

Original articles

Analysis of phonological processes in the acquisition of complex onset in children with typical phonological development

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ABSTRACT

Objective: description and analysis of the phonological processes in the acquisition of complex onset by children with typical phonological development in the age ranges of 3;0 and 5;11.

Methods: thirty-one students of a public day-care center in Maceió-AL, having no auditory, cognitive, or motor impairment, participated in this study. The data were collected using the ABFW Child Language Test (WERTZNER, 2004); spontaneous speech was also collected. Inferential statistical analysis of the data was performed, and the phonological processes were analyzed in the production of complex onset.

Results: we found evidence for late acquisition of this syllabic component in the age range of 5;0-5;11 for both types of complex onsets. In relation to the prevalence of phonological processes, a statistically significant difference was observed between the different processes, with a prevalence of the simplified phonological process for C₁V, when taking the two types of complex onset into consideration; however, the 5-year age group, in which there was a prevalence of liquid substitution, was an exception.

Conclusion: the most observed phonological processes in children's speech were: simplification of C₁V and liquid substitution. These results will contribute to the selection of the lexicon for evaluation and treatment of cases of atypical development.

Keywords: Speech; Child; Language; Articulation Disorders

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INTRODUCTION

During phonological development, children's cognitive and phonoarticulatory skills will gradually mature. Based on the adult speaker's input, children perform different adjustments, organizing their phonological system to achieve the target words. However, if the target word does not coincide with simpler forms than have already been mastered, the child will tend to avoid or simplify it, trying to adjust the target sound sequences to the inventory that has already been mastered. These attempts, which may affect a class or sequence of sounds, are called phonological processes, and they are systematically observed in children's speech. One of the most common processes in typical phonological development is the simplification of complex onset, which occurs when children cannot handle a syllabic sequence of a greater degree of complexity.

The onset, or the consonant sequence that starts a syllable, is defined as simple when composed of a single consonant, and either complex or ramified when composed of more than one consonant. There are phonological models that presuppose a flat structure as the internal organization of the syllable, in which a linear relation holds between the elements; there are others proposing that this structure is organized hierarchically. According to the hierarchical model of Selkirk (1982)¹, which was adopted in this study, a syllable consists of an attack (A) or onset and a rhyme (R); the rhyme is binary branched with a core (Co), filled by a vowel, and a coda (Cd), filled by a consonant at the end of the syllable.

Virtually all theories of the syllable agree that it follows some principle of sonority governing the internal organization of its constituents. The concept of sonority is based on observations of how sounds are produced. According to these theories, the most audible element will always occupy the syllabic core, while the less sonorous elements will occupy the margins, with increasing sonority towards the core².

Acquisition of the complex onset in Brazilian Portuguese (BP) is characterized by being the last structure to achieve stability within a child's phonological system, a fact that has been proven in several studies³⁻¹¹.

The most commonly observed processes during the acquisition of the complex onset mainly involve resources whose target is C_2 that is, a liquid either modifying the syllabic structure or erasing it. Among these processes, the simplification of the structure

to C_1V that is, deletion of a liquid is the most widely used strategy by children with normal acquisition, as reported in some studies^{6,12-14}.

According to the author,¹⁵ the reason for the complex onset being acquired later than other syllabic structures may be the articulatory difficulty posed by a sequence of consonants with no intervening vowel. Children who cannot spontaneously acquire this syllabic structure present a gap in their phonological system, characterizing an atypical development¹⁶.

The phonological processes or repair strategies performed by children with typical and atypical development may provide evidence of the mental representation of these children during the acquisition process of a phoneme or syllabic structure. Based on the use of more complex phonological processes, children who demonstrate greater phonological knowledge also present better prognosis^{13,17-20}.

Studies of phonological acquisition based on theoretical frameworks adequate to understanding the nature of typical phonological developments are necessary and urgent. Research on the acquisition of complex onsets is especially relevant, since it can generate hypotheses on the peculiarities of acquisition and allow us to expand our linguistic knowledge of the aspects of the acquisition of this syllabic sequence.

This study aims to describe and analyze the acquisition of complex onsets by children with typical phonological development between 3;0 and 5;11 years, all of them, students of a public municipal day care/school in Maceió, AL. The phonological processes in the speech of these children were analyzed to explain their motivations based on Syllable Theory^{1,2}, the constitution and complexity of the syllable, and Autosegmental Theory²¹ applied to the distinctive features of the liquids.

METHODS

This is a descriptive, cross-sectional study, characterized by an analysis of speech data. Oral productions of children with typical phonological development in the age range between 3;0 and 5;11 years, students of a day-care/school of the Child Education public school network in the city of Maceió, were collected and analyzed as part of a project database approved by the Ethics Committee of the Federal University of Alagoas, number 13091813.8.0000.5013.

Thirty-one children who were aged between 3;0 and 5;11 years and were enrolled in the day care/school in the 2013 and 2014 school years were included in this study. The samples were divided into three age groups:

10 children in the 3;0-3;11 age range; 12 children in the 4;0-4;1 age range; and 9 children in the 5;0-5;11 age range.

The children were duly authorized by their responsible guardians to participate in this study on the condition that they signed the Free and Informed Consent Form. Children who presented hearing, motor, and cognitive impairments that could influence learning and language development were excluded from the study.

In order to collect data and analyze whether the children met the inclusion or exclusion criteria, an anamnesis was initially carried out along with their parents and/or guardians to obtain information on pregnancy, birth, motor development, hearing complaints, emotional characteristics, and speech alterations. An evaluation of the spontaneous speech of all children was carried out; they were motivated to interact based on a children's story told by the assessor. This evaluation was carried out to observe general aspects of the children's language and speech. After that, all children underwent an orofacial myofunctional evaluation to identify and exclude children with changes in the orofacial myofunctional system that could affect speech sound production. Finally, children's speech productions were evaluated and recorded to evaluate their phonetic and phonological aspects.

The evaluation of the phonological systems of the children aged 3;0 to 5;11 was carried out using Part A (Phonology) the ABFW Child Language Test proposed by Wertzner (2004)²². The test includes two tests: imitation and naming. The imitation test comprises 39 vocables; in this test, the examiner asks the child to repeat a word. The naming test comprises 34 vocables related to figures; in this test, the assessor asks the child to say the name of the figure shown.

To analyze the children's speech in this study, we applied the ABFW vocables whose target was a complex onset, constituting a total of 20 words or types; 7 of them have the lateral liquid /l/ and 13 the non-lateral liquid /r/ (Figure 1).

The phonology test evaluation speech data were recorded using a high-fidelity Marantz Professional digital recorder, model PMD661 Portable Solid State Recorder, in .wav format. A Beyerdynamic microphone, model MJ-53, was used. Phonetic transcriptions and analyses of the phonological processes of the collected samples were then carried out using the symbols of the International Phonetic Alphabet (IPA, 1993), after which the data were computed and classified in tables.

Among the vocables in the imitation and naming exams of the ABFW test, 620 tokens or productions were obtained: 217 of them contained the liquid lateral, and 403 of them the non-lateral liquid.

Livro	Zebra	Travessa	Plástico
Blusa	Planta	Droga	Bloco
Trator	Cruz	Cravo	Clube
Prato	Prego	Grosso	Globo
Braço	Branco	Fraco	Flauta

Source: Author (2015)

Figure 1. Vocabulary containing complex onsets used in the evaluation of the naming and imitation tests

Regarding the phonological process analysis, all the processes that could be observed in the speech of the children participating in this study were listed (Figure 2).

An inferential statistical analysis of the data was carried out using the chi-square test, considering $\alpha < 0.05$ as significant. For the statistical analysis, the BIOEST 5.0. software was used.

Phonological processes	Examples
Simplification to C1V	livro → ['li.vu]
Substitution of the liquid	prego → ['ple.gu]
Metathesis	trator → [ta.'tro]
Epenthesis	cruz → [ku.'rujs]
Substitution of obstruent	grosso → ['bro.su]
Simplification to C2V	plástico → ['la.fi.ku]

Source: Author (2015)

Figure 2. Phonological processes involving the complex onset

RESULTS

As previously mentioned, the data collected from the ABFW Test in the imitation and naming of vocable exams were divided into three age groups: 3;0-3;11, 4;0-4;11;0-5;11.

Table 1 presents the amount and percentage of the target productions of the complex onset and productions with phonological processes in each age range.

The analysis of these productions with phonological processes revealed the occurrence of six different processes as shown in Table 2 with their respective percentages of occurrence in the different age ranges.

Table 1. Percentage of target productions and productions showing phonological processes of the complex onset (CO) in the different age ranges

Production of CO	Age range						P-value
	3;0 - 3;11		4;0 - 4;11		5;0 - 5;11		
	N	(%)	N	(%)	N	(%)	
Target productions	66	33.00	118	49.17	139	77.20	
Productions showing phonological processes	134	67.00	122	50.83	41	22.80	< 0.0001

Reference: Author (2018) (Chi-square test, significant *P*-value < 0.05)

Table 2. Occurrence of phonological processes during acquisition of complex onsets in the different age ranges analyzed

Phonological Processes	Age range						P-value
	3;0 - 3;11		4;0 - 4;11		5;0 - 5;11		
	N	(%)	N	(%)	N	(%)	
Simplification to C ₁ V	87	64.93	89	72.95	6	14.63	
Substitution of the liquid	24	17.91	26	21.31	24	58.54	
Metathesis	16	11.94	4	3.28	8	19.51	< 0.0001
Epenthesis	4	2.98	0	0	1	2.44	
Substitution of obstruent	3	2.24	1	0.82	1	2.44	
Simplification to C ₂ V	0	0	2	1.64	1	2.44	

Reference: Author (2018) (Chi-square test, significant *P*-value < 0.05)

Captions: (C₁V): CV syllable composed of obstruent + vowel; (C₂V): CV syllable composed of liquid + vowel.

Tables 3 and 4 present the percentage values of occurrences of each phonological process during the acquisition of complex onsets containing the lateral and non-lateral liquids. Based on the statistical

analysis, significant differences were found for both types of complex onsets, showing a significant relation between the phonological processes and the different age ranges.

Table 3. Occurrence of phonological processes during acquisition of the complex onset (CO) with the lateral liquid in the different age ranges analyzed

Phonological processes in acquisition of CO with /l/	Age Range						P-value
	3;0 - 3;11		4;0 - 4;11		5;0 - 5;11		
	N	(%)	N	(%)	N	(%)	
Simplification to C ₁ V	25	55.56	39	70.90	1	3.45	< 0.0001
Substitution of the liquid	11	24.44	10	18.18	24	82.76	
Metathesis	8	17.78	4	7.28	3	10.34	
Epenthesis	1	2.22	0	0	0	0	
Simplification to C ₂ V	0	0	2	3.64	1	3.45	

Reference: Author (2018) (Chi-square test, significant P-value <0.05)

Captions: (C₁V): CV syllable composed of obstruent + vowel; (C₂V): CV syllable composed of liquid + vowel.

Table 4. Occurrence of phonological processes during acquisition of complex onset (CO) with the non-lateral liquid in the different age ranges analyzed.

Phonological Processes during acquisition of CO with /r/	Age Range						P-value
	3;0 - 3;11		4;0 - 4;11		5;0 - 5;11		
	N	(%)	N	(%)	N	(%)	
Simplification to C ₁ V	62	69.67	58	78.38	5	41.67	<0.0001
Substitution of the liquid	13	14.60	15	20.27	0	0	
Metathesis	8	8.99	0	0	5	41.67	
Epenthesis	3	3.37	0	0	1	8.33	
Substitution of obstruent	3	3.37	1	1.35	1	8.33	

Reference: Author (2018) (Chi-square test, significant P-value <0.05)

Caption: (C₁V): CV syllable composed of obstruent + vowel.

DISCUSSION

According to the data in Table 1 above, the percentage of productions showing phonological processes in the three-year age range is higher than that of the target production. In the second age group, 4;0-4;11, the percentages are very close. In the 5;0 to 5;11 age range, on the other hand, the percentage of target productions increases, inverting the relation found in the three-year age group. In this last age group, there is a greater ability to produce the target sounds; stabilization of the complex onset in the children's phonological systems was found in 100% of the children in this group.

These findings corroborate phenomena observed and described in other studies of this topic^{13,17,23,24}.

The statistically significant difference between the percentage of correct productions for each age range is easily explained as due to learning this syllabic component at more advanced stages of linguistic development, as well as the gradual elimination of relevant phonological processes until full stabilization of the children's phonological system.

According to Table 2, it was found that simplification to C₁V was the most common process during the acquisition of the complex onset in the age groups investigated except for the lateral liquid in the 5-year range. The most prevalent phonological process in this age group was the substitution of the lateral /l/ for the non-lateral /r/, which has been viewed as a divergence in the literature^{6,12,15,20}. This phenomenon is attributed

to the fact that some children in this age group carried out this substitution process at a significant frequency, for example, substituting /planta/ for [ˈprã.ta], which is a characteristic of a common linguistic variation of the population investigated⁹.

The fact that simplification to C₁V is prevalent in the acquisition of the syllabic structures for both the 3;0-3;11 and 4;0-4;11 age range groups may be explained by the Sonority Sequencing Principle², according to which simpler syllables are considered less marked. The least marked syllables are preferred by children in phonological acquisition, since they have a single increase in sonority, going from an obstruent, which has a lower degree of sonority, to a vowel, a segment that has the highest degree of sonority.

The results of this study and the data on the acquisition of the Portuguese spoken in Maceió are in line with the results of other studies conducted in different regions^{13,14,25}, which also found a greater occurrence of the simplification process to C₁V in children with typical phonological development. *These studies indicate that when incapable of properly performing the complex onset, children tend to produce only the first onset consonant.* To Ribas (2002)¹⁵, there are only two stages in acquisition: C₁V production and the correct production, which could explain the highest prevalence of this process in the three and four-year age groups.

The second most frequent process in the speech of the children in the first two age groups analyzed was substitution of the liquid. In the five-year range, it was the most frequently occurring process, as mentioned above. These data are in line with a study conducted with children in the southern region¹⁵, which found, despite a lower frequency, the substitution of the liquid as the second most used strategy by children aged 2;0 and 5;3 years. However, it must be pointed out that other studies did not find a similar result in the speech data of children with typical phonological development^{13,14}.

A relevant percentage of other repair strategies was found. An intermediate percentage of liquid substitution and metathesis for most age groups was noticed, ranging from 3.28% to 58.54% within the total percentage. These findings differ from those of a study¹⁵ that found a lower percentage of other repair strategies than simplification to C₁V, which did not reach 5% of the total of strategies.

Regarding the complex onset composed of obstruent + /l/ (Table 3), it was found that the frequent substitution of the lateral liquid by the non-lateral

liquid in the 5;0-5;11 age range (e.g., the word *planta* produced as [ˈprã.ta]), may be attributed to a linguistic variation in the speech of some children, as pointed out above.

As for the complex onset composed of obstruent + /r/ (Table 4), the substitution of the non-lateral liquid for the lateral liquid, as in *prato* → [ˈpla.tu], was the second most common process in the two first age groups. In the 5;0 to 5;11 age range, there was no occurrence of this process.

It was found that during acquisition of complex onsets that some children tend to replace the second segment of the complex onset with a less marked one acquired earlier in other syllabic structures (simple onsets and codas). This information is in line with a study¹² claiming that children acquire the complex onset formed from obstruent + lateral liquid before the onset formed by obstruent + non-lateral liquid.

Other researchers^{6,15,19}, however, claim that there is no such acquisition order. In their view, during the acquisition process, the child deals with the complexity of the syllabic structure, not with a sequence of easier or more difficult segments.

The occurrence of metathesis of obstruent + /l/ and obstruent + /r/, despite its lower frequency in the data analyzed, has also been found in some studies^{13,14}. Application of this process shows that children have already mastered a more complex syllabic structure, but they still have difficulty in organizing their phonological systems; this is possibly related to the position or composition of the syllable, since they do not produce it in all positions within the word or with all types of obstruents.

An explanation of the occurrence of metathesis in the data analyzed may be that it represents transposition of the liquid in a complex syllable such as C₁C₂V to another syllable with the same composition, but carrying stress (e.g., [ta.ˈtroh] for *trator*). Some studies state that stress favors both segmental acquisition and more complex syllabic structures, such as complex onsets^{6,15,25-28}.

The transposition of the complex onset to a syllable containing an obstruent that facilitates its production would be another motivation for this process²⁰. For example, children would transfer an onset with a dorsal or coronary obstruent to an onset containing a labial obstruent (e.g., [ˈku.bli] for *clube*). The labial place of articulation has been observed in other studies as an environment that facilitates the correct production of the syllable CCV^{6,15,29}.

Labial obstruents are less marked, more robust segments according to the Robustness Scale proposed by Clements (2005)²¹. Not only will the robustness of this trait influence segment acquisition, but also the beginning of complex onset organization; thus, the obstruent most facilitating this is the one that most aids syllabic construction. This could explain the preference for obstruents in producing the most complex syllables.

A low rate of occurrence of epenthesis was found. The application of this phonological process shows that children may be more sensitive to the structure of the complex onset of these syllables since they are carrying out a more complex repair strategy^{5,13}. This is a more complex strategy because there is an additional phoneme, not a reduction to C₁V₁; that is, they are transforming C₁C₂V into C₁VC₂V.

Other low-percentage processes were simplification to C₂V and the process of substituting a trace of the obstruent (e.g., [ˈlafiku] for *plástico* and [ˈbrosu] for *grosso*). Another study¹⁴ also found a low occurrence (5%) of this process in children with a phonological development typical of the age range of 1;0 to 4;0 years.

CONCLUSIONS

In this study, a greater occurrence of the phonological process of simplification to C₁V was found in the 3;0-3;11 and 4;0-4;11 age ranges. In the five-year age range, it was the second most prevalent process.

The process of substitution of the liquid, regarded as an intermediary process, was the second most prevalent in the first two age groups. This process clearly demonstrates an attempt to produce the CCV syllabic structure in children's speech using substitutions. In the 5;0-5;11 age range, it was the process with the highest occurrence, which may be related to a speech variety of the population studied. Other processes were found at a very low rate, which may reveal the individual preferences of some children and should not be generalized.

Research on the phonological acquisition of syllabic structures, especially syllables with complex onsets, have been mostly carried out based on data from the Portuguese language spoken in the southern and southeastern regions of Brazil. In the northeastern region, studies addressing this syllabic component are still restricted. The analysis of the speech data of children resident in Maceió may contribute to diversifying the discussions of the acquisition of the complex onset in different BP dialects. Moreover, the

phonological process analyses provide relevant information regarding the mental representation of the complex onset in children with typical development, helping us select the lexicon to be used in evaluating and treating cases of atypical development.

These findings are corroborated by other studies; however, it must be highlighted that there were specific features of some aspects of the phonological acquisition of this population that warrant further investigation, as well as the desirability of including a larger number of children in future studies. Finally, it would be advised to include other age ranges in order to analyze the continuity of the acquisition and domain of this syllabic structure, which has been investigated in later age groups in several studies.

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