Sentence disambiguation in the phonology-syntax interface: results from a comprehension study

Desambiguização de sentenças na interface fonologia-sintaxe: resultados de um estudo de compreensão[1]

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Abstract: This article discusses the comprehension of syllable duration in Brazilian Portuguese as a prosodic cue in ambiguous sentences with a NP1-V-NP2-attribute structure (e.g. *A mãe encontrou a filha suada* 'The mother has found her daughter sweaty'). Phonologically speaking, interpretations of the above-mentioned structure can be explained by the fact that attributes may or may not join the head in the construction of the phonological phrase domain (NESPOR; VOGEL, 1986), and because lengthening is expected when there is a boundary (FOUGERON; KEATING, 1997). We suggest that lengthening exists in BP as an optional phenomenon. We ran a picture matching experiment,

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with versions of structures with local and nonlocal attachment of nine sentences. The overall results showed significant differences depending on the type of syntactic structure. The different sentences also played a role in the results, indicating that, although lengthening is optional in production, its application leads to a nonlocal interpretation. The Late Closure Principle (FRAZIER, 1979) seems to play a role in the results for sentences with local attachment. Finally, the findings also show that sentences that allow small clause configurations may interfere in the lengthening process, which we attribute to the fact that restructuring is blocked in this kind of structure.

Keywords: local attachment; nonlocal attachment; prosodic boundary; lengthening; small clauses.

Resumo: Este artigo analisa a compreensão no português brasileiro da pista prosódica de duração de sílabas em sentenças ambíguas do tipo SN1-V-SN2-Atributo (e.g. 'A mãe encontrou a filha suada'). Fonologicamente, tais leituras podem ser explicadas pelo fato de o atributo poder ou não se juntar ao núcleo na construção do domínio da frase fonológica (NESPOR; VOGEL, 1986), e de que, se há fronteira de domínios, um alongamento é esperado (FOUGERON; KEATING, 1997). O estudo propõe que o alongamento é um fenômeno opcional no PB. Um experimento de *picture matching* é aplicado para versões de estruturas de aposição não local e local de nove sentenças. Os resultados apontaram para diferenças significativas conforme o tipo de estrutura sintática. As diferentes sentenças também se mostraram relevantes para a interpretação de que, ainda que o alongamento seja opcional na produção, uma vez realizado, ele serve como condutor para uma interpretação não local. Os resultados para uma interpretação local parecem decorrer da interação entre o Princípio de *Late Closure* (FRAZIER, 1979) com a estrutura prosódica da sentença. Por fim, a análise evidencia que estruturas do tipo *small clause* interferem no processo de alongamento e este artigo defende que isso ocorre porque a reestruturação prosódica é bloqueada neste tipo de estrutura sintática.

Palavras-chave: aposição local; aposição não local; fronteira prosódica; alongamento; *small clauses*.

1 Introduction

In this article, we investigate the use of syllable duration as a prosodic cue for sentence disambiguation in Brazilian Portuguese (hereinafter BP), by examining the interpretation listeners assign to contexts in which phonological phrases may be restructured. Our goal is to determine whether a longer/shorter duration of a segment leads the listener to a given interpretation and, if so, whether or not there are degrees of variation in the continuum of duration. To achieve this, we have focused on cases of permanent syntactic ambiguity, specifically in NP1-V-NP2-attribute sentences, such as (1). We are interested in determining the role played by prosody in disambiguation.

Magalhães and Maia (2006) analyzed the interpretation assigned to the reading of sentences that present ambiguity between the local/non local positions of the attribute, as in (1), which may lead to a nonlocal reading (1a) or a local reading (1b).

1. *O pai abraçou o filho embriagado.* (The father hugged the son drunk.)

   a. *O pai estava embriagado.* (The father was drunk.)

   b. *O filho estava embriagado.* (The son was drunk.)

The authors applied an experiment involving two tasks: (a) the participants read the sentences and then explained how they interpreted them, and (b) the participants read the sentences with some type of information that could affect the sentences' prosodic structure (a forward slash (/) between 'son' and 'drunk'). The results suggest that in phrases without marks that could influence prosody, local attachment was always preferred. When a forward slash was placed between the object and the attribute, the number of nonlocal attachment interpretation choices increased. When the nonlocal attachment reading was preferred, the stressed syllable in the attribute was lengthened (the syllable 'ga' in the word 'embriagado').

Fonseca and Magalhães (2008) also point out some prosodic cues that interfere in the choice of interpretation for these sentences. In the reading aloud experiment, a rise in the fundamental frequency was detected in the NP1 and in the Attribute, as well as a silent pause between NP2 and the Attribute. Fonseca (2008), in turn, examined the use of intonational aspects in this type of structure to see if any specific

pattern is adopted when the speaker needs to disambiguate a sentence. The results obtained revealed that only when prosody is emphatic (F0 rises in both the subject and the attribute), the interpretation tends toward nonlocal reading.

Angelo and Santos (2015) reformulated the tests applied by Magalhães and Maia (2006) and analyzed production data to determine what happens to the duration of segments where prosodic restructuring may occur – two phonological phrases merging into a single prosodic domain – because the results presented by the authors are interesting in that they cannot be explained by current phonological theories. As we will demonstrate, in the nonlocal attachment reading, '*filho*' (son) and '*embriagado*' (drunk) are in different prosodic domains ([*o filho* (the son) φ] [*embriagado* (drunk) φ]), whereas in the local reading, '*filho*' (son) and '*embriagado*' (drunk) are in the same prosodic domain ([*o filho embriagado* (the son drunk) φ]).

The point of departure for Angelo and Santos involves the crosslinguistic results showing that stressed and word final syllables are lengthened at the end of prosodic domains (OLLER 1973; KLATT, 1976; KEATING *et al.*, 2003). If this is the case, the fact that the syllable '*ga*' becomes longer in Magalhães and Maia should not favor any interpretation, for in both interpretations, '*ga*' is the final stressed syllable in the phonological phrase domain. In addition, some studies have also found that the higher the prosodic domain, the longer the duration (see TABAIN, 2003; KEATING *et al.*, 2003). In this case, a variation would be expected in the duration of syllables in the word '*filho*' (son) only in nonlocal attachment, as they are close to the phonological phrase boundary. That is, the syllables in NP2 should be lengthened, but the syllables in the attribute should not, because the latter is found in different prosodic domains, depending on the interpretation. Lengthening of the first syllables of the attribute in nonlocal interpretation, as in the case of the syllable '*em*' in the word '*embriagado*' (drunk), would also be justified because they are close to the phonological phrase boundary. In the local attachment reading, however, such syllables are not at the end/beginning of this domain, and, therefore, should be shorter than when they are in a nonlocal attachment reading, being at the end/beginning of this domain.

The results in Angelo and Santos (2015) revealed no significant statistical differences in duration when the two interpretations are compared, although a clear tendency was detected: whenever lengthening

was relevant, it occurred in cases of nonlocal attachment (the boundary). Thus, the question that arises is whether this lengthening would be optional. A comprehension experiment may help to define the extent to which longer duration in sentences, as in (1a) (though not mandatory in production), may lead the listener to interpret them as nonlocal attachments.

However, yet another question arises. Both Magalhães and Maia (2006) and Angelo and Santos (2015) treated the sentences in (1) as potentially having only two structures. Nevertheless, Angelo (2016) points out that some of these sentences may have a third syntactic structure, as in (2):

2. *A mãe encontrou a filha suada.* (The mother found the daughter sweaty.)
    a. *A mãe estava suada.* (The mother was sweaty.)
    b. *A filha estava suada.* (The daughter was sweaty.)
    c. *A mãe se deparou com uma situação: a filha suada.* (The mother came across a situation: the daughter sweating.)

The interpretation in (2c) is generated by a third syntactic structure that leads to a prosodic mapping different from the one in local attachment sentences by adjunction. This finding brings important consequences to the expectations in the interpretation of the sentences, as no phonological difference is expected among the types of local attachment readings.

Therefore, the purpose of this article is to discuss what happens to syllables that are within the boundaries of prosodic domains of such sentences or at their boundaries. Given that there are different structural mappings (beside the studies that conclude that syllables at the beginning/ end of prosodic domains are longer and better articulated), the expectation is that the nonlocal interpretation should obtain when the duration of the syllables near the possible boundary is longer, indicating that there is a boundary between the object and the attribute (and restructuring is not possible). We also expect to determine if there is a different interpretation of the sentences when there is a difference in the syntactic structure for the local attachment readings.

This article is organized as follows: in section 2, we provide a brief summary of syntactic, phonological, and processing theories,

specifically regarding what is known about ambiguous structures. Sections 3 and 4 present the experiment's design and the results of its application, respectively. Results are then discussed in section 5, and some final considerations are added in section 6.

2 NP1-Verb-NP2-Attribute sentences at the Phonology-Syntax-Parsing interfaces

2.1 Syntax: Ambiguity by attachment and X-bar theory

From the syntactic point of view, the ambiguity in NP1-V-NP2-Attribute sentences is related to the possibility that one or more constituents may be assembled. This ambiguity may depend on the nature of the verb along with the complement that follows it. According to Foltran (1999), when the attribute is expressed by an adjective, it may function as a nominal adjunct. Therefore, in a sentence such as (4), in which only local attachment is possible, the adjective may behave as a modifier of the nominal phrase [*o carro* (the car)].

4. *O João comprou o carro quebrado* (João bought the car broken)

Constituency tests, such as passivization, topicalization, or clefting, may reveal the existence of other structures and consequently, additional ambiguity (see (5) from Foltran. 1999, p. 29). It is evident that, in Group 1, '*quebrado*' (broken) is an adjunct of '*carro*' (car) (it is part of the constituent headed by it). However, in another construction based on the same elements, the adjective '*quebrado*' (broken) behaves as a constituent distinct from the nominal phrase '*o carro*' (the car), although it still characterizes the nominal phrase - but in this case as a predicative manner – see (6).

5. Group 1: Attributive use of the adjective
   a. *O carro quebrado foi comprado por João.* (The broken car was bought by João.)
   b. *O carro quebrado, o João comprou-o.* (The broken car, João bought it.)
   c. *Foi o carro quebrado que o João comprou.* (It was the broken car that João bought.)

6. Group 2: Predicative use of the adjective
   a. *O carro foi comprado quebrado por João.* (The car was bought broken by João.)
   b. *O carro, o João comprou-o quebrado.* (The car, João bought it broken.)
   c. *Foi o carro que o João comprou quebrado.* (It was the car that João bought broken.)

Not all verbs admit these two possibilities, though: (8) and (9) show the same tests above applied to sentence (7), under the local attachment reading:

7. *O pai visitou o filho feliz*. (The father visited the son happy.)

8. Group 1: Attributive use of the adjective
   a. *O filho feliz foi visitado pelo pai.* (The happy son was visited by the father.)
   b. *O filho feliz, o pai visitou-o.* (The happy son, the father visited him.)
   c. *Foi o filho feliz que o pai visitou.* (It was the happy son that the father visited.)

Group 2: Predicative use of the adjective
   d. *#O filho foi visitado feliz pelo pai*. (The son was visited happy by the father.)[4]
   e. *#O filho, o pai visitou-o feliz*. (The son, the father visited him happy.)
   f. *#Foi o filho que o pai visitou feliz*. (It was the son that the father visited happy.)

As it may be noticed, both (4) and (7) allow for the interpretation of local attachment; however they are different as to the syntactic structure in question; whereas the former admits predicative and adjunct readings (see (5)-(6)), it is not clear that the latter allows the predicative structure

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[4] # indicates a grammatical sentence whose meaning is different from the intended one.

(see (8)-(9)). The point in question is that there is a difference between sentences such as (10) and (11) below:

　　10. *A Maria trabalhou magoada*. (Maria worked hurt.)

　　11. *O João considera a Maria bonita*. (João considers Maria to be beautiful.)

In (10), the verb *'trabalhar'* (to work) selects only one argument (the subject), in this case [*A Maria* (Maria)], which does not exclude the evident relation between the adjective phrase (AP) [*magoada* (hurt)] and the determiner phrase (DP) [*A Maria* (Maria)] In the second example, however, the verb '*considerar*' (consider) selects, in addition to the subject, the constituent [*a Maria bonita* (Maria to be beautiful)] as a whole, which is an evidence for the classification of [*a Maria bonita* (Maria to be pretty)] as a small clause (SC) – see Foltran (1999). In both cases, we have local attachment.

2.2 Prosodic phonology: Prosodic boundaries and ambiguity

The discussion on the interaction between phonology and syntax is not new (e.g. LIGHTFOOT, 1976; CHOMSKY; LASNIK, 1978), although different analyses are presented to explain how this interaction takes place.

According to Selkirk (1984) and to Nespor and Vogel (1986), part of the phonological component indirectly interacts with other grammatical components, by creating domains where the phonological rules apply: domain formation rules take information about other grammatical components into account. Once these domains have been created, phonology no longer has access to other components. These domains (known as prosodic domains) are hierarchically structured as an n-ary branching tree. According to Nespor and Vogel, the syntactic structure is phonologically mapped into the phonological phrase level (ϕ) by means of the mapping rules presented in (12):

12. Phonological Phrase formation:

    I. Domain: The domain of φ consists of a clitic group (C) which contains a lexical head (X) and all Cs on its nonrecursive side up to the C that contains another head outside of the maximal projection of X.

    II. Construction: Join into an n-ary branching φ all Cs included in a string delimited by the definition of the domain of φ.

φ Restructuring (optional):

A nonbranching φ which is the first complement of X on its recursive side is joined into the φ that contains X.

(NESPOR; VOGEL, 1986, p.168-173)

A lexical word, along with its clitics, forms the clitic group (C) (e.g. '*o filho*' (the son)). An adjective, in addition to defining a phonological phrase by itself, may be incorporated within the domain that contains the word that it modifies through a restructuring process: attach to a phonological phrase the first complement of X on its recursive side, that is, the side where the lexical head complements are usually found. Restructuring only occurs if the complement is a phonological phrase formed by a single clitic group, which prevents sequences such as ´*comeu bolo de chocolate*´ (ate chocolate cake) from being restructured, as the complement for the verb '*comer*' (eat) is '*bolo de chocolate*' (chocolate cake), which is formed by two clitic groups.

Languages vary as to whether or not they admit restructuring and if they do, restructuring may be obligatory or optional. BP has been described as a language in which restructuring is possible (see ABOUSALH, 1997; SANTOS, 2003; SÂNDALO; TRUCKENBRODT, 2002), although the issue of whether the process is mandatory or not has not been addressed.

BP is classified as a language with recursion on the right side. Therefore, an adjective is an independent phonological phrase (its maximum projection is different from the noun's maximum projection), but may be restructured, forming a single phonological phrase. This mapping may reflect structural differences in ambiguous adjunction sentences, such as (13) under the local and nonlocal readings. In the interpretation under which the son is happy, '*feliz*' (happy) is the complement for '*filho*' (son) and, therefore, both phonological phrases

may be restructured (13a); in the interpretation under which the father is happy, there is no relation between '*filho*' (son) and '*feliz*' (happy); therefore, the restructuring between [*o filho* (the son)] and [*feliz* (happy)] (13b) is not admitted:[5]

13. *O pai visitou o filho feliz*. (The father visited the son happy.)
a. reading: The son is happy.
[*o pai* (the father) ϕ] [*visitou* (visited) ϕ]
[*o filho* (the son) ϕ] [*feliz* (happy) ϕ]
  >> [*o pai* (the father) ϕ] [*visitou* (visited) ϕ]
[*o filho feliz* (the happy son) ϕ $_{restructured}$]

b. reading: The father is happy.
[*o pai* (the father) ϕ] [*visitou* (visited) ϕ]
[*o filho* (the son) ϕ] [*feliz* (happy)ϕ]
  >> *[*o pai* (the father) $_{]\,[}$ *visitou* (visited) ϕ]
[*o filho feliz* (the son happy) ϕ $_{restructured}$]
  >> [*o pai* (the father)$_{]\,[}$ *visitou o filho* (visited the son)ϕ $_{restructured}$] [*feliz* (happy)ϕ]

2.3 Parsing: The comprehension of ambiguous sentences

Studies in Psycholinguistics propose that we are equipped with a type of 'device' (parser, syntactic analyzer) that determines the structure of sentences, contributing to language production and understanding. The Garden Path theory (FRAZIER, 1979) is a model of sentence processing whose characteristics are that it is universal, innate, and based on cognitive economics principles, that is, low cost operations and less working memory (see FRAZIER; FODOR, 1978; FRAZIER, 1979). According to this model, interpretation choices are made when the processing takes place, in compliance with the following principles:

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[5] However, it should be noted that the restructuring between the verb and its complement is possible; generating '*visitou o filho*' (visited the son).

> Minimal Attachment: Attach incoming material into the phrase-marker being constructed using the fewest nodes consistent with the well-formedness rules of the language under analysis. (FRAZIER, 1979, p. 24)

> Late Closure: When possible, attach incoming lexical items into the phrase or clause currently being parsed. (FRAZIER, 1979, p. 33)

According to the first principle, when we hear/read a sentence, the parser builds the structure of the sentence with as few syntactic nodes as possible. Due to the Late Closure principle, new constituents should be attached to the phrase being processed, that is, the fewest number of non-terminal nodes possible. This means that the closure of the phrase being processed is delayed to enable new items to be integrated at the local position. To exemplify this, let us consider (14):

14. *Enquanto as meninas costuravam as meias caíram*. (While the girls sewed the socks fell)
    a. *Enquanto as meninas costuravam as meias / caíram*. (While the girls sewed the socks / they fell.)
    b. *Enquanto as meninas costuravam / as meias caíram*. (While the girls sewed / the socks fell.)

When readers reach the phrase '*as meias*' (the socks), they interpret it as the complement of the verb '*costuravam*' (sewed). This results from the Late Closure Principle: the verbal phrase is open to include the material that comes next, the DP '*as meias*' (the socks) (14a). However, after reaching other material ('*caíram*' (fell)), readers reanalyze the sentence by closing the verbal phrase (Early Closure), so that the phrase '*as meias*' (the socks) may be analyzed as the subject of the subsequent clause and not as object of the previous one (14b).

One of the goals of the research on processing is to discover the types of information with which the parser works. Fodor (1998, 2002a) points out that in the principles proposed by Frazier (1979), no reference was made to the interference of prosody, although the key role played by prosody in sentence processing is undeniable, especially considering the number of studies that identified its role in sentence disambiguation

(e.g. LEHISTE, 1973). Based on a difference in the results for ambiguity resolution in English and Spanish in a reading situation, which may be due to a different sensitivity to constituent length (FODOR, 1998)), the author proposes that prosody is present even in situations when there is no spoken production of the sentences, as in the case of silent readings, and that this mental projection of the prosodic structure (implicit prosody, in the author's words) is treated by readers as part of the input. In general terms, this is the assumption in the Implicit Prosody Hypothesis (henceforth IPH, FODOR, 2002b), which suggests the existence of a prosody that aids in solving syntactic ambiguities in silent readings in the same way as the explicit prosody does in speech:

> Implicit Prosody Hypothesis: In silent reading, a default prosodic contour is projected onto the stimulus, and it may influence syntactic ambiguity resolution. Other things being equal, the parser favors the syntactic analysis associated with the most natural (default) prosodic contour for the construction. (FODOR, 2002a, p. 1)

This implicit prosody, as well as the explicit prosody, has prosodic characteristics in each specific language. According to the IPH proposal, the specific prosodic characteristics of different languages may be responsible for the variation found in the parser's preference for attachments – such as the sensitivity to the constituent size mentioned above (FODOR, 1998).

According to Miyamoto (1999), BP is a language that exhibits a preference for local attachment. The author checked the preference for attachment (local or nonlocal) of reduced and full relative clauses, as exemplified in (15) (Miyamoto's example (7), 1999):

15. a. *A Kombi trouxe os supervisores do engenheiro [que foram pagos pela empreiteira*. (The Kombi brought the engineer's supervisors [who were paid by the contractor.)

    b. *A Kombi trouxe o supervisor dos engenheiros [que foram pagos pela empreiteira*. (The Kombi brought the engineers' supervisor [who were paid by the contractor.)

    c. *A Kombi trouxe os supervisores do engenheiro [pagos pela empreiteira*. (The Kombi brought the engineer's supervisors [paid by the contractor.)

d) *A Kombi trouxe o supervisor dos engenheiros [pagos pela empreiteira*. (The Kombi brought the engineers' supervisor [paid by the contractor.)

The results pointed to a significant interaction between the type of relative clause and the type of attachment. The performance with reduced relative clauses was better with local attachment than with nonlocal attachment. In the case of full relative clauses, performance was better with local attachment only in numerical terms, without statistical significance.

This tendency towards local attachment is interpreted as a tendency towards Late Closure (as opposed to languages with Early Closure tendency, such as French, Dutch, and Spanish – see Fodor, 2002). Miyamoto (2005) reanalyzes his data from (1999) and argues that number differences (singular and plural) affected the results.

Ribeiro (2001) detected a preference for nonlocal attachment in experiments that measure the reading time in specific sections of sentences with adjectival phrases. Other studies have confirmed the relation between prosody and attachment. Finger and Zimmer (2005) showed that long relative clauses are more often subject to nonlocal attachment than short relative clauses. Lourenço-Gomes and Moraes (2005) also found a preference for nonlocal attachment in long relative clauses. Finally, Maia *et al.* (2007), based on a meta-analysis, argue that the difference in preference for local or nonlocal attachment is only clear in off-line tests.

The studies mentioned above share the view that nonlocal attachment is always preferred under specific conditions, such as the relative clause being long. Hence, Miyamoto's (1999) initial statement that BP has a preference for local attachment is maintained. According to Magalhães and Maia (2006), in BP, in the absence of prosodic cues, speakers apply a default reading. This default would be local attachment, justified by the Late Closure Principle (FRAZIER, 1979), which suggests that a phrase is only closed after checking whether there is an element that may be subsequently attached to it. This means that when listeners hear (13), they identify that '*feliz*' (happy) may be attached to '*filho*' (son) (the parser keeps the phrase open while checking the existence of adjuncts ahead of it and closes it shortly thereafter).

3 The Experiment[6]

The purpose of this article is to analyze if and how, from a phonological point of view, duration cues in NP1-Verb-NP2-Attribute ambiguous sentences affect the listeners' choice of interpretation. The results provided by Angelo and Santos (2015) did not statistically confirm the authors' hypothesis that there should be lengthening where there are phonological phrase boundaries, but reveal that whenever the duration is longer, it favors nonlocal readings. This raises the question of why this is so and why lengthening follows the direction expected by the authors when it occurs.

Our hypothesis is that speakers use lengthening to disambiguate syntactically ambiguous sentences. Duration would thus work as a cue to interpret such sentences. As we have seen, in the absence of prosodic cues, the Late Closure principle favors local readings. Lengthening should then disambiguate sentences, signaling a nonlocal reading. However, results from previous studies indicate that lengthening is an optional, non-mandatory process (Besides, the speaker may use other processes to indicate the intended interpretation). In general, we expect that whenever lengthening occurs, it should be associated with nonlocal readings and in comprehension experiments, the relevant sentences should be interpreted as involving nonlocal attachment. Our hypothesis leads us to the following specific predictions:

    i. Given the results in Angelo and Santos (2015), it is expected that speakers will **interpret the long sentences as involving nonlocal attachment** (A).

    ii. As lengthening is optional in BP, there should be **variation in the interpretation** of short **sentences** (between local and nonlocal attachments); however, based on IPH, a preference for local reading should be detected.

In addition, since no prosodic studies have considered the possible structural differences in the interpretations of local attachments, we have assumed that in principle, adjunct structures and small clauses have

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[6] The experiment was approved by the Research Ethics Committee of the Psychology Institute of the University of São Paulo (CAAE number: 45791815.5.0000.5561).

similar behavior (both involve local attachment). However, sentences that may have a local interpretation involving a small clause were computed in separate groups so that eventual differences between them may be detected. We expect that lengthening will be interpreted above chance level as nonlocal attachment whenever it occurs. In short versions, however, regardless of whether the structure involves an adjunct or a small clause, there may be variation with respect to right and wrong answers (once lengthening is optional, local attachment answers are also possible).

3.1 Method

3.1.1. Participants

The experiment involved 30 hearing adults with college education, all born in São Paulo and between 18 and 50 years of age.[7] The recording of the sentences to be read was made with 50 speakers with the same sociolinguistic profile as the participants.

3.1.2. Materials

The sentences analyzed in this experiment are the same ones used by Angelo and Santos (2015), which were read within stories that led to the intended interpretations – see Chart 1 and story example in (16).[8]

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[7] All participants completed the experiment and no individual participant displayed behavior different from the groups'.

[8] Before the experiment was applied, the sentences were judged by nine college students, who confirmed their ambiguity and did not detect any pragmatic problems in them.

CHART 1 – Sentences Analyzed

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|---|
| S1. *O pai visitou o filho feliz*. (The father visited the son happy). |
| S2. *A babá ninou a menina chorando*. (The nanny lulled the baby crying. |
| S3. *O aluno consultou o monitor cismado*. (The student checked the TA suspicious). |
| S4. *O sobrinho cumprimentou o tio sonolento*. (The nephew greeted the uncle sleepy). |
| S5. *O assessor auxiliou o presidente furioso*. (The assistant helped the teacher furious). |
| S6. *O repórter entrevistou o político sozinho*. (The reporter interviewed the politician alone). |
| S7. *A mãe procurou a filha magoada*. (The mother sought the daughter hurt). |
| S8. *A mãe encontrou a filha suada*. (The mother found the daughter sweaty). |
| S9. *O réu encontrou o advogado nervoso*. (The defendant met the lawyer nervous). |

16. The mother found the daughter sweaty.

a. Mother and daughter were going to meet for lunch at the mall before the daughter went on a trip. Halfway through, the mother got a flat tire and, because there was nobody there to help her, the mother changed the tire herself, and this made her very tired. When she arrived at the mall, she ran a great distance so she would not be late. The mother found the daughter sweaty. However, she was able to get there before the girl left.

b. Saturday was Lucia's grandmother's birthday. Her mother told Lucia not to be late and made it clear that it would be a fancy party and Lucia should dress properly. However, on that day, the girl had several appointments: she left home early, went to work, later she went to the gym, worked out hard, ran to the mall to buy a present for her grandmother, and did not have time to go home and get cleaned up before going to the party. The mother met the daughter sweaty. Lucia was scolded for not being properly dressed.

The sentences to be tested always appeared at the end of the stories, but were not necessarily the last ones. All sentences admit nonlocal (reading A) and local interpretations. In the cases of sentences S1 to S7, only the interpretation of a local adjunct was possible (identified here as reading B), whereas sentences S8 and S9 admitted both the local adjunct and the small clause interpretation (identified as reading C). The

total number of sentences with B and C readings is not balanced because this distinction was made after the experiment was conducted.

In order to analyze the effect of duration in the interpretation of the sentences, we measured the duration of the interval between the final syllable of the object noun and the initial syllable of the adjective.[9] We then selected for the comprehension experiment the three longest versions for the relevant interval that were read under the nonlocal reading context, as well as the three shortest versions involving the same interval that were read under local reading context (54 pieces of data in total).[10] In a scale, the gradation of the measured durations is as represented in Figure 1.

FIGURE 1 – Scale of duration per structure

Structure	nonlocal (A)			local (BC)		
	A1	A2	A3	B3	B2	B1
Duration	+ long			- long		
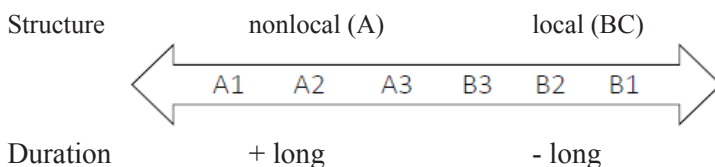
The audios selected correspond to the readings by 17 individuals (men and women) from a total of 50 speakers. The participants of the experiment were only presented to the audios, without any contextual clue that could lead to one of the interpretations.

The material also consisted of images that had been drawn for each version of the sentences to be heard. In each image, only one character illustrated the property described by the adjective. For instance, in (7) either the father was happy and the son was sad, or the son was happy and the father was sad.

The corpus consists of 1620 data entries (9 sentences x 2 interpretations x 3 gradations = 54 answers from each one of the 30 participants).

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[9] The syllable bearing primary stress was not the target of our analysis because, as the sentences show, its position varied with respect to the prosodic boundary (in some cases it was at the boundary and in other cases it was one or two syllables apart) and such a variation could affect the results, as previously reported in the literature (see also Section 2.2).

[10] There was no minimum or maximum value specified for duration in the selection of sentences A1 and B1, as they had segments with different acoustic characteristics and this analysis was not designed to investigate how long the duration should be in order to be associated with a given interpretation.

3.1.3 Procedures

Before the test, participants underwent some training prepared on PowerPoint, in which we tested their ability to recognize the characters in the images and to distinguish between nonlocal and local interpretations, according to the sentences' attribute ('*feliz*' (happy), '*suada*' (sweaty), etc.). As the training tried to identify the difference between pairs of images, the notion of ambiguity is implicit; therefore, distractor sentences were not used in the test. The training session lasted 5 minutes.

The test consisted of a Picture Matching test, run in the TP Version 3.1 software by Worken.[11] Each input in the test corresponded to one of the 54 audios, that is, all participants heard two versions/interpretations of the same sentence, and each one in three duration versions. The sentences were presented in a random fashion in order to reduce priming effects. On the screen, a pair of images appeared on the left, and an OK button appeared on the right, in the center (therefore equidistant to both images) and a sentence was played. The images were always displayed in the same order (version A on top and version B/C on the bottom), regardless of the answer expected for each audio. The participants were supposed to click on the image corresponding to the version listened (A or B/C). Then, they were asked to click on 'ok' to listen to the next audio. In the experiment, the participants used high precision, comfortable headphones, connected to the computer. The test lasted 10 minutes on average.

The results were automatically coded by the Excel program, identifying the answers of each listener as right or wrong, based on the speakers' intention as they read each sentence in the production experiment (that is, the intention was defined in terms of the context in which the sentence was uttered).

4. Results

The results for the comprehension experiment were analyzed by structure type, by sentence, and by informant; the analysis by listener did not prove statistically significant. The statistical tests were made with the R Program. For some cases, we used the proportion test; for others,

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the test for equality of proportions was used. The results by structure and sentence are reported below.

4.1 Results by structure

Table 1 below provides the general values by structure type, comparing the proportions of right answers without considering a possible influence from the sentence. Here we employed was the test of equality of proportions, which seeks to answer whether the difference in proportion of right answers for the structures equals 0. The comparison between A and B/C is based on all the 9 sentences in the experiment, whereas the comparison between A and B is based only on sentences 1 to 7. When A is compared to C, only sentences 8 and 9 are considered.

TABLE 1 – Proportion of right answers according to the structure

Test of equality of proportions		
Structure	**Difference between proportions of right answers (95% CI)**	**p-value**
A *B/C*	0.02 (-0.03; 0.07)	0.472
A *B*	0.16 (0.10; 0.21)	**<0.001**
A *C*	-0.46 (-0.55; -0.37)	**<0.001**

In Table 1, the value of the difference between the proportions of right answers subtracts local attachment readings from nonlocal ones on each line. The general comparison between A and B/C did not reveal significant differences in the frequency of right answers. However, there is a difference between the proportion of right answers in the comparison between A and B – the frequency of right answers is higher for A. When A is compared to C, there is also a significant difference, but it should be noted that in this case, the frequency of right answers is higher for C.[12]

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[12] CI positive values indicate a higher rate of right answers for A. Negative values indicate a higher rate of right answers for B or C.

Table 2 below displays the number of right and wrong answers according to structure and the scale of duration. As mentioned above, A1 refers to a sentence in which the relevant interval is the longest for nonlocal reading sentences, whereas A3 refers to the least long among them. At the same time, B1 and C1 are those that presented the shortest relevant intervals for local reading sentences, whereas B3 and C3 are the least short ones. This means that 1 refers to the sentences that have a greater chance to lead the listener to a right answer in both cases (according to our prediction), and 3 refers to those most susceptible to error.

TABLE 2 – Frequency of right and wrong answers
according to structure and the scale of duration

Proportion test					
Structure	**Right**		**Wrong**		**p-value**
	N	**%**	**N**	**%**	
A	514	63.46	296	36.54	**<0.001**
A1	196	72.59	74	27.41	**<0.001**
A2	166	61.48	104	38.52	**<0.001**
A3	152	56.30	118	43.70	**0.045**
B	351	55.71	279	44.29	**0.004**
B1	110	52.38	100	47.62	0.535
B2	124	59.05	86	40.95	**0.011**
B3	117	55.71	93	44.29	0.113
C	148	82.22	32	17.78	**<0.001**
C1	43	71.67	17	28.33	**0.001**
C2	54	90.00	6	10.00	**<0.001**
C3	51	85.00	9	15.00	**<0.001**
B/C	499	61.60	311	38.40	**<0.001**
B1/C1	153	56.67	117	43.33	**0.033**
B2/C2	178	65.93	92	34.07	**<0.001**
B3/C3	168	62.22	102	37.78	**<0.001**

As the table above shows, the number of right answers for the general structures (A, B, C, and B/C) was statistically different from 0.5.[13] For A, C, and B/C, a p-value < 0.001 was obtained; however, for structure B, a p-value = 0.004 was found, which shows that this is the least correctly answered structure in general, despite having more right than wrong answers. When the number of right answers is analyzed, we can observe that structure C had the largest number of right answers – most of the time, when listeners heard a short sentence, they assigned it a local reading. Structure B presented the fewest number of right answers (55.7%). Such results point to the optionality of lengthening for this type of structure. Sentences interpreted as local attachment can be restructured prosodically. If they can, then NP2 is not at the boundary of a phonological phrase. If there is no restructuring, there is a phonological boundary immediately after the NP2, like the sentences involving nonlocal attachment. Finally, structure A had a 63% rate of right answers, which indicated a tendency towards an interpretation of nonlocal attachment, in accordance with our prediction: longer contexts would lead to nonlocal attachments. Interestingly, we did not predict that the listeners could assign a local attachment interpretation to sentences with longer duration sentences and this occurred in 36.5% of the cases.

According to our predictions, 1-sentences should have shown a bigger number of right answers. Let's observe the results regarding the scale of duration for each structure. Nonlocal attachment structures (A1, A2 and A3) display an order of right answers: although all of them are significant, the longest ones (A1 and A2) have a significance value lower than that of A3. This can be seen even in the percentage of right answers: A1 had 72% of right answers, A2 had 61%, and A3 had 56%.

This order is not found with respect to local attachment sentences that do not admit the interpretation of small clauses (B1, B2, and B3). B2 had more right answers than B1 and B3. In the case of sentences that admitted small clauses, all gradations in C (C1, C2, and C3) had a higher number of significant right answers, although C2 had the highest

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[13] A significant p-value (<0.05) in tests that compare if the difference between right and wrong answers is different from 0.5 indicates that the listener gave right or wrong answers, falling outside the oscillation average. When the p-value is significant, the reader should also consider the percentages of right and wrong answers, as they show the directionality of the noted significance.

percentage of right answers (there were only 2 sentences with this type of structure, though). As for local reading sentences as a whole, that is, the ones that admit small clauses and the ones that do not (B1/C1, B2/C2, and B3/C3), the result is a significant p-value for all, but in the opposite direction from what was expected: B1/C1 has a higher p-value than B2/C2 and B3/C3.

4.2 Results by sentence

Table 3 below shows the proportion of right answers for each sentence, associating them with the structure types.

TABLE 3 – Proportion of right answers according to structure for each sentence

Test of equality of proportions			
Sentence	Structure	Difference between proportions of right answers (95% CI)	p-value
S1	A B	0.17 (0.01; 0.32)	**0.035**
S2	A B	0.09 (-0.06; 0.24)	0.272
S3	A B	0.17 (0.02; 0.31)	**0.025**
S4	A B	-0.10 (-0.24; 0.04)	0.175
S5	A B	-0.11 (-0.26; 0.03)	0.143
S6	A B	0.43 (0.29; 0.58)	**<0.001**
S7	A B	0.44 (0.31; 0.58)	**<0.001**
S8	A C	-0.54 (-0.68; -0.41)	**<0.001**
S9	A C	-0.38 (-0.52; -0.24)	**<0.001**

As the table above shows, the factor 'sentence' requires further investigation, as the readings in some sentences were more clearly identified than in others. A significant difference was detected in comparing A and B in sentences S1, S3, S6, and S7, and the frequency of right answers was always higher for A (nonlocal) than for B (local). Sentences S2, S4, and S5 presented no significant differences – and in the case of S4 and S5, more right answers for local structures (B) were observed. When A and C were compared (sentences S8 and S9), the difference was also significant, but the frequency of right answers was higher in the C structures.

The absence of significance in the comparison between A and B/C for each sentence is not surprising, for we expect listeners to oscillate between right and wrong answers to B or C. That is, there should not necessarily be statistical differences between the right/wrong answers for nonlocal vs. local attachment.

Table 4 considers the different structures and their scale of duration for each sentence.

TABLE 4 – Frequency of right and wrong answers according to sentence for each structure and scale of duration

		Proportion test				
Sentence	**Structure**	**Right**		**Wrong**		**p-value**
		n	**%**	**n**	**%**	
	A	59	65.56	31	34.44	0.004
	A1	23	76.67	7	23.33	0.006
	A2	16	53.33	14	46.67	0.856
	A3	20	66.67	10	33.33	0.100
S1	B	44	48.89	46	51.11	0.961
	B1	10	33.33	20	66.67	0.100
	B2	19	63.33	11	36.67	0.201
	B3	15	50.00	15	50.00	1.000

Proportion test						
Sentence	**Structure**	**Right**		**Wrong**		**p-value**
		n	**%**	**n**	**%**	
S2	A	63	70.00	27	30.00	<0.001
	A1	24	80.00	6	20.00	0.002
	A2	27	90.00	3	10.00	<0.001
	A3	12	40.00	18	60.00	0.361
	B	55	61.11	35	38.89	0.045
	B1	15	50.00	15	50.00	1.000
	B2	20	66.67	10	33.33	0.100
	B3	20	66.67	10	33.33	0.100
S3	A	69	76.67	21	23.33	<0.001
	A1	24	80.00	6	20.00	0.002
	A2	25	83.33	5	16.67	<0.001
	A3	20	66.67	10	33.33	0.100
	B	54	60.00	36	40.00	0.073
	B1	17	56.67	13	43.33	0.584
	B2	18	60.00	12	40.00	0.361
	B3	19	63.33	11	36.67	0.201
S4	*A*	61	68.89	28	31.11	<0.001
	A1	21	70.00	9	30.00	0.045
	A2	22	73.33	8	26.67	0.018
	A3	19	63.33	11	36.67	0.201
	B	71	78.89	19	21.11	<0.001
	B1	27	90.00	3	10.00	<0.001
	B2	22	73.33	8	26.67	0.018
	B3	22	73.33	8	26.67	0.018

		Proportion test				
Sentence	**Structure**	**Right**		**Wrong**		**p-value**
		n	**%**	**n**	**%**	
S5	*A*	58	64.44	32	35.56	0.008
	A1	23	76.67	7	23.33	0.006
	A2	15	50.00	15	50.00	1.000
	A3	20	66.67	10	33.33	0.100
	B	68	75.56	22	24.44	<0.001
	B1	22	73.33	8	26.67	0.018
	B2	23	76.67	7	23.33	0.006
	B3	23	76.67	7	23.33	0.006
S6	*A*	62	68.89	28	31.11	<0.001
	A1	25	83.33	5	16.67	<0.001
	A2	22	73.33	8	26.67	0.018
	A3	15	50.00	15	50.00	1.000
	B	23	25.56	67	74.44	<0.001
	B1	9	30.00	21	70.00	0.045
	B2	6	20.00	24	80.00	0.002
	B3	8	26.67	22	73.33	0.018
S7	*A*	76	84.44	14	15.56	<0.001
	A1	26	86.67	4	13.33	<0.001
	A2	26	86.67	4	13.33	<0.001
	A3	24	80.00	6	20.00	0.002
	B	36	40.00	54	60.00	0.073
	B1	10	33.33	20	66.67	0.100
	B2	16	53.33	14	46.67	0.855
	B3	10	33.33	20	66.67	0.100

		Proportion test				
Sentence	**Structure**	**Right**		**Wrong**		**p-value**
		n	**%**	**n**	**%**	
S8	A	23	25.56	67	74.44	<0.001
	A1	12	40.00	18	60.00	0.361
	A2	3	10.00	27	90.00	<0.001
	A3	8	26.67	22	73.33	0.018
	C	72	80.00	18	20.00	<0.001
	C1	18	60.00	12	40.00	0.361
	C2	27	90.00	3	10.00	<0.001
	C3	27	90.00	3	10.00	<0.001
S9	A	42	46.67	48	53.33	0.598
	A1	18	60.00	12	40.00	0.361
	A2	10	33.33	20	66.67	0.100
	A3	14	46.67	16	53.33	0.855
	C	76	84.44	14	15.56	<0.001
	C1	25	83.33	5	16.67	<0.001
	C2	27	90.00	3	10.00	<0.001
	C3	24	80.00	6	20.00	0.002

When the frequency of right answers is stratified by structure for each sentence, we see that except for sentences S8 and S9, all sentences present significant values and have more right than wrong answers in the structures of A. Interestingly, most of the times this significance is found in sentences A1 and A2 (which are the longest ones). There were no cases in S1 to S7 in which a less longer sentence (A3) was significant, while its longer versions were not. Sentences S8 and S9 behaved differently: S8 displayed a significant A (only A2), with a higher number of wrong than right answers, whereas S9 presented no significant result with respect to A.

The results found for B-versions were not so clear. S1, S3, and S7 did not display any significant differences. In the case of S2, only the general frequency of right answers was significant. Sentences S4 and S5 had significant values in all gradations. Sentence 6 displayed a different pattern, as all gradations were significant, but speakers made more mistakes in all of these cases.

In the gradations for the C-sentences, which admit small clause readings (S8 and S9), all values were significant except for C1 in S8. Similarly to what happened in nonlocal attachment sentences, there have been no cases in which gradations 2 or 3 have been significant while the corresponding shorter gradations (1 or 2) have not been significant.

Considering only the general structure values, in the structures of A (long nonlocal), all sentences had a significant p-value with right answers towards what was expected (nonlocal), except for sentences S8 and S9 (which admit the small clause interpretation). Sentence S8 had a significant p-value, but for wrong answers instead (that is, even when this sentence was long, listeners preferred the local reading). Sentence S9 did not had a significant p-value for A, indicating that listeners oscillated in choosing the answers to this sentence.

Regarding the general structure B, sentences S1, S3, and S7 showed no statistical significance. In sentences S2, S4, and S5, as well as in sentences S8 and S9, which admit small clauses, the p-value was significant for the number of right answers. Sentence S6, on the other hand, showed significance in B but only for the wrong answers, that is, even when the sentence was short, speakers preferred the nonlocal attachment interpretation.

5 Discussion

Given the results in Angelo and Santos (2015), our first prediction was that the sentences in which the analyzed interval was lengthened by speakers in the production experiment would be interpreted as a nonlocal attachment (A).

Considering the right and wrong answers according to structure, we identified that the number of right answers in A was significantly higher than the number of right answers in B. In addition, it should be noted that this result was maintained not only in the general structure

of A, but also in all gradations, with A3 (the shortest among the long phrases) having a lower p-value than A1 and A2.

At the same time, for the results by sentence, except for sentences S8 and S9, all sentences had a significant number of right answers in the A versions: that is, when listeners heard the lengthened sentences, they actually preferred the A version. These results also match the proposals that lengthening will happen in direct proportion to a greater prosodic domain (CHO; KEATING, 2001; KEATING *et al*., 2003).[14]

The second prediction was made under the assumption that lengthening is an optional process in BP. Therefore, there should be variation in the interpretation (between nonlocal and local attachment) of sentences in which lengthening did not occur: short phrases should be equally interpreted as local or nonlocal.

In order to check this prediction, the right and wrong answers should be first analyzed by structure (without contrasting them with the alternative interpretations). In general, all structures had more right than wrong answers. As seen in Table 2, the right answers were significant in all gradations of A, as well as in the gradations of C. Interestingly, significance for B was only observed in the general value and in the second gradation, but it should noted that the p-values were not as local as in A and C. Thus, the gradations in which the number of right answers is not significant in B confirm the prediction (which predicted that the number of right answers should be equal to 50%, that is, there should be oscillation in the answers). When B/C are analyzed together, we find significance, but this may well be a result of the nonlocal significance rates in C.

As for the role of the IPH, we expected that in case of oscillation, listeners would choose the interpretation of local attachment. However, the results in B do not confirm this prediction; when lengthening does not occur, the listeners did not always answered in the direction of the local attachment interpretation (as would be the case if lengthening were mandatory); in B1 and B3 a variation in the answers was observed; as a whole (B), the value is significant, but lower than in A.

Two patterns were identified. The short structures in sentences S1, S3, and S7 showed no significance. The answers to the short versions

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[14] Perceptually, they also contradict the findings by Santos and Leal (2008), who did not find lengthening in a production experiment in BP with non-ambiguous sentences.

(B) reached the average of 50% of right and wrong answers. Table 3 demonstrated that the oscillation is more present in the answers to B than in the answers to A, illustrating that lengthening may be optional and, for this reason, there is variation in the answers to the auditory short versions. This confirms Angelo and Santos's (2015) suggestion regarding the optionality of the process.

However, in other sentences, the number of right answers was significant (S2, S4, S5, S8, and S9) for interpretation B, confirming the findings of Magalhães and Maia (2006). In addition to the oscillation in the answers, a preference for the interpretation of local attachment was identified in 4 out of the 9 sentences in the absence of prosodic cues - more specifically when lengthening did not occur.[15] Fodor (2002) proposes that these the relevant principles may not be satisfied in reading situations if there are prosodic cues in the language that direct to other interpretations. Although our experiment deals with listening rather than reading, we may take the gist of Fodor's remarks at face value and interpret lack of lengthening as lack of explicit prosodic cues. If so, speakers are drawn to the default option of local attachment, confirming the results from Frazier (1979) and Magalhães and Maia (2006).

For interpretation B, S6 is left unexplained (p-value < 0.001, but with respect to the number of wrong answers), for it resulted in a preference for nonlocal attachment even when it was short.[16] This result is at odds with the expectations of a preference for local attachment in the absence of prosodic cues, along the lines of Magalhães and Maia (2006), but does not contradict the phonological proposal presented here, as nonlocal attachment interpretations are possible in this case since lengthening is optional. However, the value of "wrong answers" was significant, which proved to be different from the other cases in which there was variation or local attachments were preferred. Although none of the listeners reported having interpretation or pragmatic problems with

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[15] A reviewer pointed out that S2, S4, S5, and S8 may be pragmatically biased. The reviewer provides reasons for why this could be so only with respect to S2, but it seems that s/he takes the interpretation in these cases to always involve low attachment. However, the results provided in Table 4 reveal that the only sentences clearly directed to low attachment are S5 and S8. In the case of S8, we offer an alternative explanation in section 5.1.

[16] The long versions of S8 behave as expected, though; that is, they also received interpretations of nonlocal attachment.

this sentence, we wonder if the listener associated the AP '*sozinho*' (alone) to the DP '*o repórter*' (the reporter), as it would be pragmatically more likely that the reporter would be alone. Alternatively, it is possible that the listener would be somewhat confused, for this is the only sentence for which there were three characters in the drawings.

The sentences C, whose readings were ambiguous between the adjunct and the small clause interpretations, revealed a significant preference for local attachment, which points to the regularity of the Local Attachment principle. However, we should ask ourselves if the syntactic structure could be an alternative explanation for the results.

5.1 Small clauses, prosodic phonology and ambiguous sentences

As demonstrated above, sentences that only admitted an adjunct local attachment interpretation behaved differently from those that were identified as ambiguous in allowing both the adjunct and the small clause interpretation. Nonlocal attachments were significantly assigned to S1 to S7 (A). Local attachments were significantly preferred for S8 (A), whereas answers fluctuated for S9.

The interesting aspect is that both local syntactic structures are different. According to Foltran and Mioto (2007), in an adjunction structure, the adjective is within a DP adjoined to a nominal phrase (NP) – see (17a). In the case of small clauses, the adjective is a predicate of an argument. If the argument is a DP, the adjective is not dominated by it, but forms a small clause with it – see (17b).[17]

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[17] For a different approach to small clauses, see Starke (1995).

17. *A mãe encontrou a filha suada.* (The mother found the daughter sweaty.)

a. Adjunction: [_DP *a filha suada* (the daughter sweaty)]

b. Small clause: [_SC *a filha suada* (the daughter sweating)]
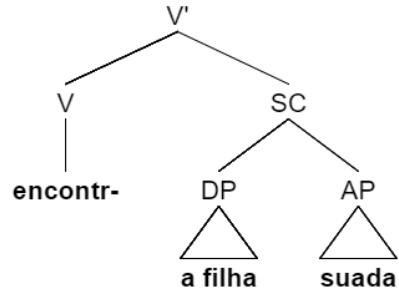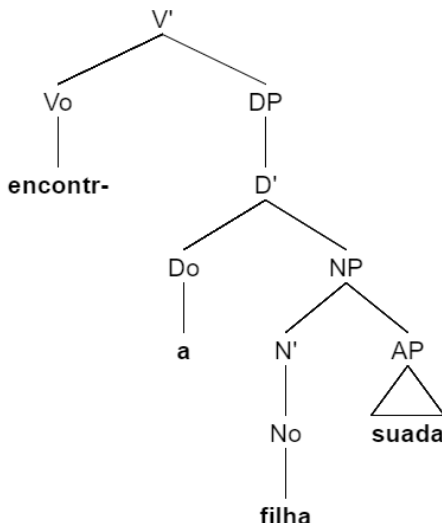
In (17a) the adjective '*suada*' (sweaty) is a within the NP headed by '*filha*' (daughter). In (17b), '*suada*' (sweaty) is the predicate and the DP is the subject, the two forming a small clause.

Keeping these two structures in mind, we must return to the restructuring algorithm of Nespor and Vogel: phonological phrase domains consist of a clitic group that contains a lexical head X and all the other clitic groups on its non-recursive side (on the left, in BP) up to the next clitic group outside X's maximum projection.

Nespor and Vogel's proposal was formulated in 1986, when the distinction between complement and adjunct in the X-bar theory did not exist, and, similarly, NP was the maximum lexical projection of the nominal domain rather than DP.[18] Recently, phonological studies have shown that adjuncts may behave like complements (e.g. SANTOS, 2003) and several studies revise Nespor and Vogel's findings (GUIMARÃES,

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[18] According to Chomsky (1970, 1986) for the X-bar theory in place at the time.

1997; FROTA, 2000; VIGÁRIO, 2003) under the light of advances in syntax studies.

As shown below, there is a different mapping in the cases of local attachment. Let us analyze the ambiguous sentence (17). In the case of local adjunct attachment, '*suada*' (sweaty) is within the NP and restructuring with '*filha*' (daughter) may take place (see (18a)). By contrast, in the case of small clauses, restructuring may not occur; although the attachment is low, the adjective is not within the maximum projection of the noun (see (18b)).[19] In the latter situation, there is a prosodic boundary between '*filha*' (daughter) and '*suada*' (sweaty), which leads us to expect these cases to pattern like cases of nonlocal attachment (10) as far as duration is concerned.

18. local attachment
   a. adjunction: [*a mãe* $_\Phi$ (the mother)] [*encontrou* $_\Phi$ (found)] [*a filha suada* $_{\Phi restructured}$ (the daughter sweaty)]
   b. small clause*:* [*a mãe* $_\Phi$ (the mother)] [*encontrou* $_\Phi$(found)] [*a filha* $_\Phi$ (the daughter)] [*suada* $_\Phi$ (sweaty)]

19. nonlocal attachment: [*a mãe* $_\Phi$ (the mother)] [*encontrou a filha* $_{\Phi restructured}$ (found the daughter)] [*suada* $_\Phi$ (sweaty)]

In the case of nonlocal attachment, '*a filha*' (the daughter) may be restructured with the verb, as it is the first complement to the verb (and is formed by a single C). In turn, the small clause structure prevents such restructuring, for the complement of the verb is the SC '*a filha suada*' (the daughter sweating) rather than '*a filha*' (see the structure in (18b)). Nevertheless, this difference does not have consequences to the context we are analyzing, as we may summarize the domain boundaries in the relevant context as follows: (i) nonlocal attachment: '*filha*' (daughter) at the boundary of the phonological phrase; (ii) local attachment by adjunction: '*filha*' (daughter) within a phonological phrase; (iii) local

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[19] We would also like to add add that restructuring is blocked regardless of whether the small clause is the projection of lexical (STOWELL, 1983) or a functional (STARKE, 1995) head. In either case the adjective is not dominated by NP.

attachment by SC: '*filha*' (daughter) at the boundary of a phonological phrase.[20]

When we discussed our predictions, we did not single out sentences that admitted small clause readings. Recall that sentences that admit small clauses may also admit the adjunction interpretation. This means that there was no way to control for the syntactic choice speakers made in our experiment and that is why these sentences received special attention in this analysis.

Let us then consider lengthening, bearing in mind that there were only two sentences of this type in our corpus. If only the issue of local attachment is at stake (and predicative structures are interpreted the same way adjunction structures are), it is thus expected that, in short versions, oscillations or preference for local attachment should continue to occur in S8 and S9. Given that lengthening is optional, the interpretation of short phrases may correspond to any of the possibilities under consideration (nonlocal attachment, small clause, or adjunction). On the other hand, if we take only Nespor and Vogel's (1986) algorithm for phonological phrase construction into account, we expect long versions of sentences that admitted small clauses (S8 and S9) to have answers that also direct to local attachment interpretations, even if produced in a nonlocal reading context. If only the prosodic domains are considered, there is no reason to expect a tendency for either answer – a right answer would be associated with the nonlocal attachment structure and a wrong answer, with the small clause or adjunction local attachment structure.

The expectation for right answers becomes even more interesting if one assumes that the Local Attachment Principle (FRAZIER, 1979) interacts with prosodic structuring. In this case, we expect longer sentences to lean towards a preference for local attachments, given that

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[20] There is a difference between nonlocal attachment and local attachment involving SC in the context verb-noun 2: in nonlocal attachment, the verb is within the phonological phrase restructured with N2; in local attachment by adjunction, the verb is at the boundary of the phonological phrase (given that N2 has the adjective adjoined to it, it cannot be restricted with the verb); and in low attachment involving SC, the verb is at the boundary of the phonological phrase (it cannot be restructured with N2 because N2 is within a small clause and a complement may only be restructured with the head if it is formed by a single C).

small clauses and nonlocal attachments admitted lengthening and small clauses involve a local attachments.[21]

In the results by structure, the number of right answers in C was significantly higher. This leads us to two interpretations: Either the number of right answers in A for sentences with small clauses was too low, or the number of right answers in C was too high. Under the first scenario, it is possible that listeners had heard long sentences and did not give the right answers, because lengthening with local attachments (the small clause reading) is possible. Under the second scenario, short sentences would lead to local attachments most of the times. This would indicate either that listeners do not access the small clause structure or that the adjunction readings for these cases are obligatorily short, in a way different from the other structures that involve adjunction structures only (B), in which we saw that variation may occur. In this case, this may well occur precisely to establish the difference between adjunction (always short) and small clause (which should be long) local attachment. In other words, for short versions, it is possible that preference for local attachment has occurred as in some sentences in B. However, in both cases that admit small clauses, the p-value was <0.001 for right answers (listeners heard short and preferred local attachment). Given that there are multiple structures for local attachment, we wonder whether the lengthening process should be obligatory to establish a difference among them, but not in nonlocal readings, as the speaker may also resort to other strategies, such as emphasis.

In the long versions of these sentences, however, sentence S8 showed a significant p-value for the number of wrong answers; listeners preferred the local reading even when this sentence is long. Sentence S9, in turn, did not show a significant p-value for A, as the number of wrong and right answers was very close to 50%. In the analysis of the results by structure we ask whether the number of right answers in C had been significantly higher than in C because there were too many wrong answers in A, or because there were too many right answers in C. In fact, if only the structures in S8 and S9 are considered, we see that there is a difference in the pattern of the long versions of these sentences. In S8, the listeners preferred C regardless of the duration. In S9, they preferred

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[21] The ideal case for the analysis would be a situation in which sentences admitted either nonlocal attachment or the small clause structure, but not both. Unfortunately, this is not the case for our sentences, but this is a suggestion for future works.

C when they heard short sentences, but their answers varied when they heard long sentences. If speakers chose short versions even when they heard long sentences, this is a strong indication that there is a local reading with lengthening, due to the phonological phrase boundary between the object and the attribute (the small clause structure blocks restructuring).

To all appearances, the lack of restructuring in C causes the long versions of sentences S8 and S9 to be interpreted as involving low attachment, which cannot happen (and did not) with sentences that admit only adjunction structures. However, two sentences are not enough to allow us to make more compelling statements, and we suggest that a future study analyze only this type of sentence in contexts where the structure read/interpreted by the speaker/listener can be determined with certainty.

6 Final considerations

The purpose of this article was to provide a reanalysis of lengthening in phonological phrase boundaries in the context of disambiguation of NP1-Verb-NP2-Attribute, seeking to shed light on interaction among different grammatical components. Assuming that this interaction occurs indirectly, phonology has an interpretative component that maps information from other components (namely, syntax) into phonological levels and domains (SELKIRK, 1984; NESPOR; VOGEL, 1986).

Based on crosslinguistic results regarding the phonetic realization of segments in prosodic boundaries in different languages (in particular, the fact that lengthening of segments varies depending on the prosodic levels where it takes place), we examined whether lengthening could be used to distinguish among interpretations of structurally ambiguous sentences. More specifically, we investigated whether lengthening may signal the presence of a prosodic boundary and whether it is perceived by the listener when it occurs.

By means of the application of a picture matching experiment, we sought to analyze the choices of interpretation for ambiguous sentences, taking lengthening gradations into account. Overall, the results confirmed our predictions. More than being just a tendency, we saw that lengthening occurs in BP in the context of disambiguation of sentences of the type NP1-Verb-NP2-Attribute: Nonlocal structures revealed a significant number of right answers and the long versions of the relevant sentences

were significantly interpreted as nonlocal attachment (except for the ones that admitted small clauses).

We observed that lengthening is not always necessary for nonlocal attachment interpretations to occur. Listeners may select nonlocal attachment answers even when they are exposed to short sentences, confirming this is an optional process in the language that is favored when sentence disambiguation is required.

For local readings, the results revealed significance for right answers, although it not as striking as it is for nonlocal readings. In addition, no statistical significance was identified for the number of right answers in the analysis of the different gradations in duration (B1, B2, and B3). When the sentences were analyzed separately, part of the data was significant for the right answers, confirming the Local Attachment Principle proposed by BP in compliance with Frazier's (1979) Late Closure principle (see MAGALHÃES; MAIA 2006), according to which a preference for local default occurs in the absence of prosodic cues.

Interestingly, two sentences were identified by informants as admitting three possible interpretations and were computed separately. These are sentences in which local attachment may involve adjunction or a small clause. As local attachments, the two cases were expected to behave alike. Nevertheless, this did not occur. Long versions were interpreted as local attachment. Our proposal is that the prosodic mapping (resulting from the syntactic structure) plays a major role in the interpretations. Specifically, small clause structures may not have their attribute restructured to N2. Therefore, as they are in different phonological phrases, they show the same prosodic structure as the nonlocal reading cases: speakers identified the lengthening and had two options to choose from - nonlocal reading or local reading with the small clause option. In these cases, the listeners selected the local attachment interpretation by IPH. In other words, it is not just a matter of preference for local attachment, but also an interaction between the prosodic mapping and the Local Attachment Principle.

These results are interesting but given that the third structure was only identified post hoc, there was no balance between the number of structures with local attachment (small clause vs. adjunction). These results should thus be taken as preliminary, suggesting that additional studies should be conducted, controlling not only for the height of the attachment, but also for the type of syntactic structure.

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