THE INTONATIONAL PHRASE CONSTRAINS CODA DEVELOPMENT IN EP*

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1. Introduction

It is a well-known fact that prosody is acquired at a very early stage (see, Gerken 1996, Morgan & Demuth 1996, Christophe et al 2003a, 2003b, Peperkamp 2003, Prieto & Bosch-Baliarda 2006, a.o.). However, to our knowledge the potential relevance of higher-level prosodic structure to syllable development has not attracted the attention of researchers. The goal of this chapter is to show, based on empirical evidence from a case study, that the intonational phrase (IP) plays a key role on the emergence of codas in European Portuguese (EP).

There are several studies on the acquisition of codas in EP. In Freitas 1997, it was shown that among coda consonants fricatives emerge first, followed by the lateral and final the flap. Combining the position in the syntactic word with the emergence of the segments, in Correia 2004 the following order of emergence is put forward: fricative > final flap > final and internal lateral > internal flap.

As far as we know, the prosodic structure at the word level and above the word level has not been the focus in acquisition studies of EP and thus it is largely known whether and what prosodic conditions may trigger or favour different aspects of phonological development. Recent studies on the acquisition of prosodic structure (Frota & Vigário 2008, Frota & Matos 2009) have proposed a path of development along three stages: first each syllable is treated as a prosodic word (PW) and a prosodic phrase; in the second stage, syllables do not coincide with PWs, but each PW is still a prosodic phrase; finally, in the third stage, PWs and prosodic phrases are treated differently.

For EP adult speech, prosodic structure has been described in literature, as follows (only the relevant aspects for the present study are mentioned; see Frota 2000, in press, and Vigário 2003 for further details). Prosodic words contain only one stress and incorporate enclitics, with proclitics being adjoined. Phonological Phrases (PhP) contain a lexical head and all elements to the left inside Lex^{max}, and may also contain a nonbranching complement of the head. Intonational Phrases

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(IP) usually correspond to the domain of a root sentence, but are strongly constrained by length effects.

This chapter is structured in three sections. After this introduction, we briefly describe the methods and procedures followed in data collection and analysis. The next section presents and discusses the main findings. The chapter ends with a summary and conclusion.

2. Methods

The corpus under analysis consists of a linguistic diary database of spontaneous production data (LumaLiDa, www.fl.ul.pt/laboratoriofonetica/lumalidaon.htm) of one child from 1;05 to 3;03. Among the special features of this database is the *online* phonetic transcription of the child utterances made by its parents, both experienced phoneticians. The database has 6 426 utterances and 18 496 words, and is freely available for research.

The database provided 5 535 utterances with at least one coda in the target, and for each of these utterances prosodic phrasing was annotated on the basis of the description of prosodic structure in EP (Frota 2000, in press; Vigário 2003, 2009), together with insights from work where temporal and intonational properties of the early speech of the same child have been inspected (Frota & Vigário 2008, Frota & Matos 2009). Importantly, the analysis of temporal and intonational properties has showed that, for this child, until 1;04 syllables, PWs and prosodic phrases coincide, whereas after 1;04 there is a different treatment of syllables and PWs, and after 1;08 a different treatment of PWs and prosodic phrases.

The crucial domains for our prosodic analysis were the PW, the PhP and IP. All occurrences of coda segments in the target were marked and their actual production by the child analysed. The position of the target syllable as initial, internal or final in the PW, PhP and IP were considered, as well as its position relative to PW stress and the two levels of phrasal stress (PhP and IP). The potential relevance of each of these prosodic factors for coda production was inspected by means of descriptive statistics, as well as by the application of a model of binary logistic regression.

To check the meaningfulness of the prosodic analysis undertaken, the size of PWs and utterance length were computed. In the *corpus*, 78% of all PWs have more than one syllable (of which 68% are disyllabic and 32% have 3 or more syllables), and 88% of all utterances contain more than one PW.

The child's utterances were divided in codaless utterances, in utterances containing repair strategies (RS) and in utterances with produced codas (CP). We considered the utterances codaless whenever there was no (visible) attempt to produce the coda segment. RS were marked to be present whenever the child does not produce the coda segment, but its presence is somehow signalled in the output

by a change like an insertion, substitution, lengthening, etc. CP were considered whenever the coda consonant is produced (even if the consonant is not fully target-like, i.e., if the fricative is anterior or if the lateral is not dark). In this chapter only RS and CP data were analysed, corresponding respectively to 919 cases and 354 cases, which is to 23% of all the target codas.

3. Results and Discussion

In EP, the segments that may occupy the coda position are the fricative (here represented by /S/) and the liquids /l/ and /ɾ/. The distribution of these coda segments in the *corpus* is 58,12% for fricatives, 35,07% for the flap and 6,81% for the lateral. Half of the target codas in the corpus occur in unstressed syllables, and codas are evenly distributed among the prosodic positions under analysis, in particular at the PhP and IP levels.

The child started to use Repair Strategies (RS) at 2;02. A longitudinal analysis showed that RS increased at 2;04, and tend to fall progressively over age (Figure 1). Recall that at this age the child is already at stage 3 of prosodic structure development (according to Frota & Vigário 2008, Frota & Matos 2009).

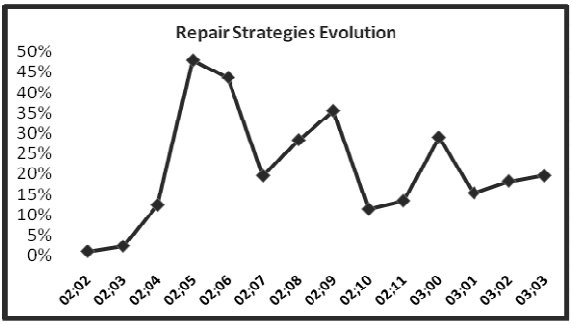

Figure 1 - Repair Strategies Evolution

RS affect especially the liquids, as shown in Figure 2. The fricative and the flap switched positions in the rank of occurrences relative to the whole corpus and the lateral more than doubles its percentage. The different distribution in RS compared to that of the entire *corpus* could imply that segment type triggers RS. However, this is not the case, as the analysis of the effect of prosodic factors in RS production will show.

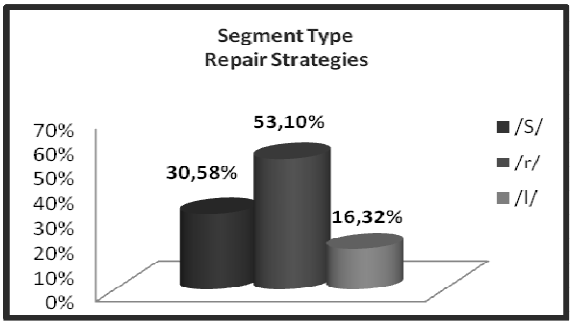

Figure 2. RS – Segment type

Also unlike the general distribution of target codas in the *corpus*, RS occur mainly at prominent positions and especially at IP boundaries, as may be seen in Figures 3 and 4.

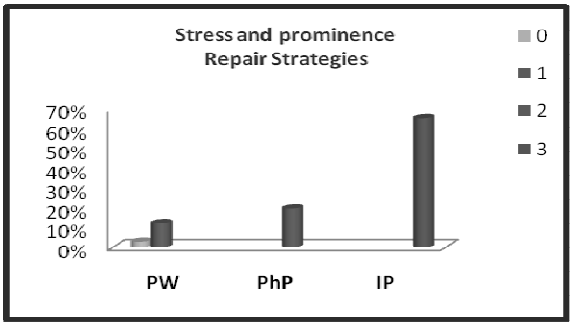

Figure 3. RS – Stress and prominence: 0-stressless, 1-stressed, 2-PhP head; 3-IP head

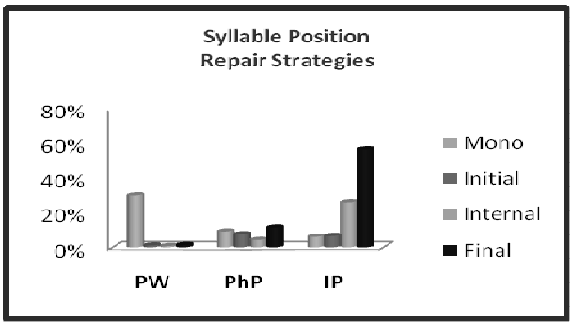

Figure 4. RS – Position of the syllable in PW, PhP and IP

The examples in (1)-(3) illustrate these facts.

(1) [ˈkɛɾu deˈtami//ˈkɛɾu deˈtai] 02;11.11
[[(quero)$_{\omega}$ (deitaR-me)$_{\omega}$]$_{\varphi}$]$_{I}$ [[(quero)$_{\omega}$ (deita**r**)$_{\omega}$]$_{\varphi}$]$_{I}$
(I want to lie down (myself); I want to lie down)

(2) [ˈkɛɾu ˈsɔ ˈve u ʁniˈmaʒ**i**] 02;11.11
[[(quero)$_{\omega}$]$_{\varphi}$] [(só)$_{\omega}$ (veR)$_{\omega}$]$_{\varphi}$] [(os (animai**s**)$_{\omega}$)$_{\omega}$]$_{\varphi}$]$_{I}$
(I just want to see the animals)

(3) [ˈnɐ̃w̃ ˈfa ˈma**l**i] 03;01.09
[[(não)$_{\omega}$ (faZ)$_{\omega}$ (ma**l**)$_{\omega}$]$_{\varphi}$]$_{I}$
(It doesn't hurt)

Note the presence of RS in stressed syllables at IP final position, whereas codas in stressed syllables that are not IP final do not show RS.

The relevance of prominence and of the IP final position was confirmed by the binary logistic regression results: prosodic prominence by itself explains 82% of RS production, and prominence and IP final position together account for 87% of the data (Table 1). The reason why liquids are favoured in RS relative to fricatives is simply due to their distribution relative to prominence: both in the target utterances in the *corpus* and in adult speech data (Frota, Vigário, Martins & Cruz, in progress), coda liquids occur mostly in stressed position while coda fricatives occur mostly in unstressed syllables. Therefore, the child is not treating segments differently in RS production. As prominence is a key factor for RS, the segments affected are naturally those that appear in the language in a prominent position.

Table 1. RS – Classification Table

Observed			Predicted		
			Coda status		Percentage Correct
			0	1	
Step 1	Coda status	0	4258	0	100,0
		1	919	0	,0
	Overall Percentage				82,2
Step 2	Coda status	0	3953	305	92,8
		1	372	547	59,5
	Overall Percentage				86,9
Step 3	Coda status	0	3915	343	91,9

		1	318	601	65,4
	Overall Percentage				87,2
Step 4	Coda status	0	3909	349	91,8
		1	309	610	66,4
	Overall Percentage				87,3
Step 5	Coda status	0	3913	345	91,9
		1	301	618	67,2
	Overall Percentage				87,5

a. Variable(s) entered on step 1: Prominence.

b. Variable(s) entered on step 2: IP position.

c. Variable(s) entered on step 3: PhP position

d. Variable(s) entered on step 4: Segment type.

e. Variable(s) entered on step 5: PW position.

The child started to produce codas at 2;08 and coda production quickly increases from 3;00 onwards (Figure 5). 92,37% of the codas produced are fricatives, 6,50% are laterals and only 1,13% are flaps. In adult speech, more than 90% of the occurrences of the palatal fricative happen in coda position, whereas only 25% to 35% of the occurrences of liquids happen in a coda (Vigário, Frota & Martins 2009). This emergence of the fricative as the first type of coda, which is in line with previous results reported in the literature, is thus consistent with a frequency effect present in the input language.

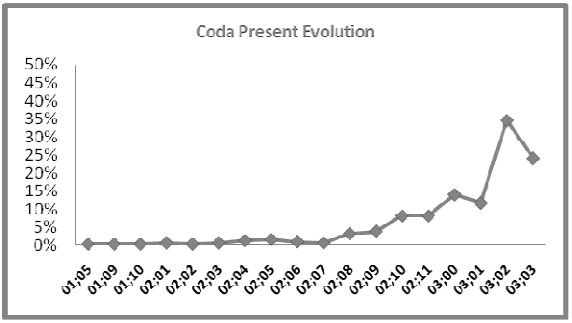

Figure 5. Coda Production Evolution

The prosodic analysis of produced codas (CP) revealed different results from RS. Most of CP occurred in unstressed syllables, showing that prominence is not a

relevant factor for coda production (Figure 6). Interestingly, among produced codas, coda fricatives dominate in unstressed position while coda laterals (and flaps) appear in stressed position. This clearly indicates that prominence is irrelevant for coda production and the pattern fricative-unstressed / liquid-stressed simply follows the general distribution of the language.

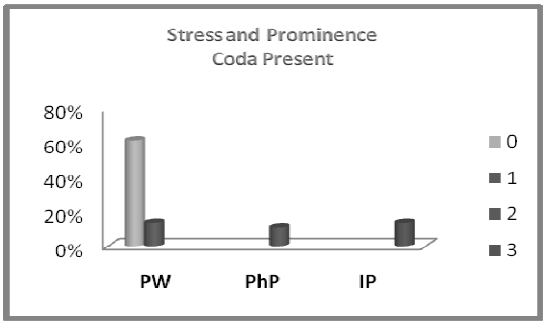

Figure 6. CP – Stress and prominence: 0-stressless, 1-stressed, 2-PhP head; 3-IP head

Unlike prominence, the IP final position is again a crucial factor: nearly 50% of produced codas occur in this prosodic position (Figure 7).

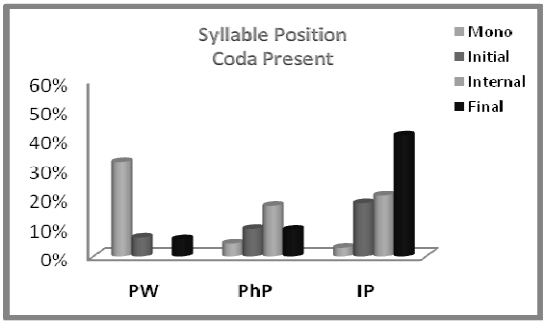

Figure 7. CP – Syllable Position

Illustrative examples of these patterns in coda production are given in (4) to (8).

(4) [ũ kɐvɐˈliɲu nu ˈsew kɐlɔˈsɛ**l**] 02;09.23

[[(um (cavalinho)$_{\omega}$)$_{\omega}$]$_{\varphi}$ [(no (seu)$_{\omega}$)$_{\omega}$ (carrosse**l**)$_{\omega}$]$_{\varphi}$]$_{I}$

(A little horse in its merry-go-round)

(5) [ˈsaj kõ ˈɔkɔ**ɬ**] 03;03.14

[[(sai)$_{\omega}$]$_{\varphi}$ [(com (álcoo**l**)$_{\omega}$)$_{\omega}$]$_{\varphi}$]$_{I}$

(Alcohol will clean it)

(6) [ˈɔʌɐ u pɐˈtiɲuʃ] 03;03.08

[[(olha)$_{\omega}$]$_{\varphi}$ [(os (patinhos)$_{\omega}$)$_{\omega}$]$_{\varphi}$]$_{I}$

(Look at the ducks)

(7) [u pɐˈtiɲu pikiˈninuʃ] 03;03.08

[[(oS (patinhoS)$_{\omega}$)$_{\omega}$]$_{\varphi}$ [(pequeninos)$_{\omega}$]$_{\varphi}$]$_{I}$

(The little ducks)

(8) [ˈvɐmu buˈka ɐ lɐ̃ˈtɛnɐʂ] … [ɐ lɐ̃ˈtɛnɐʂ] // [ˈvɐmu buˈka ɐ lɐ̃ˈtɛnɐʂ]

[[vamoS buScaR)$_{\omega}$]$_{\varphi}$ [aS lanteRnas]$_{\varphi}$]$_{I}$ [[aS lanteRnas]$_{\varphi}$]$_{I}$

[[vamoS buScaR]$_{\varphi}$ [aS lanteRnas]$_{\varphi}$]$_{I}$ 03;02.10

(Let´s get the torches, the torches, let´s get the torches)

Examples (4)-(5) shows a lateral coda produced respectively in a stressed and unstressed syllable in IP final position. Examples (6)-(7) are two utterances produced in a row: in (6), the word *patinhos* ('ducks') is IP final whereas in (7) the same word is in IP medial position. The child only produces the coda in IP final position. In (8) we have an utterance divided into three IPs. The whole utterance comprises 15 codas, but the child only produces those three in IP final position.

Table 2. CP – Classification Table

Observed			Predicted		
			Coda status		Percentage Correct
			0	1	
Step 1	Coda status	0	4258	0	2,25
		1	354	0	,0
	Overall Percentage				92,3
Step 2	Coda status	0	4258	0	100,0
		1	354	0	,0
	Overall Percentage				92,3
Step 3	Coda status	0	4232	26	99,4
		1	346	8	2,3
	Overall Percentage				91,9
Step 4	Coda status	0	4229	29	99,3
		1	342	12	3,4
	Overall Percentage				92,0

Step 5	Coda status	0	4224	34	99,2
		1	337	17	4,8
	Overall Percentage				92,0

a. Variable(s) entered on step 1: IP position

b. Variable(s) entered on step 2: Segment type.

c. Variable(s) entered on step 3: PW position.

d. Variable(s) entered on step 4: PhP position

e. Variable(s) entered on step 5: Prominence.

These results were confirmed by the binary logistic regression analysis (Table 2), which showed that the prosodic variable *position in the IP*, by itself, accounts for 92,3% of the data.

4. Conclusions

It was established that repair strategies, as a stage in coda development, emerge at prosodic phrase edges and in prominent positions, especially in the stressed syllable of the head of the Intonational Phrase which is also at the IP-edge. In line with previous results (Freitas 1997, Correia 2004), fricatives are the first codas to be produced. This precedence of fricatives relative to liquids correlates nicely with the frequency patterns of coda segments in the input language, and may thus be seen as a frequency effect. It was shown that produced codas emerge at prosodic phrase edges, but unlike repair strategies produced codas are not subject to prominence requirements. Importantly, the prosodic edge effect is not incremental: IP final position is clearly the main prosodic factor that triggers early coda production.

To our knowledge, there are not other studies that relate the development of codas with prosodic structure from the prosodic word to the intonational phrase. The present findings are based on a case study, and thus further work is needed to extend the empirical coverage and pursue the challenge of data replication. Nevertheless, these findings, for their clarity and novelty, add new data to the understanding of prosodic structure as a constraining factor for phonological acquisition.

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