

## Chapter 2

# Relative clause attachment in Brazilian Portuguese

Following the report by Cuetos & Mitchell (1988) that English and Spanish present different biases in the processing of a construction involving relative clauses (RCs), a large body of experimental work has investigated this construction in a number of languages. Surprisingly, however, no language tested so far has presented the same processing pattern as English. Hence, parameters proposed to explain this cross-linguistic difference have often relied on idiosyncratic features of English syntax that may correlate with its parsing preference. However, in the absence of other languages with a similar parsing bias or with the same relevant syntactic features, it has not been possible to test the generality of many of these proposals. The present paper reports experimental results in Brazilian Portuguese suggesting that this language has the same bias as English in the processing of the relevant construction. Because Brazilian Portuguese, as a Romance language, is more similar to Spanish than English in many respects, the present result allows for a number of possible sources of this cross-linguistic variation in parsing to be ruled out.

## 2.1 Relative clause attachment

The research on RC attachment has led to a closer scrutiny of assumptions that had often been taken to be universal across languages. In particular, several proposals in the literature favour the attachment of a modifying phrase to local heads over more distant ones in order to explain native speakers' preferences in examples like the following (Frazier, 1987; Gibson, 1991, 1998; Kimball, 1973; Phillips, 1995) .

Example (1)

I ate the ice-cream that I bought *yesterday*.

In Example (1), although the adverb **yesterday** may modify either of the underlined verbs, native English speakers prefer to associate it to the closest verb **bought**. A similar preference is not only observable in languages such as Portuguese (Example (2a)) in which the equivalent construction closely resembles the word order in English, but also in Japanese, in which the word order is markedly different (Example (2b)).

Example (2)

a. Eu tomei o sorvete que eu comprei *ontem*.

b. *Kinou* katta aisu-kurimu-o tabeta.

Furthermore, the preference to attach a modifier to the closest site available (or *locality* for short, following Gibson, 1998) correctly predicts that, in English, the RC in Example (3a) is preferentially attached to the closest noun **actress** over the non-local noun **servant**. However, in Spanish, the local attachment preference does not hold in the equivalent construction in Example (3b) (Cuetos & Mitchell, 1988).

Example (3)

a. Someone shot the servant of the actress [<sub>RC</sub> *who was on the balcony*].

b. Alguien disparó contra el criado de la actriz [<sub>RC</sub> *que estaba en el balcón*].

Native speakers of Spanish prefer to attach the RC in Example (3b) to the high noun **criado** (i.e., the highest noun available for attachment in the tree structure). Several other languages have been found to have a high attachment preference similar to Spanish (Dutch (Brysbaert & Mitchell, 1996); French (Zagar, Pynte & Rativeau, 1997); German (Hemforth, Konieczny & Scheepers, in press); results in Italian indicate an off-line preference for the

high site as well (de Vincenzi & Job, 1995)). Japanese, on the other hand, presents a low attachment preference, but because the RC precedes the head nouns in this language, the comparison with head initial constructions requires taking into account factors such as immediate interpretation (see Chapter 3 for details). Restricting the discussion here to languages in which the RC is head initial, English is the only known language to present a consistent low attachment preference both in on-line processing (Carreiras & Clifton, 1998; Henstra, 1998) as well as in off-line judgment tasks (Cuetos & Mitchell, 1988).

Moreover, no other construction tested so far, apart from Example (3), has presented a high attachment bias for RCs. For example, variations of this construction which replace the intervening preposition *de* with *con* (Gilboy, Sopena, Clifton & Frazier, 1995) or which increase the number of candidate nouns to three (Gibson, Pearlmutter, Canseco-Gonzalez, & Hickok, 1996; Gibson, Pearlmutter & Torrens, in press) have been shown to revert the RC attachment preference to the local noun. Thus, the exceptional status of Example (3b) has led most researchers to maintain the universality of the locality factor (but see the *tuning hypothesis* in Cuetos, Mitchell & Corley, 1996) by positing a second factor that competes with the local preference as it favours the highest available site.

The second factor, which favours the high site, is often assumed to be related to semantics or discourse because the high noun is the argument of a predicate. From this basic intuition, a number of proposals have been made trying to determine the exact circumstances in which this semantic factor would be relevant. According to *relativized relevance* (Frazier, 1990b), a modifier is preferentially construed as relevant to the main assertion of the current sentence. However, in sentences where an adverb may attach to either of two verbs (e.g., Examples 1 and 2; also, Kimball, 1973), relativized relevance incorrectly predicts a preference for the main verb. *Predicate proximity* (Gibson, Pearlmutter, Canseco-Gonzalez, & Hickok, 1996) makes the correct prediction in this case by proposing that a modifier is preferentially attached to sites structurally closest to a predicate. A third proposal is *anaphor resolution* (Hemforth et al., in press) which further restricts the influence of the semantic factor to the attachment of relative clauses only as it suggests that semantic/discourse salience is only relevant when a relative pronoun (or a complementizer) in a RC triggers an anaphor binding process.

The proposals above allow for the universality of the locality factor to be maintained. However, if the factor favouring the high site is also the same across all languages, then some type of parametrization is necessary to account for the fact that some languages present a low RC attachment preference while others a high attachment preference. The present chapter tests some of the factors proposed in the literature.

## 2.2 Parameterizing factors

Because English is the only language so far to present a consistent low attachment preference, proposed parametrizations have correlated the low attachment bias to specific features of this language. The following describes three such proposals.

One proposal associates the low attachment preference with the availability of an alternative construction to express the high attachment of RCs. In general terms, it is claimed that an ambiguous construction is less likely to be given one of its possible interpretations if this interpretation can be expressed through an alternative unambiguous construction. This would occur either because readers take Gricean constraints into account when resolving ambiguity and hence assume that speakers use unambiguous constructions whenever possible (Frazier & Clifton, 1996); or alternatively because readers choose an interpretation for a sentence based on the relative frequency that this interpretation is encountered with each of the available constructions that can express it (Thornton, Gil & MacDonald, in press). Consider the following example.

Example (4)

- a. the servant of the actress [<sub>RC</sub> *who was on the balcony*]
- b. the actress's servant [<sub>RC</sub> *who was on the balcony*]

In English, the high attachment of the RC in Example (4a) can also be expressed with the genitive construction as in Example (4b), whereas the low RC attachment can only be expressed through Example (4a). Hence, the RC in Example (4a) would tend to be construed as modifying the low site. This proposal makes interesting predictions about other languages in which an alternative construction exists. In particular, Dutch and German have a limited form of genitive similar to Example (4b). Although those two languages may have

an overall high attachment preference in constructions such as Example (4a), the alternative construction proposal would predict them to present a low attachment preference in the specific cases where they allow the genitive alternative.

A second proposal relates the low attachment preference in English to the optionality of complementizers in object-gap RCs (Hemforth et al., in press).

Example (5)

- a. the daughter [<sub>RC</sub> Peter visited]
- b. the daughter [<sub>RC</sub> *that* Peter visited]

Because of this optionality of the complementizer, the process to find an antecedent for the complementizer would not be relied upon to determine the attachment of RCs (with or without a complementizer) in English, contrary to what happens in languages where the complementizer is always obligatory. Consequently, the locality preference prevails in English. Note that reduced RCs (e.g., **the proposal** [<sub>RC</sub> **advanced by the committee**]) do not have a complementizer either, but this construction is also available in languages with a high attachment preference (e.g., Spanish) and therefore it cannot be responsible for the cross-linguistic variation observed in RC attachment. Hence, it will be assumed that the optionality of complementizers in RCs with object gaps is the crucial factor in this proposal.

A third parameter was proposed based on predicate proximity (Gibson et al., 1996). It suggests that in languages which allow arguments to occur after the verb in a non-adjacent position, the verb has to be activated more strongly so that enough activation is available when the non-adjacent argument is processed. Greater activation of the verb would lead to a stronger predicate proximity requirement, and hence, a stronger high attachment preference. French is one exception to this parametrization in that it has rigid SVO word order and it nevertheless presents a high RC attachment preference (Zagar, Pynte & Rativeau, 1997; but see Pynte, 1998, for a low attachment result). However, note that in French some adverbs may intervene between a verb and its direct object (Example (6a)), whereas the equivalent construction Example (6b) is ungrammatical in English.

Example (6) (Pollock, 1989)

a. Jean embrasse souvent Marie.

b. \* John kisses often Mary.

If the intervention of the adverb between the verb and its direct object is enough to require extra activation of the verb, then predicate proximity should also predict French to have a high attachment preference.

## 2.3 Brazilian Portuguese

In order to test the predictions of the parametrizations above, an on-line experiment was conducted in Brazilian Portuguese (BP). BP is a Romance language in which the subject of a sentence does not have to be phonologically realized (pro-drop) and has to agree with the verb in person and number. Of particular interest here are the following characteristics of this language.

(I) BP does not have an alternative construction to express the high attachment of RCs, in particular, it does not have a genitive construction equivalent to Example (4b).

(II) With the exception of reduced RCs, complementizers are obligatory in RCs and in particular in RCs with an object gap.

(III) BP has rigid SVO word order and adverbs cannot intervene between a verb and its direct object.

From (I) above, the alternative construction proposal predicts that BP should have a high attachment preference. From (II), anaphor resolution also predicts a high attachment bias, whereas predicate proximity predicts a low attachment preference based on (III).

On top of variation across different languages, it has also been reported that, within the same language, constructions with virtually the same meaning present different attachment preferences. Hemforth et al. (in press) compared the attachment of non-reduced RCs and PPs in German, and found that the low site was preferred for PP attachment, while RCs were preferentially attached to the high site. This result supports Hemforth and colleagues' proposal that an overt complementizer or relative pronoun at the beginning of a RC triggers an anaphor binding process which favours attachment to the high site. Because PPs do

not require anaphor binding, their attachment is presumably determined by locality alone. This proposal raises questions about reduced RCs which lack a complementizer but may still require an anaphor binding process for its null operator (see the discussion section for details). If an overt complementizer is needed in order to trigger the anaphor binding process, then reduced RCs should present a stronger low attachment preference than non-reduced RCs (full RCs for short). In order to test this hypothesis, reduced RCs were also included in the experiment to be reported next.

## **2.4 Method**

### **2.4.1 Participants**

Forty-two native speakers of BP, residents in the Boston area, participated in the study. One participant was eliminated for answering the comprehension questions at chance. A second participant was eliminated for having very slow reading times (see analysis section below).

All remaining 40 participants learned English as adults and had been in the United States between one week and 15 years at the time when they participated in the study ( $M = 25.8$  months;  $SD = 34.9$  months).

Because most participants also spoke English, there is the possibility that they transferred the parsing biases from this second language to BP, their first language. However, a study with native speakers of Spanish residents in the Boston area found a high attachment preference in the equivalent Spanish construction without any apparent influence from English (Gibson, Pearlmutter & Torrens, in press). Thus it will be assumed here that if BP has a high attachment preference then it should also be detectable in the present experiment despite the participants' proficiency in English.

### **2.4.2 Materials**

The 2x2 design included type of RC (full and reduced) and attachment site (high and low). All 32 items were presented in BP as seen in Appendix 2-A.

The difference between the full (Examples (7a) and (7b)) and the reduced RCs (Examples (7c) and (7d)) is that the latter construction does not contain the complementizer **que** or the auxiliary verb **foram**.

Example (7)

a. Full RC, high

A kombi trouxe os supervisores do engenheiro [*RC* que foram pagos pela empreiteira].

b. Full RC, low

A kombi trouxe o supervisor dos engenheiros [*RC* que foram pagos pela empreiteira].

c. Reduced RC, high

A kombi trouxe os supervisores do engenheiro [*RC* *pagos* pela empreiteira].

d. Reduced RC, low

A kombi trouxe o supervisor dos engenheiros [*RC* *pagos* pela empreiteira].

The van brought the<sub>(plural)</sub> supervisor(s) of the<sub>(plural)</sub> engineer(s) [*RC* (that were) paid<sub>(plural)</sub> by the company].

Note that both verbs in the RC (**were** as well as the participial verb **paid**) have to agree in number and gender with the head noun that the RC modifies. The present experiment only manipulated number in order to disambiguate the attachment site for the RC. As can be seen in Example (7), number is kept constant on the verb inside the RC, and the number on the underlined head nouns is manipulated. Hence, the RC has to be attached to the high noun in Examples (7a) and (7c), and to the low noun in Examples (7b) and (7d). The disambiguating region (in italics in Example (7)) for the full RCs include the auxiliary verb **be** and the participial verb, whereas in the reduced RCs only the participial verb indicates the correct interpretation.

### 2.4.3 Procedure

The experiment was conducted on a Power Macintosh 7500/100. The self-paced reading moving-window program presented sentences (Just, Carpenter & Woolley, 1982) one word at a time in a non-cumulative fashion. Stimulus words initially appeared as dashes, and participants pressed the spacebar on the keyboard to reveal each subsequent word of the sentence and cause all other regions to revert to dashes. A yes/no question was presented after each sentence and feedback was provided each time a mistake was made. The experi-



mental trials were preceded by instructions and eight practice trials. The experiment took participants approximately 20 minutes. Participants read eight sentences for each of the four conditions in a Latin Square design. These 32 sentences were presented intermixed with 62 filler items in pseudo-random order. See Appendix 2-A for the list of test stimuli used.

Most of the self-paced reading experiments investigating RC attachment have used a coarse-grained segmentation in which the first region includes all words up to the second head noun (e.g., **Someone shot the servant of the actress**) and the second is the crucial region with the RC (**who was on the balcony**). However, this type of segmentation may indicate to participants the main region of interest in the stimuli. An alternative more fine-grained-region presentation has also been used in which the head nouns in the complex NP are shown in two separate regions (e.g., one region contains **the servant** and the ensuing region **of the actress**; de Vincenzi & Job, 1995). However, this latter presentation has been claimed to induce a low attachment preference (Carreiras & Clifton, 1993) and experimental evidence suggests that no preference in attachment site is detectable when this type of segmentation is used in Spanish (Gilboy & Sopena (1996)). The third alternative, adopted in the present experiment, is to use a word-by-word presentation, which does not emphasize any one region in the stimuli and does not seem to bias participants towards low attachment given that a high RC-attachment preference has been detected in Spanish using this type of presentation (Gibson, Pearlmutter & Torrens, in press).

#### **2.4.4 Data analysis**

Analyses were performed on comprehension question response accuracy and on reading times (both raw and residual). A linear regression between word lengths and reading times was performed on each participant's data set (Ferreira & Clifton, 1986; Trueswell, Tanenhaus & Garnsey, 1994). The portion of the reading time predicted by the length of the word was subtracted from the original raw reading time, yielding a residual reading time. Furthermore, the data were trimmed so that data points beyond 3.5 standard deviations from the relevant condition  $\times$  region cell mean were discarded, corresponding to less than 2% of the total data points. The analyses only included the items for which the participants answered the

comprehension question correctly.

One participant was eliminated because of slow reading times. The slope in the regression equation, in particular, was 312 ms/char in contrast to the other 40 participants whose slopes ranged from 6 to 163 ms/char ( $M = 39.6$ ;  $SD = 31.5$ ).

For analysis purposes only, the stimulus words are collapsed into regions as follows (see Table 2.1). The first region contains the main-clause subject (a head noun and in some cases a specifier). The second region contains the main verb (including auxiliary verbs). The third region contains the article for the object NP. The fourth region is the first head noun (the high attachment site). The fifth region contains one word, namely, the preposition *of* with a definite article. The sixth region contains the second head noun, which is the low site candidate for attachment. For the full RCs, the complementizer and the verb *to be* (*foram* in Example (7)) were coded separately as individual regions. The seventh word is the participial verb in the RC. Each of the remaining words in the RC was coded as a single region.

Region	1	2	3	4	5	6	7	8	9
Words	subject	verb	article	noun <sub>1</sub>	of+article	noun <sub>2</sub>	(comp. be)	verb	(rest of the RC)
Example	the van	brought	the	supervisors	of-the	engineer	(that were)	paid by-the	company

Table 2.1: Regions used for analysis

Eleven items had exactly nine regions as shown in Table 2.1. The other 21 items had longer RCs, but in all cases at least the first nine regions were presented on a single line on the computer screen. A linebreak, when present, occurred at later regions. Eleven items had ten regions, eight items had eleven regions, and two items had twelve regions.

### 2.4.5 Norming study

In order to ensure that attachment to the two sites is equally plausible, a survey was conducted in which participants were asked to judge the plausibility of each attachment. Each of the thirty-two items used in the on-line experiment was separated into two sentences. The first sentence corresponded to the main clause, and the second sentence contained the RC

with the gap filled with one of the two head nouns. In one version, the RC gap was filled with the high noun and in the second version with the low noun. For instance, Example (7) above would correspond to the following two versions.

Example (8)

a. *High attachment.*

A kombi trouxe o supervisor dos engenheiros.

O supervisor tinha sido pago pela empreiteira.

“The van brought the supervisor of the engineers.  
The supervisor had been paid by the company.”

b. *Low attachment.*

A kombi trouxe os supervisores do engenheiro.

O engenheiro tinha sido pago pela empreiteira.

“The van brought the supervisors of the engineer.  
The engineer had been paid by the company.”

The version in Example (8a) corresponds to the high attachment of the RC, whereas Example (8b) corresponds to the low attachment condition. Participants were asked to judge the plausibility of such pairs of sentences in a scale from 1 (“natural”) to 7 (“strange”). Each participant only saw one version per item and they did not participate in the on-line experiment. Twenty-five native speakers of BP, residents in São Paulo, took part in the survey. The means for the high (3.08) and the low attachment condition (2.90) were not significantly different ( $F_s < 1$ ). Linear regression analyses detected no correlation between the plausibility judgements and the residual reading times (at regions 7 and 8) using the difference between the high and the low attachment conditions for each item ( $r^2 < 0.1$ ,  $p_s > 0.17$ ).

## 2.5 Results

In the comprehension question response accuracy, there was a significant interaction between RC type and attachment site ( $F_1(1,39) = 8.86$ ,  $p < 0.01$ ;  $F_2(1,31) = 8.81$ ,  $p < 0.01$ ). Performance for reduced RCs was significantly better in the low site attachment condition (79%) than in the high attachment condition (66%;  $F_1(1,39) = 17.69$ ,  $p < 0.01$ ;  $F_2(1,31) = 5.17$ ,  $p < 0.05$ ). For full RCs, however, performance in the low attachment condition (72%)

was only numerically better than the high attachment condition (69%;  $F_s < 1$ ).

The following are the results of the analyses using residual reading times, which are presented in Figures 2.1 and 2.2. The same pattern of results was obtained in the analyses with raw reading times.

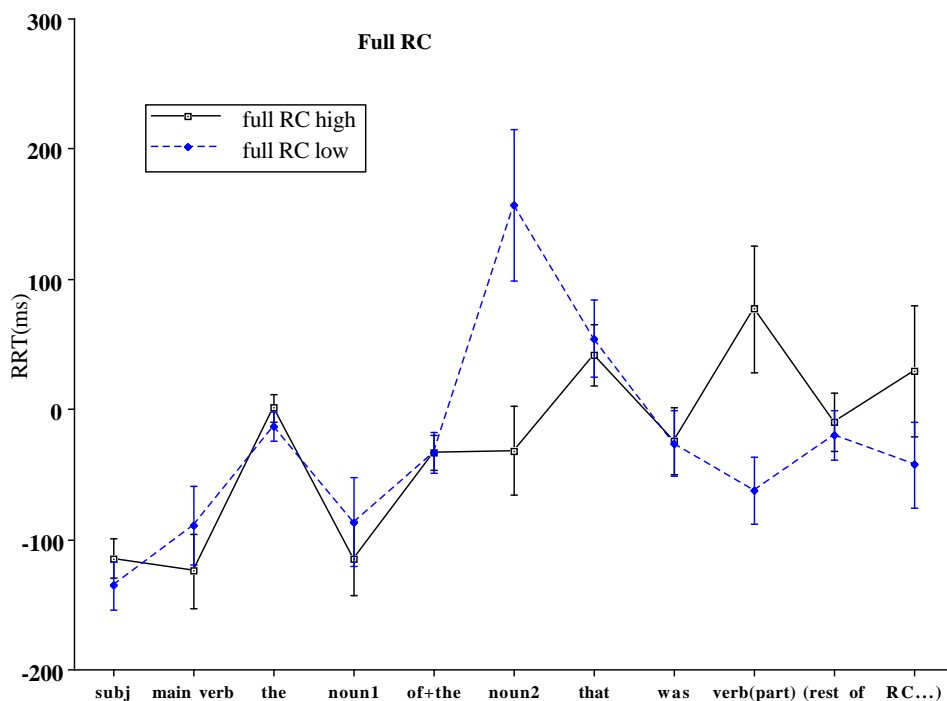


Figure 2.1: Residual reading times for full relative clauses.

Analyses for each of the first five regions yielded no differences between the four conditions ( $F_s < 1$ ). Neither were there differences between the low and high attachment conditions at the complementizer or at the auxiliary verb *be* with full RCs.

In region 6 (the second head noun), the results were as follows. The low and high attachment conditions did not differ for reduced RCs ( $F_1(1,39) = 1.84$ ,  $p = 0.18$ ;  $F_2 < 1$ ). With full RCs, the low condition was significantly slower than the high attachment condition ( $F_1(1,39) = 6.99$ ,  $p < 0.05$ ;  $F_2(1,30) = 11.2$ ,  $p < 0.01$ ). Moreover, the low attachment condition with full RCs was marginally slower than the low attachment condition with reduced RCs ( $F_1(1,39) = 3.81$ ,  $p = 0.058$ ;  $F_2(1,31) = 4.53$ ,  $p < 0.05$ ), although both conditions presented the same words up to this point. This slow reading time in the low attachment

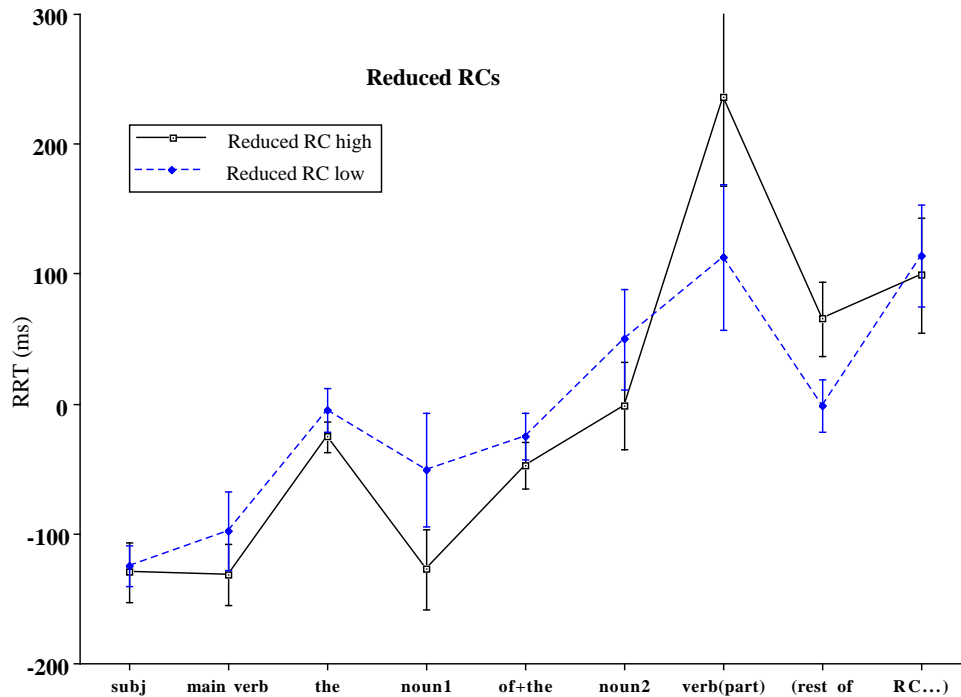


Figure 2.2: Residual reading times for reduced relative clauses.

condition with full RCs seems to persist in regions 7 and 8 in that the items that are slowest in region 6 are also the ones that presented the slowest reading times in regions 7 and 8.

The analysis at the reduced RCs had the following results. In region 7 (the participial verb in the RC), the low attachment condition was significantly faster than the high attachment condition in the analysis by subjects but not by items ( $F_1(1,39) = 4.96, p < 0.05$ ;  $F_2(1,31) = 2.23, p = 0.14$ ). In region 8, the low was significantly faster than the high attachment condition both by subjects and by items ( $F_1(1,39) = 4.25, p < 0.05$ ;  $F_2(1,30) = 8.30, p < 0.01$ ). In region 9, the low and high attachment conditions did not differ ( $F_s < 1$ ).

In the full RCs the results were as follows. In region 7, the low was faster than the high attachment condition ( $F_1(1,39) = 6.46, p < 0.05$ ;  $F_2(1,30) = 5.51, p < 0.05$ ). There was no difference in region 8 ( $F_s < 1$ ). In region 9, the low was faster than the high attachment condition, but the difference was not significant ( $F_1(1,39) = 2.79, p = 0.103$ ;  $F_2 < 1$ ).

In regions 7, 8, and 9, the reduced RCs were significantly slower than the full RCs ( $p_s < 0.05$ ). In the items with more than nine regions, there were no significant differences in

regions 10, 11 and 12, only a tendency for reduced RCs to be slower than full RCs.

Previous studies have reported a stronger advantage for low attachment when the verb has singular marking (Cuetos, Mitchell & Corley, 1996; Gibson, Pearlmutter & Torrens, in press, N. Pearlmutter through personal communication). Hence, a more detailed analysis was conducted for region 7, which contains the participial verb inside the RC. In the present experiment, verb number was kept constant within each item, but it varied across items. Fifteen items had plural marking on the verb and the other 17 items had singular verbs. Because of a mistake, the stimulus lists did not counterbalance for verb number. Collapsing regions 7 and 8, a significant interaction was detected in the analysis by items when considering number and attachment site ( $F_2(1,30) = 6.791, p < 0.05$ ). This is because the difference between the low and high attachment conditions is only significant with singular verbs ( $F_2(1,16) = 12.12, p < 0.01$ ) and not with plural verbs ( $F_2 < 1$ ). However, in the present case, this effect is confounded by the fact that the items with plural verb that are slowest in regions 7 and 8 were also responsible for the unexplained slow-down in region 6 in the low attachment condition. Moreover, there was no interaction between number marking and attachment site in comprehension performance ( $F_2 < 1$ ).

## 2.6 Discussion

Both comprehension performance and reading times suggest that the low attachment of RCs is preferred in BP. In the following, the results are discussed separately for reduced and non-reduced RCs.

### 2.6.1 Non-reduced RCs and parsing parametrizations

The slow reading time in region 6 (the second head noun) in the low attachment condition with full RCs continues in the critical regions (7 and 8), apparently decreasing the advantage of the low over the high attachment condition, nevertheless the former condition is still significantly faster in the critical regions.

The low attachment preference detected with full RCs in the critical regions does not

agree with the predictions made by the proposals based on the availability of an alternative construction (Frazier & Clifton, 1996; Thornton, Gil & MacDonald, in press) or based on the optionality of complementizers in object-gap RCs (Hemforth et al., in press). On the other hand, the result supports the parametrization proposed by predicate proximity (Gibson, Pearlmutter, Canseco-Gonzalez, & Hickok, 1996) and suggests that rigid word order may indeed correlate with the low attachment preference of full RCs. Considering the similarities between Spanish and BP, their most marked difference is in word order flexibility. Although BP allows some types of topicalizations (see Kato & Raposo, 1996, for topicalizations allowed in Brazilian and in European Portuguese), overall it presents rigid SVO word order. Predicate proximity proposes that flexible word order requires stronger activation of verbs and consequently more salient argument heads. Another reason for word order flexibility to correlate with high attachment is that it may require native speakers to be more attentive to where exactly clause boundaries lie in comparison to languages with rigid word order, in which clause boundaries are more predictable. Such attention to clause boundaries may make them more salient in languages with flexible word order and thus weaken the locality effect between a RC and the immediately preceding head noun.

Moreover, it is conceivable that flexible word order may also require more salient pauses between clauses in speech, in which case, the relation between the resulting prosodic contour and RC attachment preference may not be of causality (Fodor, 1998), but rather both may be by-products of word-order flexibility.

## **2.6.2 Reduced RCs and anaphor resolution**

According to reading times and comprehension question performance, reduced RCs are preferentially attached to the low site. Moreover, the low attachment preference is stronger with reduced RCs than with full RCs, as the interaction in comprehension performance indicates. The following discusses a few proposals to explain the weaker low attachment bias when a complementizer is present.

This pattern of results is in accordance with the anaphor resolution proposal (Hemforth et al., in press). Because an anaphor resolution process (ARP for short) is not triggered by

reduced RCs, attachment is presumably determined by locality alone. However, there are a number of issues that should be considered in this proposal. From a generative grammar point of view, reduced RCs have a null operator which requires an antecedent in the discourse (see Haegeman, 1994, and references therein). Hence, an ARP should also be taking place during the attachment of reduced RCs. But, in the absence of the complementizer, it is conceivable that the ARP is triggered too late to influence the attachment decision (see Hemforth, Konieczny & Scheepers, 1997, for details of a race model in which the locality factor and the ARP compete to provide an attachment site as early as possible). Consider the following example.

Example (9)

A kombi trouxe o supervisor do engenheiro [<sub>RC</sub> pago pela empreiteira].  
 the van brought the supervisor of engineer paid by-the company

“The van brought the supervisor of the engineer paid by the company.”

In the reduced RC in Example (9a), the ARP is triggered at **paid**, the first word where it is clear that a null operator is required. Because **paid** itself does not require an antecedent, there may be a delay before the ARP starts in order to posit the null operator, hence giving an advantage to the locality factor. However, this delay cannot explain the difference between reduced and non-reduced RCs because complementizers also require such delay. So far, in this discussion, complementizers and relative pronouns have been undifferentiated, however, strictly speaking, only relative pronouns require an antecedent whereas a complementizer in a RC has a null operator as its specifier, and it is this operator that requires an antecedent. For processing purposes, the complementizer is the first overt word at which point it is clear that such null operator is present, hence this is where the ARP may be triggered. In this case, the processing of complementizers should also involve a delay in order to posit the null operator and therefore a temporal advantage should be expected for the locality factor, but in this case the difference between reduced and non-reduced RCs would not be explained. It may be suggested then that during the processing of a full RC the complementizer itself requires an antecedent as it is compounded with the null operator into a single constituent (see for example Pesetsky, 1981, which explains **que-qui** alternations in French based on a proposal that null operator and complementizer may merge as a single element.)



An alternative explanation for the fact that complementizers weaken the locality preference may be that they signal the beginning of a new clause hence decreasing the perception that the incoming constituent (the RC) is part of the previous constituent (the NP headed by the low noun). In closure terms (Frazier, 1987; Kimball, 1973), the low or high attachment of an RC corresponds to the late or early closure of the NP headed by the local noun. The proposal here then would be that closure will be influenced by the salience of the boundary that initiates the modifier. A marked boundary (as indicated by a complementizer) would make the modifier less likely to be construed as part of the low NP.

A third alternative explanation may be that the distance from a functor in a modifier to the modified head determines the strength of the locality preference, where a functor is the predicate that takes the modified head as one of its arguments. For example, in the RC in the German Example (10a) below, the functor is the verb **came**, whereas in the PP in Example (10b), it is the preposition **from**.

Example (10) (Hemforth, Konieczny & Scheepers, in press)

- a. Die Tochter der Lehrerin, [<sub>RC</sub> die aus Deutschland kam], traf John.  
 the daughter the<sub>Gen</sub> teacher who from Germany came met John

“The daughter of the teacher who came from Germany met John.”

- b. Die Tochter der Lehrerin [<sub>PP</sub> aus Deutschland] traf John.  
 the daughter the<sub>Gen</sub> teacher from Germany met John

“The daughter of the teacher from Germany met John.”

Thus the functor in Example (10b) is closer to the local noun **teacher** than in Example (10a), correctly predicting that the local attachment is stronger with PPs than RCs (Hemforth, Konieczny & Scheepers, 1997). In the reduced RC in Example (9a), the functor **paid** is closer to the low noun **engineer** than in the full RC in Example (9b), and consequently the stronger low attachment preference in the former construction follows. Another phenomenon that may be captured by this proposal is that longer modifiers tend to attach high more strongly than short modifiers (Fodor, 1998; Pynte, 1998), which follows from assuming that functors in longer modifiers tend to occur further from the modified head. The notion that distance between constituents affects attachment preferences can be formalized in terms of

an integration cost (Gibson, 1998) incurred in the present case when the functor of the modifying phrase is processed.<sup>1</sup>

Future work comparing the three proposals above should provide further insight on the RC attachment phenomenon.

## 2.7 Conclusion

The low attachment preference of full RCs in Brazilian Portuguese reported in this chapter agrees with the proposal that word order flexibility (as in Gibson, Pearlmutter, Canseco-Gonzalez, & Hickok, 1996) is responsible for the cross-linguistic difference observed between English and other languages such as Spanish. Some possible reasons for this causality relation were considered.

A number of proposals were also discussed in relation to the stronger low attachment preference observed with PPs and reduced RCs when compared to full RCs. Some questions raised by the syntax of reduced RCs were considered in relation to the attachment of modifiers in general, and especially concerning the anaphor resolution process (Hemforth, Konieczny & Scheepers, in press).

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<sup>1</sup>In order to use such integration cost however, a more elaborate explanation may be needed in order to account for intermediate traces.

## Appendix 2-A.

Items used in the on-line experiment. All four conditions are provided for item 1. For the other items, the three last conditions can be obtained from the first condition by inverting the number on the two head nouns (conditions (b) and (c)) and by eliminating the complementizer and the auxiliary (conditions (c) and (d)).

- 1a. Uma aluna criticou os professores do curso que foram escolhidos pelos estudantes.
- 1b. Uma aluna criticou o professor dos cursos que foram escolhidos pelos estudantes.
- 1c. Uma aluna criticou os professores do curso escolhidos pelos estudantes.
- 1d. Uma aluna criticou o professor dos cursos escolhidos pelos estudantes.
  
- 2a. A rádio transmitiu a apresentação das orquestras que foi patrocinada pelo governador.
  
- 3a. A kombi trouxe os supervisores do engenheiro que foram pagos pela empreiteira.
- 4a. O museu exibiu a pintura das paisagens que foi descrita por Machado de Assis.
- 5a. O banco recusou os empréstimos do apartamento que foram examinados pelo gerente o mês passado.
  
- 6a. O arcebispo condenou a atriz das novelas que foi taxada de indecente pela igreja.
- 7a. O piloto tentou mirar nos motores do bombardeiro que tinham sido avariados no início da batalha.
  
- 8a. O cientista obteve a lente das câmeras que foi apresentada no congresso de optometria.
- 9a. Daniel checou as paredes da casa que foram arruinadas pelas enchentes.
- 10a. O electricista checou o cabo dos aparelhos que foi danificado no dia da inauguração.
- 11a. A polícia apresentou os suspeitos do assassinato que foram investigados pelo delegado.
  
- 12a. A modista redesenhou a manga das jaquetas que foi criada pelo dono da loja.
- 13a. A dona-de-casa preparou as receitas da cozinheira que foram premiadas o ano passado.
  
- 14a. Eduardo trabalha com o advogado dos sindicalistas que foi envolvido no caso de maneira imprevista.
  
- 15a. Os solistas ensaiaram os concertos do compositor que foram redescobertos na Itália

recentemente.

16a. O caçador capturou o leão dos amestradores que fora criado desde pequeno no circo.

17a. O professor se referiu às traduções da estória que foram elogiadas no jornal americano.

18a. O maestro ficou satisfeito com a gravação das músicas que foi escolhida pela companhia.

19a. O prefeito fez questão de visitar o projeto dos prédios que foi premiado pelo museu alemão.

20a. O mordomo serviu o convidado dos anfitriões que foi acusado de extelionato pela imprensa.

21a. O repórter ridicularizou os participantes do concurso que foram patrocinados pela prefeitura.

22a. O camponês avistou o pastor dos carneiros que fora atacado pelos lobos.

23a. A atriz gostou dos scripts do escritor que foram elogiados pela imprensa européia.

24a. O ator tentou ignorar a manchete das revistas que foi mencionada no rádio.

25a. O carrasco executou os conselheiros do embaixador que foram exilados de seu país.

26a. O jornalista investigou o encontro dos sindicalistas que foi cassado pela junta militar.

27a. O general teve que reavaliar os resumos do livro que foram censurados pelos militares.

28a. A agência não gostou da propaganda das companhias que tinha sido sugerida pelo publicitário.

29a. O cientista examinou os predadores do herbívoro que foram dissecados durante o experimento.

30a. O arqueólogo re-catalogou o fóssil dos dinossauros que fora descrito incorretamente no panfleto.

31a. O astrônomo confirmou as trajetórias da constelação que foram estudadas na Idade Média.

32a. O juiz elogiou a testemunha das carnificinas que foi filmada secretamente pela imprensa.