Original Article

Artigo Original

Phonological acquisition of Brazilian Portuguese in children from Rio de Janeiro

Aquisição Fonológica do Português Brasileiro em Crianças do Rio de Janeiro

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Keywords

Child development
Child language
Articulation disorders
Phonetics
Social class

ABSTRACT

Purpose: To describe the typical course of phonological acquisition in Brazilian Portuguese, in view of clinical usage. **Methods:** A picture naming test was used to collect speech samples from 480 children (240 female and 240 male) enrolled in public and private schools in the city of Rio de Janeiro, who were divided into five age groups between 3 and 8 years. Three types of analyses were conducted, and results were compared for age, gender, and socio-economic level: (1) phonological inventory analysis looking at how many and which consonants were acquired, (2) assessment of the percentage of consonants correct, and (3) phonological processes analysis. **Results:** Results clearly indicate a faster acquisition in children of higher socio-economic level than in children of lower socio-economic level. Data also indicated that age is the most important factor in phonological acquisition. The completeness of the consonant inventory, the percentage of consonants correct, and the use of phonological processes improved with increasing age, and variability among children decreased. Gender differences, however, were not observed. **Conclusion:** The information collected may ultimately help speech-language pathologists in the assessment and treatment of children with speech sound disorders.

Descritores

Desenvolvimento infantil
Linguagem infantil
Transtornos da articulação
Fonética
Classe social

RESUMO

Objetivo: Descrever a aquisição fonológica típica do Português Brasileiro, para fins clínicos. **Métodos:** Por meio de um teste de nomeação de figuras, foram coletadas amostras de fala de 480 crianças (240 do gênero feminino e 240 do gênero masculino), provenientes de escolas públicas e privadas do município do Rio de Janeiro, que foram divididas em cinco grupos etários entre 3 e 8 anos. Três tipos de análises foram realizadas e os resultados foram comparados em relação ao gênero, à idade e ao nível socioeconômico: (1) análise do inventário fonológico detalhando quantas e quais consoantes foram adquiridas, (2) avaliação do percentual de consoantes corretas e (3) análise dos processos fonológicos observados. **Resultados:** Os resultados mostraram com clareza um desenvolvimento mais acelerado de crianças de nível socioeconômico alto em comparação com as crianças de nível socioeconômico baixo. Os dados apontaram ainda que a idade é o fator mais determinante na aquisição fonológica. A completude do inventário de consoantes, o percentual de consoantes corretas e o uso de processos fonológicos melhoraram com o aumento da idade, e a variabilidade entre as crianças diminuiu. Não foram, no entanto, observadas diferenças relativas ao gênero. **Conclusão:** As informações coletadas podem ajudar os fonoaudiólogos na avaliação e no tratamento dos transtornos dos sons da fala.

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Received: 5/3/2011

Accepted: 11/22/2011

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Conflict of interests: None

INTRODUCTION

Speech-language pathologists increasingly assess and treat children from varying linguistic backgrounds. Yet, knowledge of typical development, including phonological development, is still predominantly based on studies of English. For many languages there is still a lack of norms and adequate instruments to assess phonological development in children suspect of having a disorder. A recent national survey conducted in the United States, for example, found that most speech-language pathologists still use English-only tests when evaluating non-native English speakers[1].

As far as Brazilian Portuguese is concerned most studies documenting aspects of phonological acquisition are of very recent date. The only exception is a pilot study[2] reporting speech sound acquisition and phonological process use in 70 children between 2 years and 4 months and 4 years and 4 months. Participants in this study involved children from nursery schools in Porto Alegre, a city in the south of Brazil. Data consisted of samples of spontaneous naming collected by means of five thematic pictures.

A series of studies conducted at an University in the state of Rio Grande do Sul[3], most of them from master's or doctoral theses, provide data on the acquisition of sounds and syllable structures, as observed in different samples derived from two data bases: speech samples from a cohort of 310 children aged between 2 years and 7 years and 1 month and samples from a cohort of 96 children aged between 1 and 2 years. The two data bases consisted of recorded conversations with the children. All participating children in these data bases were recruited in two cities (Porto Alegre and Pelotas) and spoke the regional variant of this area.

There are also some data available from children residing in São Paulo. One study[4] investigated the percentage of consonants correct (PCC) in a group of 40 children aged 3 to 5 years and 6 months; another study[5] described the use of cluster simplification and final consonant deletion processes in 80 children between 7 years and 1 month and 8 years and 11 months. A third study[6] compared the acquisition of singletons in initial, medial and final syllable in 88 children between 2 years and 1 month and 3 years. In each of these three studies speech samples were collected with phonology tests that consisted of picture naming and word imitation.

Although overall Brazilian Portuguese is relatively consistent throughout the country, there are nonetheless regional differences and as such, findings from one city or area cannot be automatically generalized to other Brazilian cities or areas. As far as we could ascertain, data on phonological acquisition for other cities or areas than Rio Grande do Sul and São Paulo are non-existent.

Moreover, some the above studies employed procedures for eliciting speech (such as spontaneous naming and conversational speech) that don't easily lend themselves for routine clinical use and/or reported data in forms that do not allow usage in normative ways. As there is evidence that the chosen modality for eliciting children's speech may affect the reported age of acquisition[7,8] using the data from these studies as reference norms employing an alternative elicitation procedure is not valid.

Among the Brazilian cities for which appropriate, clinically useful reference data on phonological acquisition appeared to be non-existent, is Rio de Janeiro. With a total population over 6 million inhabitants Rio de Janeiro is the second largest city of the country (after São Paulo). The number of inhabitants of the greater metropolitan area of Rio de Janeiro is estimated at 11 to 13.5 million. The regional variant of Brazilian Portuguese spoken in Rio de Janeiro has some distinctive traits among which the palatalization of the "s", aspiration of the "r", and strong palatalization of the syllables "ti", "di", "te" and "de". The purpose of the present study, then, was to detail the typical course of phonological acquisition in Brazilian Portuguese in a cohort of children from Rio de Janeiro.

METHODS

Participants

This project was approved by the Research Ethics Committee of Universidade Veiga de Almeida (process 74/07) and all the parents/guardians of the children who participated in the study signed a consent form agreeing to all the research procedures. The participants of this study were 480 children (240 female and 240 male) of five age groups between 3 and 8 years (48 boys and 48 girls in each group). The lower age limit of 3 years of age was chosen since clinical practice learns that for the overlarge majority of children suspected with speech problems parents seek intervention assistance beyond that age. The upper limit of 8 years was chosen in view of the fact that although most children develop standard speech by the age of six, it is not unusual for children to still have problems with certain sounds at age seven or eight or beyond[9,10].

Half of the children (n=240) were recruited in public schools and half (n=240) in private schools in the Rio de Janeiro area. In Rio de Janeiro, like all over the country, public and private schools attract pupils from different socio-economic levels. Private schools tend to have good teaching conditions and a high educational quality. However, there is tuition to be paid that might be quite high relative to the regional average income. In public schools, on the other hand, teaching conditions are often poor and educational standards are low, but they are tuition free and as such more accessible for lower income families. Therefore, pupils attending public and private schools can be considered as quite typical for the Rio lower and higher class, respectively.

Only children who according to their teachers and pedagogical coordinators did not present with a genetic disorder, neurological problem, visual or hearing problem, or speech-language problem were included. Children receiving speech-language therapy at the time of data collection, or who had received speech-language therapy in the past, were excluded.

Data collection and transcription

The instrument used to collect speech samples consisted of a picture naming test, eliciting 79 words containing examples

of all Portuguese consonants in each permissible word position. The test, which uses colored digital pictures (15 x 21 cm), was developed from six different sets of stimuli, such as photographs taken from magazines, drawings in crayon, thematic figures depicting scenes of everyday life, booklets with pictures, miniatures and digital photographs.

The final version consisted of those stimuli that in a pilot study had proven to be most apt to elicit desired target words and contained only high frequency words[11, 12]. The test was constructed to assess consonant production only, and not vowel production. This choice was based on the knowledge that vowels are acquired well before consonants (children use most if not all vowels before the age of 3; and that the majority of children with phonological disorders have problems primarily with consonant segments[13].

Speech sampling always took place in a silent room at the schools. Samples were digitally recorded (mini disc Sony or digital voice recording Samsung) and phonetically transcribed using the IPA[14] symbols and diacritics. A consensus transcription of the samples served as the basis for further analyses[15,16]. This consensus transcription was arrived at by comparing an on-line transcription and subsequent check by the principal investigators with that of the coordinating investigator

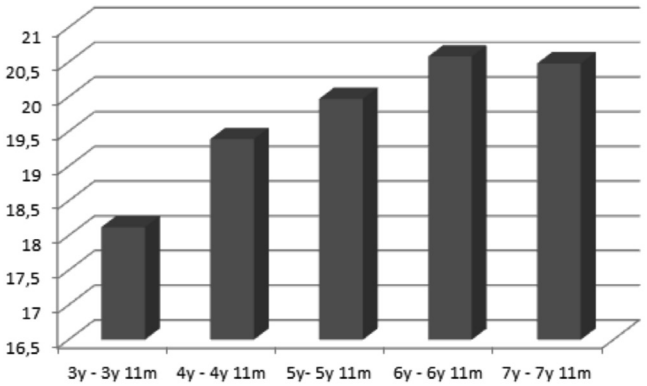
Analysis

Three types of analyses were conducted comparing results for age, gender, and socio-economic level: (1) a phonological inventory analysis looking at how many and which consonants were acquired, (2) an assessment of the percentage of consonants correct, and (3) a phonological process analysis. It concerns three types of analyses that are considered essential in the assessment of phonological disorders[17]. In each of these analyses normal variability in speech production was taken into account. The comparison of results for gender and socio-economic level, in addition to age, was motivated by the evidence that female children generally have slightly superior articulation skills than male children and that children from lower socio-economic levels tend to make more articulation errors than those in the upper classes.

RESULTS

Phonological inventory analysis

Using a criterion of 75% correct production for a sound to be considered acquired, it was found that completeness of the consonant inventories gradually increases with increasing age (Figure 1). With increasing age there is also less variability among children as to completeness of their inventories, as indicated by a decreasing standard deviation (age 3 years to 3 years 11 months: SD=2.35, age 4 years to 4 years 11 months: SD=1.82, age 5 years to 5 years 11 months: SD=1.78, age 6 years to 6 years 11 months: SD=0.93, age 7 years to 7 years 11 months: SD=0.91). Considering each age group separately, no significant differences (p>0.05) were found between girls and boys. Only for the group as a whole, completeness of the inventory proved significantly higher in girls than in boys, though the difference was actually very small (mean number of sounds acquired 19.93 vs. 19.49 respectively; Mann-Whitney U test Z=-2,442; p=0.015). A comparison between higher and lower class children, showed a significantly more complete inventory in the former group from age 4 onward (Table 1).



Note: y = years; m = months

Figure 1. Completeness of the phonetic inventories – mean number of sounds acquired (of a maximum of 21)

Table 1. Comparison between high and low class children, regarding completeness of the phonetic inventories

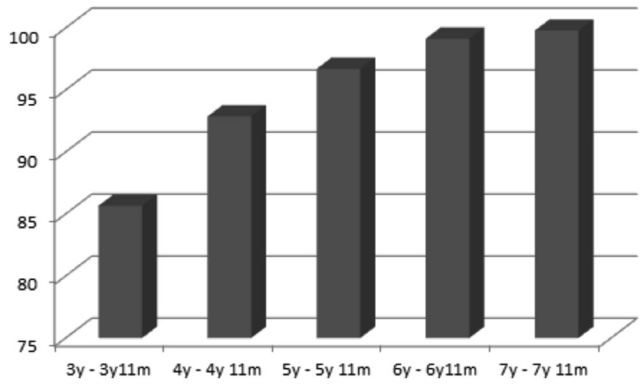
Age group	Mean number of sounds acquired		
	High class	Low class	p-value
3y- 3y11m	18.46	17.78	0.445
4y-4y11m	19.77	19.02	0.041*
5y-5y11m	20.62	19.33	<0.001*
6y-6y11m	20.92	20.25	<0.001*
7y-7y11m	20.96	20.00	<0.001*

*Significant values (p<0.05) – Mann Whitney U test
Note: y = years; m = months

Percentage of consonants correct

Also the percentage of consonants correct showed a tendency to increase with increasing age (Figure 2) and variability among children tended to decrease (age 3 years – 3 years 11 months: SD=8.70, age 4 years – 4 years 11 months: SD=6.32, age 5 years – 5 years 11 months: SD=6.55, age 6 years – 6 years 11 months: SD=3.52, age 7 years – 7 years 11 months: SD=3.56). No differences were observed between girls and boys (means, respectively, 94.33 vs. 93.03; Mann-Whitney U test Z=-1.445; p=0.146). A comparison between higher and lower class children, showed a significantly higher percentage of consonants correct in the former group from age 5 onward (Table 2)

Sounds that are acquired early (at age three already), are the plosives /p/, /b/, /t/, /d/, /k/, /g/, the nasals /m/, /n/, the affricates /tʃ / and /dʒ/ and the fricatives /f/ and /v/. Later acquired sounds appear to be the fricatives /s/, /z/, /ʃ/, /ʒ/, the /ʎ/, and /ɲ/, and the /ʀ/, /ɾ/ and /l/. Details are presented in Table 3 (lower class children) and 4 (higher class children).



Note: y = years; m = months

Figure 2. Mean percentage of consonants correct (PCC)

Table 2. Comparison between high and low class children regarding percentage of consonants correct

Age group	Percentage of consonants correct		
	High class	Low class	p-value
3y- 3y11m	85.65	86.99	0.275
4y-4y11m	92.85	91.02	0.104
5y-5y11m	96.69	93.12	<0.001*
6y-6y11m	99.12	96.26	<0.001*
7y-7y11m	99.78	95.28	<0.001*

*Significant values (p<0.05) – Mann Whitney U Test
Note: y = years; m = months

Phonological process analysis

The phonological process analysis showed that only few processes occur beyond the age of 6 (Figure 3). Most frequently used processes in the younger age groups were cluster reduction, final consonant deletion and lateralization. Again no gender differences were found (mean for girls and boys 3.53 vs. 3.97, respectively; Mann-Whitney U test Z=-1,600; p=0.110) but there clearly was a significant difference between higher and lower class children with the latter group showing a higher occurrence of processes in almost every age group (Table 5). Details on process use by the lower and higher class children are presented in Charts 1 and 2.

DISCUSSION

Epidemiological surveys investigating human communication and its disorders are scarce in the literature, especially in Brazil[18]. As far as phonological acquisition is concerned, thus far only data for Rio Grande do Sul and São Paulo were available for Brazilian Portuguese. The present study details the phonological acquisition as it takes place in children residing in the Rio de Janeiro area. Speech samples were collected in a cohort of 480 children. Analyses included a phonological inventory analysis, an assessment of consonants correct and a phonological process analysis, taking into account age, gender, and socio-economic level as variables.

Table 3. Percentage or lower class children that has acquired the sounds (criterium 75% correct)

Position	Sound	Age group				
		3y-3y11m	4y-4y11m	5y-5y11m	6y-6y11m	7y-7y11m
CV	p	97.9	100	100	100	100
	b	97.9	97.9	100	100	100
	t	100	100	100	100	100
	d	100	100	100	100	100
	k	100	100	97.9	100	97.9
	g	95.8	100	93.8	100	100
	f	95.8	97.9	100	100	100
	v	100	97.9	100	100	100
	s	85.4	93.8	89.6	95.8	100
	z	91.7	91.7	89.6	100	100
	ʃ	83.3	95.8	97.9	97.9	97.9
	ʒ	91.7	100	100	95.8	97.9
	tʃ	100	100	100	100	100
	dʒ	97.9	100	100	97.9	95.8
	m	95.8	100	97.9	100	100
	n	100	100	100	100	100
	ʎ	83.3	85.4	93.8	100	97.9
	ɲ	97.9	97.9	100	100	100
	ɾ	68.8	87.5	89.6	97.9	95.8
	ʁ	91.7	95.8	97.9	100	100
	l	93.8	95.8	97.9	100	100
CCV	p	97.9	100	100	100	100
	b	97.9	97.9	100	100	100
	t	100	97.9	100	100	100
	d	100	100	100	100	100
	k	97.9	100	100	100	100
	g	87.5	97.9	91.7	97.9	100
	f	100	100	100	100	100
	v	100	97.9	100	100	100
CCV	ɾ	50	60.4	72.9	95.8	77.1
	l	31.3	41.7	56.3	64.6	56.3
CVC	ʃ	97.9	97.9	100	100	100
	x	47.9	72.9	72.9	81.3	83.3

Note: y = years; m = months; CV = consoant-vowel; CCV = consoant-consoant-vowel; CVC = consoant-vowel-consoant

As expected, it was found that age is a major determining factor in phonological acquisition. Completeness of the consonant inventory, percentage of consonants correct and phonological process use all improved with increasing age. Also, variability among children decreased as they approached adult standards. In line with what is seen in English and other languages phonological acquisition is largely complete by the age of seven.

A striking age difference in phonological development between Portuguese and English speaking children is that in the former the process of stopping is suppressed quite early,

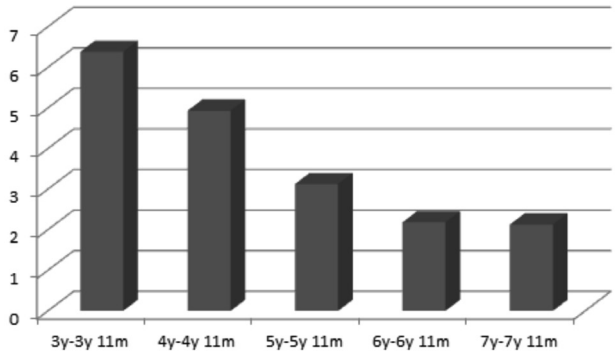
Table 4. Percentage or higher class children that has acquired the sounds (criterium 75% correct)

Position	Sound	Age group				
		3y-3y11m	4y-4y11m	5y-5y11m	6y-6y11m	7y-7y11m
CV	p	100	100	100	100	100
	b	100	100	100	100	100
	t	100	100	100	100	100
	d	100	100	100	100	100
	k	100	100	100	100	100
	g	100	100	100	100	100
	f	97.9	100	100	100	100
	v	97.9	100	100	100	100
	s	97.9	95.8	100	100	100
	z	91.7	93.8	100	100	100
	ʃ	85.4	93.8	100	100	100
	ʒ	89.6	93.8	100	100	100
	tʃ	100	97.9	100	100	100
	dʒ	100	97.9	100	100	100
	m	100	100	100	100	100
	n	100	100	100	100	100
	ʎ	81.3	95.8	91.7	100	100
	ɲ	81.3	85.4	95.8	95.8	97.9
	ɾ	56.3	77.1	87.5	100	100
	ʀ	81.3	100	100	100	100
	l	93.8	97.9	100	100	100
CCV	p	100	100	100	100	100
	b	100	100	100	100	100
	t	100	100	100	100	100
	d	100	100	100	100	100
	k	97.9	100	100	100	100
	g	97.9	100	100	100	100
	f	97.9	100	100	100	100
	v	97.9	100	100	100	100
CCV	ɾ	16.7	54.2	83.3	97.9	97.9
	l	64.6	85.4	93.8	97.9	100
CVC	ʃ	95.8	100	100	100	100
	x	50	83.3	97.9	100	100

Note: y = years; m = months; CV = consoant-vowel; CCV = consoant-consoant-vowel; CVC = consoant-vowel-consoant

around the age of 2 years and 6 months[2]. In English speaking children this pattern persists beyond the age of 4 years and 6 months. Our data seem to confirm this difference. In the age group of 3 to 4 years only 14.6 % of the lower class children and only 2.1% of the higher class children still demonstrated stopping.

Another striking difference with English speaking children concerns the occurrence of the process metathesis. For English speaking children metathesis is reported to be an unusual process[19]. In the present study, however, metathesis appeared to be quite frequent, with 24% of the lower class children and 10% of the upper class children still evidencing examples of



Note: y = years; m = months

Figure 3. Mean number of phonological processes used

Table 5. Comparison between high and low class children regarding the number of phonological processes used

Age group	Mean number of processes		
	High class	Low class	p-value
3y-3y11m	5,80	6,96	0,064
4y- 4y11m	3,65	6,21	<0,001*
5y- 5y11m	2,02	4,23	<0,001*
6y- 6y11m	0,42	3,94	<0,001*
7y- 7y11m	0,25	4,00	<0,001*

* Significant values (p<0.05) – Mann Whitney U test
Note: y = years; m = months

this process by age 7 to 8. How this discrepancy is to be explained is unclear.

An unexpected finding of this study is also that overall phonological acquisition is not different for girls and boys. Apart from a somewhat more complete phonological inventory in girls when the entire group of participants was considered, no gender differences emerged. This stands in contrast to the prevailing opinion in the international literature that boys lag behind in speech sound acquisition and the fact that speech sound disorders appear to be more prevalent in boys than in girls[20]. Estimates suggest, for instance, that developmental phonological disorders are two to three times more common in boys than in girls[21]. Interestingly, however, in a study of cluster simplification and final consonant deletion processes usage in 80 children with typical phonological development in São Paulo[5], gender was not a significant factor in explaining the probability of presenting phonological processes. Also a study that screened 1810 primary school children in the municipality of Canoas, State of Rio Grande do Sul, Southern Brazil[18], found a similar frequency of speech sound disorders in both genders. It would seem that contrary to the more general trend in English, speech sound acquisition and the occurrence of speech sound disorders in Brazilian children do not show a gender difference. It is not clear how this particular finding is to be explained. Further research into this area is certainly warranted.

Furthermore, the results of the present study clearly indicate that a difference exists between higher class and lower class

Chart 1. Percentage of lower class children using each phonological process

Process	Age group				
	3y-3y11m	4y-4y11m	5y-5y11m	6y-6y11m	7y-7y11m
Cluster reduction	85.4	85.4	79.2	68.7	77.1
Syllable reduction	41.7	43.7	12.5	6.2	4.2
Final consonant deletion	89.6	91.7	85.4	85.4	83.3
Reduplication	2.1	0	0	0	0
Epenthesis	6.2	12.5	2.1	4.2	0
Vowel insertion	0	0	0	0	0
Metathesis	64.6	58.3	50	50	37.5
Stopping	14.6	16.7	6.4	6.2	0
Affrication	10.4	6.2	4.2	0	2.1
Fronting	37.5	14.6	10.4	8.3	12.5
Backing	47.9	54.2	25	33.3	18.2
Devoicing	14.6	12.5	14.6	8.3	2.1
Lateralization	64.6	41.7	25	35.4	47.9
Gliding	12.5	12.5	2.1	0	2.1
Monophthongization	41.7	29.2	14.6	6.2	12.5
Assimilation	47.9	39.6	20.8	31.2	20.8
Liquid simplification	37.5	25	20.8	4.2	12.5
Deaffrication	4.2	0	2.1	0	2.1
consonant insertion	18.7	20.8	6.2	0	4.2
Voicing	8.3	4.2	4.2	2.1	4.2
Substitution of liquid	45.8	44.2	39.6	45.8	58.3

Chart 2. Percentage of higher class children using each phonological process

Process	Age group				
	3y-3y11m	4y-4y11m	5y-5y11m	6y-6y11m	7y-7y11m
Cluster reduction	91.7	72.9	27.1	10.4	6.3
Syllable reduction	43.7	10.4	14.6	2.1	0
Final consonant deletion	77.1	50	41.7	0	2.1
Reduplication	2.1	0	0	0	0
Epenthesis	4.2	6.2	2.1	0	2.1
Vowel insertion	0	0	0	0	0
Metathesis	54.2	45.8	47.9	18.7	10.4
Stopping	2.1	2.1	0	0	0
Affrication	0	0	0	0	0
Fronting	43.7	16.7	6.3	2.1	0
Backing	27.1	27.1	12.5	0	0
Devoicing	10.4	8.3	0	0	0
Lateralization	68.7	56.2	18.7	2.1	0
Gliding	10.4	0	4.2	0	0
Monophthongization	52.1	12.5	2.1	2.1	0
Assimilation	43.7	35.4	22.9	2.1	4.2
Liquid simplification	45.8	14.6	2.1	2.1	0
Deaffrication	0	4.2	0	0	0
consonant insertion	2.1	2.1	0	0	0
Voicing	0	0	0	0	0
Substitution of liquidae	0	0	0	0	0

children. With respect to the phonological inventory and the percentage of consonants correct differences appear from age 5 onward. With respect to the use of phonological process, differences exist as early as age 3. These results run parallel to those of a study[5] demonstrating that there is a higher probability of public school children (lower class) to use cluster simplification and final consonant deletion when compared to children of private schools (higher class). Obviously, such a sociolinguistic difference is to deplore. It is hoped that the results of the present study may be helpful in directing programs aimed at bridging the gap between lower and middle high class children in Brazilian society.

CONCLUSION

The data presented here may be useful as a reference for Brazilian speech-language pathologists assessing and treating children with speech sound disorders in the Rio de Janeiro area. Thus far no such normative data were available. In addition, the data of our study may be useful for speech-language pathologists outside Brazil as well. Speech-language pathologists increasingly assess and treat children from varying linguistic backgrounds. Unfortunately, they all too often have to settle with developmental milestones based predominantly on studies of English. A computerized version of the test used in this study that will allow for automatic reference to the normative data collected is currently being developed.

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