THE INFLUENCE OF PROSODY IN THE PROCESSING OF AMBIGUOUS RCs: A STUDY WITH SPANISH MONOLINGUALS AND BASQUE-SPANISH BILINGUALS FROM THE BASQUE COUNTRY[1]

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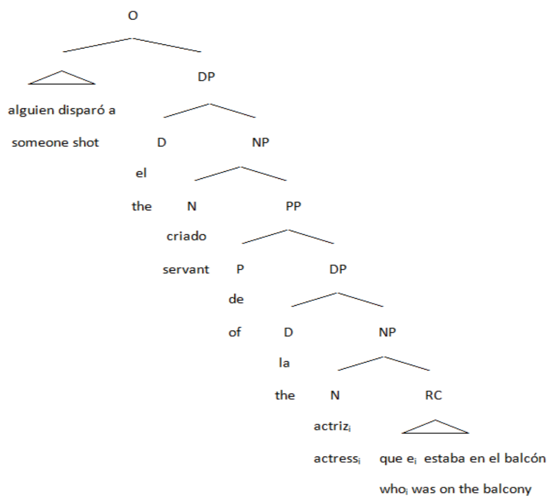
1. Introduction

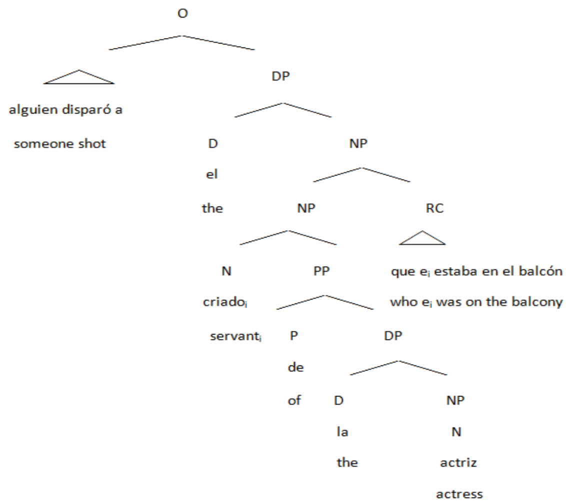
The advances in phonological theory achieved in the last few decades have forced a shift in the conception of phonology from a homogeneous system of rules to a set of subsystems that are ruled by their own principles in interaction with the phonological as well as the grammatical components. A great deal of investigation has also proven the influence of prosody in the resolution of syntactic ambiguities (M. Nespor & I. Vogel 1986; L. Frazier, et al. 2006; J. Snedeker and J. Trueswell 2003; C. Teira and J.M. Igoa 2007; K. Steinhauer, et al. 1999). The results have shown that naïve speakers introduce effective prosodic cues such as pauses or tonal rising, creating boundaries that are used by the listeners to resolve syntactic ambiguities. Furthermore, results have also shown that prosodic information can reverse syntactic processing preferences. Numerous studies have focused on the processing of local ambiguities. One of their objectives has been to determine which of the processing strategies are universal and which are language specific. My investigation will concentrate on one type of syntactic ambiguity, namely ambiguous relative clauses. These structures contain a complex NP, which consists of a simple NP followed by a PP that is accompanied by a relative clause (NP1 -*of*- NP2 RC). The ambiguity lies in the fact that both NPs are potential antecedents of the RC.

(1) *Alguien disparó [al criado de la actriz] [que estaba en el balcón].*
(Someone shot [the servant of the actress]$_{\text{complex NP}}$ [that was on the balcony]$_{\text{RC}}$.)

The RC *that was on the balcony* can be attached to either the NP1 (*the servant*), in what would be called early closure or high attachment (cf.2a) referring to the position occupied by the NP in the syntactic tree or to the NP2 (*the actress*), called low attachment or late closure (cf.2b).

(2a) High Attachment (2b) Low attachment





The attachment preference of these structures has been studied in several languages with both on-line and off-line techniques, and cross-linguistic variability has been found present. Low attachment preference has been reported in English, Brazilian Portuguese, Italian, Basque, Rumanian, Norwegian and Swedish, among other languages. (E. Gutierrez, M. Carreiras and I. Laka 2004 for Basque, see E.M. Fernández 2002: 7 and I. Fraga et al. 2005: 244 for further references). In contrast, high attachment preference has been obtained in Spanish, French, Dutch, German, Galician and Afrikaans, among other languages (references in E.M. Fernández 2002: 7 and I. Fraga et al. 2005: 244). Several theories have been proposed in order to account for this cross-linguistic variability, but so far none of them seem to account fully for the entire set of results[2].

My research concentrates on one of these models: Fodor's prosodic hypothesis (J.D. Fodor 1998). According to this theory, a universal prosodic processor acts parallel to the syntactic processor, packaging the incoming string of words into chunks at an initial stage of processing and leading the parser to resolve the ambiguities. Fodor proposes the Antigravity Law, a principle stating that the prosodic weight of a constituent determines its site of attachment. Prosodic weight is defined in terms of length and syntactic category. The longer the constituent, the greater its prosodic weight will be. In addition, a clause will be heavier than an NP, even though it is of equal length. Long (heavy) RCs constitute a prosodic constituent on their own and do not attach to the adjacent NP2. Consequently, they attach high. On the other hand, short (light) constituents need to be attached to the previous NP2 in order to form a prosodic constituent, resulting in low attachment. Therefore, this principle predicts a possible variation in syntactically identical constructions among languages, depending on the weight/length of the structure. Together with this law, Fodor proposes a Same-Size-Sister constraint that states: *Find a sister of your own size* (J.D. Fodor 1998: 302). According to this principle, the packages don't contain a fixed number of words or syllables. Instead, the sentence or constituent will tend to be divided into similar sized packages. Thus, the prosodic constituents require same-sized "sisters". In case of syntactic ambiguity, the processor will seek a balanced structure and associate a constituent to another constituent of equal size. This favors high attachment of heavy RCs and low attachment of light RCs.

Research on attachment preference of ambiguous RCs has traditionally been centered on silent reading comprehension. Hence, the following question emerges: how is it possible to apply this prosodic hypothesis to a study based on silent reading? To solve this problem, Fodor formulates the Implicit Prosody Hypothesis (IPH) which states: *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*. (J.D. Fodor 2002: 113). This hypothesis is based on the idea that, during silent reading, the reader hears an internal voice that provides the words with accent and intonation and creates prosodic boundaries that influence the syntactic processor. During sentence processing, each word must be attached to a representation of its syntactic structure. Thus, when facing a structural ambiguity, a choice among the different possible attachment sites of a word arises. The IPH proposes that the processor will choose the syntactic analysis associated with the most natural prosodic contour. Given that languages differ in their prosody, the attachment preference will also vary from language to language.

L.A. Maynell (1999) and N. Lovrić et al. (2000, 2001) report a correlation between the site of prosodic breaks or boundaries and attachment preference. Their data show that a prosodic break before the RC correlates with high attachment preference (NP1 NP2 / RC), while the presence of a break between the two nouns of the complex NP prompts low attachment (NP1 / NP2 RC). From these data they conclude that prosodic boundaries correlate with attachment preference of the RC. Furthermore, investigations conducted by S-A. Jun (2003), S-A. Jun & S. Kim (2004) and S-A. Jun & C. Koike (2004) seem to confirm Fodor's hypothesis. In these studies, length manipulations produced antigravity effects, and the longer the attached constituent was, the greater the tendency was for high attachment.

By means of a production experiment, my research will explore the prosodic contours projected into ambiguous RC structures in Spanish by monolingual speakers of Spanish and Basque-Spanish bilinguals from the Basque Country. The aim of this research is twofold. First, I intend to test the validity of Fodor's Antigravity Law by manipulating the length of the RCs in the experimental sentences. A correlation between RC size and prosodic break insertion site is predicted. A break between both NPs is expected in short RCs, and a break after NP2 in long RCs is also anticipated. Thus, as the length of the RC increases, a change in the position of insertion of the prosodic break will be expected. Second, I aim to evaluate potential differences and similarities between the prosody of monolingual and bilingual speakers so that the following question can be answered: does the prosody of bilinguals diverge from the prosody of monolingual speakers (and if this is the case, to what extent)?

2. Methodology

2.1. Participants

Nine graduate students from the UPV/EHU, with ages ranging from 22 to 26 years old, took part in this production experiment. Five of the participants were men, and the other four were women. None of them received any remuneration for their collaboration. Participants were sorted into three groups depending on their knowledge of Basque and Spanish. The first group consisted of three monolingual speakers of Spanish from the variety spoken in the Basque Country. The second group was formed by three Basque-Spanish bilinguals whose L1 and dominant language was Basque. The third group was formed by three Basque-Spanish bilinguals with Spanish as their L1. A background questionnaire based on the C.M. Weber-Fox And H.J. Neville model (1996) was used in selecting the participants.

2.2. Materials

48 experimental sentences were designed, all of them containing a complex noun phrase followed by a relative clause (NP1 *de* NP2 RC). All the sentences were syntactically ambiguous, meaning the RC could modify both NP1 and NP2.

(3) *Un ladrón robó al mayordomo del señor que llegaba a casa.*
(A thief robbed the butler of the man who came home.)

In order to test Fodor's *Antigravity Law*, the length of the RCs was manipulated, sorting the sentences into four blocks: block 1 contained 3-4 syllable RCs; block 2 contained 6-7 syllable RCs; block 3 contained 9-11 syllable RCs and block 4 contained 13-15 syllable RCs. Voiceless stops were avoided inside the critical region (the complex NP + the beginning of the RC) in order to avoid disruptions in the utterance.

2.3. Procedures

Participants were recorded individually in an anechoid room located in the Phonetics Laboratory at the UPV/EHU. The data were collected with a DAT recorder and an AKG microphone. The utterances were subsequently segmented into separate files and saved to hard disk using the program for acoustic analysis PRAAT (cs. Boersma and Weenink 2008). The task consisted of reading the sentences aloud. Participants were asked to read the sentences at a normal pace and as close as possible to their natural speech pattern. Each sentence was repeated three times. Each participant produced a total of 144 utterances. The whole session took around 20-30 minutes.

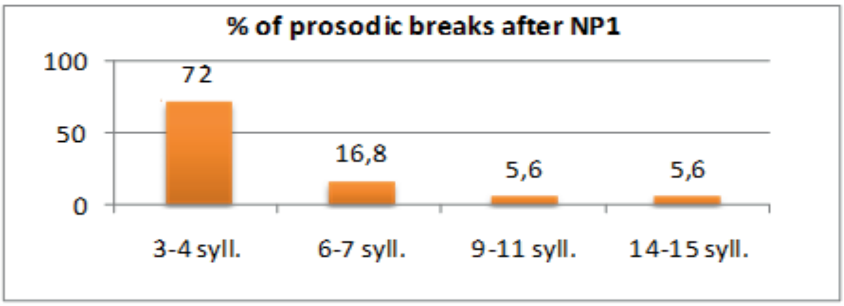
A randomly chosen participant was asked to skim each sentence briefly before reading it aloud (i.e. a total of three participants). The rest of the participants were not allowed to skim the sentences beforehand. The aim of this distinction was to observe if this skimming variable influenced the prosodic contours projected by the participants (S-A Jun and C. Koike 2003, S-A Jun & S. Kim 2004). A total of 1296 utterances were recorded (9 participants x 144 utterances per speaker). 143 of these utterances were excluded from the analysis due to disfluencies in the production (11% of the data). The prosodic segmentation of the sequence [NP1 *de* NP2 RC] was analyzed attending to the following boundary cues: intonation boundary rise, pause, phrase-final lengthening, and the combinations among these.

3. Results

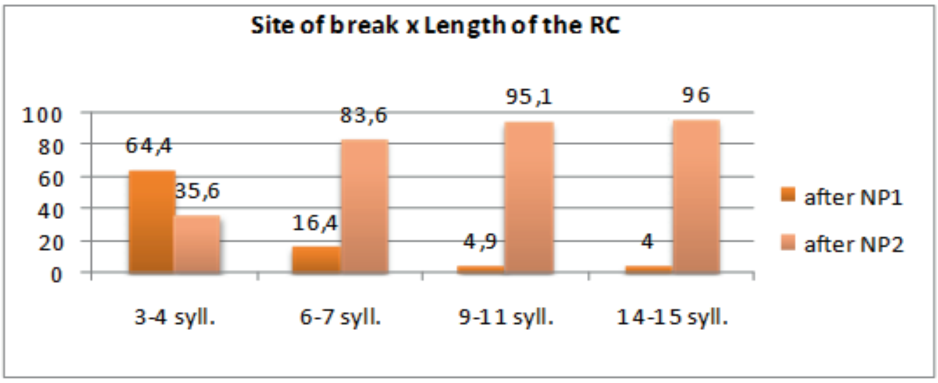
The analysis of the data indicates that 87.9% of the prosodic boundaries were marked by means of an intonation boundary rise (average ris of 17.68hz including all speakers, 14.12hz men and 21.25 women). 17% of these boundaries were combined with other prosodic cues. The prosodic breaks were mainly placed after NP2 (78.6%), indicating a general high attachment preference in these structures. This result coincides with previous evidence obtained in behavioural and electrophysiological experiments in Spanish (D.C. Mitchell & F. Cuetos 1988 among others). The remaining 21.4% of the breaks were inserted after NP1. No significant correlation was found between boundary site and linguistic group (χ^2=1.38, p>.50). Therefore, this general preference for an early closure was equally present in the three groups.

3.1. Antigravity Law

This law predicts the presence of a prosodic break after NP1 in short RCs as well as its insertion after NP2 in long RCs. The possible correlation between prosodic break site and RC length was analysed. Exactly as the Antigravity Law predicts, 72% of the total number of prosodic breaks after NP1 were inserted in the sentences containing the shortest RC (3-4 syllables), 16.8% were found in the second block (6-7 syllables), and the same percentage, 5.6%, were found in the third and fourth blocks (9-11 syllables and 13-15 syllables respectively).



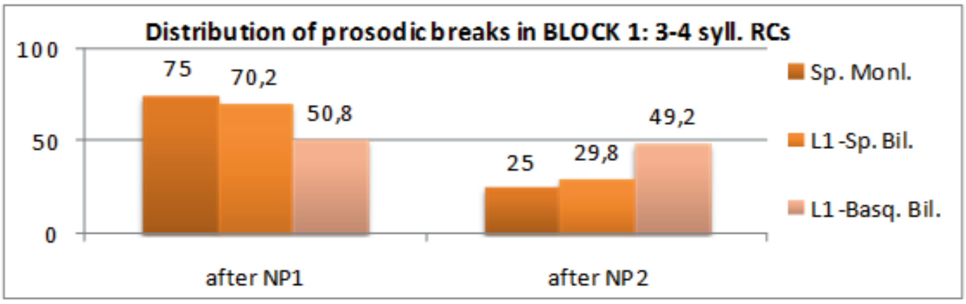
The analyses between prosodic break site and RC length revealed significant differences ($p \leq .001$), with the exception of the relation between blocks 3 and 4 (the longest RCs, $\chi^2=.18$, $p>.42$). These results show a correlation between the prosodic break site and the RC length. Thus, the longer the RC, the greater the frequency of a prosodic break was after NP2.



The analysis of these variables was carried out additionally per participant. The contingency tables revealed significant results in all speakers (all $p \leq .05$).

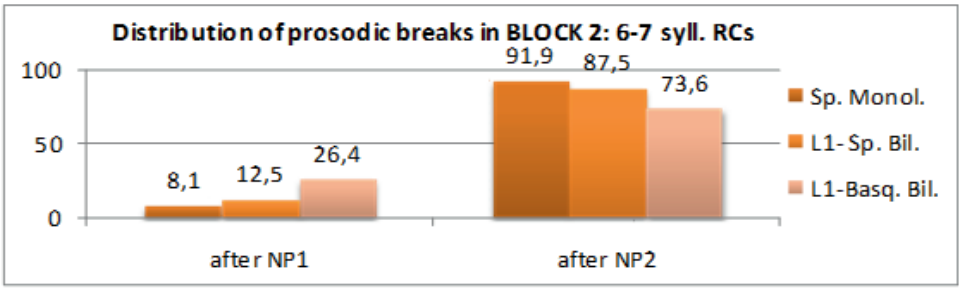
The *Linguistic Group* variable was also analyzed in order to observe if this correlation was present in every linguistic group. The differences in the distribution of the prosodic breaks depending on the RC length were significant in all groups. (Sp. Monol.: $\chi^2=117.72$, $p<.001$; L1-Sp. bil.: $\chi^2=94.27$, $p<.001$; L1-Basq. bil.: $\chi^2=48.74$, $p<.001$), showing the presence of almost all prosodic breaks after NP2 in the sentences containing the longest RCs (9-11 syllables and 13-15 syllables), but also mainly in the 6-7 syllable RCs.

Finally, an analysis of the distribution of prosodic breaks per linguistic group was conducted for each length.



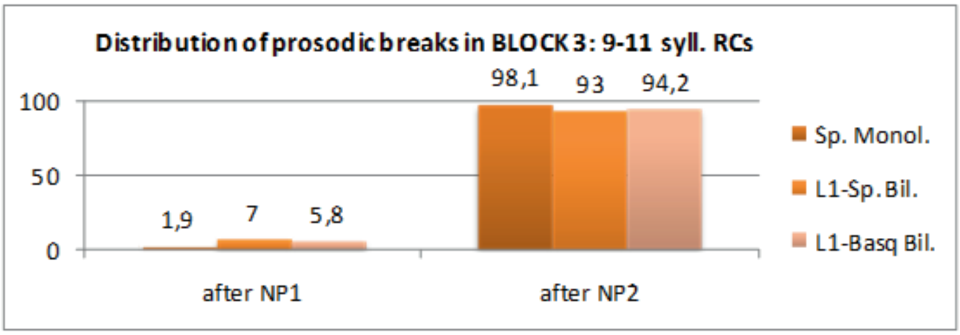
Monolinguals and L1-Spanish bilinguals introduced the majority of the prosodic breaks after NP1 in the sentences from block 1. No significant differences between these groups were found: χ^2=.29, p>.55. However, L1-Basque bilinguals placed the same amount of prosodic breaks after NP1 and NP2. The difference between this group and the other two was significant (L1-Basque bil. vs. monol.: χ^2=6.19, p<.02; L1-Basque bil. and L1 Spanish bil.: χ^2=4.53, p<.05).

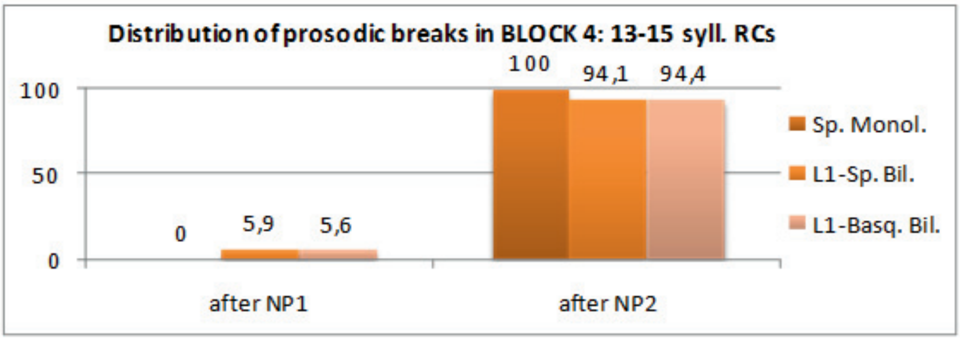
A preliminary study conducted by E. Gutierrez, M. Carreiras & I. Laka (2004), which consisted of an off-line questionnaire, showed a low attachment preference in native Basque speakers. Thus, the absence of preference found in L1-Basque bilinguals in my study is striking because it takes place in the block containing the shortest RCs, which should favour low attachment. This absence of preference would be expected, if anywhere, in the blocks containing the longer RCs, since the RC length would force a high attachment preference, as opposed to the default preference in their L1. At the moment, there is no explanation to account for this result. As such, this issue will be left for the subject of further research.



The three groups show the same tendency towards the insertion of the prosodic break after NP2. The results of the contingency tables in the second block also show significant differences between monolinguals and L1-Basque bilinguals. Monolinguals introduced a significantly higher number of prosodic breaks after NP2 than L1-Basque bilinguals (χ^2=4.77, p<.05). The differences between the rest of the groups were not significant (all ps>.05). A remarkable shift in the localization of the prosodic break was observed. Here, the prosodic breaks were mainly placed after NP2, unlike the localization seen in the previous block.

In the remaining two blocks, no statistical differences were found among the linguistic groups. Almost all the prosodic breaks were placed after NP2.

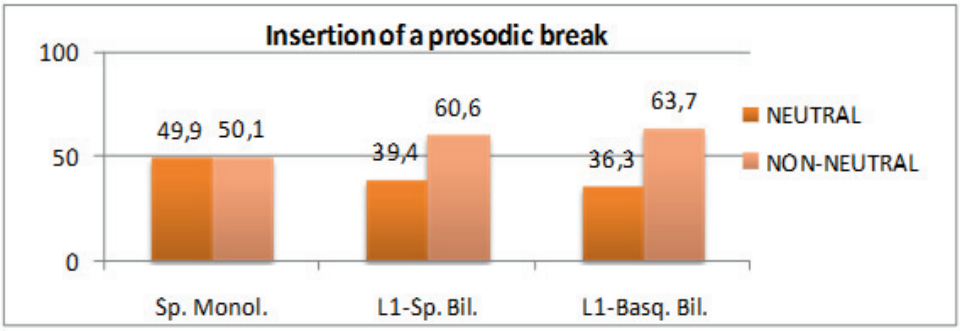




From these data it can be concluded that there is, in fact, a correlation between RC length and prosodic break insertion site. The tendency to place this break after NP2 as the RC length increases was observed in all the linguistic groups, fulfilling the Fodor hypothesis' predictions.

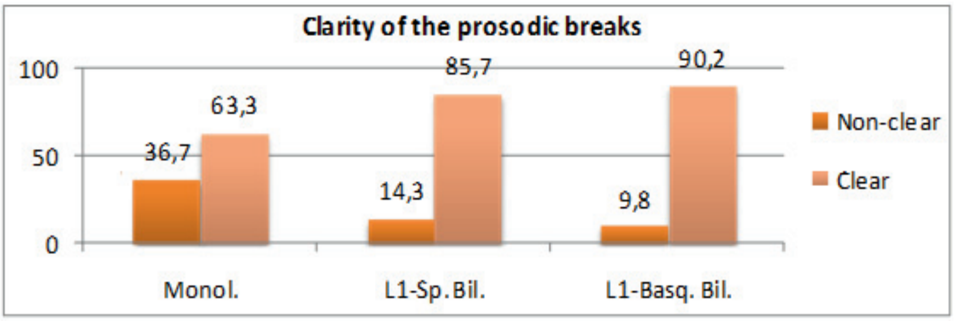
3.2. General differences between monolinguals and bilinguals

As in S-A Jun (2003), the proportion of neutral vs. non-neutral sentences was also analysed. The utterances containing one prosodic break within the critical region were considered non-neutral. Those utterances containing either no prosodic break or more than one in the critical region were considered neutral. As such, 58.02% of the total number of productions revealed the presence of a prosodic break (non-neutral). The remaining 41.98% of the utterances were neutral. The analysis of the prosodic break insertion frequency per linguistic group revealed differences between monolingual and bilingual populations. Monolingual speakers showed a similar presence of neutral and non-neutral utterances (49.9% and 50.1% respectively), while bilingual speakers from both groups produced a significantly higher number of non-neutral utterances. (L1 Sp. bil.: 60.6% non-neutral, 39.4% neutral; L1 Basq. bil.: 63.7% non neutral and 36.3% neutral). The difference between monolinguals and each of the bilingual groups was significant: monolinguals vs. L1-Sp. bil.: $\chi^2=8.631$, $p<.005$; monol. vs L1-Basq. bil.: $\chi^2=14.21$, $p<.001$. The contingency tables showed no significant difference between the two bilingual groups.



Prosodic break clarity was introduced as a new variable. Two categories were established: clear vs. non-clear breaks. Clear breaks were those in which the prosodic cue was very salient perceptively, for example by means of a high continuation rise. The analysis of frequencies showed 19.3% of non-clear breaks, vs. 80.7% of clear prosodic breaks from the total breaks uttered. The intonation boundary rise in the non-clear boundaries had an average of 11.98 hz., while the average for clear boundaries was 23.39 hz..

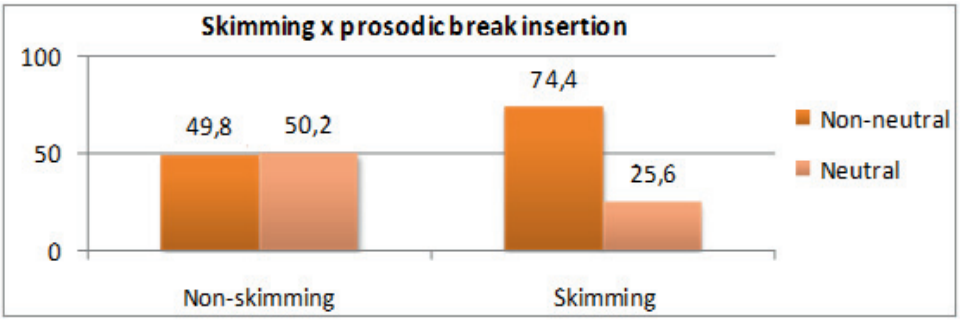
Again, an analysis by linguistic groups revealed differences between monolingual and bilingual speakers. Even though monolingual speakers produced a greater percentage of clear prosodic breaks (63.3%) than non-clear breaks (36.7%) in their utterances, this difference was much more pronounced in both bilingual groups. L1-Spanish bilinguals registered 85.7% for clear prosodic breaks vs. 14.3% for non-clear breaks. On the other hand, L1-Basque bilinguals, registered 90.2% for clear prosodic breaks, vs. 9.8% for non-clear breaks. Again, the differences between both bilingual groups were not significant (χ^2=2.26, p>.12), and the differences between each bilingual group and the monolingual groups were significant: monol. vs. L1-Sp. bil.: χ^2=29.34, p<.001; monol. vs. L1-Basq. bil.: χ^2=45.16, p<.001.



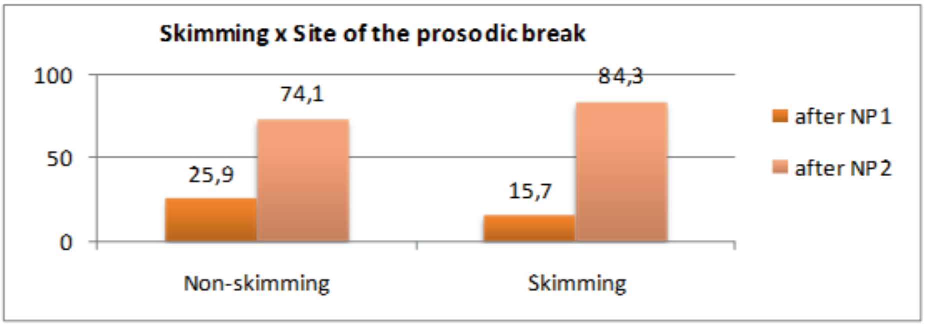
From these data it can be concluded that there exist differences between monolingual and bilingual speakers in the prosodic contours projected into the structures under analysis. Thus, bilingual speakers produce a higher number of prosodic breaks, and these are clearer than the ones produced by monolingual speakers.

3.3. The “Skimming” variable

By introducing this variable, we intended to observe whether this factor influenced the distribution of the prosodic breaks or whether it affected the proportion of neutral vs. non-neutral sentences. In the analysis of neutral vs. non-neutral sentences, the results from the contingency tables show a significant correlation between these two variables. Thus, we observe a balanced presence of neutral (50.2%) and non-neutral (49.8%) utterances in the productions of those participants who were not allowed to skim the sentences before reading them aloud. However, those speakers who skimmed the sentences produced a higher number of boundary marks (χ^2=63,53, p<.001). In other words, they uttered many more non-neutral sentences (74.4%) than the non-skimming participants. These results indicate that skimming sentences entails a higher presence of boundary marks. Please note that this is indeed an interesting correlation, since S-A Jun And C. Koike (2003) found the opposite effect in their research in Japanese.



Finally, the analysis of prosodic break site and the Skimming variable revealed that those participants who skimmed the sentences produced a significantly higher number of prosodic breaks after NP2 (84.3%) than those who did not (74.1%) (χ^2=10.17, p<.005). These data indicate that being allowed to skim a sentence before reading it aloud entails a significantly higher frequency of the prosodic contour associated with a high attachment of the ambiguous RCs, i.e. the default contour in Spanish. The results converge with those obtained by S-A Jun & S. KIM in Korean.



4. Discussion

The data from this research show that 78.6% of the total number of boundaries was placed after NP2. Assuming that the site of the prosodic boundaries correlates to attachment preference and that a prosodic boundary after NP2 prompts high attachment, these data confirm the high attachment preference observed in previous behavioural and electrophysiological studies conducted in Spanish. In addition, these results support the prediction stated by Fodor's Antigravity Law: i.e. a shift in the prosodic break insertion site can be found as the RC length increases. Thus, in the sentences containing the shortest RCs, a prosodic break after NP1 is introduced, producing prosodic phrasing that is associated with low attachment. However, 6-7 syllable RCs showed mainly the prosodic phrasing associated with high attachment, and RCs from 9 syllables and up placed virtually all breaks after NP2 with no difference among linguistic groups. Therefore, in the sentences containing longer RCs, this prosodic break is mainly observed after NP2, which is associated with high attachment. The logical conclusion is that prosodic weight (i.e. the length of syntactic constituents), influences the processing of ambiguous relative clauses and determines their attachment preference. Light RCs tend to attach low, while long RCs attach high in the syntactic tree.

When comparing bilingual and monolingual populations, the results obtained also turned out to be of great interest. Regarding the distribution of the prosodic breaks, these populations behave similarly, except for the L1-Basque bilingual group in the first block. So, as far as the prosodic hypothesis' predictions are concerned, monolingual and bilingual speakers show a similar behaviour. However, when looking into general prosodic characteristics such as neutral vs. non-neutral breaks and the clarity of these prosodic boundaries, the data reveal some differences. Both L1 Spanish and L1 Basque bilingual speakers seem to produce a significantly higher number of non-neutral utterances than do Spanish monolinguals. Also, these utterances are significantly clearer than the ones produced by monolinguals. We can only speculate about the cause of these differences. It is possible that bilingual speakers have two phonological inventories with their respective prosodic contours. J. Snedeker and J. Trueswell (2003) reported that the speakers who took part in their investigation introduced the disambiguating prosody only when the referential context didn't provide them with accurate cues for its resolution. In other words, they only introduced the prosodic cues that helped in the resolution of the ambiguity when strictly necessary. So, it may be the case that our bilingual speakers introduce a greater number of prosodic cues with the purpose of differentiating between their two phonological systems, i.e. distinguishing between the Basque and Spanish prosodic contours. Monolingual speakers, however, only have one phonological system and, therefore, do not need to be so clear with their contours. In order to test this hypothesis, it would be necessary to analyze the prosodic contours projected into these structures in Basque. This would be a difficult task, however, considering that are almost no monolingual speakers of Basque in the age range studied.

Finally, the analysis of the Skimming variable shows the influence of this factor in the prosodic contours projected. On one hand, the data revealed a higher frequency of the default prosodic contour in Spanish in the utterances of those participants who were allowed to skim the sentences, i.e. the one associated with high attachment. On the other hand, the skimming of the sentences also significantly increased the number of non-neutral utterances (from 49.8% to 74.4%). However, this last result does not converge with the findings obtained by S-A. Jun and c. koike (2003) in Japanese. So, further research seems necessary to understand the influence of this variable fully.

To summarize, the results of this experiment show that prosodic weight influences the prosodic contours imposed on ambiguous RCs, namely the location of prosodic breaks. What remains to be confirmed is the correlation of boundary site and attachment preference in Spanish. The next step in this investigation will be to design a new production experiment complemented with an off-line questionnaire with the same participants in order to compare their attachment preference with the contours projected. I also intend to carry out a parallel investigation in Basque in order to compare in detail the prosody of monolingual and bilingual speakers. This will also allow for an exploration of potential prosodic differences in languages that show cross-linguistic variability in their attachment preference.

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[1]Acknowledgements: I am very grateful to Gorka Elordieta, who directed this research. Thank you also to all the participants as well as the Basque Government predoctoral grant (BFI07.253) and CONSOLIDER INGENIO: MCIT (CSD 2007-00012) for funding this investigation.

[2] Garden-Path model and late closure strategy: L. Frazier 1987; Construal: L. Frazier and C. Clifton 1996; Recency-Predicate Proximity Model: E. Gibson et al. 1996; Tuning Hypothesis: D.C. Mitchell & F. Cuetos 1991a, among others.