Prosody and the Production of Ambiguous Relative Clauses in French

Amanda Edmonds[1,2], Audrey Liljestrand Fultz[1], and Jason Killam[3]

Departments of French & Italian[1], Linguistics[2], and Spanish & Portuguese[3]
Indiana University
amaedmon@indiana.edu

Abstract

When we hear the sentence *he respects the butcher of the doctor who gains weight each year*, it is not clear whether the appreciated butcher has put on weight or whether it is the doctor who is a bit heavier. Without additional information, the attachment of the relative clause (RC) is ambiguous, a case of structural ambiguity that is found in many languages, including English and French. Although such phrases are usually disambiguated by context, it has been shown that speakers and listeners can disambiguate several structural ambiguities by prosodic means [1]. Yet, this body of literature has concentrated almost exclusively on the ambiguity resolution of a small set of structures in English. The current study examines the prosodic strategies of final lengthening and F0 rise used to disambiguate the attachment of a RC to a complex noun phrase (NP) as employed by three native speakers (NS) of both Hexagonal and Quebecois French. Participants completed two tasks, one in which the intended interpretation of the RC was indicated through context and the other a more explicit minimal pairs task. Almost all participants employ a similar pattern of final lengthening to differentiate between the two interpretations of the RC, whereas results from F0 rise are mixed, with several patterns emerging.

1. Introduction

A large number of studies on the disambiguation of structurally ambiguous phrases in English have shown that prosodic means of marking boundaries constitute an efficacious disambiguation strategy, which is employed by speakers and interpretable by listeners [1], [2]. However, this generalization only seems to be valid when the two meanings of an ambiguous sentence differ only by the placement of a syntactic boundary [1], [3]. In such sentences, it has been shown that prosody (most often by means of final lengthening and boundary tone phenomena) can be used to express one of two meanings, and that this is done by highlighting the position of the syntactic break that differentiates the two interpretations. Although the use of prosody in structural disambiguation boasts of a rich literature, several gaps remain. First, the majority of the existing literature examines English. Additionally, several structural ambiguities have not yet been researched in terms of their prosodic disambiguation. These two gaps motivated the current project, in which the prosodic strategies for disambiguation of RC attachment to a complex NP in the production of two varieties of French are examined.

2. Literature review

Two studies on English were among the first to examine the role of prosody in structural disambiguation [1, 3]. Both examined a wide range of ambiguities and results from the production and perception experiments showed that prosodic strategies could not successfully disambiguate all the ambiguous structures tested. Listeners were successful in identifying the intended interpretation only for those items for which the placement of a syntactic boundary was responsible for the ambiguity. In what follows, those experiments that have examined such ambiguities (including attachment ambiguities, the object of this study) are considered.

2.1. Prosodic disambiguation

Both the perception and the production of prosodic disambiguation have been the subject of past studies. With respect to perception, it has been shown that NSs of English are sensitive to the manipulation of the duration of pauses and syllables in resolving attachment ambiguities [4] and conjunction ambiguities [5]. NSs of English have also been shown to respond to changes in F0 when resolving attachment ambiguities [4, 6], including RC attachment [7]. In other words, changes in prosody (operationalized as durational or intonational changes) consistently lead NSs of English to different interpretations of structurally ambiguous phrases. A similar finding was reported for French [8], in which evidence of durational cues disambiguating preposition attachment appeared in RT measures of syntactic processing.

Although the speech signals used in the preceding perception studies were synthetically altered, there exist several studies that began by examining (controlled) production before presenting the naturally produced items to listeners. For English, these studies demonstrate that for each of the interpretations of a structurally ambiguous phrase, speakers produce distinct durational and intonational patterns (particularly in more controlled, decontextualized tasks), and that listeners' interpretation of these patterns match the intended interpretation of the speaker [2, 9].

2.2. RCs and prosody in French

Given the sentence in (1), it is not clear whether the banker or the stylist is returning from Japan.

Luc accuse le banquier du coiffeur qui revient du Japon   (1)
"Luc accuses the banker of the stylist who returns from Japan"

Although the potential prosodic strategies that speakers of French use and that listeners interpret in differentiating the two interpretations have not been empirically studied, their existence has been invoked in the sentence processing literature in an attempt to explain a well-known cross-linguistic difference [10]: Whereas speakers of English are generally shown to prefer attachment of an ambiguous RC to the second noun (N2) of a complex NP, results for speakers of French generally show a preference for attachment to the first noun (N1). However, at least for French, results are not entirely consistent, with some studies showing preference for

attachment to N1 [11] and others finding evidence for initial N2 attachment [12]. In the face of these results, Fodor [10] suggested that some of the confusion may be due to the uncontrolled effects of prosody. Specifically, Fodor claims that default prosodic structures can bias certain ambiguity resolutions. With respect to French, she suggests that all right-branching complements project their own prosodic constituent. Thus, the syntactic boundary preceding the RC generally coincides with a prosodic boundary ([N1 *de* N2] [RC]). This coincidence facilitates attachment of the RC to N1, whereas the lack of such a default prosodic boundary—[N1] [*de* N2 RC]—presumably encourages interpretation of the RC with N2. If correct, this prosodic pattern has interpretative effects visible in sentence processing experiments (explaining the general N1 preference found for French) and may conceivably influence the production of such ambiguous phrases.

As discussed in the previous subsection, studies have shown that prosodic disambiguation of structurally ambiguous phrases is generally accomplished by the displacement of syntactic boundaries, with the boundary phenomena for the language under investigation marking this change. Analyses of French boundary phenomena have shown that French tends to mark the right edge of prosodic groups located within the utterance with both duration and F0 differences [13], [14]. Specifically, the final full (non-schwa) syllable before a prosodic break is expected to show both lengthening effects and a F0 rise. Thus, if a prosodic break is located by default before a right-branching constituent (like a RC) in French, we can expect both durational and intonational cues to mark this boundary. Similarly, we can expect to find the same cues before a syntactic boundary displaced in an attempt to convey a different interpretation.

3. Method

Three NSs of Quebecois French and three NSs of Hexagonal French completed two tasks. There were two females and one male in each group. All were graduate students at a large mid-western University in the United States.

Twenty experimental items with the form subject + main verb + article N1 + of N2 + complementizer and subordinate verb + adjunct were designed for use in two tasks (one contextualized, one minimal pair). Each of these items was structurally ambiguous (and was thus read two times in each task). For each sentence, the number of syllables in the critical region—article N1, of N2, complementizer and subordinate verb—was kept constant. All nouns in the complex NP referred to professions. Moreover, the order of the nouns in the complex NPs was counterbalanced. Both tasks were recorded using Audacity at a sampling rate of 44,000 Hz.

In task 1, each of the 20 items was paired with two disambiguating contexts (one requiring attachment of the RC to N1, the other to N2). The order of items was randomized. There was always a unique plausible referent in the context for the common noun not modified by the RC, whereas there were multiple plausible referents in the context that satisfied the denotation of the noun modified by the RC. Participants silently read each context and a follow-up question designed to draw their attention to the relationship between N1 and N2 (e.g., Who does Luc accuse?). The experimental item was then read aloud. Finally, the participants were asked to respond to a comprehension question concerning the attachment of the RC (e.g., Who returns from Japan?). Only those items for which the correct answer to this comprehension question was provided were analyzed.

Task 2 was a minimal pairs task. For each pair, the two sentences were segmentally identical, although the intended interpretation differed; each item appeared twice, with the desired interpretation (N1 or N2 attachment) indicated in parenthesis. Participants read both members of a pair aloud.

A total of 195 sentences were analyzed for task 1 and 240 for task 2. With the help of Wavesurfer, two measurements of duration and four F0 measurements were taken for each sentence. For duration, the length of the final full vowel of N1 and N2 including any following coda or pause was determined. Each measurement ended before the onset of the following plosive consonant, providing a global measure of duration. F0 rise on the same syllables was also calculated. The valley preceding the final syllables of N1 and N2 as well as the peak on the target syllables were located and measured. The difference between the peak and the valley is used to represent F0 rise on the target syllables.

4. Hypotheses

Hypothesis 1. It is expected that participants will more clearly differentiate between the two interpretations on the more explicit, decontextualized task 2 [9].

Hypothesis 2. It is expected that participants will use prosodic boundaries in order to express different interpretations of the RC. We expect that these boundaries will be marked by final lengthening. For an interpretation of the RC as modifying N1, a boundary will be placed before the RC and, thus, the final syllable of N2 will be lengthened with respect to the final syllable of N1: [N1 de N2] [RC]. For modification of N2, the boundary will occur after N1, which will be subject to the effects of final lengthening: [N1] [de N2 RC].

Hypothesis 3. Participants are expected to differentiate between the two interpretations of the RC by manipulating the placement of syntactic boundaries. It is expected that participants will use F0 rise to mark the right edge of these boundaries. When the RC modifies N1, the boundary will be placed after N2 and the F0 rise on its final syllable will be greater than the rise on N1 in the same sentence: [N1 de N2] [RC]. For modification of the N2, the boundary will be placed after N1 and, in this case, greater F0 rise will be found on the final syllable of N1: [N1] [de N2 RC].

5. Results

For each participant on each of the two tasks, the duration and F0 rise measurements were subjected to a paired comparison *t*-test. The independent variable was interpretation of the RC with N1 or N2. For each sentence, the durational and F0 rise measurements taken on the second noun were subtracted from those taken on the first. Sentences were separated by interpretation and the differences then compared in order to determine if the prosodic realizations (duration and F0 rise) differed for a given speaker within a given task according to interpretation.

5.1. Duration

On the contextualized task, one female Quebecois French speaker (QF1) and one female Hexagonal French speaker (HF1) significantly differed between the two RC attachments with their lengthening of the final syllables of N1 and N2. The

patterns for both of these speakers matched those described in hypothesis 2. In the minimal pairs task, all six speakers used duration cues at a significant level to distinguish between the two interpretations. For five of the six participants, the observed patterns matched exactly those described in hypothesis 2. For the male Quebecois speaker (QM1), a different strategy was apparent: Phrases in which the RC was interpreted with N1 were pronounced significantly more slowly than those that required interpretation of the RC with N2. Table 1 presents the mean duration of the final syllables of N1 and N2 according to attachment on the two tasks.

Table 1: *Mean duration (in ms) of the final syllables of N1 and N2 by interpretation*

Speaker	N1 attachment		N2 attachment	
	N1	N2	N1	N2
HF1				
Task 1*	244	397	302	229
Task 2*	226	491	350	221
HF2				
Task 1	330	395	281	278
Task 2*	456	424	383	181
HM1				
Task 1	188	376	200	438
Task 2*	255	494	386	208
QF1				
Task 1*	198	343	296	290
Task 2*	209	426	546	230
QF2				
Task 1	233	202	222	225
Task 2*	249	284	284	245
QM1				
Task 1	231	257	244	229
Task 2	313	350	195	195

Note. * *indicates significant difference (p < .05) between the two interpretations.*

5.2. F0 rise

On the contextualized task, only one of the six participants (QF1) came close to significantly distinguishing between the two interpretations using F0 rise, $t(13) = -2.118$, $p = .054$. Moreover, this speaker's pattern matched the predictions in hypothesis 3. On the minimal pairs task, four of the six participants showed significantly different F0 rise patterns as a function of interpretation. The pattern for two of these participants (HM2 and QF1) follows precisely what was described in hypothesis 3. HF1 and QF2, however, chose a different strategy. Both speakers produced a significantly greater F0 rise on the noun to which the RC was intended to attach. In other words, for a N1 attachment, the F0 rise on N1 was greater than the F0 rise on N2. This pattern is reminiscent of strategies described by [7] for English focus and runs contrary to the expectation that F0 rise would be used to mark boundaries (and, as such, would go hand in hand with final lengthening). Thus, for both of these speakers, their F0 rise data on task 2 run counter to the predictions made in hypothesis 3 and appear to be at odds with their final lengthening data (which supported the predictions of hypothesis 2). The final two speakers (HF2 and MF1) showed no difference in F0 rise according to interpretation. Table 2 presents the average F0 rise for all six participants.

Table 2: *Average F0 rise (in Hz) on the final syllables of N1 and N2 by interpretation*

Speaker	N1 attachment		N2 attachment	
	N1	N2	N1	N2
HF1				
Task 1	70	92	68	62
Task 2*	105	58	59	74
HF2				
Task 1	37	83	55	81
Task 2	4	82	60	96
HM2				
Task 1	32	51	37	51
Task 2*	37	44	59	34
QF1				
Task 1*	68	109	67	74
Task 2*	52	118	135	111
QF2				
Task 1	138	143	141	134
Task 2*	201	152	183	194
MF1				
Task 1	25	26	26	28
Task 2	28	28	22	26

Note. * *indicates significant difference (p < .05) between the two interpretations; bold-face indicates a significant pattern than runs contrary to the predictions of hypothesis 3*

6. Discussion

6.1. Hypothesis 1

The first hypothesis predicted an asymmetry between the context-based task 1 and the artificial and explicit minimal pairs task (task 2), insofar as prosodic differences were expected to be more clearly made in the second task. This hypothesis was supported by the data from both the Hexagonal and Quebecois speakers. Whereas all speakers used duration in a statistically significant way in differentiating between the two interpretations in task 2, only two speakers did so in task 1. As for F0 rise, only one speaker came close to significantly distinguishing between the two RC attachments in task 1, whereas four adopted a significantly different F0 rise pattern in task 2. In the first task, the contexts indicated to participants which RC attachment was required and the order of the items was randomized; in the second, this attachment was explicitly stated and items were read in pairs. The significant patterns discovered appeared almost exclusively on the more artificial minimal pairs task. That said, the results demonstrate that the participants are capable of acoustically disambiguating structurally ambiguous sentences, and often in such a way that matches predictions made on the basis of theoretical descriptions of the prosodic system under investigation. However, it is not clear from these results that this ability is employed as a strategy in authentic speech situations.

6.2. Hypothesis 2

The second hypothesis assumed that prosodic disambiguation of the experimental items would involve prosodic marking of displaced syntactic boundaries ([N1 de N2] [RC] for N1 attachment and [N1] [de N2 RC] for N2 attachment) and, as such, predictions were made concerning the resultant lengthening effects depending on the positions of these boundaries. Although less robust in task 1 (where only 2 of 6 participants reached significance), on task 2, five of the six

participants showed a significant difference that matched the predicted pattern. Only QM1, who seemed instead to rely on a global lengthening strategy (phrases were significantly longer when the RC attached to N1), did not show the predicted pattern. Thus, overall, it appears that final lengthening was used to disambiguate RC attachment in accordance with the predictions of hypothesis 2.

6.3. Hypothesis 3

Like hypothesis 2, hypothesis 3 presumed that displaced syntactic boundaries would be used by speakers to differentiate between RC attachments. Following descriptions of boundary marking in French, hypothesis 3 predicted that F0 rise would occur on the final full syllable before the prosodic break. Although it was expected that the findings for hypothesis 3 would be similar to those reported for hypothesis 2, the findings for the two prosodic phenomena diverge; in this dataset, F0 rise and final lengthening do not pattern as closely together as predicted. Specifically, only one of the six speakers showed near-significantly different F0 rises on the final syllables of N1 and N2 by interpretation on task 1. Although four speakers on task 2 significantly modified F0 rise as a function of interpretation, patterns from only two of these speakers (QF1, HM1) matched the predictions. For the other two speakers (QF2, HF1), the greater F0 rise occurred on the final syllable of the noun to which the RC was intended to attach (as opposed to on the final syllable preceding the presumed prosodic break). Thus, for QF2 and HF1, data from final lengthening corresponded to the predictions, whereas F0 rise data did not. This divorce between F0 rise and final lengthening suggests that, at least in these sentences, these particular speakers are employing the two prosodic phenomena for different ends: final lengthening is the faithful marker of the right edge of a prosodic constituent, whereas F0 rise may correspond to a focal accent ([15] mentions the presence of focal accent in French).

Whereas the patterns for final lengthening were consistent across speakers, the same cannot be said of F0 rise. In task 2, two speakers (QM1, HF2) show no significant differences in F0 rise by interpretation, two speakers seem to use F0 rise as a sort of focal accent (QF2, HF1), and the data from two speakers were in line with the predictions from hypothesis 3 (QF1, HM1).

7. Conclusions

The purpose of this study was to investigate the prosodic strategies (final lengthening and F0 rise) employed by speakers of two varieties of French in the structural disambiguation of RCs whose attachment site is ambiguous. To this end, disambiguation strategies were predicted and these predictions guided our hypotheses as well as the subsequent acoustic analyses. The results from these analyses revealed that all participants were able to acoustically disambiguate the two attachments, although most were only able to do so on the more explicit task. Moreover, final lengthening was used by more of the speakers than was F0 rise, and almost all speakers shared the same pattern of final lengthening (the pattern consistent with our prediction). F0 rise, on the other hand, was used less often by the participants, and at least three different F0 rise patterns are in evidence in these data. Additionally, the presence of a significant difference between the two interpretations on the basis F0 rise was always accompanied by a significant

difference on the basis of final lengthening. However, final lengthening differences were found independent of interpretation-based differences in F0 rise. Finally, although two different varieties of French are represented in these data, prosodic disambiguation strategies for RCs do not appear to differ on the basis of this variable.

8. References

[1] Lehiste, I., 1973. Prosodic disambiguation of syntactic ambiguity. *Glossa* 7, 107-121.

[2] Van Lancker, D.; Canter, G. J.; Terbeek, D., 1981. Disambiguation of ditropic sentences: acoustic and phonetic cues. *Journal of Speech and Hearing Research* 24, 330-335.

[3] Lehiste, I.; Olive, J. P.; Streeter, L. A., 1976. Role of duration in disambiguating syntactically ambiguous sentences. *The Journal of the Acoustical Society of America* 40, 1199-1202.

[4] Kjelgaard, M. M.; Speer, S. R., 1999. Prosodic facilitation and interference in the resolution of temporary syntactic closure ambiguity. *Journal of Memory and Language* 40, 153-194.

[5] Scott, D., 1982. Duration as a cue to the perception of a phrase boundary. *Journal of the Acoustical Society of America* 71, 996-1007.

[6] Marslen-Wilson, W. D.; Tyler, L. K.; Warren, P.; Grenier, P.; Lee, C. S., 1992. Prosodic effects in minimal attachment. *The Quarterly Journal of Experimental Psychology* 45A, 73-87.

[7] Schafer, A.; Carter, J.; Clifton, C., Jr.; Frazier, L., 1996. Focus in relative clause construal. *Language and Cognitive Processes* 11, 135-163.

[8] Pynte, J.; Prieur, B., 1996. Prosodic breaks and attachment decisions in sentence parsing. *Language and Cognitive Processes* 11, 165-191.

[9] Van Lancker, D.; Canter, G. J., 1981. Idiomatic versus literal interpretations of ditropically ambiguous sentences. *Journal of Speech and Hearing Research* 24, 64-69.

[10] Fodor, J. D., 2002. Prosodic disambiguation in silent reading. In M. Hirotani (ed.), *Proceedings of the North East Linguistic Society 32* (Vol 1, pp. 113-132). GSLA, University of Massachusetts, Amherst.

[11] Pynte, J.; Colonna, S., 2000. Decoupling syntactic parsing from visual inspection: the case of relative clause attachment in French. *Reading as a Perceptual Process*, In A. Kennedy; R. Radach; D. Heller; J. Pynte (eds.). Oxford: Elsevier. 529-547.

[12] Baccino, T.; De Vincenzi, M.; Job, R., 2000. Crosslinguistic studies of the late closure strategy: French and Italian. In *Crosslinguistic Perspectives on Language Processing*, M. De Vincenzi; V. Lombardo (eds.). Dordrecht, The Netherlands: Kluwer, 89-118.

[13] Jun, S.-A.; Fougeron, C., 2002. Realizations of accentual phrases in French intonation. *Probus* 14, 147-172.

[14] Vaissière, J.; Michaud, A., 2006. Prosodic constituents in French : A data-driven approach. In *Prosody and Syntax*, I. Fonagy, Y. Kawaguchi, T. Moriguchi (eds.). Amsterdam : Benjamins, 47-64.

[15] Gabriel, C. 2003. Signaling focus in Spanish and French double object constructions. In *Nouveaux departs en phonologie*, T. Meisenburg, M. Selig (eds.) Tiibingen: Niemeyer, 183-198.