

The acquisition of Onset clusters in European Portuguese¹

M. JOÃO FREITAS

Abstract

In this paper, we observe the productions of seven monolingual Portuguese children in order to account for the acquisition of Onset clusters in European Portuguese. The results will be compared with results from other languages, with a specific reference to the acquisition of Dutch. Although similar initial stages between the two groups of children were found, the final stages reveal significant differences. Our analysis will then focus on the dissimilarities exhibited by the Portuguese children, with special reference to the vowel epenthesis strategy, which is frequently attested in Portuguese children's productions, although infrequent in the data reported in previous studies of phonological acquisition.

1. Introduction

The research on the acquisition of syllable structure in the last decade has been mainly concerned with (i) identifying the order of acquisition of syllabic constituents, (ii) defining relations between syllabic constituency and segmental emergence and (iii) testing the adequacy of formal linguistic tools for building developmental scales that are able to account for children's behaviour

1. The database used in this paper was taken from a project on the acquisition of EP (PCSH/C/LIN/524/93), developed at the Laboratório de Psicolinguística – Universidade de Lisboa. This research is component of the project FCT/FEDER.POCTI/33277/LIN/2000. I am grateful to Paula Fikkert, Maria Helena Mateus, Tania Zamuner and the three anonymous *Probus* reviewers for their comments and suggestions. All errors are, of course, my responsibility.

(cf. Fikkert 1994, Demuth 1995, Fee 1995, Lleó and Prinz 1996, Miranda 1996, Stemberger 1996, Barlow 1997, Freitas 1997, Goad 1997, Fikkert and Freitas 1998, Grijzenhout and Joppen 1998, Mezzomo 1999, Rose 2000, among many others). In this paper, and following the goals mentioned above, we examine monolingual Portuguese children's productions in order to account for their acquisition path of target Onset clusters.

We will observe that, at the initial stage of production, Portuguese children tend to reduce Onset clusters to a single skeletal position, as attested in the acquisition of other target systems. However, unlike children acquiring other languages, Portuguese children exhibit different intermediate strategies before they reach the target form. We will therefore specifically focus on describing and accounting for the different behaviour attested in Portuguese children's productions of target Onset clusters.

The study of Onset clusters in the acquisition of European Portuguese (EP) will allow us to explore the interaction between segments and syllabic constituents and to discuss the relations between adjacent phonological levels in acquisition. The issue of segmental and syllabic constraints' interaction in the path of acquisition is part of a larger topic concerning the identification of both orders of emergence and types of relations between different structures in the grammar. Since a theory of acquisition has to be able to make predictions on the order of emergence of linguistic structures, the question concerning the relations between segmental material and syllabic constituency in the child's system is whether (i) the acquisition of syllabic constituents constrains the segmental emergence (a 'top-down' model) or (ii) the emergence of segments constrains the development of syllable structure (a 'bottom-up' model). In Sections 5 and 6, we will discuss this topic based on the Portuguese children's data.

The 'Onset-Rhyme' approach within Syllable Theory provides us with the tools for data description and analysis in this paper (Fudge 1969, Selkirk 1982, McCarthy and Prince 1986, among others).

2. The problem

From the set of possible syllabic constituent shapes considered within the 'Onset-Rhyme' approach (Onset, Rhyme, Nucleus and Coda, all with branching and non-branching shapes), previous research has argued that the branching Onset is the last one to become stable in the path of acquisition (Fikkert 1994, Fee 1995, Lleó and Prinz 1996, Freitas 1997, among others). The contrast between the production strategies used by Portuguese children and the ones mentioned in the literature raises a number of questions that we will explore in this paper.

The initial question is a general one concerning the way Portuguese children acquire target branching Onsets. Assuming that children's productions go from simple to more complex linguistic structures, the initial hypothesis is that non-branching Onsets will become available before branching ones. Moreover, if branching Onsets are not yet available in the child's system, the output of a target branching Onset will be a non-branching Onset. As demonstrated below (cf. Section 5), this hypothesis is confirmed by data from the acquisition of EP and matches similar results from Dutch (Fikkert 1994), Spanish (Lleó and Prinz 1996), German (Lleó and Prinz 1996, Grijzenhout and Joppen 1998 and in press), English (Gnanadesikan 1995, Barlow 1997) and Canadian French (Rose 2000), among others. For example, in EP a target word like *prato* ['pratu] 'dish' is initially produced with cluster reduction (*prato* ['pratu] becomes ['patu]) and only later does the target form ['pratu] emerge, with the production of the target branching Onset.

However, between the productions ['patu] and ['pratu], we find intermediate productions that have not been attested in the acquisition of other languages. It has been reported in the literature (cf. Bernhardt and Stemberger 1998) that the presence of an epenthetic vowel between the two members of an Onset cluster (*prato* ['pratu] becomes [pi'ratu]) is a possible but rare repair strategy in the acquisition of branching Onsets. This behaviour, therefore, is never included in developmental scales due to its low frequency in children's productions.

If vowel epenthesis is frequent ([pi'ratu]) in the acquisition of a specific language, one could argue that this strategy works as an intermediate stage between cluster reduction ([patu]) and full production of the branching Onset ([pratu]). This strategy would then make the production of Onset clusters an easier task. It seems plausible to assume that both ['patu] and [pi'ratu] are outputs of a stage where only CV is allowed, i.e., the non-branching Onset is the only available structure and all target branching Onsets have to match the non-branching format. As we will see in Section 5.2, this hypothesis is inadequate for two reasons: (i) it cannot explain how children move from cluster reduction ([patu]) to vowel epenthesis ([pi'ratu]); (ii) in the acquisition of EP, the form ['pratu] co-occurs with and precedes the form [pi'ratu]. The acquisition of branching Onsets in EP exhibits the following problematic U-shape development, exemplified with the production of the target word *prato* ['pratu]:

- (1)
 - a. ['patu]
 - b. ['pratu]
 - c. [pi'ratu]/['pratu]
 - d. ['pratu]

In Sections 4 and 5, we will explore the apparent retreat exhibited by the Portuguese children observed, represented in the sequence (b)-(c)-(d) in (1).

3. Data collection

The *corpus* considered for analysis contains longitudinal cross-sectional data from 7 monolingual Portuguese children aged 0;10 to 3;07. The children have been videotaped monthly for 1 year (one of the children has been videotaped for 2 years). The sessions took place in the children's home, with the mother and the researcher present, and the sessions lasted between 30 to 60 minutes. The database format used to analyse the children's productions is the CHILD-PHON wordbase, an application of the *4th Dimension* software for Macintosh, developed at the Max Planck Institut for Psycholinguistics – Nijmegen – and first used in Levelt (1994) and Fikkert (1994). The database for EP contains 18 654 spontaneous utterances. For this paper, we examined all utterances containing target words with branching Onsets.

4. The target system

Portuguese children are faced with both non-branching and branching Onsets in their target system (Mateus and d'Andrade 2000):

- (2) *Types of Onsets in EP*
- a. Non-branching Onsets
 - (i) Simple Onset

<u>b</u> ola	['bɔlə]	'ball'
<u>f</u> ala	['falə]	'speak'
 - (ii) Empty Onsets

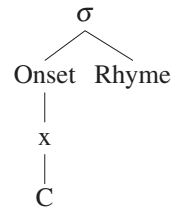
<u>_</u> asa	['azə]	'wing'
<u>_</u> erva	['ɛrvə]	'herb'
 - b. Branching Onsets

<u>br</u> uxa	['bruʃə]	'witch'
<u>cl</u> ube	['klubɨ]	'club'
<u>fr</u> ito	['fritu]	'fried'
<u>fl</u> or	['flɔr]	'flower'

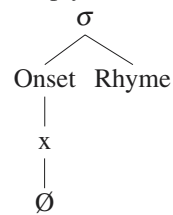
The structures presented in (2a) involve the projection of one skeletal position (see (3a) and (3b)); the structure in (2b) projects two skeletal positions (see (3c)):

(3) Representation of types of Onsets

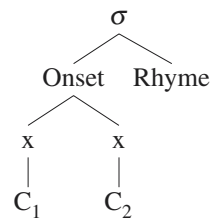
a. Simple Onset



b. Empty Onset



c. Branching Onset



The simple Onset associates with any consonant in EP (plosive [p, b, t, d, k, g], fricative [f, v, s, z, ʃ, ʒ], nasal [m, n, ɲ] or liquid [l, λ]); the branching Onset is composed of a sequence of an obstruent followed by a liquid:²

2. Other clusters in EP are analyzed as sequences of two simple Onsets, the first one being the Onset of a syllable with an empty Nucleus, obligatorily associated with the vowel [i] in Brazilian Portuguese (a[fit]a) and occasionally associated with the vowel [i] in EP (a[fit]a) (Mateus and d'Andrade 2000):

(i)	Plosive + Nasal	a[dm]irar	'to admire'
	Plosive + Fricative	[ps]icologia	'psychology'
(ii)	Plosive + Plosive	o[bt]er	'to obtain'
	Fricative + Plosive	a[ft]a	'ulcer'
	Nasal + Nasal	a[mn]ésia	'amnesia'

Notice that these types of targets are scarce in our database – 36 productions of 6 target words in a database with 18,654 utterances (see Freitas 1997).

(4) *Branching Onsets in EP*

Plosive + alveolar flap /ɾ/

[pr]ato	‘dish’
[br]ilho	‘shine’
[tr]ago	‘bring (1st sg)’
[dr]oga	‘drugs’
[kr]avo	‘carnation’
[gr]ito	‘scream’

Plosive + Alveolar lateral /l/

[pl]ano	‘plan’
[bl]usa	‘blouse’
a[tl]eta	‘athlete’
[kl]aro	‘light’
[gl]ória	‘glory’

Fricative + Alveolar flap /ɾ/

[fr]ito	‘fried’
li[vɾ]o	‘book’

Fricative + Alveolar lateral /l/

[fl]or	‘flower’
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5. The acquisition of branching Onsets*5.1. Data description*

The first remark is that lexical targets with branching Onsets are absent in Portuguese children’s early productions:

(5) *Sessions with no lexical targets containing plosive+liquid branching Onsets*

Subjects	Session	Age
João	I to XIV	0;10.2 to 1;10.8
Inês	I to V	0;11.14 to 1;04.9
Marta	I to III	1;02.00 to 1;04.8

(6) *Sessions with no lexical targets containing fricative+liquid branching Onsets*

Subjects	Session	Age
João	I to XX	0;10.2 to 2;4.30
Inês	I to V	0;11.14 to 1;4.9
Marta	I to II	1;2.00 to 1;3.8

At first, words with branching Onsets are not possible targets, and we consider this the first developmental stage in the acquisition of Onsets. This behaviour is also attested for the acquisition of Dutch (as we will see in Section 5.2.). This has been classified in the literature as a selection strategy³ and may illustrate that, by this time, constraints related to the syllable structure prevent the child from processing branching Onsets because this syllabic format is not yet available in the child's system.

When target lexical items with branching Onsets first appear, the most frequent repair strategy used by Portuguese children is cluster reduction (73 % of target words with Onset clusters were produced with cluster reduction), where the left-edge consonant of the cluster is preserved and the right-edge one is deleted ($C_1C_2 \rightarrow C_1\emptyset$):

- (7) *Cluster reduction in EP ($C_1C_2 \rightarrow C_1\emptyset$)*
- | | | | |
|-----------------------------|-------------|-----------------|-----------------------|
| <i>creme</i> /'krɛmi/ | → ['kɛ] | Inês (1;5.11) | 'cream' |
| <i>abre</i> /'abri/ | → ['abi] | Inês (1;8.2) | 'open (Imperative)' |
| <i>praia</i> /'pɾajɐ/ | → ['pajɐ] | Inês (1;10.29) | 'beach' |
| <i>triciclo</i> /tri'siklu/ | → [ti'kiko] | Inês (1;10.29) | 'bicycle' |
| <i>ladrar</i> /lɐ'drar / | → ['dal] | Marta (1;5.17) | 'to bark' |
| <i>grande</i> /'grɐ̃di/ | → ['gɐ̃:di] | Marta (1;11.10) | 'big' |
| <i>letras</i> /'lɛtrɐʃ/ | → ['ɛtɐʃ] | Marta (1;11.10) | 'letter' |
| <i>abre</i> /'abri/ | → ['abi] | JoãoII (2;0.19) | 'open (Imperative)' |
| <i>quatro</i> /'kwatru/ | → ['atu] | JoãoII (2;1.23) | 'four' |
| <i>braço</i> /'brasu/ | → ['bafu] | JoãoII (2;4.30) | 'arm' |
| <i>abri</i> /ɐ'bri/ | → [ɐ'bi] | Raquel (2;7.8) | 'open (1st sg. Past)' |
| <i>branco</i> /'brɐ̃ku/ | → ['bɐ̃ku] | Raquel (2;10.8) | 'white' |
| <i>prédio</i> /'prɛdju/ | → ['pɛdu] | Raquel (2;10.8) | 'building' |

This behaviour matches acquisition data from other languages:

3. For the definition of the concept of *selection strategy*, see Ferguson and Farwell (1975) and Stoel-Gammon and Cooper (1984).

(8) *Cluster reduction in the acquisition of other languages ($C_1C_2 \rightarrow C_1\emptyset$)*

a. Dutch (Fikkert 1994)

trein /trɛin/ → [tɛi] Leon (1;10)*klok* /klɔk/ → [ko:k] Tom (1;5)

b. German (Grijzenhout and Joppen in press)

brot /bro:t/ → [bo:] Naomi (1;4)*frau* /frau/ → [bau] Naomi (1;6)

c. English (Gnanadesikan 1995)

please /pli:z/ → [piz] Gitanjali (2;3–2;9)*clean* /kli:n/ → [kin] Gitanjali (2;3–2;9)

d. Spanish (Lleó 1990)

truita /trujtə/ → [tutja] Laura (3;10)*bicicleta* /bisikleta/ → [bɛka] Laura (2;3)

e. Canadian French (Rose 2000)

clé /kle/ → [ke] Théo(2;4)*fleur* /flœʁ/ → [βœ:] Clara (1;7)

A different repair strategy that is not attested in other languages occurs simultaneously in Portuguese children's productions, i.e., both consonants of the cluster are deleted ($C_1C_2 \rightarrow \emptyset\emptyset$)⁴. This was attested in 9 % of the target words with Onset clusters produced by the Portuguese children observed:

(9) *Empty Onsets replace branching Onsets**bicicleta* /bisi'kletə/ → [pisi'etə] Luís (1;11.20) 'bicycle'*bicicleta* /bisi'kletə/ → [pisi'etə] Luís (2;0.27) 'bicycle'*flor* /'flot/ → ['oli] Inês (1;9.19) 'flower'*grande* /'grɛdi/ → ['ɛŋi] JoãoII (2;2.28) 'big'*bruxa* /'bruʃə/ → ['ũgə] JoãoII (2;2.28) 'witch'*bicicleta* /bisi'kletə/ → ['etə] JoãoII (2;4.30) 'bicycle'*Pedro* /'pedru/ → ['peu] JoãoII (2;4.30) 'Peter'*obrigada* /obri'gadə/ → [i'adə] JoãoII (2;4.30) 'thank you'*fotografia* /futugrɛ'fia/ → [ftuɐ'fiɐ] Raquel (2;10.08) 'picture'

Another repair strategy attested for Dutch children is cluster reduction to the right-edge member (Fikkert 1994). This strategy, however, is infrequent in the Portuguese children productions observed (2 % of the target words with Onset clusters produced by the children):

4. The presence of empty Onsets from the beginning of production in the Portuguese children observed and the use of this structure as a default one for dealing with problematic target Onsets have been treated in Freitas 1996 and 1997 and in Costa and Freitas 1998 and 1999. The fact that the use of empty Onsets by Portuguese children might be due to characteristics of the target prosodic system, as one of the reviewers suggested, is now under investigation, in collaboration with my colleagues M. Vigário and S. Frota.

- (10) *Cluster reduction with deletion of the left-edge consonant*
 $(C_1C_2 \rightarrow \emptyset C_2)$
bicicleta /bisi'kletə/ → [bsi'letə] Luís (2;2.27) 'bicycle'
flores /'floriʃ/ → ['loliʃ] Marta (1;7.17) 'flowers'

Before branching Onsets become stable in EP, another repair strategy emerges in the Portuguese children's data: vowel epenthesis between the two members of the cluster ($C_1C_2V \rightarrow C_1VC_2V$), usually [i] but also [ə]. Notice that the use of this strategy is not attested or scarce in the acquisition of other languages (Fikkert 1994, Gnanadesikan 1995, Lleó and Prinz 1996, Barlow 1997, Bernhard and Stemberger 1998, Rose 2000, Goad and Rose in press, Demuth p.c.). However, this strategy is used in 16 % of the target words with Onset clusters produced by the Portuguese children observed, rising up to 32 % in Luís and to 29 % in Laura, the children exhibiting strategies other than cluster reduction:

- (11) *Vowel epenthesis in the acquisition of EP branching Onsets*
grande /'grɛdi/ → [ki'rɛdi] Luís (2;5.27) 'big'
monstro /'mɔʃtru/ → ['mɔʃtɪru] Luís (2;2.27) 'monster'
pedra /'pɛdrɐ/ → ['pɛdɪrɐ] Luís (2;5.7) 'rock'
fralda /'fraɫdɐ/ → [fi'rawdɐ] Luís (2;6.26) 'diaper'
flores /'floriʃ/ → [fi'lojʃ] Luís (2;9.21) 'flowers'
prenda /'prɛndɐ/ → [pi'rɛdi] Laura (2;2.30) 'gift'
branco /'brɛku/ → [bi'rɛ:ku] Laura (2;2.30) 'white'
livro /'livru/ → ['livɪru] Laura (2;8.23) 'book'
bicicletas /bisi'kletɐʃ/ → [bisiki'letɐʃ] Laura (2;11.4) 'bicycles'
bicicletas /bisi'kletɐʃ/ → [bisiki'letɐʃ] Laura (3;1.6) 'bicycles'
bicicleta /bisi'kletə/ → [bisiki'letə] Pedro (3;5.18) 'bicycle'
cobra /'kɔbrɐ/ → ['kɔbiɾɐ] Pedro (3;5.18) 'snake'

Although the use of this strategy precedes the final stage of the acquisition of branching Onsets in EP, the use of vowel epenthesis does not occur in an isolated fashion: vowel epenthesis and the production of the target cluster co-occur in the data observed:

- (12) *Co-occurrence of C_1C_2V and C_1VC_2V*
Luís
cabra /'kabɾɐ/ → ['kabɪɾɐ] (2;5.7) 'goat'
cabra /'kabɾɐ/ → ['kwabɾɐ] (2;5.7) 'goat'
cobra /'kɔbrɐ/ → ['kɔbrɐ] (2;5.27) 'snake'
zebra /'zebrɐ/ → ['sepɪɾɐ] (2;5.27) 'zebra'
depressa /di'prɛsɐ/ → ['prɛ:θɐ] (2;8.16) 'fast'
depressa /di'prɛsɐ/ → [pi'rɛsɐ] (2;8.16) 'fast'

<i>príncipe</i>	/ˈpɾĩsɨpi/	→	[pɨˈɾisp]	(2;11.2)	‘prince’
<i>príncipe</i>	/ˈpɾĩsɨpi/	→	[ˈpɾiːspi]	(2;11.2)	‘prince’
<i>bruxa</i>	/ˈbruʃɐ/	→	[bɨˈruʃɐ]	(2;11.2)	‘witch’
<i>bruxa</i>	/ˈbruʃɐ/	→	[ˈbruʃɐ]	(2;11.2)	‘witch’
Laura					
<i>fiambre</i>	/fiˈẽbɾi/	→	[fiˈẽbɾi]	(2;3.20)	‘ham’
<i>comprado</i>	/kõˈɾadu/	→	[kõpiˈradu]	(2;3.20)	‘to buy (Past P.)’
<i>livro</i>	/ˈlivɾu/	→	[ˈlivɾu]	(2;4.30)	‘book’
<i>letra</i>	/ˈletɾɐ/	→	[ˈletɾɐ]	(2;4.30)	‘letter’
<i>flores</i>	/ˈfloriʃ/	→	[fiˈlors]	(2;7.16)	‘flowers’
<i>grande</i>	/ˈgrẽdi/	→	[ˈgrẽdi]	(2;7.16)	‘big’
<i>livros</i>	/ˈlivɾu/	→	[ˈlivɾu]	(2;8.23)	‘book’
<i>livros</i>	/ˈlivɾu/	→	[ˈlivɾu]	(2;8.23)	‘books’
<i>livro</i>	/ˈlivɾu/	→	[ˈlivɾu]	(2;11.4)	‘book’
<i>zebras</i>	/ˈzeβɾɐʃ/	→	[ˈzeβɾɐʃ]	(2;11.4)	‘zebras’

An unexpected pattern seen in Portuguese children’s data is that productions with a C_1C_2V format may precede productions with a C_1VC_2V format:

(13) C_1C_2V preceding C_1VC_2V

Luís					
<i>zebra</i>	/ˈzeβɾɐ/	→	[ˈzeβɾɐ]	(1;11.20)	‘zebra’
<i>praia</i>	/ˈpɾajɐ/	→	[ˈpɾajɐ]	(2;2.0)	‘beach’
<i>grandes</i>	/ˈgrẽdiʃ/	→	[ˈkrɛts]	(2;2.27)	‘big (pl)’
<i>grande</i>	/ˈgrẽdi/	→	[kiˈrẽdi]	(2;5.27)	‘big’
<i>branca</i>	/ˈbrẽkɐ/	→	[biˈrẽkɐ]	(2;11.2)	‘white’
<i>bruxa</i>	/ˈbruʃɐ/	→	[biˈruʃɐ]	(2;11.2)	‘witch’
Laura					
<i>flores</i>	/ˈfloriʃ/	→	[ˈflors]	(2;2.30)	‘flowers’
<i>branco</i>	/ˈbrẽku/	→	[ˈbrẽku]	(2;3.20)	‘white’
<i>fiambre</i>	/fiˈẽbɾi/	→	[fiˈẽbɾi]	(2;3.20)	‘ham’
<i>flores</i>	/ˈfloriʃ/	→	[fiˈlors]	(2;7.16)	‘flowers’
<i>branca</i>	/ˈbrẽkɐ/	→	[biˈrẽkɐ]	(2;7.16)	‘white’
mais					
<i>fiambre</i>	/majʃ fiˈẽbɾi/	→	[majʃiˈẽbirɿ]	(3;3.10)	‘more ham’

Apparently, the children exhibit a retreat in development before they reach the target grammar: (1) the cluster reduction strategies are used followed by (2) faithful productions of the target cluster, which are followed by (3) the co-occurrence of vowel epenthesis and target clusters, and (4) the process ends with the exclusive production of the target cluster, according to the adult system. This U-shape development, already mentioned in Section 2, is exemplified in Table 1 and will be discussed in Section 5.2; Table 1 presents percentages

Table 1. The emergence of Onset clusters in Luís

Age (Luís)	Strategies for the acquisition of Onset clusters		
	C ₁ C ₂ V (%)	C ₁ VC ₂ V (%)	Cluster reduction (%)
1;9.29	0	0	100
1;11.20	0	0	100
2;0.27	17	0	83
2;2.0	50	0	50
2;2.27	26	32	42
2;4.4	33	67	0

Table 2. Portuguese children's situation by the end of data collection

Subject	End of data collection	Situation
João	2;8.27	non stable
Inês	1;10.29	non stable
Marta	2;2.17	non stable
Luís	2;11.2	<i>stable</i>
Raquel	2;10.08	non stable
Laura	3;3.10	<i>stable</i>
Pedro	3;7.24	non stable

concerning of different realizations of target Onset clusters by Luís: (i) column 'C₁C₂V' refers to faithful productions of the target cluster; (ii) column 'C₁VC₂V' contains information about vowel epenthesis; (iii) the 'Cluster reduction' column refers to reduction to the left-edge or right-edge member and productions of an empty Onset.

As illustrated in Table 1, Luís initially produces target Onset clusters by exclusively using cluster reduction strategies (see information at 1;9.29 and 1;11.20); afterwards he apparently starts producing target-like Onset clusters (see 2;0.27 and 2;2.0) before he uses simultaneously vowel epenthesis and target-like clusters (see 2;2.27 and 2;4.4).

As a final remark, notice that the acquisition of branching Onsets in EP is a long process in the child's development, this syllabic structure being the last one to become stable in production (Table 2).

The summary in Table 2 suggests that age is not a reliable cue for measuring linguistic development. Considering the oldest children observed (Laura and Pedro), at the age of 3;3.10, Laura already shows a stable behaviour for target Onset clusters while, at 3;7.24, Pedro still uses cluster reduction exclusively:

- (14)
- | | | | | |
|----------------|-----------|---|----------|--------------------|
| Laura | | | | |
| <i>branco</i> | /brẽku/ | → | [brẽku] | (3;3.10) 'white' |
| <i>cruz</i> | /kru/ | → | [kru] | (3;3.10) 'cross' |
| <i>abrir</i> | /ẽbrĩ/ | → | [ẽbrĩ] | (3;3.10) 'to open' |
| Pedro | | | | |
| <i>branco</i> | /brẽku/ | → | [bẽku] | (3;7.24) 'white' |
| <i>comprar</i> | /kõ'prar/ | → | [kũ'par] | (3;7.24) 'to buy' |
| <i>grande</i> | /grẽdi/ | → | [gẽdi] | (3;7.24) 'big' |

5.2. Data analysis

Fikkert (1994) observes the following stages for the acquisition of branching Onsets based on data from Dutch children:

- (15) *Acquisition of branching Onsets in Dutch (Fikkert 1994)*
- Stage 0: The branching Onset is not represented in the set of target lexical items selected by the child (use of the selection strategy)
- Stage 1: The branching Onset is reduced to its left-edge member ($C_1C_2 \rightarrow C_1\emptyset$)
klok /klɔk/ → [ko:k] Tom (1;5.28)
- Stage 2: The branching Onset is reduced to its right-edge member ($C_1C_2 \rightarrow \emptyset C_2$)
klap /klap/ → [lap] Leonie (1;11.15)
- Stage 3: The branching Onset is produced according to the target system (C_1C_2)
trein /trɛin/ → [trɛin] Elke (2;3.27)

The data described in Section 5.1 illustrate that Portuguese children behave like Dutch children in the first two stages: (i) at an initial stage, they all avoid target lexical items with branching Onsets (see (5) and (6)); (ii) immediately afterwards, they all use cluster reduction to the left-edge member of the cluster ($C_1C_2 \rightarrow C_1\emptyset$) (see data in (7)).

However, the following facts show that the strategies used by Portuguese children in the next stages of branching Onset acquisition differ from those described for Dutch children: (i) cluster reduction to the right-edge member of the cluster is rare ($C_1C_2 \rightarrow \emptyset C_2$); (ii) the use of an empty Onset to replace the cluster is not attested in the Dutch data, yet it is more frequent in EP than cluster reduction to its right-edge member (see (16)); (iii) vowel epenthesis, which is not included in the developmental scale for Dutch, is the second most frequent strategy in the acquisition of branching Onsets in EP (see the percentages in

(16), where the productions of target Onset clusters by all Portuguese children observed were considered):

- (16) *Frequency of the repair strategies in the acquisition of EP branching Onsets*
- a. cluster reduction to the left-edge member
 $(C_1 C_2 \rightarrow C_1 \emptyset) = 73 \%$
 - b. cluster reduction to the right-edge member
 $(C_1 C_2 \rightarrow \emptyset C_2) = 2 \%$
 - c. empty Onset
 $(C_1 C_2 \rightarrow \emptyset) = 9 \%$
 - d. vowel epenthesis
 $(C_1 C_2 \rightarrow C_1 V C_2) = 16 \%$

If we focus on Luís and Laura, the children exhibiting all the repair strategies attested for target clusters, we observe that the percentage of vowel epenthesis is higher than 16 %: (i) 32 % in Luís (52 productions with epenthesis/163 target clusters); (ii) 29 % in Laura (39 productions with epenthesis/136 target clusters).

Comparisons between Portuguese and Dutch children have shown the tendency for similar initial stages and different final stages between the two groups of children, attested in Fikkert and Freitas (1998) for the acquisition of the Rhyme structure. The same tendency is now observed in the acquisition of the branching Onset, i.e., similar initial stages versus different final stages. A developmental scale able to account for the acquisition of branching Onsets in EP includes the following initial stages (see 17), similar to the ones presented in Fikkert (1994), except for the use of empty Onsets replacing Onset clusters (due to its rare occurrence – cf. data in (16) – cluster reduction to the right-edge member will not be included in the scale):

- (17) *Acquisition of branching Onsets in EP*
- Stage 0: the branching Onset is not represented in the set of target lexical items selected by the child (use of the selection strategy)
 - Stage 1: the branching Onset is reduced to its left-edge member
 $(C_1 C_2 \rightarrow C_1 \emptyset)$ *grande* /'grẽdi/ → ['gẽ:di] Marta (1;11.10)
 'big' or replaced with an empty Onset ($C_1 C_2 \rightarrow \emptyset \emptyset$)
grande /'grẽdi/ → ['ẽɲi] JoãoII (2;2.28) 'big'

The stage 3 for the acquisition of Dutch corresponds to the production of branching Onset clusters according to the target system. In the acquisition of EP, as mentioned in Section 5.1, Portuguese children exhibit a more complex behaviour: (i) after stage 1, they apparently produce clusters according to the target system ($C_1 C_2$); (ii) afterwards, they start using simultaneously branching Onsets ($C_1 C_2 V$) and epenthetic vowels ($C_1 V C_2 V$); (iii) finally, only $C_1 C_2$

is possible and branching Onsets become stable in the system. As mentioned in Section 2, our goal is now to explain how Portuguese children apparently retreat from a final stage of production according to the target ([ˈpratu]) to a period of alternate productions ([piˈratu] and [ˈpratu]), before they reach the target again ([ˈpratu]).

Hypothesis 1

The first hypothesis to explain the vowel epenthesis strategy would be to argue that it works as an intermediate stage of acquisition of branching Onsets: an Onset cluster is a marked structure and children tend to first use unmarked patterns before they produce marked ones, therefore, they turn a problematic structure C_1C_2V into a non problematic C_1VC_2V one by using the unmarked CV pattern (Jakobson 1941/68, Selkirk 1982, McCarthy and Prince 1986, among others). In this case, vowel epenthesis (C_1VC_2V) should precede the production C_1C_2V , which matches the adult format. However, as we showed in Section 5.1, this is not the case: (i) C_1C_2 occurs before vowel epenthesis; (ii) both productions co-occur:

- (18) C_1C_2V precedes C_1VC_2V
*flor*_{es} /ˈfloriʃ/ → [ˈflors] Laura (2;2.30) ‘flowers’
*flor*_{es} /ˈfloriʃ/ → [ˈfilors] Laura (2;7.16) ‘flowers’
- (19) Simultaneous production of C_1VC_2V and C_1C_2V
bruxa /ˈbruʃɐ/ → [biˈruʃɐ] Luís (2;11.2) ‘witch’
bruxa /ˈbruʃɐ/ → [ˈbruʃɐ] Luís (2;11.2) ‘witch’

The data show that vowel epenthesis does not occur as a strategy to merely make production an easier task.

Hypothesis 2

Another hypothesis to account for the pattern of vowel epenthesis would be to assume that it works as a phonetic strategy. It would then be interpreted as a frequency effect of the predominance of CV in the target system (around 50 %, according to d’Andrade and Viana 1993). This repair strategy would simply reveal the child’s rhythmic preference for the CV pattern. The phonological processing of the consonant cluster would no longer be a problem for the child and the vowel epenthesis would only affect the surface structure.

As an empirical argument which supports this hypothesis, notice that there is a lot of vowel reduction in EP spontaneous speech (Mateus and d’Andrade 2000) and this post-lexical process allows the adult speakers to either produce or delete unstressed vowels (*vestido* [viʃˈtidu] alternates with [vʃˈtidu] ‘dress’).

On the other hand, based on prosodic reasons, adults often add a post-lexical vowel (i) at the right-edge of words ending on /l/ or /t/ (*anel* [ɐ'nɛɫ]≈[ɐ'nɛli] 'ring'; *mar* [ˈmar]≈[ˈmari] 'sea') or (ii) between the members of the consonant clusters mentioned in the Footnote 2 (*afta* [ˈaftɐ]≈[ˈafitɐ] 'ulcer'; *admirar* [ɐdmiˈrar]≈[ɐdimiˈrar] 'to admire'). The child receives information about these post-lexical processes involving vowel insertion and vowel deletion – usually [i] – and could start using the vowel epenthesis within Onset clusters as a surface strategy in order to copy the adults' phonetic procedure in other contexts.

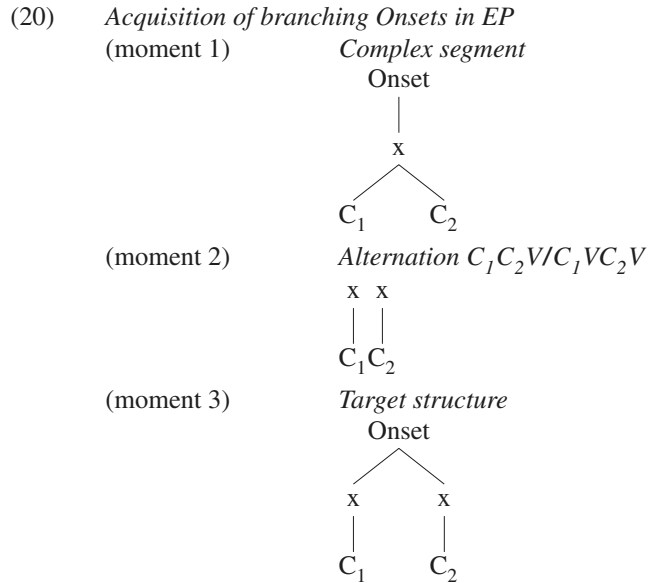
Yet, this hypothesis also fails to explain and account for the fact that C_1C_2V precedes C_1VC_2V or for the co-occurrence of the C_1C_2V and C_1VC_2V structures.

Hypothesis 3

The fact that the Portuguese children produce C_1C_2 before they reach the alternation C_1C_2/C_1VC_2V may be interpreted as follows:

- (a) Initially when children produce exclusively C_1C_2 structures, branching Onsets are not yet represented in the child's phonological system. Since only non branching Onsets are available, the child is interpreting the C_1C_2 target structure as a complex segment. This is compatible to the projection of a single skeletal position in the Onset domain since complex segments associate with non branching syllabic structures.
- (b) Afterwards the child reaches a stage where C_1C_2V and C_1VC_2V alternate. At this transitional stage, the child starts the process of segmental discrimination (C_1 and C_2 are different segmental entities). In syllabic terms, he/she is finally able to project different skeletal positions for the two different consonants. However, the branching Onset pattern is not yet available in the child's system, which prevents the child from projecting two skeletal positions within the same syllabic domain. The vowel epenthesis then results from the absence of branching Onsets in the child's system and the need to project different skeletal positions for different segments. At this stage of alternations between C_1C_2V/C_1VC_2V : (i) the cluster C_1C_2 is still interpreted as a complex segment associated with a single skeletal position within the non branching Onset domain, as in the previous stage; (ii) the production C_1VC_2V is the result of segmental discrimination and each consonant associates with a different skeletal position, within different non branching Onset domains. The non branching pattern for Onsets is still the only structural configuration available.
- (c) Finally, only C_1C_2 is possible, which means that the child is finally able to project two skeletal positions within the same Onset domain: branching Onsets are at last part of the child's system.

The interpretation under the hypothesis 3 is represented below:



As an argument for the interpretation of the Onset cluster as a complex segment that is associated with a single skeletal position, note that Portuguese children have to deal with other complex segments in the target system, namely [k^w] and [g^w], in words like *quarto* ['k^wartu] 'bedroom' and *guarda* ['g^wardə] 'guard'.⁵ These complex segments are acquired before branching Onsets, as shown in Freitas (2001b):

- (21) [k^w]/[g^w] precede branching Onsets in the acquisition of EP
- | | | | | | | |
|---------------|-----------------------|---|-------------------------------------|-------|----------|--------|
| <u>quatro</u> | /k ^w atru/ | → | ['k ^w atu] | Luís | (1;9.29) | 'four' |
| <u>quatro</u> | /k ^w atru/ | → | ['k ^w at̪ru] | Luís | (2;9.21) | 'four' |
| <u>quatro</u> | /k ^w atru/ | → | ['k ^w at ^h i] | Pedro | (3;6.22) | 'four' |

From a developmental point of view, it seems that within the same syllabic constituent – here the Onset – children first deal with complex segments within a non branching domain before they are able to project bipositional structures at the skeleton level. Notice that Lleó and Prinz (1997) report the same behaviour for German and Spanish children: affricates are complex segments and they are mastered before Onset clusters, which shows that complex segments are not interpreted as branching Onsets.

5. For details on this proposal, see d'Andrade and Viana (1993).

Other sequences that involve the processing of complex segments in the path of acquisition of EP are the sequences traditionally called falling diphthongs. It is an ongoing discussion over to what extent falling diphthongs are complex segments in Portuguese (see, among others, Bisol 1999 and Mateus and d'Andrade 2000). For a long time, children acquiring EP show the alternation $VG \approx V$ for VG targets. This alternation was interpreted in Freitas (1997) as a consequence from the projection of a single skeletal position for VG structures in the acquisition of this target structure.

Based on the analysis under the *hypothesis 3*, the developmental scale that accounts for the behaviour attested during the acquisition of EP branching Onsets is presented in (22):

(22) *Acquisition of branching Onsets in EP*

- Stage 0: The branching Onset is not represented in the set of target lexical items selected by the child (use of the selection strategy)
- Stage 1: The branching Onset is reduced to its left-edge member ($C_1C_2 \rightarrow C_1\emptyset$) or replaced with an empty Onset ($C_1C_2 \rightarrow \emptyset\emptyset$)
- Stage 2: Both members of the cluster are produced
 - Stage 2a: As a complex segment (C_1C_2)
 - Stage 2b: With vowel epenthesis ($C_1C_2V \rightarrow C_1VC_2V$) and as a complex segment (C_1C_2), in alternation
 - Stage 2c: As a branching Onset, according to the target system

The data on the acquisition of branching Onsets discussed in this paper empirically confirm that a 'top-down' model of phonological acquisition accurately accounts for the relation between the adjacent phonological levels under analysis – the syllables and the segments (cf. Fikkert 1994 and Freitas 2001a, among others). We observed in this paper that the segmental tier (in this case, the sequence obstruent+liquid) only becomes stable in production when children are able to project two skeletal positions within the same Onset domain.

6. Final Remarks

The study of Portuguese children's productions confirms the developmental path already attested for the acquisition of other languages. Children produce non branching Onsets before they start using branching Onsets, and the most frequent strategy used to deal with branching Onsets is cluster reduction to its left-edge member (see Fikkert 1994, Fee 1995, Gnanadesikan 1995, Lleó and

Prinz 1996, Bernhardt and Stemberger 1998, Grijzenhout and Joppen 1998, Rose 2000, among others).

However, when we compare the results from EP with those reported from Dutch (Fikkert 1994), although the initial stages are similar, the final stages exhibit significant differences (this is in accordance with the findings of the comparative analysis of Fikkert and Freitas (1998) concerning the Rhyme structure in Dutch and in EP). The most important aspect that discriminates Dutch and Portuguese children is the occurrence of a period of exclusive production of the cluster, followed by a period of vowel epenthesis alternating with the production of the target cluster, in the acquisition of EP. This was first interpreted as a retreat in the child's behaviour. However, the theoretical tools used for data analysis allowed us to propose that this pattern does not constitute a retreat in the child's development. The child has to be able to manipulate information concerning the syllabic constituency, the projection of skeletal positions and the segmental structure of consonants. Therefore, our hypothesis is that:

- (i) the first occurrences of C_1C_2 are surface instances of complex segments, associated with a single skeletal position;
- (ii) the alternation between vowel epenthesis and cluster (C_1VC_2V/C_1C_2V) that follows illustrates that the child is finally able to discriminate the two consonants and to associate each segment to a skeletal position. Branching Onsets are not yet available in the child's system; therefore, he/she cannot project the two skeletal positions within the same domain (this is shown by the vowel epenthesis procedure). The C_1C_2 production in this period still matches the complex segment analysis because branching Onsets are not yet available;
- (iii) finally, the child produces exclusively C_1C_2 and the vowel epenthesis strategy disappears, which means that branching Onsets are already available in the system and it is possible to project two skeletal positions within the same syllabic domain.

The results reported in this paper confirm that, although prosodic information plays a crucial role from early stages in the child's linguistic development for both perception and production (Morgan and Demuth 1996, Mehler and Christophe 1996, Jusczyk 1997, Guasti et al. 2001, Christophe 2002, among others), some prosodic constituents only become stable in the child's system at later stages of production. Moreover, our findings provide evidence for a top-down account of the process of phonological acquisition (Fikkert 1994, Freitas 2001a, among others): taking into account the representational levels focused in this study – syllabic constituents, skeletal tier and segmental tier – the results presented in this paper match those previously reported in the literature, i.e., the mastering of the syllabic constituents constrains the mastering of the lower segmental level. In other words, for a specific phonological structure,

the segmental tier only becomes stable when the relevant syllabic domains are represented in the child's system.

Universidade de Lisboa

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