Speech sounds data for typically developing European Portuguese children 6-9 years old

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ABSTRACT

Purposes: To identify the European Portuguese (EP) speech sounds competence in children. ***Methods:*** A total of 240 children between 6 and 9;11 years old named 37 pictures. Gender and age effect as well as the age limit for EP speech sound mastery were analyzed. The percentage of consonants correct (PCC) were determined. The criteria used were PCC ≥75% (acquired sound) and ≥90% (mastered sound). ***Results:*** No gender effect for speech sound development was found in the studied age range. Children with older ages [8-9;11] showed a slightly significant mean performance than younger ages [6-7;11]. The girls appeared to reach higher mean competence than boys; however, gender effect did not reach significance. At the [6-6;11] years old age range all plosives (except the word-medial /t/ and /g/), four fricatives (/f/, /v/, word-initial /ʃ/ and word-medial /ʒ/) and two laterals (word-medial /r/ and word-initial and medial /R/) are mastered. The other targeted sounds are mastered either at the [7-7;11] or at the [8-8;11] year old range. ***Conclusion:*** The EP targeted speech sounds are mastered between 6 and 8;11 years old.

1 INTRODUCTION

There has been a long tradition, in the speech-language pathologists' (SLP) field to relate the speech sound pattern of a child to the reference cutoff age for the typically developing children in the same linguistic community.

A clear idea about speech sound development is highly relevant either for an identification of the developmental performance, appropriateness as for identification of delay or disorder (e.g. Speech sound disorders). Early intervention based on appropriate and thorough analyses is essential due to the role that phonetic system plays in early speech development [1].

The age at which children acquire the speech sound is somehow ambiguous due to several reasons, e.g., the different underlying criteria used for correct sound production either 75% or 90%. Moreover, in the psychometric field the lowest 5-10% of the performances on a validated tool is considered to be outside the normal range. In fact, the current findings support the utility of the 90% as a primary criteria to identify all possible true positives for the sound acquisition accuracy. Evidence reports that developmental speech sound difficulties may persist beyond the early into older years and that there is a gap of two years between acquiring a speech sound (75%) and mastering (90%) it [2].

Whilst data on age-appropriated speech sound production for EP speaking children between 3 and 6;11 years old is available, to the date there have been limited studies including older EP speaking children [3-4]. For the PCC≥75% all vowels, plosives, fricatives, laterals and four consonant clusters are acquired at the age limit of 5;06 years old (e.g. /l/ and /r/ in clusters; word-final /r/) [3]. Others, however, have also used a more stringent criteria (PCC≥90%) and stressed that not all consonant sounds are mastered at the upper age limit of 5,11 years old (e.g., the lateral liquids (/l/ /ʎ/) and seven consonant clusters) [4]. Evidence for other languages supports the cutoff age between 8 and 9 years old for the typical speech sound acquisition to be completed [2].

Consequently, consideration of a study on the correct consonant production of EP speaking children aged [6-9;11] years old will provide reference values for an uncovered age span knowledge. Specifically, this study aimed to address the following questions: (i) Is there any age-gender effect in the speech sound development for the age span of 6-9;11? (ii) At which age limit is the targeted EP speech sounds mastered?

2 METHODS

Data for this study were taken from a large study of speech analysis previously approved by the Ethical board of the Alcoitão School of Health Sciences and the local authority's committees of the schools. An informed consent,

approval from the children's legal guardians was gathered.

2.1. Participants

Children were selected from a sample of speaking children between 3 and 11 years old. Inclusion criteria involved children that were monolingual, EP speaking, without delay language development or learning disability did not have a speech sound disorder or follow up in SLP.

2.2. Materials

The assessment protocol in the larger study included the following materials: an oromotor examination, a Verbal Articulation Test (TAV) for EP and a sequence of pictures to elicit story telling. The assessment instrument for the present study included only the TAV a single-word screening test. TAV uses pictures arranged by semantic category (e.g. Animals, objects) to increase the probability of spontaneous identification. It includes 37 pictures that examine the children's performance of EP consonant targets that occur in word-initial (16 consonants), word-middle (19 consonants) and word-final (3 consonants) and EP consonant clusters (8 word-initial and 3 word-middle) [4] (Table 1).

Table 1 – TAV type and number of EP speech sounds targets

	Plosives	Fricatives	Laterals	Clusters
Word-initial	/p/ /b/ /t/ /d/ /k/ /g/ /m/ /n/	/f/ /v/ /s/ /z/ /ʃ/ /ʒ/	/l/ /R/	/pr/ /br/ /tr/ /dr/ /kr/ /gr/ /fr/
Frequency	**16**	**9**	**4**	**7**
Word-medial	/p/ /b/ /t/ /d/ /k/ /g/ /m/ /n/ /ɲ/	/f/ /v/ /s/ /z/ /ʃ/ /ʒ/	/l/ /ʎ/ /ɾ/ /R/	/br/ /gr/ /vr/
Frequency	**18**	**8**	**14**	**4**
Word-final	EP-Non existent	/ʃ/	/ɬ/ /ɾ /	EP-Non existent
Frequency		**5**	**4**	
TAV Total	**34**	**22**	**22**	**11**

2.3. Procedure

Children were recruited in the region of Lisbon at public schools over the period of six months (September 2016 – March 2017). Parents and teachers had to refer healthy children with typical development.

Children were assessed individually in a quiet room at their school setting by an SLP or a final graduated SLP student previously trained in TAV administration.

Each of the 37 pictures was shown to the child who was asked to name it. If the child did not answer the examiner could give standardized previous clues (e.g. It is something you can use to cut paper. So, what is the name?'). All the child's utterances were recorded digitally.

2.4. Equipment

A portable Digital Audio Tape (DAT) recorder (Sony TCD–D8) battery powered and a unidirectional condenser microphone was used.

2.5. Data analysis

Only spontaneously or elicited child's utterances, were considered for scoring.

A score of one, acceptable response, was given to word correctly uttered for each tested speech sound in the different word position and a score of zero for no response or if incorrect productions were detected (e.g. Omission, distortion). The possible total raw score for the TAV correct consonant production is 89.

The word uttered database audio recordings were analyzed one by one by two SLP's who were blind to the status of the children. A measure of reliability of the transcriptions from the two SLPs was carried out using 24 randomly selected samples. Intra- and inter-judge reliability was evaluated by using Intraclass Correlation Coefficients (ICCs). ICCs greater than 0.75 were considered excellent and accepted as the minimum for reliable individual measurements [5]. The ICCs for intra-judges agreements were 0.79 and 0.89, respectively, and the inter-judge ICCs was 0.86. The highly statistically significant intra-examiner strength of agreement within the two examiners suggests the stability of the TAV perceptual assessment while the high inter-examiner agreement shows that it can be used interchangeably between examiners in a valid way.

The percentage of acceptable responses for each sound target was calculated for each age group over the age range tested. The PCC were scaled according to literature recommendation: a consonant correctly produced is considered mastered at ≥90%, acquired at ≥75-89%, present at ≥ 50-74%, emergent at > 10-49% and rare or absent at ≤ 10% [6-7].

The mean, standard deviation and 95% Confidence Interval (CI) were calculated for TAV total score according to age and gender. To examine the effect of age on TAV performance, the children were divided into four groups of one-year range (because non-significant differences were found within the 6 month age range). Also, the gender effect did not

reach the statistical significance (p<.05) therefore the results were reported without gender subdivision.

To test for the significance of the change between age groups was carried out using independent samples t-test without assuming equal variances and the probability level accepted as significant was p<. 05.

3 RESULTS

3.1 Participants

A total of 240 typically developing children (47.1% boys), with an equal sample proportion across ages, participated in the study (Table 2).

Table 2 – Participants

Age (years; months)	6-6;11	7-7;11	8-8;11	9-9;11
Girls	32	35	29	31
Boys	28	25	31	29
Total	60	60	60	60

3.2 TAV total score

Table 3 shows TAV total data according to age groups. Globally data shows that the TAV mean score slightly raise while its variability (95% CI) slightly lowers with increasing age.

Table 3 - TAV total score across ages

	Mean	SD*	95% CI*
6-6;11	79.9	10.1	77.3-82.5
7-7;11	81.8	8.1	79.7-83.9
8-8;11	86.9	3.2	86.1-87.7
9-9;11	86.0	4.5	84.8-87.1

* Standard deviation(SD); 95% Confident Interval (CI)

Children within the range of [6- 6;11] years old show significantly worst mean compare to those with [8-8;11] (t=-5.076 df=70.8 p<0.001) and [9-9;11] years old (t=-4.218 df=81.8, p<0.001). Also, TAV total score for [7- 7;11] is significantly different from the [8-8;11] (t=-4.531 df=77.263, p<0.001) and the [9-9;11] (t=-3.485 df=92.873, p<0.001) years old children.

3.3 Individual speech sound targets

Based on the PCC≥75% criteria at the lower limit of [6-6;11] years old children had acquired the plosive, fricative, lateral and cluster sounds with few exceptions for the word-final lateral /r/, the word-initial clusters /tr/, /dr/, /fr/ and word-medial cluster /gr/ (Table 4).

If the more stringent criteria is used, PPC≥90%, as shown in the Table 4: (i) plosives are mastered at the age limit of 6 years old except the word-medial /g/ that is mastered at the age limit [7-7;11] and the word-medial /t/ that is mastered at the age limit [8-8;11]; (ii) the /f/ and /v/, word-initial /ʃ/ and the word-medial /ʒ/ fricatives sounds are mastered at 6-6;11; the word-initial /s/ at [7-7;11] and the following /s/ medial, /z/, word-medial and final /ʃ/ and word-initial /ʒ/ at 8-8;11 years old; (iii) the majority of laterals are mastered at the age range [8-8;11] except the /R/ and the word-medial /r/ at [6-6;11] years old; (iv) with the exception of the word-medial cluster /vr/, four clusters (/pr/, /br/, /kr/ and word-initial /gr/) are mastered at [7-7;11] age range and four clusters (/tr/, /dr/, /fr/ and word-medial /gr/) at the [8-8;11] age range (Table 3).

Table 4 – PPC≥75% according to word position and age

	*F	*Word	6-6;11	7-7;11	8-8;11
Plosives					
/p/	1	I	100		
	2	M	100		
/b/	1	I	100		
	1	M	100		
/t/	2	I	98		
	4	M	85	86	96
/d/	1	I	97		
	3	M	95		
/k/	7	I	99		
	2	M	98		
/g/	2	I	98		
	3	M	87	91	
/m/	1	I	100		
	1	M	95		
/n/	1	I	98		
	1	M	95		
/ɲ/	2	M	98		
Fricatives					
/f/	1	I	100		
	1	M	95		
/v/	1	I	95		
	2	M	98		
/s/	2	I	84	90	
	1	M	85	87	95
/z/	1	I	82	84	95
	1	M	85	87	98
/ʃ/	2	I	98		
	2	M	88	88	97
	5	F	88	88	97
/ʒ/	2	I	88	83	95
	1	M	97		
Laterals					
/l/	3	I	83	88	91
	6	M	81	88	91
	2	F	85	86	96
/ʎ/	2	M	80	87	95
/r/	5	M	92		
	2	F	74	79	95
/R/	1	I	97		
	1	M	98		
Clusters					
/pr/	1	I	88	97	
/br/	1	I	88	100	
	1	M	83	91	

/tr/	1	I	50	57	90
/dr/	1	I	68	80	95
/kr/	1	I	75	90	
/gr/	1	I	83	97	
	1	M	72	80	98
/fr/	1	I	73	80	95
/vr/	1	M	91		

*F (frequency); I (word-initial); M (word-medial); F (word-final)

4 DISCUSSION

There is evidence of no gender effect in the speech sound development for the age limit of [6-9;11] years old. However, an age effect was verified for the TAV total score with younger aged children [6-7;11] presenting a significantly lower score than older ones [8-9;11]. The evidence of a developmental increase with age is in agreement with the published data for EP younger ages and other languages [2-4,6-7]. Not surprising is the slightly lower variability (95% CI) with increasing age as expected for the typical child development.

Data obtained confirmed that all individual targeted sounds are mastered at the cutoff age limit of [8-8;11] years old when a PCC≥90% criteria was used. This is in line with Wren et al. [2] that suggests a cutoff age between 8 and 9 for the typical speech sound acquisition to be completed. Therefore, a similar pattern as for other languages was observed, confirming that phonemic inventories show universal similarities [6-7].

The findings of the present study also support the typical development order of sound classes frequency where plosives precede that of more complex sounds such as fricatives, laterals and consonant clusters. This is also evident for EP preschool children [3-4].

Although this study is unique in that it provides EP information on consonant acquisition for older children than previous studies, it has weaknesses that limit the generalization of the results [3-4]. First, the sample representativeness is restrictive and thus it is only possible to accept the results as preliminary data for EP speech sound mastery. Larger studies to cover the studied age span are needed. Second, the results application, specifically advocating clinical purposes, must be exercised with caution. TAV is a screening test with limited frequency of consonants, word contexts to be representative of a child's speech sound production. Also, TAV score, as any test score, must be broadly interpreted, as it is only an estimate of a child's level of speech sound performance. A child's TAV score may be higher or lower than the 'mean' or 'norm' or her/his age peer group and still be within normal limits. Finally, given the complexity and diversity of speech sound development, other variables, e.g., phonological and linguistic, may have influenced the results. More in-depth research is needed in order to arrive at effective normative data.

5 CONCLUSIONS

The goal of the present research was to seek empirical support for: (i) age-gender effect on the speech sound development for the age span of [6-9;11]. Although results show no gender effect, an age effect between the younger [6-7;11] and older [8-9;11] age ranges was observed; and (ii) the EP speech sounds age limit of mastery (PCC≥90%) which was found to be between [6-8;11] years old.

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