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Correlations between the production of phonological classes and word classes in Brazilian Portuguese

Correlações entre a produção de classes fonêmicas e classes gramaticais no Português Brasileiro

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ABSTRACT

Purpose: Describing the word classes and phonological classes' acquisition of the Brazilian Portuguese in children typically developed and verifying the correlations between these two language systems. **Methods:** In this study 186 children with typical language development, aged from 1 year, 6 months to 5 years, 11 months, who were Brazilian Portuguese speakers took part. The data collection involved speech, language and hearing assessments and spontaneous speech recordings. The production probabilities of each sound class were considered and the words produced were divided into word classes. The correlations among sound and word classes were analyzed. **Results:** Nasals and stops are the first sounds acquired followed by fricatives and liquids. Nouns and verbs are the first word classes produced. Regarding to statistically significant correlations, stops were positively correlated with nouns, adjectives, adverbs and pronouns. Fricatives had a lot of positive and negative correlations with different word classes. Liquids had positive correlations with adjectives and articles; and negative correlations with nouns, adverbs and numerals. No correlation was found among nasals and the sound classes. **Conclusion:** The acquisition of stops and nasals are precocious. The fricatives and liquids are more complex. Nouns and verbs are prevalent in the beginning of acquisition. The elements mostly related to syntax are acquired later. There are many correlations between phonology and vocabulary, showing a clear relationship between one another.

Keywords: Child; Child, Preschool; Child language; Speech; Vocabulary

RESUMO

Objetivo: Descrever a aquisição das classes fonêmicas e gramaticais do Português Brasileiro em crianças com desenvolvimento típico e verificar as correlações entre esses dois sistemas da linguagem. **Métodos:** O presente estudo contou com 186 crianças com desenvolvimento típico de linguagem, com idades entre 1 ano e 6 meses e 5 anos e 11 meses, falantes de Português Brasileiro. A coleta de dados envolveu avaliações fonoaudiológicas e gravações da fala espontânea. Considerou-se a probabilidade de produção de cada classe fonêmica e as palavras produzidas foram divididas em classes gramaticais. Após, buscou-se estabelecer as correlações entre essas classes. **Resultados:** Nasais e plosivas foram os primeiros sons adquiridos, seguidos pelas fricativas e líquidas. Substantivos e verbos foram as primeiras classes gramaticais produzidas. Em relação às correlações estatisticamente significantes, as plosivas tiveram correlação positiva com substantivos, adjetivos, advérbios e pronomes. As fricativas apresentaram várias correlações positivas e negativas com diferentes classes gramaticais. As líquidas tiveram correlações positivas com adjetivos e artigos e correlações negativas com substantivos, advérbios e numerais. Não foram encontradas correlações entre as nasais e as classes gramaticais. **Conclusão:** A aquisição das plosivas e das nasais é precoce. Já as fricativas e líquidas, são mais complexas. Substantivos e verbos são prevalentes no início da aquisição e os elementos mais relacionados à sintaxe são adquiridos mais tarde. Diversas correlações foram encontradas entre fonologia e vocabulário, mostrando clara relação entre um componente e outro.

Descritores: Criança; Pré-escolar; Linguagem infantil; Fala; Vocabulário

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INTRODUCTION

The focus of the current study is the correlations between vocabulary and phonology in the period of language acquisition. Researches that correlate different language domains are not as common as those ones which explore only one language component. The researchers face many difficulties to do this kind of work. When different language domains are studied, more than one type of analysis is needed and, consequently, the researcher needs to be really conversant with more than one study field.

Only a few researches were found with a subject that is similar to what is proposed here: correlating the production of word classes and phonological classes in children with typical language development. The relevance of this type of research is related to both the knowledge of what is typical and expected in a language and the development of therapeutic approaches to the deviant cases. The clinician has to be able to select some parts of the grammar expected to certain age group or that follow certain acquisition sequence.

A research[1] aimed to study the influence of consonantal information in the acquisition of new words by children in an early phase of language acquisition. The authors concluded that French children who are 20 months of age can learn two words that differ only by a consonant in either onset or coda position. The authors explain that precise phonological information in different syllabic positions can be included in lexical representations from a very young age.

Another one[2] analyzed the spontaneous speech data of 18 children who were monolingual speakers of American English in the phase that they produced less than 50 words. The analysis focused on the sounds /m g r ɵ/. After, the children were exposed to new words inserted on illustrated stories. The new words were chosen based on the sounds acquired and non-acquired in the phonological system subjects. So, eight novel consonant-vowel-consonant words were presented to the children, four with a /m/ onset (acquired sound) and four with a /r/ onset (non-acquired sound). The children were divided into two groups, one with more knowledge of the non-acquired sound /r/ and one with less knowledge of the non-acquired sound /r/.

The results of the author[2] showed that the children of the more knowledge group had better performance for words composed of non-acquired sounds than words composed of acquired sounds, but without significance. In contrast, for the less knowledge group there was a significant effect of knowledge with novel words composed of non-acquired sounds being responded to more accurately than those composed of acquired sounds. In this way, the author concluded that higher phonological knowledge was associated with poorer word learning, more knowledge with intermediate word learning, and less knowledge with better word learning.

The author[2] also affirms that her results are different from previous researches with younger children. So, she proposes that her different results can be explained by conceptual evidence that differentiates types of phonological knowledge: stable conceptual structure in phonology is associated with a neutral effect on word learning, emerging conceptual structure in phonology is associated with facilitation of word learning, and impoverished conceptual structure in phonology is associated with avoidance in word learning.

Another research[3] with 15 children typically developed and aged between 2;0 e 2;5 (years; months) aimed to analyze the influence of word frequency, phonological neighborhood density, age of acquisition and phonotactic probability on production variability and accuracy of known words. The authors found that there is an important role of phonological neighborhood density – words with sounds and syllabic structures acquired later are produced with greater variability and both the word frequency and the phonoctactic probability influence in the speech variability, i.e., high frequency words were less variable.

An older research point that nouns are produced more precisely than verbs[4]. And, there are evidences that a greater semantic requirement corresponds to more errors in the production[5].

In this way, the purpose of this paper is to describe the word classes and phonological classes acquisition of Brazilian Portuguese in children typically developed and to verify the correlations between these two language systems.

METHODS

This study is a cross-sectional quantitative research and it is part of a project, of which the ethical and methodological aspects were approved by the Research and Ethics Committee of *Universidade Federal de Santa Maria*. The number of approval is 0219.0.243.000-11. The guardians' consent was asked through explanation, reading and signing of the Term of Informed Consent.

The sample was composed of 186 children of both genders, aged between 1;6 and 5;11, who had typical development of speech and language skills, members of Brazilian monolingual families. The exclusion criteria were as follows: presenting hearing loss; neurological, psychological and/ or cognitive impairments; syndromes; motor or organic oral disease; having undergone prior speech therapy.

From all children analyzed, nine were in the age group of 1;6 – 1;11; 13 were in the age groups of 2;0 – 2;3 and 2;4 – 2;7; 16 were in the age group of 2;8 - 2;11 and 15 were in the age groups of 3;0 – 3;3, 3;4 – 3;7, 3;8 – 3;11, 4;0 – 4;3, 4;4 – 4;7, 4;8 – 4;11, 5;0 – 5;3, 5;4 – 5;7 and 5;8 – 5;11.

The data collection procedures were performed in eight public nursery and kindergarten schools located in different areas of a town located at the southern tip of Brazil. The speech assessment was composed by a questionnaire addressed to the guardians, an oral motor assessment, a comprehensive and

expressive language assessment, a phonological and phonetic assessment and a hearing assessment.

The questionnaire answered by the guardians aimed at getting some information about pregnancy, parturition, language and motor development, clinical history, general behavior, history of bilingualism, and general aspects about the family.

In the oral motor assessment, a specific protocol[6] was used, aimed at analyzing the aspect, position, muscle tone and the movements of the oral structures.

The oral praxis and language were also assessed through specific and standardized protocols. The oral language assessment[7] aimed at analyzing the cognitive and language development of children until four years old, which is the age covered by the protocol. The older children were assessed through spontaneous speech, answering questions and creating narratives. The phonetic aspects of speech were assessed through a phonetically balanced list of words.

The hearing assessment of the children until 2;6 was the Visual Reinforcement Audiometry[8], using the portable pediatric audiometer with pure tones in the frequencies from 500 to 4000 Hz, in the intensities from 20 dB to 80 dB presented in a free field.

The children aged between 2;7 to 5;11 were assessed through the Conditioned Play Audiometry or Pure Tone Audiometry[9]. The frequencies tested by air conduction only were from 500 to 4000 Hz, in the intensity of 20 dB. If the child failed in one or more frequencies and in two consecutive screenings, he/she was recommended an evaluation with a medical doctor and a complete audiological assessment.

The children who passed in all mentioned assessments were submitted to phonological and vocabulary assessments. Spontaneous speech and naming were used to analyze these aspects in a play situation. A list of words based in Children's Phonological Assessment[10] was created, and after, the toys and objects listed were organized in a box. The instrument Children's Phonological Assessment analyzes all consonants in each syllabic position of the Brazilian Portuguese.

The play interactions between each child and the examiner, lasting about 20 minutes, were recorded and stored in a database for further broad phonetic transcription of the children's speech and transcription of the examiner's speech.

An important research of the phonological area[11] was the standard to diagnose phonological disorders. A margin of error of two months higher or lower was considered, since the phonological acquisition is a peculiar phenomenon.

Test-retest reliability[12,13] was used for the phonetic transcriptions of children until 3;3 years of age. In this method, two judges worked apart in the transcriptions; after, the transcriptions were compared and the differences between the transcriptions were heard again by a third judge until all words and sounds were in agreement. If no agreement was found, the passage of speech was excluded. In this way, the reliability between the transcriptions was guaranteed and it was possible to avoid that many words were excluded, because younger children have more variability and unintelligibility in their speech.

Older children have more intelligible speeches, so the following method of reliability was used: all recordings were transcribed by an expert judge. A second judge with the same experience transcribed, independently, 20% of the same recording to certify the reliability[3,14]. In this way, the mean agreement was 79.6% by ages of three; 81.9% by ages of four; and 80.1% by ages of five.

The phonological assessments were analyzed using the contrastive analysis. In this analysis four cards are used: phonetic description 1 – recording of consonantal segments; phonetic description 2 – recording of phonetic inventory and consonantal clusters; contrastive analysis 1 – recording of the percentages of correct productions, substitutions and omissions; contrastive analysis 2 – presents the phonological system of the children, recording of the contrasts, substitutions and omissions[10].

Based on that contrastive analysis, the following criteria[15] were used to determine the phonological system: the consonant is considered to be established if its production is greater than 80%, whereas percentages fewer than 40% indicate that the consonant is absent and percentages from 40% to 79% indicate that the consonant is partially acquired.

The subjects' phonological system characteristics and the production probabilities of each sound were considered according to the general phonological systems analyzing the consonants /p, b, t, d, k, g, f, v, s, z, ʃ, ʒ, m, n, ɲ, l, ʎ, r, R/ in the simple onset position, /l, r/ in the second position of the complex onset and /s, r/ in the coda position. The lateral coda was produced by all children as the glide [w], resulting in a diphthong[16]. The nasal in the post-vocalic position was considered as a floating consonant because it is the nasalization of the previous vowel[17]. In this way, the post-vocalic nasal and lateral were not considered in the coda position.

Regarding to the vocabulary analysis, the data were classified according to a thesis[18] available on line. The data transcriptions were performed entirely, including the children's speech and the examiner's speech. This way, we avoided to count words produced by imitation like a new type or occurrence.

In this way, all different words produced by the children (in the play situation) were counted (repeated words were not counted), according to the word classes, based on the mentioned thesis[18]. So, the categories are: nouns, verbs and verb phrases, adverbs and adverbial phrases, adjectives, conjunctions, pronouns, prepositions, articles, numerals, interjections and onomatopoeias.

Finally, the number of sounds in each sound class and the number of words in each word class produced by each participant were compared among the age groups. The computational program Statistica, version 9.1 was used with the non-parametric statistical test Kruskal-Wallis, followed by multiple comparisons when necessary, with the significance level of 5%.

After, using the same program, the correlations among the sound classes and the word classes in each age group were calculated, using the Spearman correlation coefficient. The correlation significance was also calculated. Some calculations of the correlation coefficient were not possible because the values were constant. The significance level was 5% ($p \leq 0.05$) for both tests.

RESULTS

Regarding to the numbers of Brazilian Portuguese sounds produced per class in each age group, nasals and stops are acquired first followed by fricatives and liquids. In general, the standard deviation decreases in the last ages, indicating little or no variability among the older children (Table 1).

Regarding to the average numbers of words produced in each word class in each age group analyzed, a prevalence of nouns and verbs was found in all ages. Only interjections and onomatopoeias decreased in the last ages. The means are described in Table 2.

Concerning to the statistically significant correlations found between the sound class of stops and the word classes produced by the children per age group, the stops are correlated with nouns, adjectives, adverbs and pronouns in the beginning of language acquisition (Table 3).

About the statistically significant correlations between the sound class of fricatives and the word classes produced by the children per age group,the fricatives had the greatest number of correlations, which occurred in the ages of 1, 2 and 3 (Table 4).

Only a few significant correlations were found among liquids and the word classes produced by the children in each age group, which occurred with adjectives, articles, nouns, adverbs and numerals (Table 5).

No statistically significant correlation between the sound class of nasals and the word classes produced by the children was found.

It is important to highlight that only the statistically significant correlations were showed in Tables 3, 4 and 5.

DISCUSSION

One of the goals of this study was describing the phonological acquisition of the subjects. Comparing the data found here with other researches about the Brazilian Portuguese, the phonological acquisition of these children was similar to the acquisition of children from high socioeconomic status, who were born in Rio de Janeiro (RJ), Brazil[19]. Both studies found that the stop and nasal acquisition is precocious and stabilize around three years old, even aged five years old, some children didn't present the phonological system totally acquired.

The most important researches of the state of Rio Grande do Sul, Brazil[11,16] indicated that the acquisition order of the sound classes is the same, but, generally, it was more precocious in the above mentioned researches than in this one. The methodological difference between this research and the other mentioned before refers to socioeconomic aspects. In this research, the subjects belonged to a low socioeconomic status.

Regarding to the word classes, the production of nouns and verbs was prevalent. There was a great improvement of nouns and verbs in the early ages with certain stabilization in the last ages. This occurred because nouns and verbs are the first items produced in the children's vocabulary. Furthermore, they are open class words, i.e., they have constant and unlimited improvement,

Table 1. Numbers of sounds produced per class by age group

Age group	Stops				Fricatives				Nasals				Liquids			
	Mean	Min	Max	SD	Mean	Min	Max	SD	Mean	Min	Max	SD	Mean	Min	Max	SD
(A)1;6 – 1;11	3.2 (D – M)	2	5	1.4	0.4 (E – M)	0	1	0.5	1.0 (C – M)	0	2	0.7	0.1 (G – M)	0	1	0.3
(B) 2;0 – 2;3	4.2 (D, F – M)	2	6	1.2	2.5 (F – M)	0	5	1.3	2.5	0	3	0.9	0.6 (G – M)	0	2	0.6
(C) 2;4 – 2;7	5.2	2	6	13	3.5 (H – M)	0	6	1.5	2.8 (A)	2	3	0.4	1.3 (G – M)	0	3	1.1
(D)2;8 – 2;11	6.0 (A.B)	6	6	0	4.6	3	6	1.3	3.0 (A)	3	3	0	1.6 (G – M)	1	3	0.6
(E) 3;0 – 3;3	5.9 (A)	5	6	0.3	5.3 (A)	3	6	1.0	3.0 (A)	3	3	0	2.1 (J – M)	1	3	1.0
(F) 3;4 – 3;7	6.0 (A.B)	6	6	0	5.6 (A – B)	3	6	0.9	3.0 (A)	3	3	0	2.8	2	4	0.7
(G)3;8 – 3;11	6.0 (A.B)	6	6	0	5.7(A – B)	4	6	0.6	3.0 (A)	3	3	0	3.1 (A.B)	1	4	0.8
(H) 4;0 – 4;3	6.0 (A.B)	6	6	0	5.9 (A – C)	5	6	0.3	3.0 (A)	3	3	0	3.5 (A – D)	2	4	0.8
(I) 4;4 – 4;7	6.0 (A.B)	6	6	0	6.0 (A – C)	6	6	0	3.0 (A)	3	3	0	3.3 (A – D)	2	4	0.7
(J) 4;8 – 4;11	6.0 (A.B)	6	6	0	5.9 (A – C)	5	6	0.3	3.0 (A)	3	3	0	3.9 (A – E)	3	4	0.3
(K) 5;0 – 5;3	6.0 (A.B)	6	6	0	6.0 (A – C)	6	6	0	3.0 (A)	3	3	0	3.9 (A – E)	3	4	0.3
(L) 5;4 – 5;7	6.0 (A.B)	6	6	0	6.0 (A – C)	6	6	0	3.0 (A)	3	3	0	3.7 (A – E)	3	4	0.5
(M) 5;8 – 5;11	6.0 (A.B)	6	6	0	6.0 (A – C)	6	6	0	3.0 (A)	3	3	0	3.9 (A – E)	3	4	0.3

Kruskal-Wallis test ($p \leq 0.05$)

The superscript letters in brackets represent the age in which statistical difference occurred. The dash (-) indicates statistical difference from one age to another and the comma (,) indicates statistical difference in one age and in another. Examples: The stop production in the age group of 2;0 to 2;3 (B) is different from the ages of 2;8 – 2;11 (D) and the ages of 3;4 – 3;7(F), 3;8 – 3;11 (G), 4;0 – 4;3 (H), 4;4 – 4;7 (I), 4;8 – 4;11 (J), 5;0 – 5;3 (K), 5;4 – 5;7 (L), 5;8 – 5;11 (M).

Subtitle: Min = Minimum; Max = Maximum; SD = Standard Deviation

Table 2. Average numbers of words in each word class by age group

Age group	Average numbers of words									
	Nouns	Verbs	Adv	Adj	Conj	Pron	Prep	Art	Num	I + O
(A)1;6 – 1;11	7.3 (F - M)	5.1 (D, F - M)	1.3(F - M)	0.1 (F - M)	0.1 (F - M)	1.2(D,F - M)	0.4 (D - M)	1.7 (D - M)	0	3.6
(B) 2;0 – 2;3	20.4(G - M)	16.7(G - J)	5.5(F - M)	1.6 (F - M)	0.9 (F - M)	5.8 (F - M)	2.8 (G - M)	3.8 (G - K,M)	0.1 (G,L,M)	2.4
(C) 2;4 – 2;7	30.7 (I,J)	27.6	10.1 (J)	2.9 (J)	1.8 (J,M)	10.6	4.8 (J)	5.1	1.2	4.8 (M)
(D) 2;8 – 2;11	36.5	30.6 (A)	10.6 (J)	2.6(G - J,M)	1.8(H - J,M)	11.7 (A)	6.5 (A)	5.6 (A)	1.3	5.4 (M)
(E) 3;0 – 3;3	36.2	27.8	9.7 (J)	5.1 (A.B)	1.7(H - J,M)	10.7	6.7 (A)	5.5 (A)	0.5	2.7
(F) 3;4 – 3;7	39.3 (A)	32.2 (A)	15.5 (A,B)	6.8 (A.B)	3.4 (A,B)	14.1 (A,B)	7.3 (A)	5.5 (A)	2.3	5.0 (M)
(G) 3;8 –3;11	47.3 (A,B)	35.5 (A,B)	16.3 (A,B)	8.1 (A,B,D)	3.8 (A,B)	14.1 (A,B)	7.9 (A,B)	5.8 (A,B)	1.9 (B)	4.7 (M)
(H) 4;0 – 4;3	47.8 (A,B)	35.5 (A,B)	15.3 (A,B)	8.4 (A,B,D)	4.1 (A,B, D,E)	14.1 (A,B)	8.0 (A,B)	5.9 (A,B)	1.4	5.5 (M)
(I) 4;4 – 4;7	51.7(A - C)	36.9 (A,B)	17.6 (A,B)	8.9 (A,B,D)	4.1 (A,B, D,E)	14.8 (A,B)	8.3 (A.B)	5.8 (A.B)	2.9	4.7 (M)
(J) 4;8 – 4;11	54.8(A - C)	45.1 (A,B)	19.7(A - E)	10.2 (A,B)	4.3 (A - E)	15.2 (A,B)	8.8 (A – C)	6.0 (A.B)	1.9	5.3 (M)
(K) 5;0 – 5;3	44.3 (A,B)	31.7 (A)	15.7 (A,B)	7.0 (A,B)	4.0 (A,B)	12.9 (A,B)	8.2 (A.B)	6.2 (A.B)	1.7	2.3 (M)
(L) 5;4 – 5;7	48.1 (A,B)	30.7 (A)	16.5 (A,B)	8.2 (A.B)	3.9 (A,B)	13.1 (A,B)	7.4 (A.B)	5.5 (A)	2.2 (B)	2.3
(M) 5;8 –5;11	45.8 (A,B)	34.5 (A)	17.2 (A,B)	8.6 (A,B,D)	4.4 (A - E)	13.1 (A,B)	7.6 (A.B)	6.0 (A.B)	3.0 (B)	1.5(C,D,F - K)

Kruskal-Wallis test ($p \leq 0.05$)

The superscript letters in brackets represent the age in which statistical difference occurred. The dash (-) indicates statistical difference from one age to another and the comma (,) indicates statistical difference in one age and in another. Examples: the noun production in the age group of 1;6 a 1;11 (A) is different from the age groups of 3;4 – 3;7 (F); 3;8 – 3;11 (G); 4;0 – 4;3 (H); 4;4 – 4;7 (I); 4;8 – 4;11 (J); 5;0 – 5;3 (K); 5;4 – 5;7 (L); 5;8 – 5;11 (M). The noun production in the age group of 2;4 – 2;7 (C) is different from the age groups of 4;4 – 4;7 (I) and 4;8 – 4;11 (J).

Subtitle: Adv = Adverbs; Adj = adjectives; Conj = conjunctions; Pron = pronouns; Prep = prepositions; Art = articles; Num = numerals; I + O = interjections and onomatopoeias

Table 3. Correlations between the sound class of stops and the word classes produced

Age group	Word classes			Coefficient (r)	p-value
1:6 – 1:11	Stops	X	Word classes	No significant correlation	
2;0 – 2;3	Stops	X	Nouns	0.566	0.044*
			Adjectives	0.624	0.023*
2;4 – 2;7	Stops	X	Adverbs	0.592	0.033*
			Pronouns	0.735	0.004*
2;8 – 2;11	Stops	X	Word classes	No significant correlation	
3;0 – 3;3	Stops	X	Word classes	No significant correlation	
3;4 – 3;7	Stops	X	Word classes	No significant correlation	
3;8 – 3;11	Stops	X	Word classes	No significant correlation	
4;0 – 4;3	Stops	X	Word classes	No significant correlation	
4;4 – 4;7	Stops	X	Word classes	No significant correlation	
4;8 – 4;11	Stops	X	Word classes	No significant correlation	
5;0 – 5;3	Stops	X	Word classes	No significant correlation	
5;4 – 5;7	Stops	X	Word classes	No significant correlation	
5;8 – 5;11	Stops	X	Word classes	No significant correlation	

*Significant values ($p \leq 0.05$) – Student's t-test

Subtitle: r = Spearman correlation coefficient and statistical significance

even in the adulthood[18,20]. In this way, the hypothesis is that the growing is initially tremendous to the rapid vocabulary expansion. So, the acquisition of the other word classes will be possible with consequent development of the syntax. Therefore, when children are about four years old, the growing in the verb and noun production is smaller, because they have to process the acquisition of more complex word classes, and the other domains of language, such as syntax and phonology.

Adverbs, pronouns and prepositions also demonstrated a substantial number of items produced, with a great increase until approximately the age of four and stabilization after this age. In German, the adverbs are also abundant in the beginning of acquisition, but pronouns and prepositions are less produced with the increase of the age[21].

Table 4. Correlations between the sound class of fricatives and the word classes produced

Age group	Word classes			Coefficient (r)	p-value
1;6 – 1;11	Fricatives	X	Prepositions	0.725	0.027*
			Articles	0.791	0.011*
2;0 – 2;3	Fricatives	X	Adjectives	0.709	0.007*
			Conjunctions	0.592	0.033*
2;4 – 2;7	Fricatives	X	Verbs	0.733	0.004*
			Adverbs	0.618	0.024*
			Conjunctions	0.644	0.017*
			Pronouns	0.589	0.034*
2;8 – 2;11	Fricatives	X	Word classes	No significant correlation	
3;0 – 3;3	Fricatives	X	Pronouns	- 0.709	0.003*
			Prepositions	- 0.650	0.009*
3;4 – 3;7	Fricatives	X	Articles	- 0.617	0,014*
3;8 – 3;11	Fricatives	X	Word Classes	No significant correlation	
4;0 – 4;3	Fricatives	X	Word Classes	No significant correlation	
4;4 – 4;7	Fricatives	X	Word classes	No significant correlation	
4;8 – 4;11	Fricatives	X	Word classes	No significant correlation	
5:0 – 5:3	Fricatives	X	Word classes	No significant correlation	
5:4 – 5:7	Fricatives	X	Word classes	No significant correlation	
5:8 – 5:11	Fricatives	X	Word classes	No significant correlation	

*Significant values (p≤0.05) – Student's t-test
The calculation of the coefficient was not possible for some variables, which; was represented by the dash (-).
Subtitle: r = Spearman correlation coefficient and statistical significance

Table 5. Correlations between the sound class of liquids and the word classes produced

Age group	Word classes			Coefficient (r)	p-value
1;6 – 1;11	Liquids	X	Adjectives	1.000	0.00*
2;0 – 2;3	Liquids	X	Word classes	No significant correlation	
2;4 – 2;7	Liquids	X	Articles	0.583	0.037*
2;8 – 2;11	Liquids	X	Word classes	No significant correlation	
3;0 – 3;3	Liquids	X	Word classes	No significant correlation	
3;4 – 3;7	Liquids	X	Word classes	No significant correlation	
3;8 – 3;11	Liquids	X	Word classes	No significant correlation	
4;0 – 4;3	Liquids	X	Word classes	No significant correlation	
4;4 – 4;7	Liquids	X	Word classes	No significant correlation	
4;8 – 4;11	Liquids	X	Nouns	- 0.563	0.029*
			Adverbs	- 0.705	0.003*
			Numerals	- 0.587	0.021*
5;0 – 5;3	Liquids	X	Word classes	No significant correlation	
5;4 – 5;7	Liquids	X	Word classes	No significant correlation	
5;8 – 5;11	Liquids	X	Word classes	No significant correlation	

*Significant values (p≤0.05) – Student's t-test
The calculation of the coefficient was not possible for some variables, which; was represented by the dash (-).
Subtitle: r = Spearman correlation coefficient and statistical significance

The data mentioned in the two previous paragraphs have support in the syntax to be explained, i.e., when the children start the period when they produce two words, around two years of age, most of them combine two open class words or one open class word and a pronoun, generally a demonstrative one[22]. In this way, according to the data, the most abundant words in the beginning of acquisition are nouns and verbs (open class words), followed by pronouns (including the demonstratives)

and prepositions (in Portuguese it is common to combine prepositions with demonstrative pronouns, e.g. "neste" - in this or "deste" - of this). These word classes are prevalent to the syntax development and there is a mutual relationship between lexical and syntax development.

Conjunctions, numerals, interjections and onomatopoeias are less abundant. The conjunctions almost didn't appear in the early stages, but according to the age, they presented slow and gradual increase. The syntax can also explain the phenomena found here, because the conjunctions are only produced after the coordination among sentences, which requires maturity in terms of linguistic knowledge. So, the child is capable to use the conjunctions after certain age, when he/she knows other word classes. One evidence of the conjunction complexity acquisition is a research showing that these words are still improving in the age of 10[23].

The low occurrence of numerals in all age groups can be related to the absence of formal teaching of numeral concept, because this notion is learned in class in a later period. The semantic criteria would be limiting the use of these words in the speech, because the child who's three years old presents some awareness of quantity, but he/she doesn't understand that the count routines are related to these quantities[24]. The presence of numerals in the children's speech is generally associated with counting routines, which the child doesn't relate a meaning.

The interjections and onomatopoeias presented a decrease in the averages of production according to the age. This fact was also observed in other languages, as German[21]. These words are considered as less rational[25] and they are used more instinctively. So, according to the increase of age, the child presents more knowledge about the different structures of his/her language and need to use fewer words that represent emotion and irrationality.

In general, all word class averages increased with the age, except the interjections and onomatopoeias. The increase is expected due to the maturation of the linguistic system, which presents a lot of changes in a short period.

The significant correlations to the stops were positive in the entire sample and the calculation was impossible to the nasals in most ages due to the precocious acquisition of these sounds. These data pointed to the influence of sound complexity in the lexical production, because the more words produced, the more the stops were produced correctly. Conversely, the fricatives and liquids showed some negative significant correlations, being also an evidence of the sound complexity. These sounds are more complex, i.e., they are acquired later because of the distinctive features [continuant] and [approximant][10]. Furthermore, they require greater oral motor control for production than nasals and stops.

Generally, the positive significant correlations occurred more and appeared in the three first age groups, when the vocabulary improvement is bigger. This is proven by researches in which there was a high increase in the measures of lexical diversity and productivity and occurrence of vocabulary spurt[18,26].

The ability to produce markedness structures in early ages can represent a minimal competence in the linguistic, perceptual and motor systems that can influence positively the acquisition of linguistic system, including lexical and morphosyntax[27]. Furthermore, the sounds produced in this age are, generally, nasals and stops, both are easy to acquire. There are also evidences that children in the beginning of phonological acquisition select the words to speak at least partially on the basis of how pronounceable they are[28].

The fricatives presented the most significant correlations, whether they are positive or negative. A North American research showed that children who produced at least one fricative at the age of 18 months demonstrated better vocabulary and grammar scores, with a greater use of present progressive and past tense markers at 18, 24 and 30 months[29]. In the present study, we found significant positive correlations between the production of fricatives and prepositions, articles, adjectives, conjunctions, verbs, adverbs and pronouns at the ages from 1;6 to 2;7 supporting the research just mentioned[29]. So, there are evidences that the ability to produce fricatives in the early stages of language acquisition is one of the factors that lead to better abilities of vocabulary and grammar.

An explanation suggested by the author[29] is that the children who produce more complex sounds such as fricatives may have a better memory to store more complex phonological information including sounds and sequences that they can use to enhance vocabulary development and word production.

The negative significant correlations were found in the word classes: pronouns, prepositions, articles, adverbs, numerals and nouns. Excluding the nouns, all other word classes mentioned are grammatical elements, which are more related to syntax. In this way, syntax can destabilize more the phonological development than vocabulary. Probably, the syntactical complexity demands more of the linguistic processing.

The negative correlations are concentrated in the intermediate age groups (three and four years of age). In this stage the child may have awareness of his/her phonological mistakes that demands more of the linguistic processing. So the child focuses his/her attention to a single aspect, phonology or lexicon.

A complementary explanation is the U-shaped curve. The child presents a good vocabulary and some acquired sounds, so he/she starts to generalize the patterns he/she uses most, adapting fewer accessible target words, syllabic structures or sounds to one or more emergent templates[28].

The U-shaped curve also explains the absence of negative correlations at the age of five years[28], because after this unstable period, both vocabulary and phonology improve, so both domains become stable.

Comparing the data presented here to others, the results of a unique study or theoretical view will rarely be enough to explain the complex phenomena of acquisition. One research[30]

found various clues that the lexical input frequency influences both the learning time and production accuracy of the cluster. However, some data pointed to the effect of the age of lexical acquisition as a strong predictor to the cluster acquisition.

In this way, however the current analysis presents a generative view, other influences in the process of phonological and lexical acquisition can't be denied, such as the number of sounds in the words, neighborhood density, input frequency, phonological and syllabic complexity, and so on. However, it's almost impossible to deal with all these variables in one unique study. Thus, the studies with different theoretical views should be seen as complementary and not excluding in the attempt to explain the language acquisition.

Other limitations of the study are: the research was conducted in just one city and the children belonged only to the low socioeconomic status.

This research is an information source about phonology and vocabulary acquisition of the Brazilian Portuguese. It must be seen as a tool to understand the typical development and to infer the deviations and find solutions to them.

CONCLUSION

The acquisition of Brazilian Portuguese starts with stops and nasals, so the fricatives and liquids are more complex. Even in the last age group analyzed, some children do not produce all liquids. In the vocabulary development, nouns and verbs are prevalent in the beginning of acquisition. The elements mostly related to syntax, such as conjunctions, are acquired later and have slower evolution. In general, the word classes improve according to age. Only interjections and onomatopoeias decrease with age, because they are more primitive words.

There are many correlations between phonology and vocabulary, showing a clear relationship between one another. The correlations are positive in the first age groups, negative in the intermediate age groups and absent in the last age groups. These data are related to the U-shaped curve.

The most significant correlations are positive, indicating that, in general, vocabulary and phonology improve together. The most significant negative correlations are related to grammatical words and more complex sound classes, pointing to the influence of syntax and phonological complexity in the vocabulary acquisition.

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