The Vowel [ɨ] in the Acquisition of European Portuguese[1]

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1. Introduction

Research on the acquisition of L1 phonology in the last decades has been primarily concerned with featural architecture of segments and with prosodic constituency; reports on acquisition of phonological processes and implications of this aspect on the mastery of the internal structure of segments are scarse in the literature (see Bernhardt & Stemberger 1998, Hayes *to appear*). The description of allophonic (and allomorphic) alternations in children's production data is, however, a crucial aspect for the debate on how children build lexical representations (see Bybee 2001, Fikkert & Freitas 2002, Dupoux 2002). The study of schwa in children's data is one of the topics that provide us empirical evidence to observe the acquisition of allophonic variation since this segment is often an instance of an underlying full vowel in languages with vowel reduction. Research on the acquisition of languages like European Portuguese (EP) - where the process of vowel reduction in unstressed position is highly productive and affects both the phonological and the morphological structure of words - may therefore contribute for the discussion on how children build their lexical representations in early stages.

In this paper, we will focus on the presence of the vowel [ɨ] in Portuguese children's production. The description of how this vowel behaves will contribute for the evaluation of the interface between three different aspects of grammar in the process of phonological development: (1) the setting of featural geometry; (2) the acquisition of phonological processes; (3) the behaviour of empty prosodic constituents. Based on the observation of acquisition data, we will argue for the presence of two [ɨ] vowels in EP - the neutralized [ɨ] and the inserted [ɨ] - with two different featural architectures, both in the child's system and in the adult grammar.

2. The target system

It is generally assumed that the behaviour of schwa is associated to both segmental and prosodic levels of the phonological hierarchy (see Oostendorp 1995 for an overview). As for other languages, the vowel [ɨ] in EP seems to play both segmental and prosodic roles. At the segmental level, [ɨ] is the overt output form of the process reducing /ɛ, e/ to [ɨ] in unstressed position (see (1a)); the vowel [ɨ] never occurs in stressed position in EP, therefore, it is not assumed to be part of the phonological inventory of the language and it does not occur in lexical representations (Mateus 1975, Mateus & d'Andrade 2000). This vowel reduction process is highly productive in EP. The /ɛ, e/ reduction follows from the general

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tendency of EP vowels to reduce in unstressed position: (i) /ɛ, e/ are generally reduced to [ɨ] (see (1a); (ii) /ɔ, o/ are generally reduced to [u] (see (1b); (iii) /a/ is generally reduced to [ɐ] (see (1c)); (iv) on the contrary, /i/ and /u/ are generally not under the effect of vowel reduction (see (1d) and (1e)).

(1) *Vowel reduction in EP*

	Stressed position		*Unstressed position*	
a. /ɛ, e/ → [ɨ]	s['ɛ]rra	'saw'	s[ɨ]rrar	'to saw'
	m['e]sa	'table'	m[ɨ]sinha	'table-diminutive'
b. /ɔ, o/ → [u]	p['ɔ]rta	'door'	p[u]rtaria	'entrance'
	ceb['o]la	'onion'	ceb[u]linha	'onion-diminutive'
c. /a/ →[ɐ]	s['a]l	'salt'	s[ɐ]leiro	'salt cellar'
d. /i/ → [i]	f['i]lha	'daughter'	f[i]lhinha	'daughter-diminutive'
e. /u/ → [u]	m['u]ro	'wall'	m[u]ralha	'fortress'

Neutralized vowels [ɨ] and [u] are often optionally deleted in spontaneous speech, which increases the mismatch between lexical representations and phonetic strings [2]:

(2) *Vowel deletion in EP*

a.	[ɨ]	*lume*	['lumɨ]	→ ['lum]	'light'
		destemido	[dɨʃtɨ'midu]	→ [dʃt'midu]	'brave'
b.	[u]	*fotógrafo*	[fu'tɔgɾɐfu]	→ [f'tɔgɾɐfu]	'photographer'
		espelho	[ʃ'pɐʎu]	→ [ʃ'pɐʎ]	'mirror'

The featural representation of vowels in EP is assumed to be the one in (3):

(3) *The featural representation of vowels in EP (Mateus & d'Andrade 2000: 32)*

	i	e	ɛ	a	ɐ	ɔ	o	u	ɨ
Height	•	•	•	•	•	•	•	•	•
[high]	+	–			–		–	+	+
[low]		–	+	+	–	+	–		
Dorsal				•	•				•
[back]				+	+				+
Labial						•	•	•	
[round]						+	+	+	

At the prosodic level, [ɨ] is often used as an epenthetic vowel in the domain of an empty prosodic category. It is possible to observe [ɨ] insertion in problematic consonant clusters that violate principles of syllabic constituency (see (4)); in this case, Mateus & Andrade 2000 assume that C_1 and C_2 are non-branching Onsets of

[2] The deletion of [ɨ] gives rise to long phonetic consonantal strings (*despregar* 'to detach' [dʃpɾ'gaɾ], from [dɨʃpɾɨ'gaɾ] (Mateus & d'Andrade 2000)), which clashes with the simple syllable properties of EP phonological system (for this mismatch between phonological representations and the phonetic string in acquisition , see Vigário, Frota & Freitas 2003).

adjacent syllables, C_1 being the Onset of a syllable with an empty Nucleus; the vowel [ɨ] optionally fills this empty Nucleus in EP[3]:

(4) [ɨ] *insertion in consonant clusters*

pnew	['pnew] / [pɨ'new]	'tyre'
admirar	[ɐdmi'ɾaɾ] / [ɐdɨmi'ɾaɾ]	'to admire'

This [ɨ] insertion is often attested in word-final position, after a liquid:

(5) [ɨ] *insertion in word-final position*

comer	[ku'meɾ] / [ku'meɾɨ]	'to eat'
mar	['maɾ] / ['maɾɨ]	'sea'
anel	[ɐ'nɛɬ] / [ɐ'nɛlɨ]	'ring'

3. The acquisition problem

As we have seen in section 2, while [ɨ] is often deleted when it is the output form of /ɛ, e/ neutralization in unstressed position, it is often inserted for prosodic purposes. Moreover, targets like the ones in (6)

(6) *desprezar*	[dɨʃpɾɨ'zaɾ]	→	[dʃpɾ'zaɾɨ]	'to ignore'
repetir	[ʁɨpɨ'tiɾ]	→	[ʁp'tiɾɨ]	'to repeat'
senil	[sɨ'niɬ]	→	[s'nilɨ]	'senile'

are often produced in spontaneous speech with deletion of neutralized [ɨ] and insertion of [ɨ] in the domain of empty prosodic constituents. This aparently makes EP a fuzzy system for children to acquire (Freitas 1997, Vigário, Frota & Freitas 2003). Although several authors have described the distributional properties of [ɨ] in EP (Mateus 1975, Mateus & Andrade 2000, among others), no one has ever presented a segmental analysis assuming the discrimination of this two entities in the system: a prosodic [ɨ] and a neutralized [ɨ], with distinctive featural representations. The question is then to know whether Portuguese children are or not able to discriminate this two roles of [ɨ] in the target system.

In order to be able to formulate our working hypotheses, let us consider the following aspects: (a) early sensitivity to prosodic properties by infants is well documented in the literature (see Jusczyk 1997 for an overview); (b) Portuguese children, like children acquiring other systems, provide us empirical evidence to assume that prosodic constituency may constrain segmental development, which favours a top-down processing model in the interface prosody-segments, in the path of acquisition; (c) it is traditionally assumed that stressed vowels emerge before unstressed vowels due to the perceptual prominence of the former; (d) predictions in the literature claim that allophonic and allomorphic contrasts are acquired late (see Hayes *to appear*), specially if they occur in unstressed position; moreover, it is assumed that young children are unable to relate allomorphic variants, which

[3] In Brazilian Portuguese, [i] obligatorily fills this empty Nucleus (*pnew* [pi'new] 'tyre'.

predicts no allophonic variation of related stressed and unstressed forms of a specific underlying vowel within a specific stem: young children will store both variants.

Based on these facts and claims in the literature, our hypotheses for the nature and the chronology of events related to the acquisition of [ɨ] in EP are as follows:
(i) *Hypothesis 1*: *a)* Portuguese children are able to discriminate neutralized [ɨ] and inserted [ɨ], based on their distributional properties; *b)* due to the prominence of prosody since early stages, the use of inserted [ɨ] will precede the mastery of neutralized [ɨ]; *c)* both entities will emerge late in acquisition, due to the lack of perceptual prominence of this unstressed high central vowel.
(ii) *Hypothesis 2*: Since it is predicted that allophonic/allomorphic variation involving the contrast stressed/unstressed position is acquired late and since [ɨ] never occurs in stressed position, Portuguese children will store both the stressed and the unstressed form of the vowel, therefore, no alternation for unstressed neutralized [ɨ] will be attested in early utterances.

4. Data

In this paper, we will observe longitudinal cross-sectional production data from 8 monolingual Portuguese children aged 0;10 to 3;7 years. The children have been videotaped monthly for 1 year**,** at home, in sessions during 30 to 60 minutes. Data was collected in spontaneous, non-structured situations, by using objects of the child's daily life. A database with 18 654 utterances was considered for analysis; this database was built on the CHILDPHON wordbase format, developed at the Max Planck Institut for Psycholinguistics and first used in Fikkert 1994 and Levelt 1994.

5. Data description

5.1. Inserted [ɨ]

The first aspect we will report is that [ɨ] is attested in children's early words. Along with [ɐ], it is used at the left-edge of words, whether it is interpreted as an instance of a proto-morpheme/proto-determiner or as a filler of a prosodic position in the domain of a foot or of a higher prosodic domain[4] (see (7)):

(7) [ɨ] *at the left-edge of the word*

mãe	/'mɐ̃j̃/	→	[ɨ'mɐ]	(João: 0;11.6)	'mummy'
está	/ʃ'ta/	→	[ɨ'tɐ]	(João: 0;11.6)	'(it) is'
não	/'nɐ̃w̃/	→	[ɨ'nɐ]	(Inês: 1;0.25)	'no'
dá	/'da/	→	[ɨ'da]	(Inês: 1;4.9)	'give (me)'
pé	/'pɛ/	→	[ɨ'pɛ]	(Inês: 1;5.11)	'foot'
mão	/'mɐ̃w̃/	→	[ɨ'mɐ̃w̃]	(Marta: 1;3.8)	'hand'
chão	/'ʃɐ̃w̃/	→	[ɨ'ʃɐ̃w̃]	(Marta: 1;3.8)	'floor'
flores	/'floɾiʃ/	→	[ɨ'ʃojʃ]	(Marta: 1;4.8)	'flowers'
não	/'nɐ̃w̃/	→	[ɨ'nɐ̃w̃]	(Marta: 1;4.8)	'no'

[4] For an overview on therole of these vowels in children's early utterances, see Peters 2001.

Moreover, Portuguese children produce [ɨ] at the right edge of words when they end with a liquid (/l, ɾ/)[5], whether this vowel is interpreted (i) as a filler of an empty Nucleus in the domain of the word-final syllable or (ii) as a filler of a higher prosodic domain (a foot or a prosodic word) - 34% of target words with final /l/ were produced with word-final [ɨ] (82/243); 33% of target words with final /ɾ/ were produced with word-final [ɨ] (344/1042):

(8) [ɨ] *at the right edge of words* (*after* /l, ɾ/)

a. word-final /ɾ/

flor	/'floɾ/	→	['ʃowɨ]	(Marta: 1;2.0)	'flower'
senhor	/siˈɲoɾ/	→	['tolɨ]	(Marta: 1;2.0)	'mister'
mar	/'maɾ/	→	['malɨ]	(Inês: 1;9.19)	'sea'
colher	/kuˈʎɛɾ/	→	[kɐˈɤɛlɨ]	(Inês: 1;9.19)	'spoon'
tambor	/tɐ̃ˈboɾ/	→	[tɐˈpoɾɨ]	(Luís: 1;11.20)	'drum'
cantar	/kɐ̃ˈtaɾ/	→	[kɐˈtaɾɨ]	(Luís: 1;11.20)	'to sing'
ar	/'aɾ/	→	['aɾɨ]	(Laura: 2;2.30)	'air'
telefonar	/tilifuˈnaɾ/	→	[tufuˈnaɾɨ]	(Laura: 2;2.30)	'to call'
dormir	/duɾˈmiɾ/	→	[duˈmiɾɨ]	(Pedro: 2;8.19)	'to sleep'
senhor	/siˈɲoɾ/	→	[θiˈɲoɾɨ]	(Pedro: 3;2.0)	'mister'

b. word-final /ɬ/

sol	/ˈsɔɬ/	→	['ʃølɨ]	(Marta: 1;4.8)	'to go out'
sal	/ˈsaɬ/	→	[ɨ'salɨ]	(Marta: 2;0.26)	'to go out'
caracol	/kɐɾɐˈkɔɬ/	→	[kɔˈkɔlɨ]	(Marta: 2;0.26)	'snail'
papel	/pɐˈpɛɬ/	→	[pɐˈpɛlɨ]	(Marta: 2;2.17)	'paper'
Natal	/nɐˈtaɬ/	→	[tɐˈtalɨ]	(Marta:2;2.17)	'Christmas'
azul	/ɐˈzuɬ/	→	[ɐˈzulɨ]	(Luís: 1;11.20)	'blue'
azul	/ɐˈzuɬ/	→	[ɐˈʒulɨ]	(Laura: 2;2.30)	'blue'
azul	/ɐˈzuɬ/	→	[ɐˈzulɨ]	(Pedro: 2;7)	'blue'

This vowel [ɨ] is also used in intermediate stages of acquisition of problematic syllable structures. It emerges before word-initial sC cluster, which argues for the Coda status of the word-initial fricative (Freitas 1997, Fikkert & Freitas 1999 and Freitas & Rodrigues 2003); [ɨ] is therefore filling an empty Nucleus position:

(9) [ɨ] *at stage II of acquisition of s+C clusters*

estrela	/ʃˈtɾelɐ/	→	[ɨʃːˈtɛlɐ]	(Marta: 1;8.18)	'star'
escova	/ʃˈkovɐ/	→	[ɨ//ˈkowɐ]	(Raquel: 1;11.0)	'brush'
escreve	/ʃˈkɾɛvi/	→	[ɨˈkɛv]	(Marta: 1;11.10)	'write'
está	/ʃˈta/	→	[ɨˈta]	(Luís: 1;9.29)	'(it) is'
estão	/ʃˈtɐ̃w̃/	→	[ɨˈtɐ̃w̃]	(Laura: 2;7.16)	'(they) are'
estou	/ʃˈto/	→	[ɨːʃˈto]	(Laura: 3;0)	'(I) am'

[5] These word-final liquids are analysed as Codas in EP; Freitas 1997 shows that, in children's data, these word-final liquids behave like Onsets: they are attested (i) by the time Onset liquids are available and (ii) longer before syllable-final liquids are attested word-medially.

We showed in previous work (Freitas 2003) that Portuguese children frequently use inserted [ɨ] between two members of a branching Onset, as a repair strategy to deal with this problematic structure. C_1 and C_2 are interpreted as two non-branching Onsets of two adjacent syllables and the vowel [ɨ] is considered to fill the empty Nucleus projected within the syllable dominating C_1. This behaviour allows the child to preserve the only possible Onset template, i.e., the non-branching one:

(10) [ɨ] *and the acquisition of branching Onsets*

grande	/'gɾɐ̃dɨ/	→	[kɨ'ɾɐ̃dɨ]	(Luís: 2;5.27)	'big'
pedra	/'pɛdɾɐ/	→	['pɛdɨɾɐ]	(Luís: 2;5.7)	'rock'
fralda	/'fɾałdɐ/	→	[fɨ'ɾawdɐ]	(Luís: 2;6.26)	'diaper'
flores	/'floɾɨʃ/	→	[fl̇ɨ'lojʃ]	(Luís: 2;9.21)	'flowers'
três	/'treʃ/	→	[tɨ̇'reʃ]	(Laura: 2;2.30	'three'
prenda	/'pɾɐ̃dɐ/	→	[pɨ'ɾɐ̃dɨ]	(Laura: 2;2.30)	'gift'
branco	/'bɾɐ̃ku/	→	[bɨ'ɾɐ̃ku]	(Laura: 2;2.30)	'white'

As we have seen, Portuguese children exhibit inserted [ɨ] early in production and keep on use it in the path of development. This V insertion occurs in cases where an empty prosodic position is available in the system, whether this empty category is present in the target grammar (as in word-final position or in word-initial s+C clusters) or it is produced as a strategy to deal with non-available structures in the child's system (as at the left-edge of words or with target branching Onsets).

5.2. Neutralized [ɨ]

Unlike inserted [ɨ], neutralized [ɨ] is not present in Portuguese children's first words. As for the acquisition of other languages, these early words tend to preserve information from stressed syllables (Fikkert 1994, Levelt 1994, Kehoe 2002 and, for EP, Costa & Freitas 2003):

(11) *Deletion of unstressed syllables with neutralized* [ɨ̇]

telefone	/tɨlɨ'fɔnɨ/	→	[t^hɔju]	(Marta: 1;2.0)	'phone'
senhor	/sɨ'ɲoɾ/	→	['tolɨ]	(Marta: 1;2.0)	'mister'
creme	/'kɾɛmɨ/	→	['kɛ]	(Inês: 1;5.11)	'cream'
pele	/'pɛlɨ/	→	['pɛ]	(Inês: 1;5.11)	'skin'
balde	/'bałdɨ/	→	[ɐ'ba]	(Inês: 1;6.6)	'bucket'
vestido	/vɨʃ'tidu/	→	['tiw]	(Inês: 1;8.2)	'dress'
chave	/'ʃavɨ/	→	['ʃa]	(Marta: 1;10.4)	'key'
levanta	/lɨ'vɐ̃tɐ/	→	['vatɐ]	(Marta: 1;11.10)	'get up'

Gradually, children start exhibiting instances of target neutralized [ɨ]. This target vowel generally surfaces as [ɨ] or [i], although other formats are possible:

(12) *Production of target neutralized* [ɨ]

a) [ɨ]

creme	/'kɾɛmɨ/	→	['kɛmɨ]	(Inês: 1;10.29)	'cream'
mexer	/mɨ'ʃeɾ/	→	[mɨ'ʃe]	(Laura: 2;2.30)	'to move'

vermelha /vɨɾ'mɐʌɐ/ → [vɨ'meʌɐ] (Laura: 2;2.30) 'red'
cenoura /sɨ'noɾɐ/ → [sɨ'noɾɐ] (Laura: 2;3.20) 'lady'
cevada /sɨ'vadɐ / → [ʒɨ'baʌɐ] (Raquel: 2;8.11) 'barley'
remédio /ʁɨ'mɛdju/ → [ʁɨ'mɛdju] (Laura: 2;11.4) 'medicine'
iogurtes /jɔ'guɾtiʃ/ → [jɔ'gutiʃ] (Pedro: 3;2.25) 'yoghurts'
presunto /pɾɨ'zũtu/ → [pɨɾ'zũtu] (Laura: 3;3.10) 'ham'

b) [ɨ] -> [i]

menina /mɨ'ninɐ/ → [mi'ʌina] (Inês: 1;9.19) 'girl'
creme /'kɾɛmɨ/ → ['kɛmi] (Inês: 1;10) 'cream'
gelado /ʒɨ'ladu/ → [ʒi'zadu] (Raquel: 1.11.0) 'ice cream'
árvore /'aɾvuɾɨ/ → ['a:fi] (João: 2;3) 'tree'
fechar /fɨ'ʃaɾ/ → [pi'ʃaɾ] (Raquel: 2;3.3) 'to close'
melhor /mɨ'ʌɔɾ/ → [i'ɔ] (João: 2;8.27) 'better'
pequeno /pɨ'kenu/ → [pi'kiɲu] (João: 2;8.27) 'small'
Teresinha/tiɾɨ'ziɲɐ/ → [ti'sĩjɐ] (João: 2;7.22) 'Teresa-dim'
desculpa/diʃ'kuɬpɐ/ → [diʃ'ku:pɐ] (Laura: 2;7.16) 'sorry'
senhor /sɨ'ɲoɾ/ → [θi'ɲoɾɨ] (Pedro: 3;2.0) 'mister'

c) [ɨ] -> other vowels ([ɐ, ɔ, u, e, ɛ])

apertado /ɐpɨɾ'tadu/ → [pɐ'tadu] (Inês: 1;8) 'tight'
estrelinha /ʃtɾɨ'liɲɐ/ → [ʃtɐ'liɲɐ] (Marta: 2;2.17) 'star-dim'
menina /mɨ'ninɐ/ → [mɐ'ninɐ] (Marta: 1;10.04) 'girl'
estrelinha /ʃtɾɨ'liɲɐ/ → [ɨʃtɛ'ɾiɲɐ] (Marta: 2;0.26) 'star-dim'
fechou /fɨ'ʃo/ → [fɛ'ʃo] (Marta: 1;11.10) 'he/she closed'
zebrinha /zɨ'bɾiɲɐ/ → [ze'biɲɐ] (Luís: 2;5.27) 'zebra-dim'
segura /sɨ'guɾɐ/ → [gɔ'ɤuɾɐ] (Inês: 1;10.29) 'hold (it)'
fechar /fɨ'ʃaɾ/ → [tu'ʃaɾɨ] (Marta: 1;11.10) 'to close'
presépio /pɾɨ'zɛpju/ → [ɨβu'zepɐ] (Luís: 1;11.20) 'nativity scene'
relógio /ʁɨ'lɔʒju/ → [ʁu'lɔʒju] (Pedro: 3;1) 'watch'

Only later children use optional deletion of [ɨ] present in adults' spontaneous speech:

(13) [ɨ] -> ∅

pescoço /pɨʃ'kosu/ → [βʃ'kosu] (Luís: 2;9.21) 'neck'
fechar /fɨ'ʃaɾ/ → [f'ʃaɾ] (Laura: 2;9.30) 'to close'
pescoço /pɨʃ'kosu/ → [pʃ'koθ] (Laura: 2;11.04) 'neck'
comes /'kɔmɨʃ/ → ['kɔmʃ] (Pedro: 3;3.18) '(you) eat'
chocolates /ʃuku'latiʃ/ → [ʃuku'la:tʃ] (Laura: 3;3.10) 'chocolate'
certeza /sɨɾ'tezɐ/ → [sɾ'tezɐ] (Laura: 3;3.10) '(are you) sure?
dentes /'dẽtiʃ/ → ['dẽtʃ] (Pedro: 3;7.24) 'teeth'
começou /kumɨ'so/ → [kum'so] (Pedro: 3;7.24) 'he/she started'

(14) *Production of* [ɨ] *before deletion of* [ɨ]

vermelha /vɨɾ'mɐʌɐ/≈/vɾ'mɐʌɐ/ → [vɨ'meʌɐ] (Laura: 2;2.30) 'red'
menino /mɨ'ninu/≈/m'ninu/ → [mɨ'ninu] (Laura: 2;2.30) 'boy'
cenoura /sɨ'noɾɐ/≈/s'noɾɐ/ → [sɨ'noɾɐ] (Laura: 2;2.30) 'carrot'
creme /'kɾɛmɨ/≈/'kɾɛm/ → ['kɾɛmɨ] (Laura: 2;3.20) 'cream'

flores /'floɾɨʃ/≈/'floɾʃ/	→	['floɾʃ]	(Laura:3;0.5) 'flowers'
meninos /mɨ'ninuʃ/≈/m'ninuʃ/	→	[m'ninʃ]	(Laura: 3;2.4) 'boys'
senhores /sɨ'ɲoɾɨʃ/≈/s'ɲoɾʃ/	→	[s'ɲoɾʃ]	(Laura: 3;2.4) 'men'
certeza /sɨɾ'tezɐ/≈/sɾ'tezɐ/	→	[sɾ'tezɐ]	(Laura: 3;3.10) 'sure'

To sum up, Portuguese children use several repair strategies when faced with target neutralized [ɨ]. The attested repair strategies are: (i) production of [ɨ] according to the target ([ɨ]); (ii) V deletion ([ɨ]→∅); (iii) production of [i]; (iv) deletion of the unstressed syllable with [ɨ] (σ→∅); (v) production of other vowels ([ɐ], [u], [e], [ɔ], [ɛ]). Table 1 presents information (%) on each of the repair strategies used by Portuguese children when dealing with target neutralized [ɨ]:

Table 1: repair strategies used of target neutralized [ɨ]

	nºtargets	[ɨ]	σ→∅	[ɨ]→∅	[i]	[ɨ]	[u]	[e]	[ɔ]	[ɛ]
João	212	18.4	45.3	∅	29.3	2.8	1.4	2.8	∅	∅
Inês	104	11.5	47.1	6.7	23.1	1.9	∅	4.8	4.8	∅
Marta	277	35.4	27.8	13	12.6	7.2	3.6	0.3	∅	0.3
Luís	270	35.6	26.3	25.9	5.2	1.8	4.1	1.1	∅	∅
Raquel	131	33.5	19.5	26.6	12.1	6.1	2.2	∅	∅	∅
Laura	347	47.2	3.4	43.2	3.1	0.2	1.4	0.8	∅	0.2
Pedro	302	44.3	16.8	27.4	6.2	2.6	2.3	∅	∅	∅

6. Discussion

6.1. On the nature of inserted [ɨ] and neutralized [ɨ]

The data provided in sections 4 and 5 shows that Portuguese children are able to discriminate the segmental and the prosodic roles of target [ɨ], thus confirming our *Hypothesis (1a)* ('*Portuguese children are able to discriminate neutralized [ɨ] and inserted [ɨ], based on their distributional properties'*). Portuguese children start using inserted [ɨ] since early words in order to deal with prosodic constituency (in the domain of an empty category associated to a syllabic constituent, a foot or a higher prosodic domain) and they go on using it in the path of development (see (7) - (10)). Although the use of inserted [ɨ] at the left periphery of word-initial s+C clusters and within branching Onsets occurs in later stages (see (9) and (10)), the other two cases of inserted [ɨ] (word-initially and word-finally) are attested since early words (see (7) and (8)). This prosodic [ɨ] is thus available in the child's system from the beginning of production and it is used to fill empty prosodic categories whenever necessary, either they are present in the adult system or they are projected by children as a strategy to deal with problematic target prosodic structures. It tipically shows the behaviour of an unmarked vowel in the path of development.

Unlike inserted [ɨ], the use of target neutralized [ɨ] is not available in the system since early words (see (11) and (12) and rates in Table 1). The youngest children show low rates of production of neutralized [ɨ] (João=18%; Inês=12%); although belonging to the youngest group, Marta (=35%) shows a behaviour similar to Luís and Raquel. In the oldest group, the production of [ɨ] according to the target is gradually implemented (Luís=36% and Raquel=34%; Pedro=44% and Laura=47%).

Comparing the behaviour attested for inserted [ɨ] and neutralized [ɨ], the facts support our *Hypothesis (1b)*, i.e., *'due to the prominence of prosody since early stages, the use of inserted [ɨ] will precede the mastery of neutralized [ɨ]'*. It is unexpected that a perceptually non-prominent unstressed high central vowel is available since early stages in production. However, this early use of inserted [ɨ] may follow from the well established early prominence of prosodic constituents (see Jusczyk 1997 for an overview): since the phonological role of inserted [ɨ] in the target system is to fill prosodically empty categories, children use this segmental material to proceed with prosodic development. The presence of inserted [ɨ] in early production data is then not a matter of segmental development but rather a consequence of early prosodic development. As attested for the acquisition of syllable structure (Fikkert 1994, Freitas 1997 and 2001, among others), the behaviour of [ɨ] in our data shows that prosody may constrain children's segmental emergence. The facts just described for both inserted and neutralized [ɨ] do not provide empirical evidence to support our *Hypothesis (1c)* (‘*both entities will emerge late in acquisition, due to the lack of perceptual prominence of this unstressed high central vowel*’).

If we consider, in Table 1, the rates in the columns reporting production and deletion of neutralized [ɨ] according to the target grammar (column ‘[ɨ]' and column ‘[ɨ]->∅'), we get a picture of how distant children are from the adult system: (i) Laura is almost reaching the target system (90%); (ii) Pedro (72%), Luís (62%) and Raquel (60%) come next; (iii) the youngest children (João and Inês, both with 18%) are very distant from the target system; although belonging to the youngest group, Marta is closer to the intermediate group (48%). In other words, the youngest children are far from using neutralized [ɨ] according to the target grammar. Although the oldest children show development, for some of them the system is not yet stable (Raquel, Luís and Pedro) by the end of data collection. Laura is the only child showing an adult-like behaviour.

If we look at Table 1, we notice that syllable deletion is a repair strategy frequently responsible for the lack of success of children's production concerning neutralized [ɨ]: (i) the rates for syllable deletion are higher in children showing less phonological development (João=45%; Inês=47%); (ii) it is possible to identify an intermediate group (Marta=28%; Luís=26%; Raquel=20%; Pedro=17%); (iii) finally, the child closer to the target system basically does not show up syllable deletion (Laura=3%). However, this syllable deletion strategy does not mean that children are not dealing with target neutralized [ɨ] by the time they are deleting unstressed syllables. We mentioned before the rates for production and deletion of neutralized [ɨ]. These two facts, alone, are not enough to say that children are mastering this vowel: one might assume that they simply store the vowel in the lexical representation and that they sometimes do not produce it because its deletion is optional in the system; notice that inserted [ɨ] does not obligatorily fill all empty categories, both in the child's system and in the adult grammar.

However, appart from production and deletion of neutralized [ɨ], we also find vowel alternation associated to target neutralized [ɨ]. If we go back to rates in Table 1, we notice that production of [i] is the most frequent repair strategy (see (12c)), specially in the youngest children (João=29%; Inês=23%; Marta=13%), although other repair vowels are possible. The use of this strategy decreases with the

increasing of use of neutralized [ɨ]. Our question is as follows: if children are lexically storing all variants (Bybee 2001) and if they are not able to deal with allophonic and allomorphic variation until late stages in development (Hayes *to appear*, Peperkamp & Dupoux *to appear*), why do Portuguese children exhibit vowel alternation in the case of neutralized [ɨ]? Our interpretation of this fact is that [ɨ]≈[i] alternation shows that Portuguese children are dealing with the phonological structure of neutralized [ɨ] from early stages in acquisition (remember that neutralized [ɨ] is the overt output form of /e, ɛ/ in unstressed position - see (1)). Mateus & Andrade 2000 (see (3)) consider that /i, e, ɛ/ share the same Place of Articulation in the target system (an underspecified V-place, presumably Coronal); on the other hand, [ɨ] is considered to be Dorsal. According to the same scholars, both [ɨ] and [i] share Height: they are both [+high]. If we assume Mateus & Andrade's representations for [ɨ] and [i], it is licit to claim that the Height node tends to become stable before the V-Place node. However, only the global results of ongoing research on the acquisition of the EP vowel system may provide empirical evidence to support this claim. The early assymetry under the Vocalic node argues against storage of all variants and supports the claim that lexical representations may lack phonological specification in early stages of acquisition. Moreover, the use of [i] for target neutralized [ɨ] shows that, since the V-place is not stable, children may use the V-place of the underlying vowel (/e/ or /ɛ/), which shows that they are able to deal with allophonic (and allomorphic) variation from early stages in development. This argues against our *Hypothesis 2* (‘*Portuguese children will store both the stressed and the unstressed form of the vowel, therefore, no alternations for the unstressed neutralized [ɨ] will be attested in early production’*).

According to our description in sections 2 and 5, inserted [ɨ] plays the role of an unmarked vowel used for prosodic purposes in EP, both in the target system and in phonological development. The absence of segmental alternation for inserted [ɨ] may be interpreted as empirical evidence for a maximally underspecified vowel (Oostendorp 1995) in EP, where only [-cons] associates to the root node. Mateus & Andrade 2000's proposal is that /i/ is the underspecified vowel in Portuguese for it is the unmarked one in the system. If their proposal is right, then why do Portuguese children use [ɨ], and not [i], as the default vowel to fill prosodically empty categories? Acquisition data suggests a different interpretation of the target system: [ɨ], and not [i], works as the unmarked segment. The implications of this finding is a matter of future research. Our proposal for the analysis of EP, based on acquisition facts, is as follows: (i) there are two different [ɨ] vowels in the system; (ii) neutralized [ɨ] is an instance of either /e/ or /ɛ/; since it is a complex entity (both for its featural structure and for its phonological behaviour - it results from a phonological process of vowel reduction in unstressed position), children start acquiring it early on but its behaviour only becomes stable later on in development; (iii) as for inserted [ɨ], its behaviour of a prosodic filler licitates its unmarked status; as for schwa in other languages, one might assume it to be a maximally underspecified vowel, where only [-cons] associates to the root node. This lack of featural complexity would explain why children are able to use it since early words.

6.2. Deletion of [ɨ]

Deletion of [ɨ] is frequent but still considered to be an optional process in EP spontaneous speech; as shown before, this process is part of the mastery of neutralized [ɨ] in the acquisition of EP. If we go back to rates of [ɨ] deletion in Table 1, we may observe that this variable is a good cue for phonological development: (i) the youngest children avoid [ɨ] deletion (João=0%; Inês=7%; Marta=13%); the intermediate group shows higher rates of deletion (Luís=26; Raquel=27; Pedro=27%); (iii) the most phonologically developed child shows the highest rate of [ɨ] deletion (Laura=43%). Comparing these rates with the ones for production of neutralized [ɨ] (Table 1), it is clear that the mastery of both processes (production and deletion of neutralized [ɨ]) co-occur in acquisition, although the deletion of [ɨ] emerges and tends to become stable later then the production of [ɨ]. Faced with an input where neutralized [ɨ] is frequently deleted, Portuguese children first rebuild the segmental string by dealing with vowel reduction in unstressed position (putting [ɨ]s where they belong) and only later start mastering vowel deletion (see Vigário, Frota & Freitas for the interpretation of this fact under a rhythmic approach).

7. Final remarks

The results reported in this paper show that: (i) Portuguese children discriminate both neutralized [ɨ] and inserted [ɨ] from early stages in production; (ii) they start using inserted [ɨ] before neutralized [ɨ], which shows an early preference for prosodic constituency over segmental aspects of grammar; (iii) although faced with a mismatch between lexical representations and the phonetic string (mainly due to V deletion), children are able to first start mastering the phonological process of V reduction and only later start acquiring the process of V deletion; (iv) since [ɨ]≈[i] alternation occurs in the case of neutralized [ɨ] but not in the case of inserted [ɨ], this may be interpreted as the result of different featural structures of the two segmental entities: 1) in early words, neutralized [ɨ] is specified for Height [+high] but not for V-place; in the case of neutralized [ɨ], Portuguese children are able to process the V-place of the underlying vowel and project it into the structure of the output form of the neutralized vowel ([i] has the V-place of /e, ɛ/, the full vowels underlying [ɨ] in the vowel reduction process); 2) inserted [ɨ] is maximally underspecified ([-cons] associates to the root node).

Our findings enable us to propose a re-evaluation of the adult grammar in what concerns the nature(s) of [ɨ] in the adult grammar, with implications on the featural architecture and on the markedness assumptions about [i] and [ɨ] in Portuguese. The data described also shows that the acquisition of the vowel system provides adequate cues to measure development. Moreover, it allows us to confirm a top-down-model in the interface prosody-segments, where prosodic constituency constrains segmental development. Finally, the data under evaluation argues against lexical storage of all variants by reporting the early mastery of a phonological process involving allophonic variation in unstressed position.

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