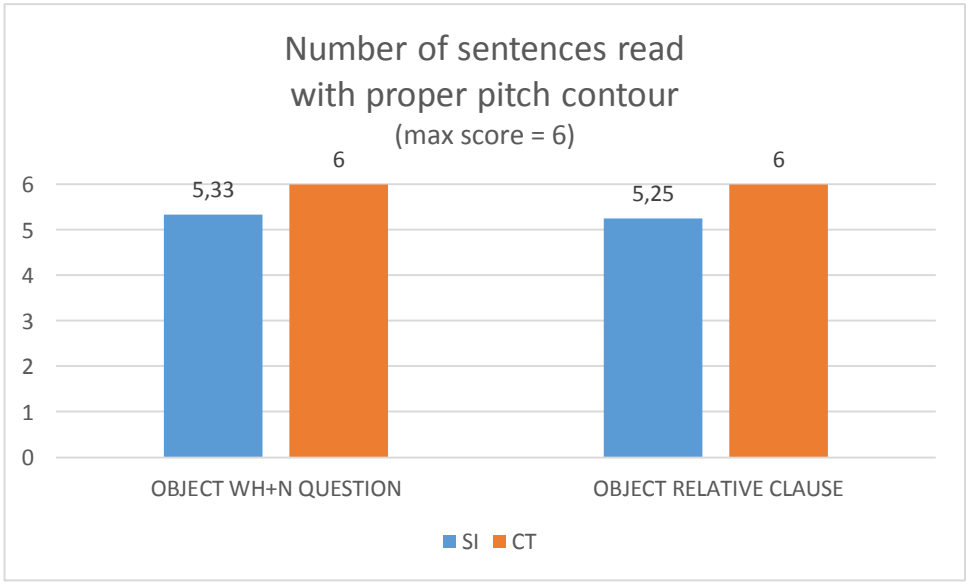


Figure 21: Example of ORC with inappropriate pitch contour.

For *number of sentences read with proper pitch contour*, there was a significant effect of *group* for object relative clauses (t (1,22) = 4,28 p<.03) and for object WH+N questions (t (1,22) = 4.00 p <.03). The number of OWH+N and ORCs read with proper pitch contour by both SI and CT groups are exhibited on the graph below (36).

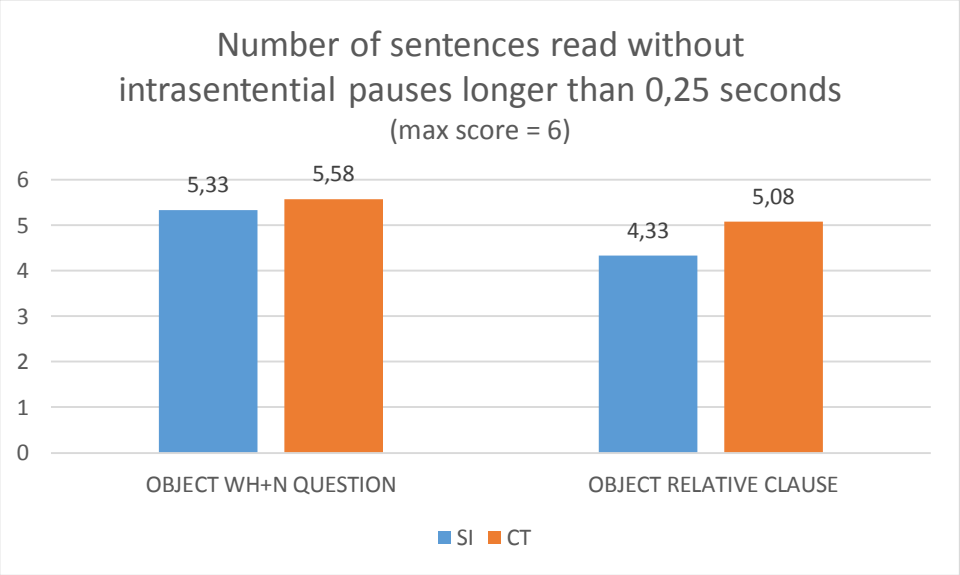


Graph 36: Mean number of sentences read with proper pitch contour per sentence type.

As for *number of sentences read with no intrasentential pauses*, no significant effect was obtained, though for object relative clauses, the difference approached significance, as observed on the following results:

- Object WH+N questions: t (1,22) = 1.36 p=.25
- Object relative clauses: t (1,22) = 2.98 p=.08

Graph 37 presents the number of object WH+N questions and object relative clauses read without intrasentential pauses of both groups.



Graph 37: Number of sentences without intrasentential pauses.

Figure 22 shows an example of intrasentential pause.

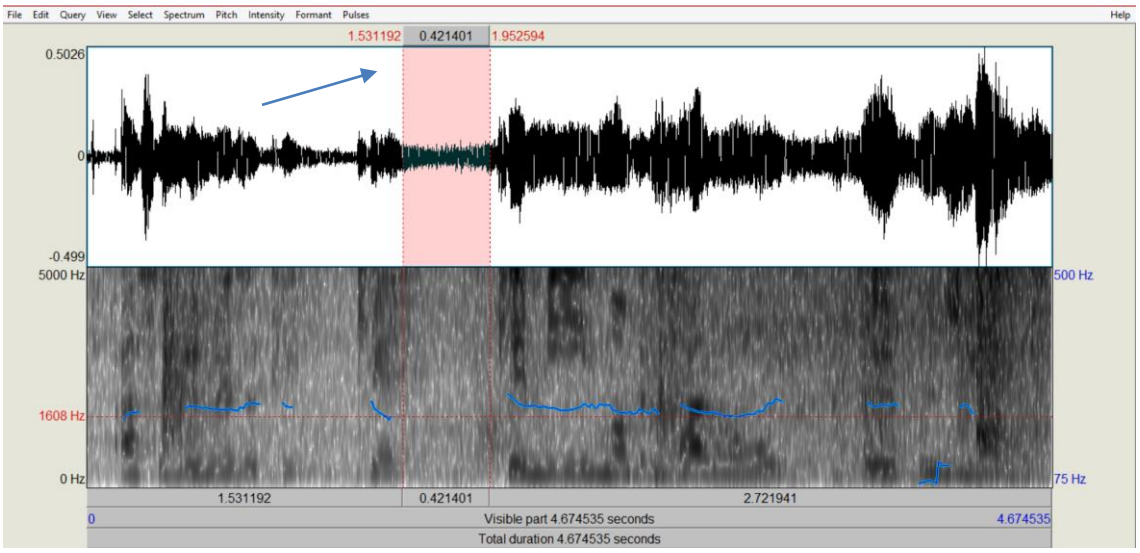


Figure 22: Example of misplaced intrasentential pause.

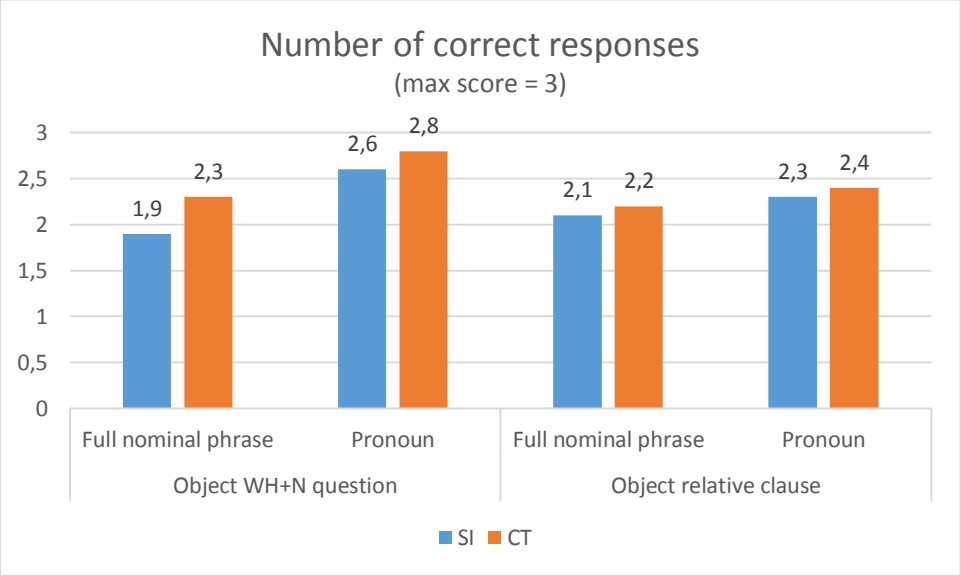
The data suggest that, as observed in the analysis of isolated sentences in the previous chapter, the syntactic impairment identified in the oral comprehension of the highly costly structures affects reading prosody, as detected in the use of proper pitch contour. The group factor does not have a major impact on the occurrence of misplaced or unexpected intrasentential pauses, though. In any case, for object relative clauses, the effect of group approached the level of significance in the expected direction.

8.1.6
Reading comprehension

As previously explained, participants should answer three comprehension questions (1 distractor, 1 object WH+N question and 1 YES/NO question involving an object relative clause), after reading aloud the stories. The *number of correct responses* was taken, so that their comprehension abilities could be examined.

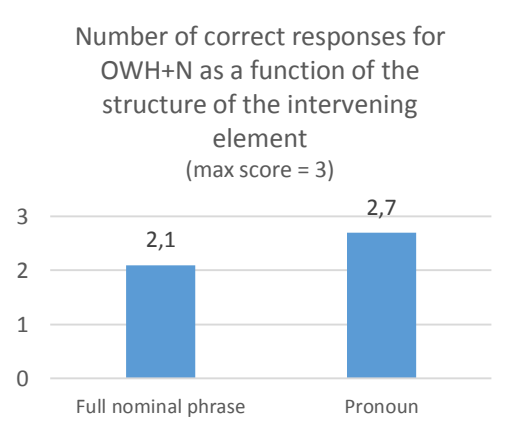
8.1.6.1
Results

Graph 38 presents the distribution of correct responses per experimental condition.

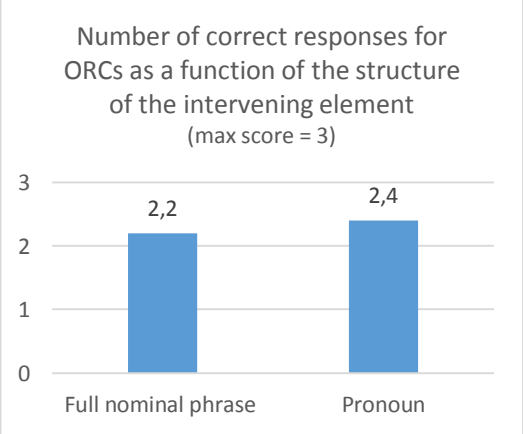


Graph 38: Number of correct responses

The data were analyzed by means of a 2 (group) × 2 (intervening element) ANOVA, in which the latter is a within-subject factor. There was a significant effect of *the structure of intervening element* for object WH+N questions (F (1,22) = 11.5 p<.01), but not for object relative clauses (F (1,22) = 1.15 p=.295). Graphs 39 and 40 below present the number of correct responses for each structure.



Graph 39: Number of correct responses for WH+N interrogatives as a function of the structure of the intervening element.



Graph 40: Number of correct responses for ORCs as a function of the structure of the intervening element.

No effect of group was obtained for either OWH+N (F (1,22) = 1.14 p=.298) or for ORCs (F (1,22) = 0.104 p=.75).

As observed above, there was only an intervention effect in WH+N interrogatives. The result obtained in the relative clauses may be related to a misinterpretation of the comprehension task of such structure, since only 41.6% of participants seemed to have understood it. The expected responses were YES or NO, but most part of the participants gave inappropriate answers. For a question such as *O animal que ele adotou vai dormir debaixo da cama?* (Will the animal that he adopted sleep under the bed?)[4], for which the response could be YES or NO, they replied "a dog" or "a turtle", for example. Although all participants have been able to cope with the task during the instruction, many of them showed difficulty when the critical question involved an object relative clause. Such a difficulty may be related to a problem in assigning interrogative illocutionary force to the yes/no question that involved the relative clause. Since the results described above (as well as in chapter 7) suggest that the syntactic impairment in the oral comprehension affects the use of proper pitch contour, it may also have an impact on the recognizing and planning of proper illocutionary force of YES/NO questions.

The results related to the object WH+N questions suggest that the intervention effect can be captured in the discourse. In these sentences, for both groups, the structure of the intervening element affects reading, making the presence of a full nominal element harder to process, which causes some impairment in the comprehension.

8.1.7
Discussion

The results described above indicate that reading rate for the structures investigated in discourse is not affected by the syntactic impairment identified in the oral comprehension.

The effect of group approached the level of significance in the expected direction for relative clauses as far as *number of words read correctly per minute*

[4] Notice that there is not auxiliary inversion in Portuguese. It is just the intonation that defines the illocutionary force of YES/NO questions.

and *number of sentences read without inappropriate intrasentential pauses* are concerned. A bigger sample is, therefore, required in order to verify whether this tendency is suggestive of a significant difference between groups.

The syntactic impairment observed in the oral comprehension also appears to have an impact on *number of disfluencies* and, consequently, on *reading accuracy* when the sentences are presented in discourse. Syntactic impairment also seems to affect the use of *proper pitch contour*.

Unlike the comprehension of isolated sentences (cf. chapter 7), the comprehension of the target structures in discourse was not affected by the group factor. It can be observed, in this regard, that in the oral and reading comprehension of isolated sentences, all nominal phases were animate, in reversible thematic relations (the tiger that the lion pushed, for instance). In the narratives created for the present experiment, there was a concern of presenting situations that could be related to the teenagers family/social activities and it seemed more natural to control for features such as gender and number, but not for features such as animate/human or for semantic distinctions in terms of superordinate/subordinate categories (animal - dog) (cf. stories in appendix 3). It is possible, therefore, that animacy/human (if taken as formal features) minimize a possible effect of intervention thereby facilitating the overall comprehension or even the overall processing cost. The presence of an inanimate element in the sentence (not affecting the reversible relation in the relative clause) has been shown to make comprehension easier for young children in an acting-out task (Correa, 1995). The presence of an inanimate feature in the intervening element has recently been found to minimize or eliminate the asymmetry between object and subject relative clauses (Cabral, 2016; Mak, Vonk & Schriefers, 2002).

In order to verify the extent to which lexical selection may have contributed to facilitate the comprehension of the target sentences in discourse, a small follow up was conducted in which animate/human characters were taken as the moved and the intervening element of the target sentences. A brief report of this follow up is presented below.

8.1.7.1
Follow up

Three stories were created, as illustrated in figure 23 below (see Appendix 4 for all the stories). The same subjects, procedures and apparatus were used. For OWH+N, pronouns were used as intervening element, whereas for relative clauses, the intervening elements were full nominal phrases. Each participant read, therefore, 3 OWH+N and 3 ORC within the stories[5]. The effect of group (SI and CT) was verified. The results were analyzed by means of one-tailed t-tests.

Story 1

Ana adora se divertir com sua amiga Érica.
Todos os fins de semana elas inventam alguma coisa para fazer.
No último sábado, elas foram a uma festa onde diferentes artistas se apresentaram.
Ana e Érica conseguiram tirar fotos de alguns deles e ficaram muito contentes.
No dia seguinte, Ana contou tudo para a sua prima Marina.
Marina curiosa perguntou: "Que artista você fotografou?"
Ana respondeu: "Eu fotografei o ator. Ele namora uma atriz da nova novela da Record. Mas minha amiga fotografou outro artista."
Marina disse: "Já sei! Sua amiga fotografou o apresentador."
Ana animada falou: "Que nada! O artista que minha amiga fotografou foi o cantor. Ele sempre convida uma fã para subir ao palco."

Critical questions:

- Ana fotografou um artista. Que artista ela fotografou?
- Érica, amiga de Ana, também fotografou um artista.
O artista que a amiga de Ana fotografou sempre convida uma fã para subir ao palco?

Story 1

Ana loves to have fun with her friend Érica.
Every weekend they come up with something to do.
Last Saturday, they went to a party where different artists performed.
Ana and Erica managed to take pictures of some of them and they were very happy.
The next day, Ana told everything to her cousin Marina.
Marina asked her: "Which artist did you photograph?"
Ana replied: "I photographed the actor. He dates a famous actress. But my friend photographed another artist."
Marina said: "Your friend photographed the dancer."

[5] Because of the short time to conduct this follow up and as it was intended to challenge the participants with a more demanding task, the most costly structures were considered on this analysis: relative clauses in which the intervening elements were full nominal phrases; and animate/human characters were taken as the moved and the intervening element of the target sentences.

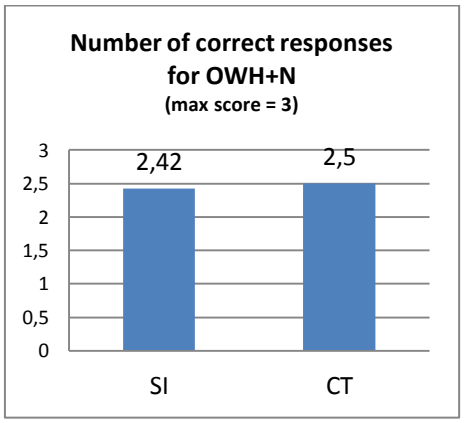
Ana excited said: "You're wrong! The artist that my friend photographed was the singer. He always invites a fan to the stage. "

Critical questions:

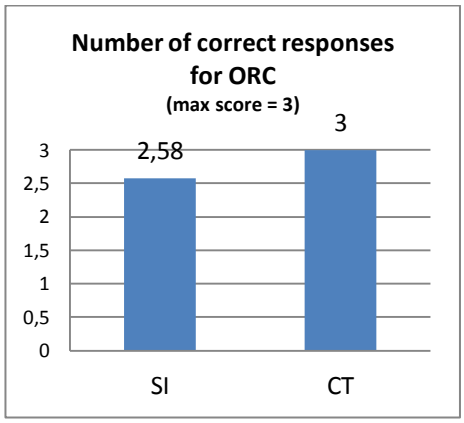
- Ana has photographed an artist. Which artist did she photograph?
- Erica, Ana's friend, has also photographed an artist. Does the artist that Ana's friend photographed invite a fan to the stage?

Figure 23: Example of the stories and the critical question from the follow up.

Group did not give rise to significant effect for WH+N questions (t (1,22) = 0,52 p=.40), though, for relative clauses, it approached the level of significance (t (1,22) = 3,2 p=.06). The means for both structures are presented in the following graphs (41 and 42).



Graph 41: Number of correct responses for object WH+N questions.



Graph 42: Number of correct responses for object relative clauses.

The two groups had a similar overall performance even when animate/human nouns were used, though it is possible that the more demanding the sentences are (in terms of the features shared by the intervening element and the moved one), the more likely it is for syntactic impairment, as detected in the isolated sentences, to affect reading sentences in discourse. Notice that it was in the relative clauses, in which the intervening element was a full nominal phrase, that lower scores were obtained in the SI group. A bigger sample, the specific manipulation of *animacy* (and other features) and more trials are required in order for the conditions in which syntactic impairment is likely to hamper reading discourse comprehension to be identified.

In general, the expectations generated by the discourse context are likely to facilitate lexical access, or the retrieval of referents (of the subject of WH and ORC), as sentence is analyzed (Forster & Correa, in press), thereby contributing to facilitate comprehension by the SI group.

8.1.8
Overall reading fluency

In order to assess the participants' abilities to read texts fluently, an overall analysis was performed. Six sentences from one same story were taken for this purpose and they are presented below:

1. No último sábado, Pedro convidou seu primo Daniel e o amigo dele, Cauã, para uma feira de animais.
   [Last Saturday, Pedro invited his cousin Daniel and his friend, Cauã, to an animal fair.]

2. No dia seguinte, Pedro soube que Cauã tinha adotado um animal.
   [The next day, Pedro heard that Cauã had adopted an animal.

3. Pedro encontrou Daniel e perguntou:
   [Peter met Daniel and asked him:]

4. Que animal seu amigo adotou?
   [Which animal did your friend adopt?]

5. Pedro logo falou:
   [Pedro said:]

6. Já sei! O cachorro vai dormir no quintal!
   [Let me guess! The dog will sleep in the yard!]

Figure 24: Sentences selected from a story for an overall analysis of fluency.

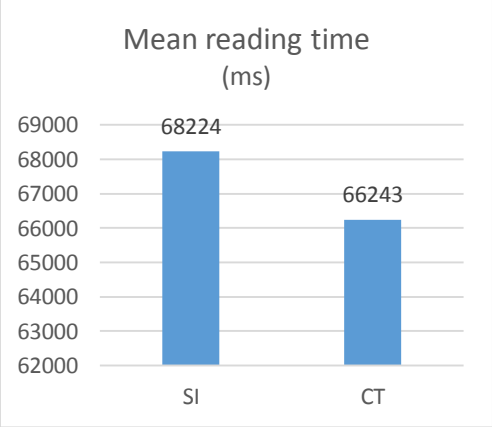
Reading rate, reading accuracy and prosody were examined the same way as in the previous analyses. The effect of group was analyzed by means of one-tailed t-tests.

8.1.8.1
Reading rate

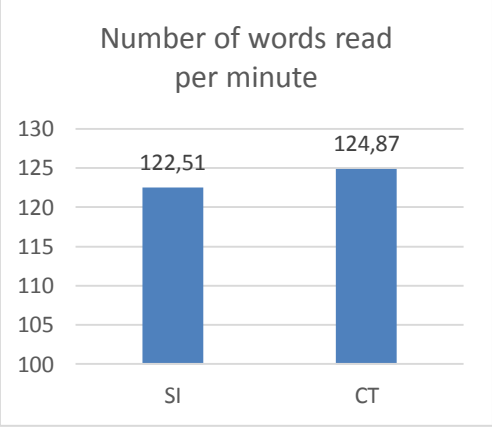
The analysis of reading rate was conducted the same way as in the previous analyses, that is, two measures were considered: *reading time* and *number of words read per minute*[6].

8.1.8.1.1
Results

There was no effect of group for *reading time* (t (1,22) = 0.84 p=.34) (cf. graph 43) or for *number of words read per minute* (t (1,22) = 0,56 p=.39) (cf. graph 44).



Graph 43: Mean reading time (ms).



Graph 44: Number of words read per minute.

[6] All words were considered in this analysis.

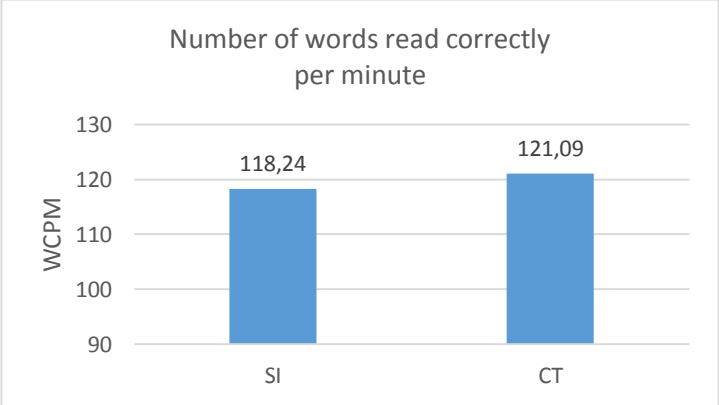
The overall reading rate was not affected by the syntactic impairment in the oral comprehension.

8.1.8.2
Reading accuracy

Two measures of reading fluency were used: (i) *number of words read correctly per minute*[7] (WCPM); and *number of disfluencies*. The same categories of errors from the previous analysis, described above, were considered.

8.1.8.2.1
Results

No effect of group was obtained for *number of words read correctly per minute* (t (1,22) = 0,64 p=.38) (cf. graph 45) or for *number of disfluencies* (t (1,22) = 1,48 p=.23).



Graph 45: Number of words read correctly per minute.

The following table (6) presents the distribution of errors of both groups.

[7] All words were considered in this analysis.

TYPE OF DISFLUENCY	SI	CT
Word repetition	9 (3,41%)	10 (3,79%)
Word omission	1 (0,38%)	3 (1,14%)
Word addition	3 (1,14%)	-
Misread words	4 (1,52%)	5 (1,89%)
Self-corrections	25 (9,47%)	18 (6,82%)
Hesitation	20 (7,58%)	15 (5,68%)
Total	**62 (23,48%)**	**51 (19,32%)**

Table 6: Breakdown of reading disfluencies.
n=264 (Total of sentences read within the story per group)

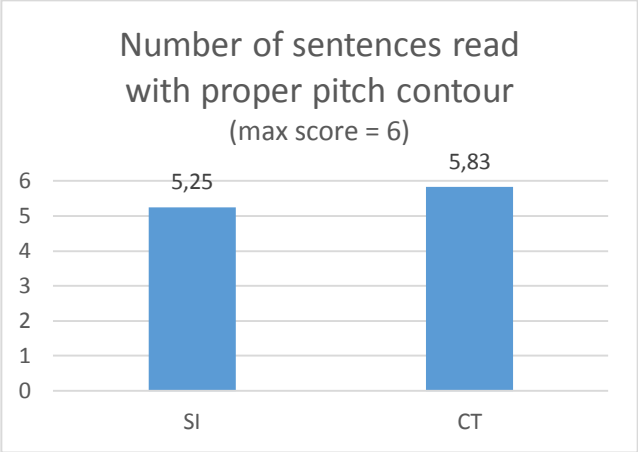
The syntactic impairment did not affect overall reading accuracy either.

8.1.8.3
Prosody

The analysis of prosody was also conducted the same way as in the previous analyses and the same measures were considered: (i) *number of sentences read with proper pitch*; (ii) and *number of sentences without intrasentential pauses*.

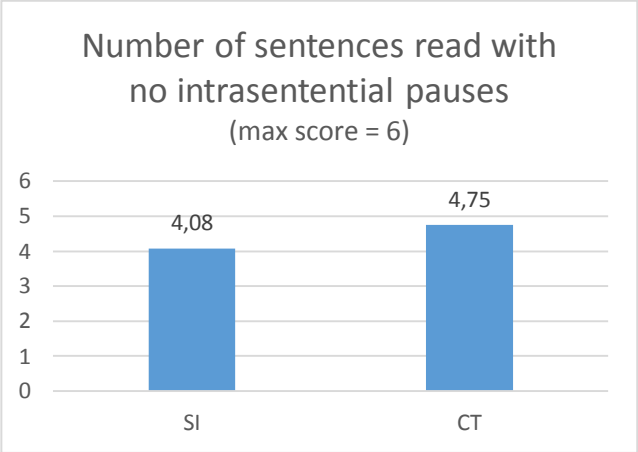
8.1.8.3.1
Results

For *number of sentences with proper pitch contour*, there was a significant effect (t (1,22) = 5,52 p<.006) (cf. graph 46).



Graph 46: Number of sentences read with proper pitch contour per group.

As for *number of sentences without intrasentential pauses*, no effect of group was obtained (t (1,22) = 2,52 p=.11). The following graph (47) shows the means per group.



Graph 47: Number of sentences read with no intrasentential pauses.

The use of proper pitch contour seems to be related to the syntactic impairment, unlike the use of misplaced or unexpected intrasentential pauses.

8.1.8.4 Discussion

This overall analysis of fluency indicates that the syntactic impairment identified in the comprehension of the highly costly structures does not affect the

overall reading rate, accuracy or the use of intrasentential pauses by the 6th grade student population investigated here. Prosody, as characterized by the pitch contour, however, can be taken as an index of the reflection of syntactic impairment upon reading fluency both in the reading of the target sentences and in the ascription of the proper prosodic contour to sentences based on a diversity of punctuation marks.