

# Vowel epenthesis in children's oral and written productions of consonant clusters

## 1. Introduction

Since the 80s, following the development of phonological multilinear models, some research has been conducted on the acquisition of different types of consonant groups in several languages of the world, particularly in the context of the observation of how children acquire their mother tongue(s)' syllabic structure (among others Fikkert, 1994; Freitas, 1997, 2003; Rose, 2000; Freitas & Rodrigues, 2003; Goad & Rose, 2004; Fikkert & Freitas, 2004; Almeida, 2011). The identification of the different natures of the various consonant groups studied has been possible thanks to studies that focus on the research of different orders of acquisition and of different repair strategies. Similarly, multiple studies have provided information on the learning of orthography in the early years of schooling (for data on the Portuguese, see Pinto, 1997; Alves Martins & Nisa, 1998; Miranda, 2007; Veloso, 2010), usually being the segmental dimension more crafted than the syllabic one. However, possible correlations between phonological development and the consolidation of orthographic knowledge have not been explored. In fact, for European Portuguese, no study has analyzed the relationship between phonological development, focused on implicit knowledge, and learning of writing.

In the context of language acquisition studies, several studies have been published on the acquisition of different syllabic constituents, empirically proving Jakobson's proposal (1941/68) that the first structures to be acquired are the non-marked ones, present in all languages of the world and the most frequent, hence the first syllabic structure to be acquired has the CV format (Blevins, 1995; Fikkert, 1994; Freitas, 1997). In European Portuguese, aware of what happens in other languages, branching onsets, which are more complex than the non-branched onsets, are the last syllable structure to stabilize in the child's phonological system (Fikkert, 1994; Freitas, 1997; Bernhardt & Stemberger, 1998; Lamprecht *et al.*, 2004). In some children, its productions may not be stabilized yet when going to school (Sim-Sim, 1997, 1998; Freitas, 1997, 2003; Gonçalves *et al.*, 2011; Mendes *et al.*, 2009/2013). Additionally, there are some other consonant groups designated in the literature as problematic in what concerns its acquisition, which, being rare in the target system, are also rarely selected by children in an acquisition phase of the European Portuguese (Freitas, 1997). In Freitas (1997), in a total of about 18,500 spontaneous productions, only the following lexical targets were registered: *helicóptero* "helicopter" (9 productions), *gnu* "gnu" (1 output), *subtil* "subtle" (2 productions), *pneu* "tyre" (1 output), *Batman* "Batman" (21 productions), *Simpson* "Simpson" (2 outputs). However, these productions were not always produced in accordance with the targets. Its acquisition is thought, therefore, to be even more problematic and delayed than the acquisition of branching onsets, although there are no hitherto experimental data to support this evidence.

Branching onsets are formed by sequences of two consonants. However, due to strong adjacency constraints to the consonants which may occur in this position (The Sonority Sequencing Principle; The Dissimilarity Condition; concerning these principles, see, for instance, Selkirk, 1982/1984 and Blevins, 1995; for data on Portuguese, see Vigário & Falé 1994; Mateus & d'Andrade, 2000; Bisol, 2005; Veloso, 2006), Portuguese does not accept all consonant clusters as onsets.

The Sonority Sequencing Principle predicts the segment sequences which are permitted in a language taking into account the sonority hierarchy; for the European Portuguese it is set, in Mateus *et al.* (2003: 1040), as follows: "The sonority of the segments that constitute the syllable increases from the beginning till the nucleus and decreases till the end"<sup>1</sup>. The hierarchy of the segments is defined by the sonority scale, presented by decreasing sonority: vowels > liquids > nasals > fricatives > plosives (Vigário & Falé, 1994). Thus, in onset position, only sequences formed by a stop consonant followed by a lateral /l/ or a vibrant /r/ - ([br]aço "arm"; [pl]uma "plume") and sequences formed by a fricative consonant followed, likewise, by a lateral or a vibrant - (li[vr]o "book"; [fl]amingo "flamingo"), or *obstruent +liquid* sequences can occur. These sequences are considered to be tautosyllabic combinations and, as such, they are represented under the domain of the same syllabic node of the onset ([C<sub>1</sub>C<sub>2</sub>]<sub>onset</sub>[V]<sub>nucleus</sub>]<sub>syllable</sub>).

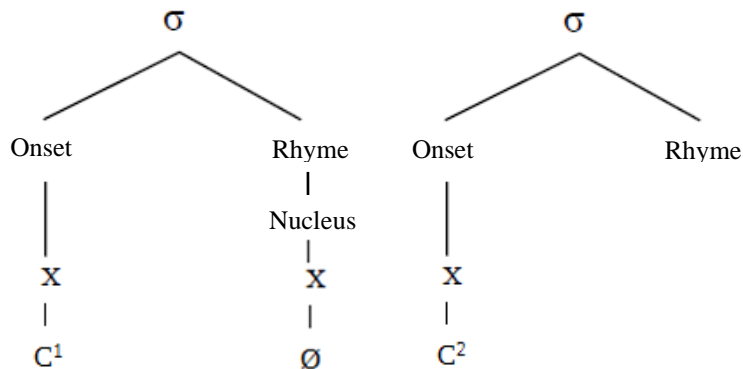
In problematic consonant sequences (*afita* "aphtha"), both consonants are considered to be heterosyllabic as they mandatorily require vocalic epenthesis in Brazilian Portuguese and optional vocalic epenthesis in European Portuguese (*afita* [afita] in Brazilian Portuguese and [afitɐ] in European Portuguese) as well as they violate phonotactic principles: the Sonority Sequencing Principle and the Dissimilarity Condition. Consequently, Mateus and d'Andrade (2000) suggest that the two consonants are represented under the domain of two non-branched onsets of different and adjacent syllables: the first consonant being the simple onset of a first syllable with an empty Nucleus, this one hosting

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<sup>1</sup> "A sonoridade dos segmentos que constituem a sílaba aumenta a partir do início até ao núcleo e diminui desde o núcleo até ao fim" (translation by the author).

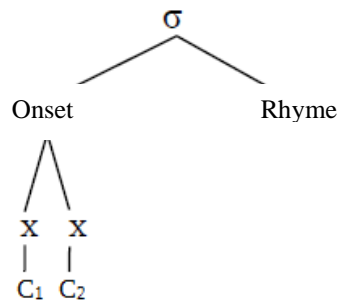
the epenthetic vowel; the second consonant being the onset of the adjoining syllable, on the right ([[C]<sub>onset</sub>[Ø]<sub>nucleus</sub>]<sub>syllable</sub> + [[C]<sub>onset</sub>[V]<sub>nucleus</sub>]<sub>syllable</sub>).

(1) Syllabic representation of problematic consonant groups.



The representation above contrasts with the representation adopted for the sequences formed by *obstruent+liquid*, which do not violate phonotactic principles. They are, as such, analyzed as tautosyllabic and are represented under the domain of the same syllabic node of the onset ([[C<sub>1</sub>C<sub>2</sub>]<sub>onset</sub>[V]<sub>nucleus</sub>]<sub>syllable</sub>). In (2), it is given the syllabic representation of branching onsets, in the form of a tree diagram.

(2) Syllabic representation of branching onsets.



The table presented below, adapted from Veloso (2003), sets out briefly the distinguishing characteristics between true branching onsets and problematic consonant groups in European Portuguese.

	TYPE I Consonant sequences	TYPE II Consonant sequences
Typical segmental combinations	Obstruent+Liquid	Obstruent+Obstruent Obstruent+Nasal
Syllabic status according to the phonological descriptions (Câmara, 1970, 1971, 1977; Mateus & d'Andrade, 1998, 2000)	Tautosyllabic	Heterosyllabic
Frequency	Frequent (Barbosa, 1965, 1994; Câmara, 1970, 1971; Vigário & Falé, 1994; Freitas, 1997)	Rare (Barbosa, 1965, 1994; Câmara, 1970, 1971; Vigário & Falé, 1994; Freitas, 1997)
The Sonority Sequencing Principle	Respected (Vigário & Falé, 1994; Mateus & d'Andrade, 1998, 2000)	Violated (Vigário & Falé, 1994; Mateus & d'Andrade, 1998, 2000)
The Dissimilarity Condition	Respected (Vigário & Falé, 1994; Mateus & d'Andrade, 1998, 2000)	Violated (Vigário & Falé, 1994; Mateus & d'Andrade, 1998, 2000)
Phonological acquisition	Present in children's productions. Acquired after the acquisition of the non-branched onsets. Prior to the acquisition in accordance to the adult phonology : repair strategies (namely: partial deletion and epenthesis) (Freitas, 1997, 2002)	Virtually absent in children's productions (Freitas, 1997)
Epenthesis		Frequent and attested (Barbosa, 1965; Câmara, 1970, 1971, 1977; Vigário & Falé, 1994; Mateus & d'Andrade, 1998, 2000; Freitas, 2002)

Table 1: Summary of the distinguishing characteristics of branching onsets and problematic consonant groups (adapted from Veloso, 2003: 121)

Given the complex nature of both types of consonant clusters, children often resort to the activation of repair strategies, which arise from the phonological and orthographic development stage in which they are. Children's oral productions are a crucial empirical evidence to understand better the phonological processing (Fikkert, 1994). Similarly, children's written productions can provide clues to that same processing as Treiman states (1998: 291): "Children's spellings also provide an excellent window into their knowledge of phonology and orthography".

Often used between the two consonants which make up a heterosyllabic consonant cluster, vowel epenthesis is one of the main criteria to distinguish branching onsets (Type I consonant sequences) from heterosyllabic consonant clusters (Type II consonant sequences) in European Portuguese (Mateus & d'Andrade, 2000). However, that strategy is rare and seldom attested in other languages of the world (Bernhardt & Stemberger, 1998). Hence, to carry out the research reported in this article, we define the following goal: to identify the level of productivity of epenthetic productions in oral and written outputs of both types of consonant clusters in primary education.

## 2. Methodology<sup>2</sup>

In this investigation, both spoken and written infantile productions of isolated words containing consonant clusters of both types were observed. 56 children of both sexes participated in this study divided into two experimental groups: (i) 27 1st graders; (ii) 29 4th graders; the couple attending two public primary schools. The distribution of children observed is shown in Table 2:

<sup>2</sup> For a more detailed description of the methodology of this study, as well as a description and discussion of the broader data, see Santos (2013).

School		<i>Escola Primária de Turquel</i> <sup>3</sup>		<i>Centro Escolar da Benedita</i> <sup>4</sup>		Total	
		<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Grade	1 <sup>st</sup> grade	23	41,07%	4	7,14%	27	48,2%
	4 <sup>th</sup> grade	23	41,07%	6	10,71%	29	51,8%
Total		46	82,1%	10	17,9%	56	100%

Table 2: Sample Distribution

Data for this investigation was collected during individual sessions with an instrument specifically created for this study. The tasks applied to the 1<sup>st</sup> graders were composed by 20 pictures that served as incentives for the production of 20 lexical items; in turn, the tasks applied to the 4<sup>th</sup> graders included 26 pictures. Note that we have opted to include fewer lexical stimuli in the tests aimed to the first group of children due to their lower attentional capacities. All pictures were displayed on a computer screen, which was placed in front of both the child and the researcher, through the Windows 2007<sup>®</sup> PowerPoint<sup>™</sup> program. In both tasks (oral production task and written task), the pictures used for both tasks (oral production and written production) were the same, for each grade level.

For the tests applied to the subjects attending the 1<sup>st</sup> grade of primary education, two-syllable words with branching onsets (*globo*; “globe”) and also problematic groups consisting of *plosive+nasal consonant* (*pigmeu*; “pygmy”) and *fricative+plosive* (*afta* ; “aphtha”) were used. For the tests applied to the subjects attending the 4<sup>th</sup> grade, one used polysyllabic branching onsets (*radiografia*; “x-ray”, eg.) and also problematic groups composed by *plosive+plosive* (*pictograma*; “pictogram”), *plosive+nasal consonant* (*algoritmo*; “algorithm”), *plosive+fricative* (*fricção*; “friction”) and *fricative+plosive* (*oftalmologista*; “ophthalmologist”). The distribution of the various types of structures tested in the instrument created for the collection of data is shown in Table 3, below. Note that given the nature of children’s lexicon, it was not possible to include *stimuli* composed by *nasal consonant+nasal consonant*.

		1 <sup>st</sup> grade	4 <sup>th</sup> grade
Branching onset	<i>plosive+vibrant</i>	2	2
	<i>plosive+lateral</i>	2	2
	<i>fricative+vibrant</i>	2	2
	<i>fricative+lateral</i>	2	2
Problematic consonant group	<i>plosive+plosive</i>	0	2
	<i>plosive+nasal</i>	4	2
	<i>plosive+fricative</i>	0	2
	<i>fricative+plosive</i>	1	1
	<i>nasal+nasal</i>	0	0

Table 3: Structure of the instrument used for collecting the data.

The oral production task (*naming task* done after pictures) was followed by the writing task (*written production task*). In the instruction given for the execution of the *naming task*, children were asked to visualize the image that appeared on screen and to name it. It was mentioned that it was intended that the child only used a word for what the child visualized. In some situations, the researcher had to resort to the use of the definition of the item (semantic clue). This semantic clue was a part of the test application protocol and it was used in order to encourage a response from the child (see Santos, 2013, Appendix 3). As a last resort, when the child could not name a certain item, repetition was used – the researcher verbally produced the *stimulus* for the child to repeat it. For data analysis purposes, whenever the researcher had to fall back upon “imitation”, the child’s production was, then, encoded as such. The written production task was in turn registered by the child in an A4 white sheet of paper with all the coloured pictures arranged in the order they were displayed on the computer screen throughout the naming task. Note that there was a training phase to ensure that both tasks were understood by the child.

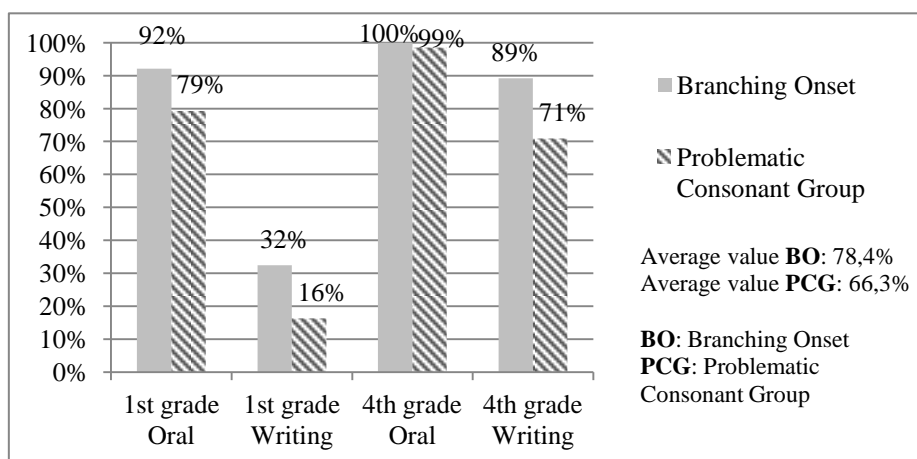
<sup>3</sup> Primary school of Turquel.

<sup>4</sup> Primary school of Benedita.

The researcher audio recorded the entire process of the execution of the tasks using a Philips digital recorder LFH0635/0, which was placed near the computer so as not to interfere with the implementation of the tasks. The data were then transferred to a laptop HP Pavilion dv6500 Notebook PC. The children's verbal productions were later heard, transcribed and analyzed. In the research reported here, all productions where the target structures (either a branching onset or a problematic consonant group) were produced in accordance with the adult form, even though other word structures did not meet the target format, were considered correct productions.

### 3. Description and discussion of the results

In this study both branching (Type I sequences formed by *obstruent+liquid*) and non-branching onsets (Type II sequences) prove to be problematic for the children: children do not completely master them. The graphic below (Graphic 1) illustrates the success rates for branching onsets and problematic consonant groups as well as the overall success values for each structure studied in this paper.



Graphic 1: Success rates for both types of consonant clusters, by grade and by type of production.

Analyzing Graphic 1, branching onsets arise, then, as less complex structures than problematic consonant groups: branching onsets always record higher success values than the problematic consonant groups. Considering the total sample, branching onsets have an overall average of success of 78%; problematic consonant groups have an average of success of 66%.

Data in Graphic 1 also show that the children who are attending the 1<sup>st</sup> grade reveal a symmetrical behaviour towards the two types of consonant sequences covered in this research: levels of success for both sequences are high in oral productions (above 79%) and low in written productions (below 32%). In both cases, the success in oral productions is not accompanied by success in writing. In the 4<sup>th</sup> grade, the difference between success rates in oral productions and written productions is lower for branching onsets and higher for problematic consonant groups, registering therefore an asymmetrical behaviour between the two types of consonant sequences.

When dealing with complex structures, there are several resources used by children in order to tailor their productions to target forms, namely, children often resort to repair strategies, which arise from the phonological and orthographic development stage in which they are. In this study, in order to produce either branching onsets or problematic consonant groups, children used the repair strategies displayed in the tables below.

Type of production	Used strategies	Frequency per structure	
		Branching Onset	Problematic Consonant Group
Oral production	Vowel epenthesis	29%	46%
	Deletion	59%	43%
	Metathesis	12%	--
	Segmental substitution	--	11%
Written production	Vowel epenthesis	62%	76%
	Deletion	32%	18%
	Metathesis	4%	--
	Segmental substitution	--	3%
	Other productions	2%	3%

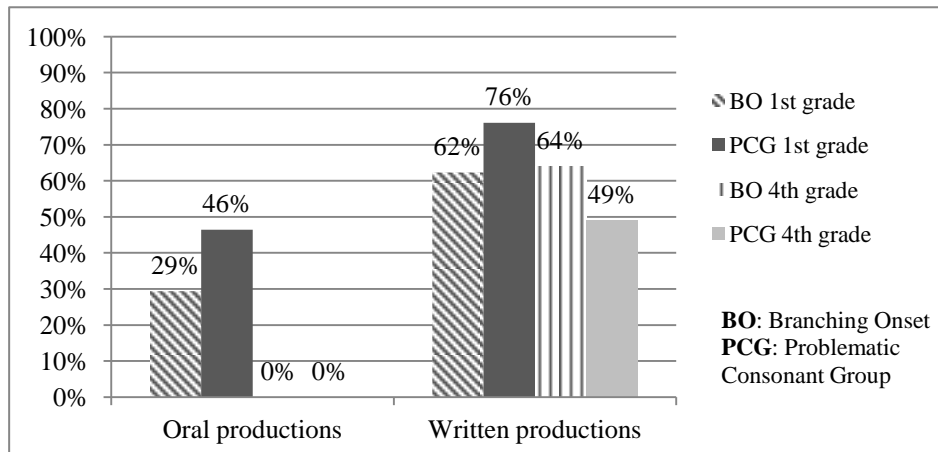
Table 4: Strategies used by 1<sup>st</sup> graders to produce both consonant clusters.

Type of production	Used strategies	Frequency per structure	
		Branching Onset	Problematic Consonant Group
<i>Oral production</i>	Deletion	--	100%
<i>Written production</i>	Vowel epenthesis	60%	48%
	Deletion	12%	19%
	Metathesis	20%	5%
	Segmental substitution	8%	12%
	Homophone spellings	--	16%

Table 5: Strategies used by 4<sup>th</sup> graders to produce both consonant clusters.

One of the main criteria to distinguish branching onsets from heterosyllabic consonant clusters in European Portuguese is the strategy of *vowel epenthesis*. This strategy is often used between the two consonants which make up a heterosyllabic consonant cluster but it seldom occurs between members of a tautosyllabic consonant cluster (see Table 1. adapted from Veloso, 2003). Common and documented productions of *vowel epenthesis* amidst the problematic consonant groups seem to suggest that the children’s phonological knowledge recognizes the existence of a different phonological nature between those clusters and branching onsets. Nevertheless, apart from the strategy *homophone spellings*, which only occurs in the production of problematic consonant groups, children in this study use the same repair strategies when dealing with the two types of consonant clusters.

The insertion of an epenthetic vowel is found, in this study, not only in the middle of problematic consonant sequences – which is legitimised by the presence of an empty nucleus in the analysis of Mateus and d’Andrade (2000) (see the representation in (1)) – but also in between the two consonants of branching onsets (see Table 4), evidencing thus the complexity of both structures. Graphic 2 illustrates the frequency of use of the strategy *vowel epenthesis* in both types of consonant sequences.



Graphic 2: Frequency of the *vowel epenthesis*’ strategy in the two different syllabic structures.

Despite being common to all the productions above, *vowel epenthesis*’ strategy is used in different manners by the children of this study. When it comes to oral productions, children insert no more than the vowel [i] between tautosyllabic clusters (29% of *vowel epenthesis*’s productions, see Graphic 2 *supra*), hence corroborating the findings of Freitas (2002). This author reports some uses of [i] before the stabilization of branching onsets (*fralda* “diaper” /’fɾaldɐ/ → [fɾi’rawdɐ] Luís 2;6, eg.). Thus, if we assume that epenthetic vowels are unmarked segments in linguistic systems, the use of [i] (or <e> in written productions) as epenthetic vowel, in the collected corpus, gives no empirical evidence to Mateus and d’Andrade (2000) hypothesis that in European Portuguese the unmarked vowel is [i].

Epenthetic vowel by excellence, [i] is considered a prosodic filler in European Portuguese, operating also as a filler for an empty nucleus in problematic consonant groups (Freitas, 2002, 2004; Veloso, 2010, 2012). Consequently, it is expected [i] to be the chosen segment by the children to be orally produced between the two consonants that make up the problematic groups. However, when children showed *vowel epenthesis* with heterosyllabic clusters, present in 46% of oral productions (see Graphic 2), in addition to the insertion of the vowel [i] – which represents 36% of the cases of epenthesis (*pneu* “tyre” → [pi’new]<sup>5</sup>, eg.) – children in this study also inserted the segments [ɐ] and [u] 11% of the

<sup>5</sup> Child 141.

times they produced epenthesis (*afia* "aphtha" → [ˈafet̪ɐ]<sup>6</sup>; *pneu* "tyre" → [ˈpunew]<sup>7</sup> and *pigmeu* "pygmy" → [piguˈmew]<sup>8</sup>). The heterogeneity and the amount of different epenthetic vowels inserted between the clusters of these problematic groups seem to confirm that there is indeed a distinct phonological nature among the two types of structures studied in this paper. Such procedure leads us to consider the possibility for the children to be following a trend of assimilation of the properties of a vowel or of a surrounding consonant, in these oral productions. Note that the production of [ˈafet̪ɐ] can be considered as a result of vowel harmony. In the case of the insertion of [u] ([ˈpunew] and [piguˈmew]), there is the assumption that the [w] could legitimize the harmony, although it never occurs in *gnomo* "gnome", which has two labial vowels.

In written productions, the insertions of the epenthetic vowel <e>, which may be interpreted as a record of [i], are predominant: see the values of 61% for branching onsets (69% in the 1<sup>st</sup> grade and 53% in the 4<sup>th</sup> grade) and 65% for problematic consonant groups (69% in the 1<sup>st</sup> grade and 61% in the 4<sup>th</sup> grade). Such behaviour is expected as it establishes a parallel with the oral data, where [i] is the epenthetic vowel by excellence. Nonetheless, in their written productions, children choose to use other vowels besides the vowel <e> when inserting segments between both types of consonant clusters. In *obstruent+liquid* sequences, the insertion of vowels <a>, <o> or <u> occurs in 31% of the productions of children attending the 1<sup>st</sup> grade; 4<sup>th</sup> graders, on the other hand, insert the vowels <a>, <i>, <o> and <u> in 47% of the cases. In problematic consonant sequences, in turn, 1<sup>st</sup> graders resort to the use of <a>, <o> or <u> in 31% of the times, and the older children opt to use <a>, <i> or <o> 39% of the times. The following table shows some examples of these productions.

		<i>Branching onset</i>			<i>Problematic consonant group</i>		
		<i>EV</i>	<i>Target production</i>	<i>Example</i>	<i>EV</i>	<i>Target production</i>	<i>Example</i>
1 <sup>st</sup> grade	<a>	<i>planta</i> "plant"	<i>palata</i> (I21)	<i>afata</i> (I221)			
	<o>	<i>flores</i> "flowers"	<i>foloro</i> (I231)	<i>submarino</i> "submarine"			
	<u>	<i>globo</i> "globe"	<i>gulobu</i> (I61)	<i>gnomo</i> "gnome"			
4 <sup>th</sup> grade	<a>	<i>atlântico</i> "atlantic"	<i>atãntica</i> (I204)	<i>fricção</i> "friction"			
	<i>	<i>biblioteca</i> "library"	<i>bilibioteca</i> (I84)	<i>tsunami</i> "tsunami"			
	<o>	<i>confront</i> "confrontation"	<i>conforante</i> (I204)	<i>oftalmologista</i> "ophthalmologist"			
	<u>	<i>insuflável</i> "inflatable"	<i>infubnal</i> (I234)				

EV: Epenthetic vowel

Table 5: Examples of vowel harmony in the written productions of the 1<sup>st</sup> and 4<sup>th</sup> graders of this study.

Children seem to be assimilating the vocalic features of the vowels from contiguous syllables when they spell epenthetic vowels other than the non-marked (<e> / [i]). In fact, when 1<sup>st</sup> graders note *obstruent+liquid* sequences, in 20% of their productions, they resort to the assimilation of the vocalic features of the following vowel. When 1<sup>st</sup> graders write heterosyllabic clusters, the frequency of vowel harmony increases up to 27%. 4<sup>th</sup> graders, in turn, seem to resort to this phonological process in 47% of their productions of *obstruent+liquid clusters* and 25% of their heterosyllabic clusters. Thus, by revealing traces of adjacent syllable vowels', the insertions of vowels that are different from the epenthetic vowel *par* excellence, can be interpreted as examples of vowel harmony in writing.

#### 4. Final considerations

In this paper, we described the productivity of vowel insertions between complex consonant clusters in oral and written productions of monolingual children attending the 1<sup>st</sup> and 4<sup>th</sup> grades of primary education in two public schools. In European Portuguese, branching onsets are formed by sequences of two consonants (an obstruent as C1 – either a plosive or a fricative – followed by a liquid – which can be either a lateral or a vibrant). These clusters obey

<sup>6</sup> Child 221.

<sup>7</sup> Child 221.

<sup>8</sup> Child 111.

phonotactic principles: The Sonority Sequencing Principle and The Minimal Distance Principle and are, therefore, considered being tautosyllabic and, as such, they are represented under the domain of the same syllabic node of the onset ( $[[C_1C_2]_{\text{onset}}[V]_{\text{nucleus}}]_{\text{syllable}}$ ). In problematic consonant sequences (*pneu* “tyre”), both consonants are considered to be heterosyllabic as they mandatorily require vocalic epenthesis in Brazilian Portuguese and optional vocalic epenthesis in European Portuguese, as well as they violate phonotactic principles. Given the complex nature of both types of consonant clusters studied in this paper, children often resort to the activation of repair strategies in order to attain the target. Consequently, it was found that the *vowel epenthesis* strategy occurs in greater numbers: (i) in the 1<sup>st</sup> graders’ productions, which confirms the expectation that the group of older children show a more advanced phonological development and orthographic knowledge than the group of younger children, since children attending the 4<sup>th</sup> grade are more advanced in their phonological development path, have a longer school career – which results in a more stable knowledge of spelling rules – and they are also more familiar with the existing lexicon in European Portuguese; (ii) in the productions of problematic consonant clusters, which shows a distinct phonological nature of the two types of structures studied in this paper and which can also be justified by the low frequency of lexical items with this complex structure in European Portuguese (among others, Vigário & Falé, 1994; Freitas, 1997); (iii) in written productions, which, in our opinion, is related to their quality of apprentices of the spelling rules and it simultaneously corroborates the existence of processing differences regarding the type of record (oral and written record).

Children assessed in this study activate vowel harmony especially when they have to write down the clusters (whether they are tautosyllabic or heterosyllabic); however, during their oral productions, the same children show a preference for the insertion of [i] between both consonant clusters. Aforementioned results contribute to the discussion of the non-marked vowel in European Portuguese. According to Mateus and d’Andrade (2000), [i] is the default vowel in the system; however, the low activation of vowel harmony in the oral collected corpus and the frequent use of [i] as epenthetic vowel gives no empirical evidence to Mateus and d’Andrade (2000) hypothesis that in EP the unmarked vowel is [i].

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