DEVELOPMENT OF /ɾ/ IN CROATIAN

Diana Tomić & Vesna Mildner

Faculty of Humanities and Social Sciences, University of Zagreb
dtomic@ffzg.hr; vesna.mildner@ffzg.hr

ABSTRACT

The aim of this study was to determine age of acquisition of the alveolar trill /r/ in typically developing Croatian children and to describe developmental renditions of the target phoneme – age of their occurrence and suppression. The study included 600 participants aged between 3 and 7. Speech elicitation was conducted by a picture-naming task in which target phoneme was represented in initial, medial, final and syllabic position. The results show that the alveolar trill should be developed by the age of six after an intensive period of development at the age of five. Omissions do not occur in the speech of three year olds and are not typical rendition for that age; substitutions should be considered developmental by the age of 4;6 and distortions by the age of 6;0.

Keywords: speech acquisition, alveolar trill, rhotics, Croatian, preschool children.

1. INTRODUCTION

Croatian belongs to the Slavic group of languages and it is the mother tongue of 4.5 million people in Croatia. The vowel system consists of five monophthongal vowels /i, e, a, o, u/ and the diphthong /ie/, which may also be pronounced as [ije]. The accent determines whether the vowels are long or short. There are 25 consonants in Croatian: stops /p, b, t, d, k, g/, affricates /ʦ, ʧ, ʤ, ʨ, ʥ/ fricatives /f, s, z, ʃ, ʒ, x/ nasals /m, n, ɲ/ approximants /j, ʋ/ lateral approximants /l, ʎ/ and an alveolar trill /r/. Also, Croatian alveolar trill can have syllabic function when it occurs between consonants in words like *vrt* (engl. garden) or *prst* (engl. finger) [11].

Alveolar trill /r/ belongs to the group of rhotics and is considered to be a prototypical member [10] of the group of sounds grouped together because of their auditory similarity and lower F3 values [5, 8] although Lindau [12] began to question the validity of F3 as a common feature. Regardless of the ongoing debate about the categorisation of rhotics [19] the group shows not only phonetic and phonological idiosyncrasies but it is also interesting form a developmental perspective.

Due to its articulatory complexity, the sound /r/ is expected to occur later in the course of speech development. Out of 36 languages with speech acquisition described in McLeod's guide [15], 21 languages have data on the age of acquisition of rhotics. The earliest age for a rhotic to be developed is 1;8–3;3+ for Japanese alveolar tap /ɾ/, 2;5 for alveolar approximant /ɹ/ in Maltese, 2;6–2;8 for Dutch alveolar tap /ɾ/ and 2;6–2;11 for 75% of German children acquiring uvular trill /ʁ/. Development of rhotics around the age of six is reported for American, British and Scottish English, Welsh, Spanish, Hungarian, Arabic, Thai and Greek, while Hebrew, Chinese, Norwegian, Brazilian and Turkish children acquire rhotics around the age of four. According to the results from Croatian normative study [25] alveolar trill in Croatian is acquired between 4;0 and 4;6 years. Developmental patterns are omissions of /r/, substitutions with /ʋ/, /j/ and /l/, and finally distortions which can, according to Vuletić [25] be tolerated only by the age of 3;6. However, it remains unclear what category of developmental renditions is typical from the age of 3;6 till the age of 4;0 when it should be completely developed. If compared to the languages with alveolar trill, the reported age of acquisition in Croatian is slightly lower. In Finnish, alveolar trill should be acquired last (age not specified) and in the already mentioned Spanish, Welsh and Arabic around the age of 6;0.

Therefore, the aim of this study is to determine the age of acquisition of the Croatian alveolar trill /r/ and to describe the course of its development, i.e. the occurrence and suppression of developmental renditions.

Linguistic material is also important for assessment of speech sound production. Most normative studies tested acquisition of speech sounds in initial, medial and final position [1, 2, 3, 20] while some, including Croatian normative study, did not include medial position [4, 25]. Other studies

[13, 14, 22, 23], emphasized the importance of tasks with target sounds represented in every position, including medial, for thorough and precise assessment of speech sound production. Hence, this study will also try to determine whether medial position should be included in the material for assessment of speech sound production.

2. MATERIAL AND METHOD

2.1. Participants

The study included 600 (300 F and 300 M) participants aged 3 to 7. Each 1-year age band was represented by 75 M and 75 F. All participants were considered healthy and typically developing by both their kindergarten teachers and parents who signed an informed consent for participation in the study.

2.2. Task

Development of Croatian trill was assessed in a picture-naming task. Target stimuli included /r/ in the syllable-initial and final position either followed or preceded by each of the five Croatian vowels /i, e, a, o, u/; /r/ in a medial position and the syllabic /r/. List of words is presented in Table 1.

Table 1: Target words used in the experimental task.

	Croatian	IPA	English
Initial	Riba	/riba/	Fish
	Rep	/rep/	Tail
	Rak	/rak/	Crab
	Roda	/roda/	Stork
	Ruka	/ruka/	Hand
Final	Papir	/papir/	Paper
	Šećer	/ʃetɕer/	Sugar
	Mokar	/mokar/	Wet
	Motor	/motor/	Motorcycle
	Tanjur	/taɲur/	Plate
Intervocalic	Pero	/pero/	Feather
Syllabic	Prst	/pəro/	Finger

2.3. Procedure

2.3.1. Task administration

Each child was tested individually in the familiar preschool setting. The testers were three females trained to ensure the consistency of testing. All testers used similar cues to elicit the target words ('What is this?'). Children's productions were digitally recorded by Marantz PMD 660 with stationary microphone AKG SE 300 B.

2.3.2. Assessment

The production of /r/ in target words was assessed in four developmental categories following Croatian normative study [25] and some recent studies [16]: omissions, substitutions, distortions and developed sound /r/.

Auditory assessment was conducted by a trained phonetician experienced in assessment of child speech. It included three stages: a) preliminary assessment during which categories and planned procedures were validated for two children from each gender and age group, b) main auditory assessment during which all recordings were assessed starting with the oldest female group (F6), followed by the oldest male group (M6) to M3 which was assessed last. This order was employed to avoid more stringent criteria for the youngest age groups. The third part of auditory assessment (c) was control auditory assessment which was conducted four months after the main assessment. 8% of the speech sample was reassessed. Intra-rater agreement was 93%. Also, another two assessors participated in the third part of the assessment; an experienced kindergarten SLP (F; 9 years of professional experience) and an experienced clinical phonetician (F; 11 years of professional experience). Inter-rater agreement between the author and the other two assessors was 83% and 87%, respectively thus validating the obtained results.

2.3.3. Scoring and data analysis

In order to address some methodological issues, such as missing responses typical in younger age groups who are often 'underscored' and the issue of developmental variability (i.e. a child may produce certain sound as developed in one position but also show distorted renditions in the other two) which can be ignored in the large sample studies, the results were calculated according to the formulas similar to the error consistency index [21, 24]. The results represent the percentage of certain developmental renditions in the sample.
Representation of developed renditions:

$$(1) \quad 1-(N_{distortions}+N_{substitutions}+N_{omissions})/(N_{distortions}+N_{substitutions}+N_{omissions}+Nd_{eveloped\ speech\ sounds})$$

Representation of each category of developmental renditions:

(2) $N_{category}/(N_{omissions}+N_{substitutions}+N_{distortions}+N_{developed\ speech\ sounds})$

SPSS 17 was used for data analysis. Besides descriptive statistics, t-test and ANOVA were used. Sidak-test was chosen for post-hoc test.

3. RESULTS AND DISCUSSION

The percentage of each developmental category in children's speech is shown in Table 2. At the age of five, Croatian children produce 71% of the developed renditions of alveolar trill /r/. Comparison of the results of all age groups shows statistically significant difference ($p = 0.000$) between all groups except the five-year olds (71%) and six-year olds (80%) ($p = 0.130$) when /r/ seems to be developed.

Table 2: Representation of developmental renditions of alveolar trill /r/ in Croatian (1-year age bands).

		Age			
Category		**3 yrs**	**4 yrs**	**5 yrs**	**6 yrs**
Omissions	%	3%	3%	1%	0%
	s.d.	0.08	0.09	0.04	0.02
Substitutions	%	40%	18%	5%	4%
	s.d.	0.41	0.33	0.18	0.16
Distortions	%	42%	37%	23%	16%
	s.d.	0.35	0.33	0.30	0.30
Developed /r/	%	16%	43%	71%	80%
	s.d.	0.26	0.38	0.36	0.35

The results also show that omissions cannot be considered developmental renditions of /r/ among children older than three. Different studies disagree about the necessary percentage of certain developmental rendition in children's speech to consider it typical for that age. Vuletić [25] thinks that more than 30% of participants of certain age have to demonstrate certain developmental pattern while Smit et al. [20], on the other hand, use 15–30% range as a criterion to determine which phonological process is typical. Therefore, the results in this study will be interpreted in the 15–30% bands. 40% of substitutions were found in the speech of three year olds showing that they are a typical developmental rendition by the age of four when they are suppressed to 18%. Once more, statistically significant differences in the amount of substitutions were found for all age groups ($p = 0.000$) except the two older groups (aged five and six; $p = 0.997$) showing that this category of developmental renditions cannot be considered typical at that age. Three-year old children have 42% of distortions in their speech and four year olds 37%. The difference between these two groups is not statistically significant ($p = 0.778$) but when the results are compared to both older groups the differences are significant ($p = 0.000$) although the five year olds and six year olds do not differ significantly ($p = 3.337$).

The results of the three developmental categories imply that the age of five is a kind of 'developmental boundary' between undeveloped and developed /r/. This is also confirmed by the results of six month age bands (by the age of 6;5) with 80% of developed renditions.

These results confirm developmental continuum of the phoneme /r/ because there are no statistically significant differences between the younger and older subgroups in each age band ($p > 0.05$). There is no statistically significant difference between the results of the older five year olds and younger six year olds (6;0–6;5) ($p = 0.443$). However, when older three year olds (3;6–3;11) and younger four year olds (4;0–4;5) are compared the difference is significant ($p = 0.04$). Finally, if the group of children aged between 4;6–4;11 (51% of developed renditions) is compared to the group aged 5;0–5;5, with 73% of developed renditions, the difference is statistically significant ($p = 0.002$). Table 3 also shows a slight regression in the production of /r/ at the age of five. The younger group of five year olds (5;0–5;5) has 73% of developed renditions while the older group (5;6–5;11) 69%. Regression of results is a typical feature of large-sample studies on phonological development and it was first noted by Prather et al. [18] for /s/, /r/, /l/ and /ʤ/ in English but it has occurred in other studies as well [1, 20]. Regression usually occurs in the older age band (i.e. older five year olds with 69% of developed renditions of /r/) than the one in which the percentage of developed renditions of the target sound has reached the level required to be considered developed (younger five year olds with 73% of developed renditions) and it is followed by the older age band with high rise in the percentage of developed renditions. The results in this study also follow that pattern because children aged 6;0–6;5 have 80% of developed renditions.

The results of this study are in accordance with other findings about speech acquisition. The third stage of motor development begins at the age of five when the tongue can be placed properly for the production of /r/ and /l/ [9]; also, after the age of five there are regularities in the patterns of muscular activity of lower jaw which is necessary for the production of sounds that require jaw-tongue coordination [6, 7].

Table 3: Representation of developmental renditions of alveolar trill /r/ in Croatian (6-month age bands).

Age								
Category		**3;0-3;5**	**3;6-3;11**	**4;0-4;5**	**4;6-4;11**	**5;0-5;5**	**5;6-5;11**	**6;0-6;5**
Omissions	%	4%	3%	3%	2%	1%	1%	0%
	s.d.	0,08	0,09	0,10	0,08	0,03	0,04	0,01
Supstitutions	%	40%	40%	25%	11%	5%	5%	4%
	s.d.	0,40	0,42	0,37	0,26	0,17	0,20	0,17
Distortions	%	44%	40%	37%	37%	20%	25%	16%
	s.d.	0,36	0,35	0,34	0,32	0,26	0,33	0,30
Developed /r/	%	12%	18%	34%	51%	73%	69%	80%
	s.d.	0,22	0,28	0,37	0,37	0,34	0,38	0,34

Studies on development of perceptual categories of phonemes, conducted predominantly for English, have shown that the perceptual category of the phoneme /r/ is developed at the age of five [17]. Since it is well known that the development of perception precedes production, these results support the findings about speech sound development even more. Consequently, based on the findings of both motor and perceptual development it can be concluded that articulatory complex speech sound such as alveolar trill in Croatian cannot be developed before the age of five as the older studies suggest.

After the age of 4;6 children suppress substitutions of /r/ and when compared to the older groups the results do not differ significantly implying that substitutions should be supressed by the age of 4;6.

Substitutions were found in 33% of the participants (17% aged three; 10% aged four and 3% aged five and six, respectively). However, some substitutions were not produced systematically but were result of the children's speech variability and occurred only in several words. 15% of participants aged three and four produced substitutions in more than 50% of words and this is the actual occurrence of substitutions in the speech of Croatian children.

The most frequent substitutions of /r/ are /j/ and /l/. Substitutions with /j/ in more than 50% of words were found in 5% of the sample aged (3.5% aged three and 1.5% aged four) 7% of the sample produced more than 90% of the substitutions of /r/ with /l/ in their speech (4% aged three and 3% aged four) and 3% of the sample (aged three) produced between 50 and 90% of /l/-substitutions when targeting /r/.

Distortions can be considered typical by the age of six when the representation of that developmental category reaches 16%.

Finally, the largest amount of distortions is found in the final position – 32%, compared to 26% in intervocalic position and finally with 30% of occurrences in initial position. Substitutions are more frequent in initial position (17%) and medial position and slightly lower in final. These. statistically significant) differences for single phoneme /r/ suggest that in the future, the Croatian phonological development test should comprise all phonemes in all three positions. On the other hand, vowels do not influence the pronunciation of /r/, therefore this should not be the criterion for selection of target words in assessment.

4. CONCLUSIONS

Speech sound /r/ is developing intensively during the fifth year and it should be developed by the age of six in Croatian. This result agrees with literature reporting about recent findings on motor development and shaping of perceptual categories. The result of this study is further supported by the fact that 71% of developed renditions of /r/ occur among five-year olds. The regression in the pronunciation quality which occurs in the older part of the group aged five supports the results even more. Omissions should not occur in the speech of children aged three and older. Substitutions should be considered developmental by the age of 4;6 and distortions by the age of 6;0.

5. ACKNOWLEDGEMENTS

The authors wish to thank the children and parents who have participated in the study, SLPs and headmasters of the kindergartens: Cvrčak, Kolibri, Duga, Travno, Dugo Selo, Hrvatski Leskovec, Remetinec, Siget, Vladimir Nazor, Trnoružica, Sunce in Zagreb; Sara Ferberuš and Marsela Alić with recordings; Marko Štengl with statistical analyses; Ana Generalić and Nataša Klarić Bonacci with auditory assessment.

5. REFERENCES

[1] Acevedo, M. A. 1993. Development of Spanish Consonants in Preschool Children. *Communication Disorders Quarterly*, 15(2), 9–15.

[2] Amayreh, M. M. 2003. Completion of the consonant inventory of Arabic. *Journal of Speech, Language and Hearing Research*, 46(3), 517–529.

[3] Amayreh, M. M., Dyson, A. T. 1998. The acquisition of Arabic consonants. *Journal of Speech, Language and Hearing Research*, 41(3), 642–653.

[4] Dodd, B., Holm, A., Hua, Z., Crosbie, S. 2003. Phonological development: a normative study of British English-speaking children. *Clinical Linguistics & Phonetics*, 17(8), 617–643.

[5] Espy-Wilson, C. Y., Boyce, S. E., Jackson, M., Narayanan, S., Alwan, A. 2000. Acoustic modeling of American English /r/. *J. Acoust. Soc. Am*., 108(1), 343–356.

[6] Green, J. R., Moore, C. A., Ruark, J. L., Rodda, P. R., Morvée, W. T., Vanwitzenburg, M. J. 1997. Development of chewing in children from 12 to 48 months: Longitudinal study of EMG patterns. *Journal of Neurophysiology*, 77(5), 2704–2716.

[7] Green, J. R., Nip, I. S. B. 2010. Some organization principles in early speech development. In B. Maassen & P. van Lieshout (Eds.), *Speech motor control: New developments in basic and applied research* 171–188.

[8] Johnson, K. 2003. *Acoustic and auditory phonetics 2nd ed.* Malden, Mass: Blackwell Pub.

[9] Kent, R. D. 1992. The biology of Phonological Development. In C. A. Ferguson, L. Menn, & C. Stoel-Gammon (eds.), *Phonological Development Models, Research, Implications*. Timonium, MD: York Press. 65–90.

[10] Ladefoged, P., Maddieson, I. 1996. *The sounds of the world's languages*. Oxford, OX, UK; Cambridge, Mass., USA: Blackwell Publishers.

[11] Landau, E., Lončarić, M., Horga, D., & Škarić, I. (1995). Croatian. *Journal of the International Phonetic Association*, 25(02), 83–86.

[12] Lindau, M. (1985). The story of /r/. In V. Fromkin (ed.), *Phonetic Linguistics: Essays in Honor of P. Ladefoged.* Orlando, FL: Academic.157–167.

[13] Locke, J. L. 1980a. The inference of speech perception in the phonologically disordered child: I. A rationale, some criteria, the conventional tests. *Journal of Speech and Hearing Disorders*, 45(4), 431–444.

[14] Locke, J. L. 1980b. The Inference of Speech Perception in the Phonologically Disordered Child. Part II Some Clinically Novel Procedures, Their Use, Some Findings. *Journal of Speech and Hearing Disorders*, 45, 445–468.

[15] McLeod, S. (ed.) 2007. *The international guide to speech acquisition*. Clifton Park, NY: Thomson Delmar Learning.

[16] Munson, B., Edwards, J., Schellinger, S. K., Beckman, M. E.,Meyer, M. K. 2010. Deconstructing phonetic transcription: covert contrast, perceptual bias, and an extraterrestrial view of Vox Humana. *Clinical Linguistics & Phonetics*, 24(4-5), 245–260.

[17] Ohde, R. N., Sharf, D. J. 1988. Perceptual categorization and consistency of synthesized/r-w/ continua by adults, normal children and/r/-misarticulating children. *Journal of Speech, Language and Hearing Research*, 31(4), 556–568.

[18] Prather, E. M., Hedrick, D. L., Kern, C. A. 1975. Articulation development in children aged two to four years. *Journal of Speech and Hearing Disorders*, 40(2), 179–191.

[19] Punnoose, R. 2011. *An auditory and acoustic study of liquids in Malayalam* (PhD Thesis). Newcastle University.

[20] Smit, A. B., Hand, L., Freilinger, J. J., Bernthal, J. E., Bird, A. 1990. The Iowa articulation norms project and its Nebraska replication. *Journal of Speech and Hearing Disorders*, 55(4), 779–798.

[21] Stoel-Gammon, C. 2007. Variability in Speech Acquisition. In S. McLeod (ed.), *The international guide to speech acquisition.* Clifton Park, NY: Thomson Delmar Learning. 55–60.

[22] Thomas, E. M., Sénéchal, M. 1998. Articulation and phoneme awareness of three-year-old-children. *Applied Psycholinguistics*, 19, 363–391.

[23] Thomas, E. M., Sénéchal, M. 2004. Long-term association between articulation quality and phoneme sensitivity: A study from age 3 to age 8. *Applied Psycholinguistics*, 25(04). 513-544.

[24] Tyler, A. A., Lewis, K. E. 2005. Relationships among consistency/variability and other phonological measures over time. *Topics in Language Disorders*, 25(3), 243–253.

[25] Vuletić, D. 1990. *Test artikulacije*. Zagreb: Fakultet za defektologiju Sveučilišta u Zagrebu.