7

Assessment of reading fluency and comprehension of isolated sentences

Those participants who had not demonstrated difficulties at the word level took part in the third experiment, which intended to test their abilities to read fluently and to comprehend isolated sentences.

This test included the highly costly structures investigated here, i.e. object WH+N questions and object relative clauses. All sentences included in the experiment at stake have been selected from MABILIN I. The data for each type of structure were analyzed separately.

The participants' reading abilities were assessed based on *reading rate*, *reading accuracy*, *prosody* and *reading comprehension*.

7.1

The reading fluency and comprehension of isolated sentences task

An oral reading and picture identification comprehension task was conducted, in which the participants should read aloud isolated sentences presented on a computer screen and choose the corresponding picture. The effect of group was analyzed by means of one-tailed t-tests for all measures.

7.1.1

Experimental design

- Independent variable for each type of sentence structure

- Group (SI; CT);

- Dependent variables

For each reading aspect, different dependent variables were stipulated, as described below:

- 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 read with proper pitch*, according to the pitch contour of fluent adults; and *number of sentences read with no misplaced or unexpected intrasentential pause longer than 0,25 seconds*[1];
- Reading comprehension – *number of correct responses* for the comprehension task.

7.1.2

Method

- Participants

24 participants (mean age: 12; 8 girls) took part in this experiment. They had been divided, according to the previous experiments, into two groups:

- *SI*: 12 subjects (mean age: 12), 8 boys and 4 girls.
- *CT*: 12 subjects (mean age: 12), 8 boys and 4 girls.

- Material

Two blocks of sentences were created. In block 1, 8 object WH+N questions and 8 object right-branching relative clauses were presented. In block 2,

[1] Pause length cutoff values vary a lot in pause studies, ranging from 10 ms to 550 ms (Fors, 2015). This dissertation considered 0,25 seconds as a pause minimum duration.

8 center-embedded object relative clauses with transitive verbs and 4 distractors were included. All participants read the same sentences, but they had access to them in different sequences. Block 2 was presented if the participant agreed to continue being tested after a brief interval.

Example of object WH+N question:
Que menina o garoto pintou? [Which girl did the boy paint?]
Example of object right-branching relative clause:
Mostra o palhaço que o menino molhou. [Show me the clown that the boy wetted.]
Example of center-embedded object relative clause with transitive verb:
A vaca que o elefante molhou comeu o capim. [The cow that the elephant wetted ate the grass.]

Table 3: Examples of sentences of each type of structure investigated[2].

- Apparatus and experimental set up

A DEL Inspiron 15 laptop, an RV411 Samsung laptop and the computer program LINGER were used in this experimental activity. A Panasonic MP3 player was also used, so that the subjects' production could be recorded. The analysis of these recordings was conducted using Praat, which is a comprehensive speech software package designed to analyze, synthesize, and manipulate digital speech data.

The two laptops were arranged in such a way that the one presenting the reading stimuli was placed on a desk in front of the child with the keyboard ready to be used. The other one was placed over the former (on a pile of books hidden behind the screen of the other laptop), in such a way that only its screen was available. This screen presented the images that appeared as the child pressed the key after reading the test sentence. The pictures presented on this screen enabled the comprehension part of the task to be accomplished. The two laptops were used since it was not possible to present images and written material by means of the software used in this task.

[2] The complete list of the test sentences can be found in appendix 2.

- Procedure

At first, participants were invited to take part in a new test, which would be conducted in an isolated room at their schools. All students wanted to participate. They were then instructed to read aloud the sentences, which were presented on the screen of the laptop placed on the desk in front of them, and then to press a key to continue the task, after reading aloud the sentences. Right after that, three pictures were presented on the screen of the second laptop. Among the three pictures there were the target-picture, the most probable error and the least probable error. Participants should point to the picture that corresponded to the sentence they had read. The pictures were exposed on the screen only for 7 seconds[3]. When participants exceeded such time, their answers were considered to be incorrect. The training part included 4 trials. All participants understood the task and decided to continue. After a brief interval, they were invited to continue the task, being challenged to a more demanding part. All participants agreed to continue and were presented to Block 2. The activity took about 10 minutes. All sentences were recorded for the analyses of rate, accuracy and prosody.

7.1.3

Reading rate

Reading rate was analyzed based on two measures: (i) *reading time* per sentence type, defined by the latency between the presentation of the test sentence on the computer screen and the pressing of a key at the computer keyboard by the student after reading aloud such sentence; (ii) and *number of words read per minute*[4] for each sentence type.

7.1.3.1

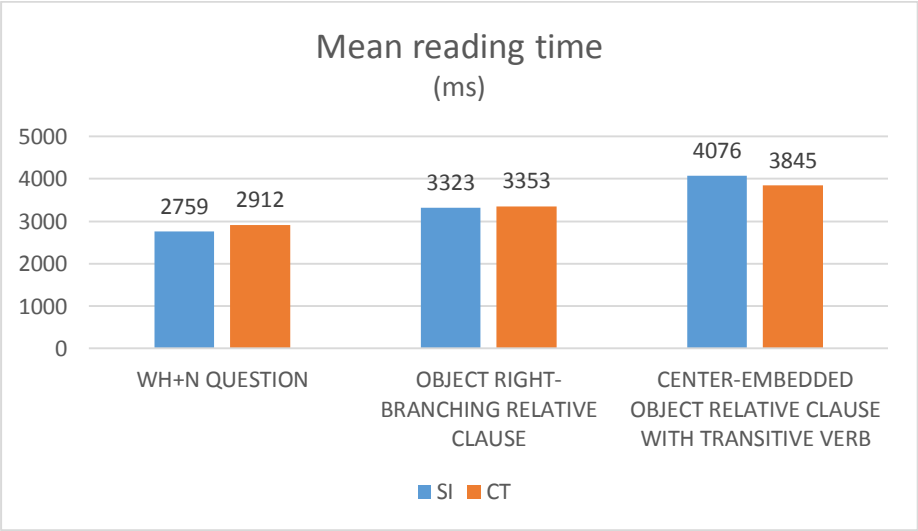
Results

[3] This time was established based on the performance of 10 adults.

[4] The number of content words was considered on this analysis. There were not omissions of function words/morphemes.

There was no significant effect of group for *reading time* in any of the structures presented. The results are exhibited below and graph 27 presents the mean *reading time* of SI and CT groups for each type of structure.

- Object WH+N questions: t (1,22) = 1,48 p=.23
- Object right-branching relative clauses: t (1,22) = 0,26 p=.45
- Center-embedded object relative clauses with transitive verbs: t (1,22) = 1,20 p=.28

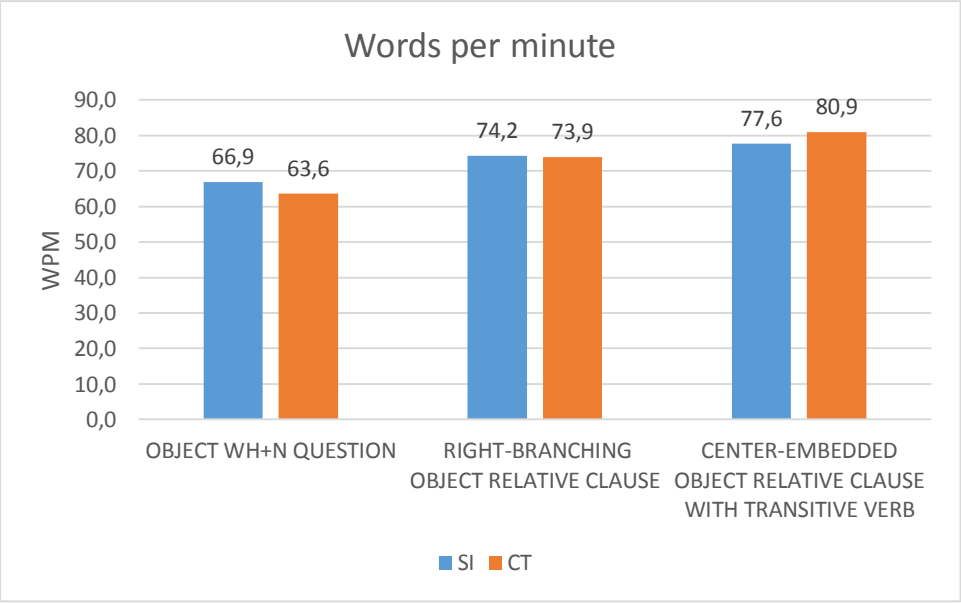


Graph 27: Mean reading time (ms).

As far as *number of words per minute* is concerned, no significant effect of group was obtained either, as observed in the following results.

- Object WH+N questions: t (1,22) = 1,54 p=.23
- Object right-branching relative clauses: t (1,22) = 0,08 p=.48
- Center-embedded object relative clauses with transitive verbs: t (1,22) = 0,98 p=.31

The *number of words read per minute* of each group for each type of structure in shown in the following graph (28).



Graph 28: Number of words per minute.

It appears therefore that syntactic impairment as detected in the oral comprehension of these structures has no impact on reading rate.

7.1.4
Reading accuracy

The *number of words read correctly per minute* (WCPM)[5] was calculated for each type of structure, as well as the *number of disfluencies*.

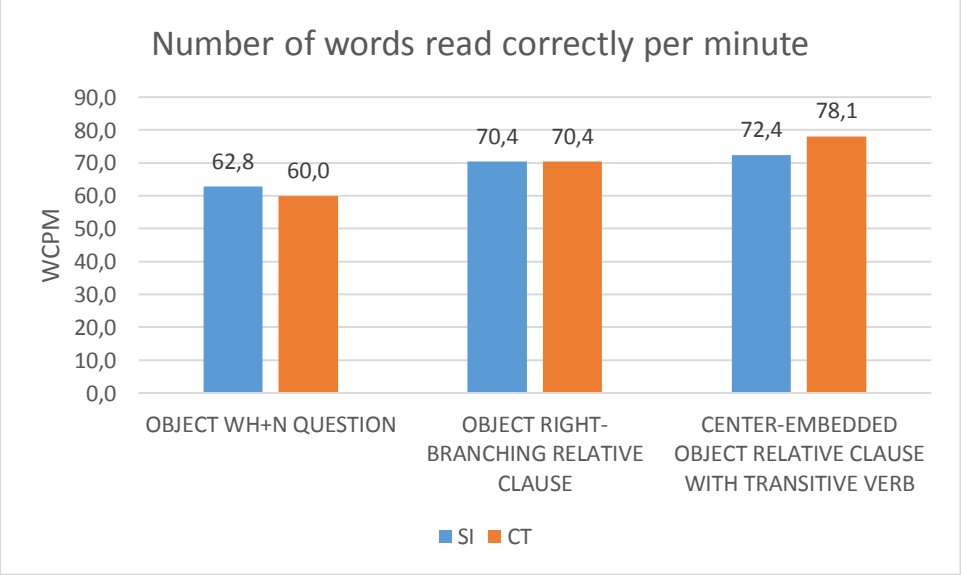
Six categories of errors were considered: (1) word repetition; (2) word omission; (3) word addition; (4) misread words; (5) self-corrections (e.g. "a baca…vaca"); and (6) hesitation, that was characterized by the lengthening of the determinant vowel or of a syllable of the noun or verb (e.g. "aaaaa menina", "a meniiiiina", "segurooooou").

[5] For each type of structure, the total number of words (content words) read correctly and the total reading time were considered for this analysis.

7.1.4.1

Results

The *number of words read correctly per minute* (WCPM) of both SI and CT groups for each type of structure is shown in Graph 29.



Graph 29: Number of words read correctly per minute.

Group did not give rise to significant main effects as far as *number of words read correctly per minute* is concerned. The results are presented below:

- Object WH+N questions: t (1,22) = 1,14 p =.29
- Object right-branching relative clauses: t (1,22) = 0,02 p=.495
- Center-embedded object relative clauses with transitive verbs: t (1,22) = 1,64 p=.21

Table 4 shows the breakdown of reading disfluencies of both groups per sentence type.

TYPE OF DISFLUENCY	OBJECT WH+N QUESTION		OBJECT RIGHT-BRANCHING RELATIVE CLAUSES		CENTER-EMBEDDED OBJECT RELATIVE CLAUSES WITH TRANSITIVE VERBS	
	SI	**CT**	**SI**	**CT**	**SI**	**CT**
Word repetition	-	-	-	2 (2,08%)	-	-
Word omission	-	-	-	-	-	-
Word addition	-	-	-	-	-	-
Misread words	4 (4,17%)	5 (5,21%)	1 (1,04%)	6 (6,25%)	2 (2,08%)	1 (1,04%)
Self-corrections	5 (5,21%)	3 (3,13%)	9 (9,38%)	3 (3,13%)	17 (17,71%)	9 (9,38%)
Hesitation	10 (10,42%)	9 (9,38%)	11 (11,46%)	8 (8,33%)	15 (15,63%)	8 (8,33%)
Total	**19 (19,79%)**	**17 (17,71%)**	**21 (21,88%)**	**19 (19,79%)**	**34 (35,42%)**	**18 (18,75%)**

Table 4: Breakdown of reading disfluencies.
n=96 (Total of sentences read per group)

The figures in Table 4 show that there was a tendency of more self-corrections and more hesitations in the SI group. There was however a tendency of more misread words in the control group (CT). For *number of disfluencies*, there was a significant difference between groups for center-embedded object relative clauses only ($t(1,22) = 4,80$ $p<.013$).

The analysis of the number of words read correctly per minute suggests that both groups present similar reading accuracy. As for number of disfluencies, they also seem to behave similarly, except in center-embedded object relative clauses. Such structure is considered to be particularly demanding in so far as the cost of keeping a complex subject in working memory until the main clause verb is reached adds to the cost of the internal processing of the relative clause. It is possible, therefore, that the syntactic impairment affects the reading process of these sentences.

7.1.5
Prosody

Prosody was characterized in terms of (i) *pitch contour* and (ii) *absence of misplaced or unexpected intrasentential pauses*[6]. Spectrographic analyses were used, which enabled those features to be visually represented. The patterns of pitch were taken as indicators that the reader had planned the intonation of the sentence based on the syntactic structure. Intrasentential pauses were considered to indicate non-fluent prosody.

The pitch contour of each type of sentence was defined based on the pattern of two fluent adult readers (one male/one female adult). For object WH+N questions, a rising contour in the WH+N segment and a sentence-final fall pitch were obtained. Figure 10 presents an example of the pattern of the pitch contour of such structure.

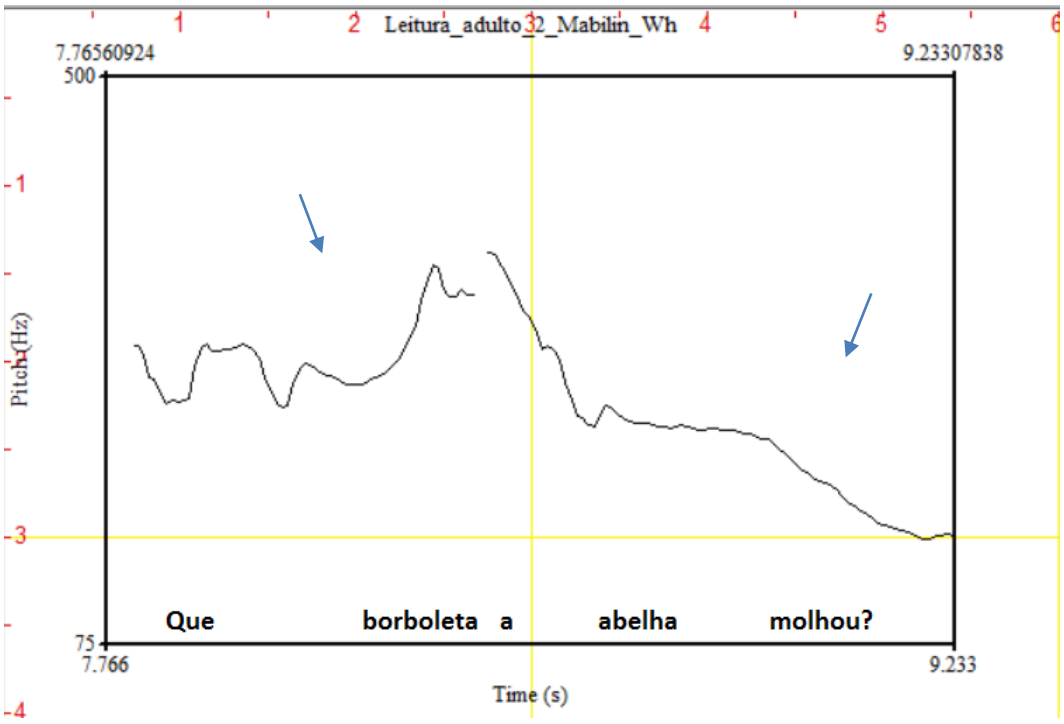


Figure 10: Example of the pattern of the pitch contour of WH+N interrogatives.

[6] It is relevant mentioning that the analysis of prosody was conducted by two raters. Both of them are language teachers.

As for right-branching object relative clauses, a rising pitch at the head noun and a falling pitch at the end were noticed, as shown in the following picture (11).

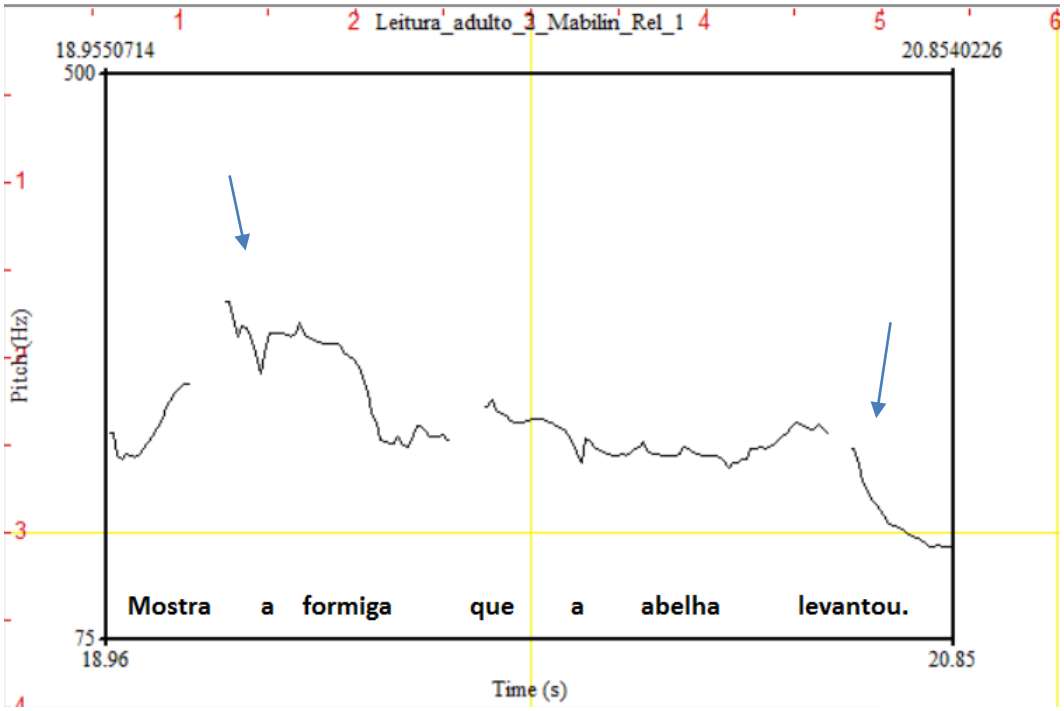


Figure 11: Example of the pattern of the pitch contour of right-branching object relative clauses.

For center-embedded object relative clauses, a rising pitch at the head noun and between the complex subject and the main clause verb, as well as a sentence-final fall pitch were obtained. An example of the pattern of this structure is exhibited in picture 12.

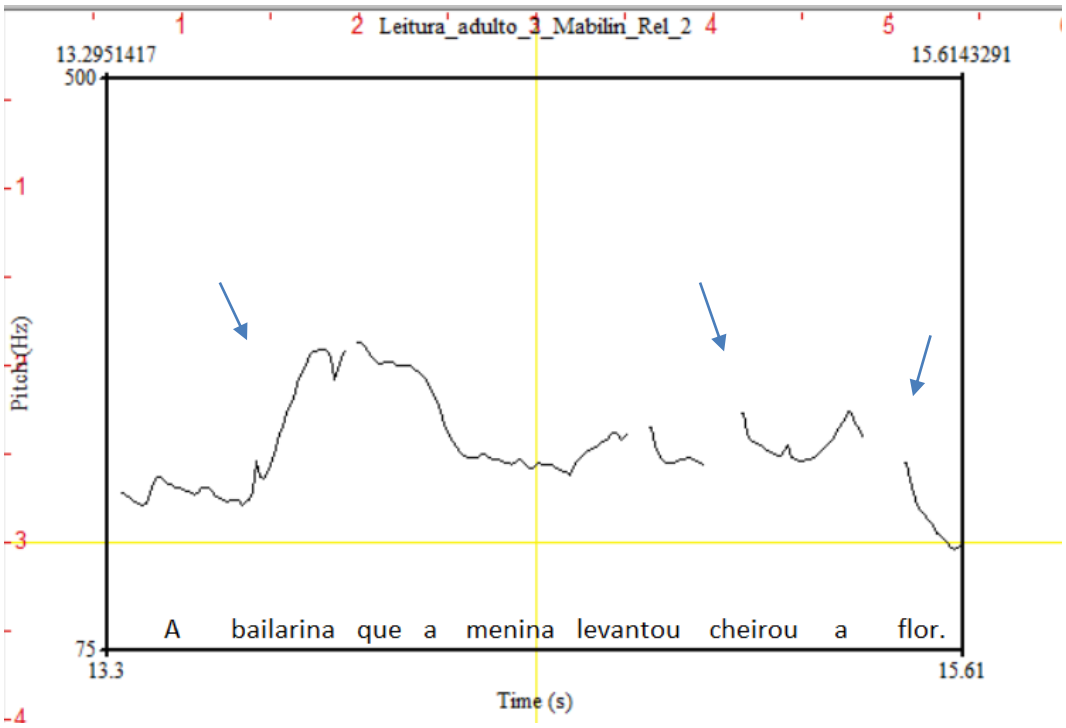


Figure 12: Example of the pattern of the pitch contour of center-embedded object relative clauses.

The patterns, defined by the adults' readings, were taken for the analysis of pitch contour. The *number of sentences read with proper pitch* was then taken as a dependent variable.

Intrasentential pauses longer than 0,25 seconds were also identified in each type of structure, by visually demarking the spectrographs at the limits of the pause interval and noting the duration in seconds (cf. figure 13). The dependent variable for each sentence was then stipulated as follows:

- For object WH+N questions: number of sentences with no intrasentential pauses.
- For right-branching object relative clauses: number of sentences with no intrasentential pauses between the head noun and the relative clause; the relative pronoun and the subject of the relative clause; and between the subject and the verb of a relative clause.
- For center-embedded object relative clauses: number of sentences without intrasentential pauses between the head noun and the relative clause; the relative pronoun and the subject of the relative clause; and between the complex subject and the verb of a relative clause.

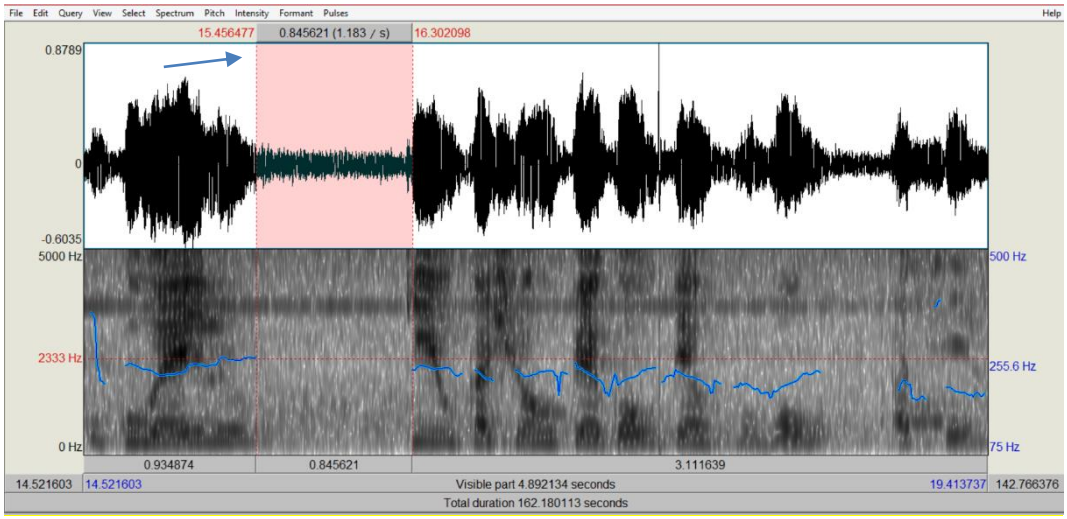


Figure 13: Example of intrasentential pause.

7.1.5.1
Results

Figures 14, 15 and 16 present examples of sentences produced with inappropriate pitch contour.

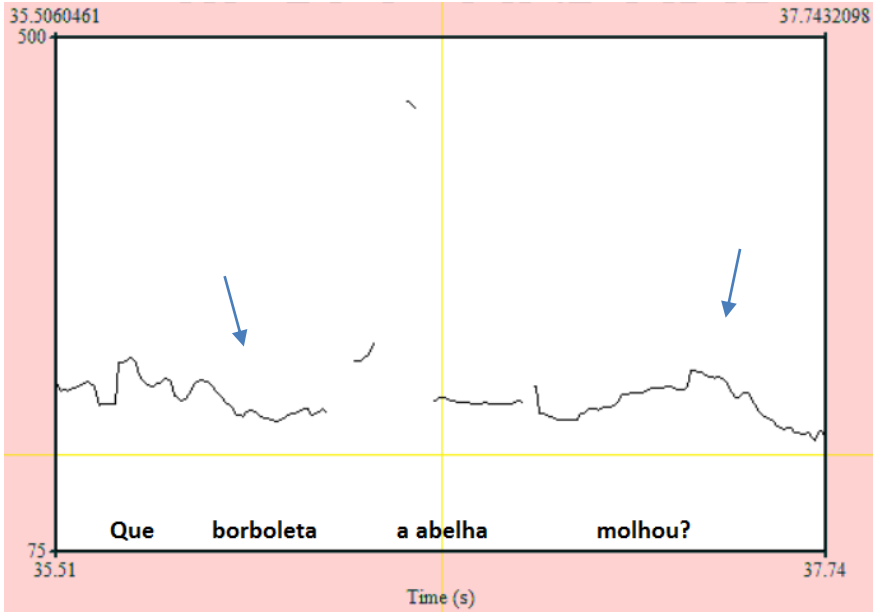


Figure 14: Example of WH+N interrogative with inappropriate pitch contour.

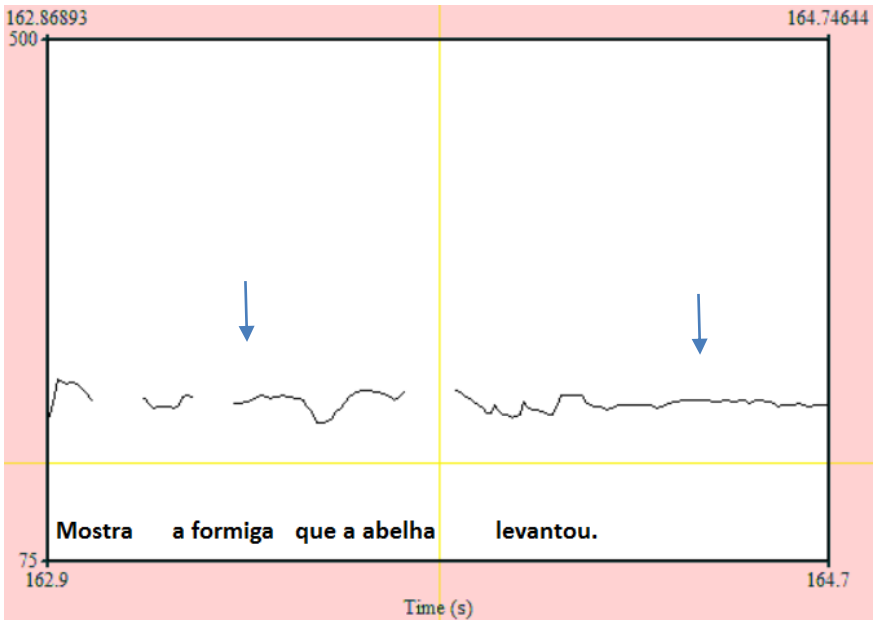


Figure 15: Example of right-branching object relative clause with inappropriate pitch contour.

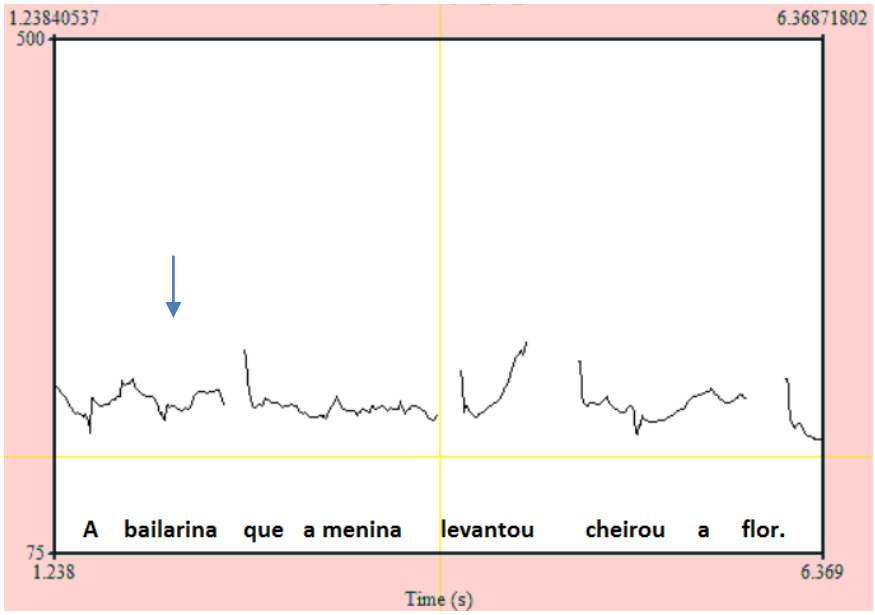
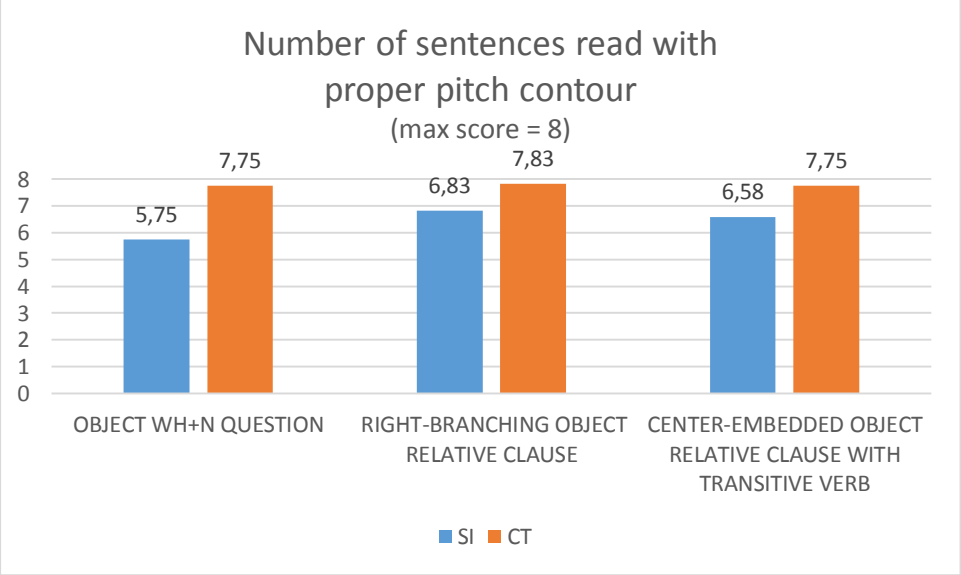


Figure 16: Example of center-embedded object relative clause with inappropriate pitch contour.

For *number of sentences read with proper pitch contour*, there was a significant effect of group for all the three structures. The results are shown below and the means are presented in graph 30.

- Object WH+N questions: t (1,22) = 4,5 p<.02

- Object right-branching relative clauses: t (1,22) = 3,86 p<.04
- Center-embedded object relative clauses with transitive verbs: t (1,22) = 5,14 p<.01

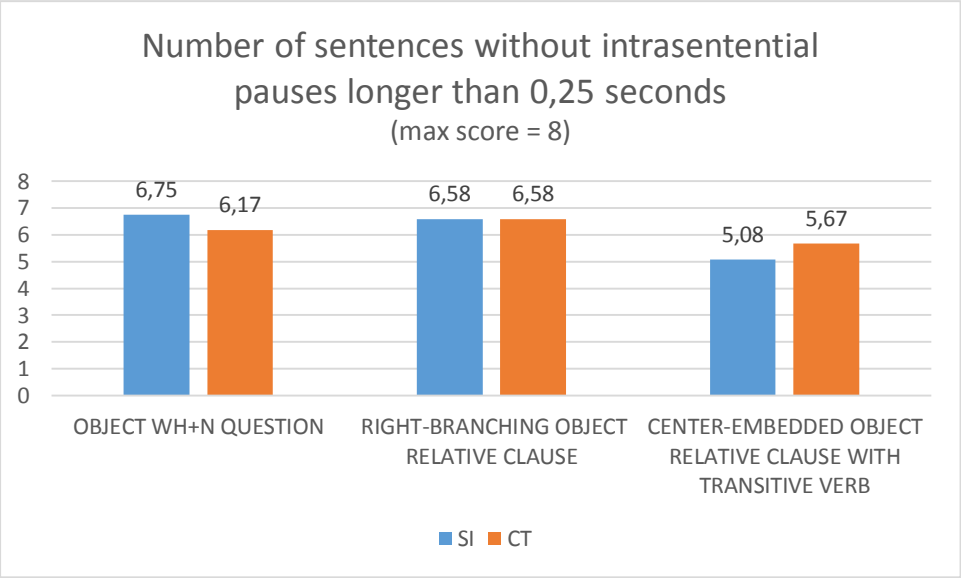


Graph 30: Mean number of sentences read with proper pitch contour per sentence type.

There was no effect of group for *number of sentences without intrasentential pauses*. The results were the following:

- Object WH+N questions: t (1,22) = 1,46 p=.24
- Object right-branching relative clauses: The means were identical in the two groups.
- Center-embedded object relative clauses with transitive verbs: t (1,22) = 1,46 p=.26

Graph 31 presents the means of both SI and CT groups for each type of structure.



Graph 31: Number of sentences without intrasentential pauses.

The syntactic impairment detected in the oral comprehension of the structures investigated does not have effect on the occurrence of misplaced or unexpected intrasentential pauses when such structures are read in isolation. However, the pitch contour, which contributes to the definition of the prosodic structure of the sentence was sensitive to that factor, i.e. the syntactic impairment appears to have an effect on pitch.

7.1.6

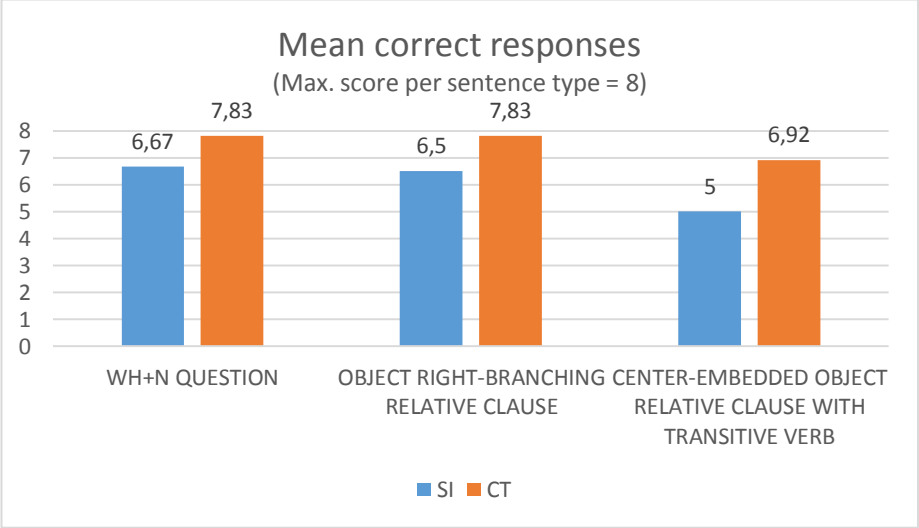
Reading comprehension

As explained above, after reading aloud each sentence, participants should identify the matching picture among three pictures exhibited on a laptop screen placed in front of them. The *number of correct responses* was considered to reflect the participants' comprehension ability.

7.1.6.1
Results

There was a significant difference between the groups in the *number of correct responses* for the three structures at stake. The results are presented below and graph 32 illustrates the mean number of correct responses.

- WH+N questions: t (1,22) = 5.44 p< .01
- Object right-branching relative clauses: t (1,22) = 5.94 p< .01
- Center-embedded object relative clauses with transitive verbs: t (1,22) = 7.24 p< 0,001



Graph 32: Mean correct responses.

The data suggest, therefore, that the syntactic impairment detected in the oral comprehension of the highly costly structures investigated here affects the reading comprehension of these sentences in isolation.

7.1.7
Discussion

It was observed in chapter 6 that the reading abilities of the SI and the CT groups were similar at the word level, i.e. the syntactic impairment detected in the

oral comprehension did not affect their abilities to recognize and read written words.

In this chapter, a different experiment was conducted in order to assess the participants' abilities to read fluently and to comprehend the structures investigated in isolation. The three key-components related to reading fluency were thus examined: reading rate, reading accuracy and prosody.

The results suggest that reading rate and reading accuracy are not affected by the syntactic impairment observed in the oral comprehension (except for the accuracy when the center-embedded object relative clauses are concerned). However, the analysis of the proper use of pitch contour indicates that the syntactic impairment may have an impact on the planning of prosody in reading, since it is a function of syntax. Such an impairment also appears to affect the comprehension of the highly costly structures in reading.