The Acquisition of Vowels in Hungarian: Developmental Data

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ABSTRACT

The current study examined the acquisition of vowel quality by monolingual children acquiring Hungarian, a language with a relatively large vowel inventory characterized by phonemically short and long vowel pairs. Cross-sectional data were gathered from 80 children at the ages of 2;0, 2;6, 3;0, 3;6 and 4;0 years, with equal number of boys and girls in each age group. Production of 28 C1V1(:)C1V1(:) structured forms (14 nonsense and 14 meaningful; first syllable stress) were elicited in a free play situation. The first five productions of each token were recorded using Hungarian orthography by a native speaker of Hungarian who was familiar with the list of elicited tokens. Vowels were judged for acceptability of vowel quality. Findings showed that, as expected, older children (both boys and girls) produced vowels with higher accuracy than younger children. In general, mastery (e.g., a 90% accuracy level) was reached earlier for unrounded than for rounded vowels. Among the back rounded vowels, mid vowels exhibited higher accuracy than high vowels. Accurate production of front rounded vowels proved most challenging in all age groups in both genders.

1. RATIONALE

Until recently, the acquisition of vowels in children has been a largely ignored research area. The limited amount of data gathered so far has focused on vowel acquisition in children acquiring English; data from other languages are scarce. Development of a theory of vowel acquisition requires data from languages with a variety of vowel inventories and phonological patterns in order to identify universal patterns and language-specific differences in the acquisition of vowels. To enhance our understanding of vowel acquisition processes in languages other than English, this study set out to examine developmental tendencies in the acquisition of Hungarian vowel inventory, as reflected by perceptual measurements of vowel quality.

2. HUNGARIAN VOWEL INVENTORY

The vowel inventory of the standard dialect of Hungarian consists of fourteen monophthong vowels that are perceived by native adult listeners as seven vowel pairs. The vowels are differentiated along four dimensions: (a) front or back tongue positions; (b) high, half-closed, half-open or open tongue height (the vowel [a:] being the only open vowel); (c) rounded or unrounded lip position; and (d) short or long duration, with an average duration ratio 1:2 in the adult language. Perceptual studies suggest that five vowel pairs (the high and mid vowel pairs) are differentiated primarily by their duration, with the qualitative differences between the members being marginal. The remaining two vowel pairs [ɛ]-[e:] and [ɑ]-[a:] differ both in quality and duration, as reported by adult listeners.

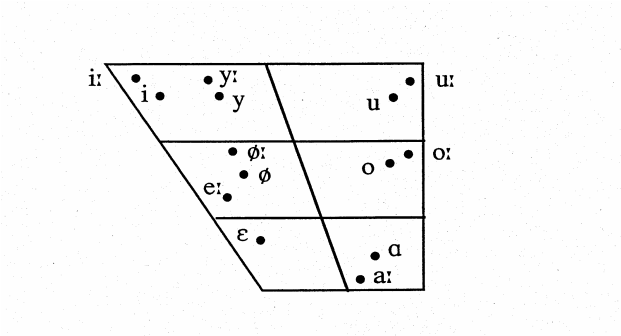

Figure 1: The vowel inventory of the standard dialect of Hungarian, adapted from Szende [1].

Szabados [2] reported the four Hungarian rounded vowel pairs in general to be characterized by more exaggerated lip protrusion than their English cognates. Studies have shown that the vowel [ɑ] is most often realized as an unrounded vowel, even though in some environments it is formulated as a slightly rounded vowel /ɔ/. For the purposes of the current study, we considered the half-open back vowel to be unrounded.

3. METHODOLOGY

3.1. Participants

Participants included 16 children (8 boys and 8 girls) at the ages of 2;0, 2;6, 3;0, 3;6 and 4;0 years (n=80) and their caregivers. At the time of testing, children were within a 15-day interval of their designated age. Inclusionary criteria for the children included a clear bill of health, typical development of communicative, motor, auditory and

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language behaviors and no family history of speech and language developmental problems. At the beginning of the first session, all children passed an age-appropriate battery of communicative/language screening (a detailed description of screening methods is reported in Zajdó [3]).

3.2. Elicited tokens

To elicit children's production of all members of the vowel inventory, caretakers were instructed to model bisyllabic C1V1(:)C1V1(:) structured tokens (as puppet names) in a naturalistic (free-play) situation. This token structure was selected in order to ensure that all children have already had exposure to and have had experience with producing similarly structured words. Research suggests that C1V1(:)C1V1(:) syllable structures are present in infant-directed adult speech [4] and in the infant's and toddler's production repertoires [5], [6]. Consonants in the target tokens were selected among those that are reported to be present in 2;0 year-old children's consonant inventory [5], [7]. In accordance with stress-assignment patterns in Hungarian, the first syllable was stressed while the second was unstressed in each elicited token.

Participants were recorded during two sessions that were no more than 14 days apart. During the first session, target tokens included only those containing phonemically short vowels. Tokens including phonemically long vowels were elicited during the second session. Each session was divided into two sub-sessions ("A" and "B") with a 10-minute break between sub-sessions. The schedule of elicited tokens appears in Table 1.

Session 1A	Session 1B	Session 2A	Session 2B
Nonsense tokens	*Meaningful tokens*	*Nonsense tokens*	*Meaningful tokens*
/gɑgɑ/	/bɑbɑ/	/ka:ka:/	/pa:pa:/
/bɛbɛ/	/pɛpɛ/	/de:de:/	/le:le:/
/titi/	/pipi/	/mi:mi:/	/pi:pi:/
/toto/	/lolo/	/no:no:/	/lo:lo:/
/pøpø/	/gøgø/	/bø:bø:/	/kø:kø:/
/dudu/	/bubu/	/tu:tu:/	/pu:pu:/
/mymy/	/nyny/	/ly:ly:/	/my:my:/

Table 1. The schedule of tokens elicited

3.3. Recording procedures

Speech samples were recorded in a sound-attenuated room, using an omni-directional AKG CK 77-3 condenser Lavalier microphone that forwarded signals to a SONY Vaio PCG-FX190K laptop. The "Sound Forge" acoustic software (Version 5.0, Built 117) was used for digital recording, with attributes set to 32 kHz, 16 bit, mono.

3.4. Data selection and analysis procedures

In order to create a balanced data set, five productions of each target token in each child were analyzed, thus resulting in a data set of 10366 C1V1(:)C1V1(:) structured tokens (for the results of the full data set, see Zajdó [8]). If a child produced fewer than five attempts, only the actual number of attempts was considered. Perceptual analysis of the data set was carried out by a monolingual native speaker of Hungarian, who was asked to judge perceived vowel quality in each token by using a binary system ("acceptable" vs. "non-acceptable" vowel quality). Vowel quality was judged to be acceptable only if both vowels appeared to be the results of what the rater considered "correct" / "acceptable" production. Making judgments about acceptability of vowel quality in each token by considering both vowels was necessary since a vowel is only considered mastered if it is correctly produced both in stressed and unstressed positions. For the purposes of reliability measures, a second rater was also asked to judge vowel quality in 12% of the tokens. Inter-rater reliability results were within the range of 80.9 - 100% in each vowel category.

4. RESULTS

4.1. Overall percentage correct values

In order to explore general tendencies in vowel accuracy in the five age groups, overall percentage correct values were calculated for each vowel in both genders, by pooling together data from nonsense and meaningful tokens. Results for phonemically short vowels are displayed in Tables 2 and 3.

Age group	CɑCɑ	CɛCɛ	CiCi	CoCo	CøCø	CuCu	CyCy
2;0	92	81	88	85	60	59	60
2;6	96	89	89	79	81	91	84
3;0	97	94	97	86	77	89	85
3;6	100	97	99	94	90	96	81
4;0	95	99	99	96	88	95	85

Table 2. Overall percentage correct values of individual phonemically short vowels in boys.

Age group	CɑCɑ	CɛCɛ	CiCi	CoCo	CøCø	CuCu	CyCy
2;0	93	90	96	91	66	81	69
2;6	97	92	100	90	81	94	68
3;0	100	96	96	95	86	91	85
3;6	97	92	100	94	97	96	92
4;0	100	99	100	95	83	95	80

Table 3. Overall percentage correct values of individual phonemically short vowels in girls.

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Accuracy results for phonemically short vowels suggest that, in general, vowel accuracy between the ages of 2;0 and 4;0 years increases with age for both boys and girls. Further, unrounded vowels are characterized by higher accuracy levels than the rounded ones, in both genders.

Overall percentage correct values for phonemically long vowels are displayed in Tables 4 and 5.

Age group	Ca:Ca:	Ce:Ce:	Ci:Ci:	Co: Co:	Cø: Cø:	Cu:Cu:	Cy:Cy:
2;0	83	83	88	81	62	68	56
2;6	84	81	87	99	92	84	77
3;0	93	80	95	96	81	89	81
3;6	100	96	97	95	85	97	84
4;0	95	100	91	98	96	86	92

Table 4. Overall percentage correct values of individual phonemically long vowels in boys.

Age group	Ca:Ca:	Ce:Ce:	Ci:Ci:	Co: Co:	Cø: Cø:	Cu:Cu:	Cy:Cy:
2;0	97	65	94	99	66	82	66
2;6	95	92	95	92	81	97	67
3;0	96	93	91	94	86	84	75
3;6	99	94	96	100	95	98	92
4;0	99	92	96	94	93	91	76

Table 5. Overall percentage correct values of individual phonemically long vowels in girls.

Accuracy results for phonemically long vowels suggest that, in general, vowel accuracy between the ages of 2;0 and 4;0 years increases with age in both genders. Results indicate that, similar to tendencies observed in the accuracy results for phonemically short vowels, rounded vowels are characterized by lower levels of accuracy than unrounded ones.

4.2. Statistical analyses

In order to determine appropriate statistical methods for the analysis of the data set, Levene's test of equality of error variance was applied. Results of the test did not support the hypothesis that our data set was normally distributed ($F=1.029$, $p \leq .426$). Therefore, non-parametrical tests were used in the subsequent phases of data analysis.

To test the effect of age on vowel accuracy, the Kruskal-Wallis test was applied. Test results ($\chi^2=32.35$, $p \leq .000$) suggested that older children produced significantly more accurate vowels than younger ones. Testing the two genders separately yielded similar results (Boys: $\chi^2=17.057$, $p \leq .002$; Girls: $\chi^2=14.583$, $p \leq .006$). Thus, children in the older age groups in both genders appeared likely to exhibit significantly higher levels of vowel accuracy than their younger peers.

To test the effects of two confounded factors, that of semantic and consonantal contexts, the Wilcoxon signed rank test was applied. Results did not support the hypothesis that children were significantly more likely to produce correct vowels in meaningful vs. nonsense contexts ($Z= -1.432$, p(two tailed) $\leq .152$). The test results indicated that it is justifiable to pool together vowel accuracy data from both semantic contexts.

Testing gender effects on vowel accuracy required the application of Mann-Whitney test. Results did not support the hypothesis of a gender difference in accuracy of vowel production ($Z= -.770$, p(two tailed) $\leq .441$). Consequently, data from both genders were pooled in subsequent analysis.

Testing the effect of phonemic vowel length required the application of Wilcoxon signed rank test. Results indicated no statistical difference in the accuracy of production of phonemically short vs. long vowels ($Z= -1.669$; p(two tailed) $\leq .095$).

Testing the effect of unrounded vs. rounded vowel target on vowel accuracy required another Wilcoxon signed rank test. Results indicated a significant difference in accuracy of unrounded vs. rounded vowels ($Z= -5.885$, p(two tailed) $\leq .000$). Ranking data from the individual children revealed that, out of the 80 participants, 64 were more successful producing accurate unrounded as opposed to rounded vowels, while 14 children's data exhibited the opposite tendency, and 2 children were equally successful with producing both vowel categories. Taken together, this finding indicates that the production of rounded vowels appears to be challenging for children between the ages of 2;0 and 4;0 years.

Further explorations into the nature of vowel accuracy development involved testing the effect of back vs. front rounded target vowels. Results of Wilcoxon signed rank test indicated that production of accurate back rounded vowels was significantly higher than accurate production of front rounded vowels ($Z= -4.563$, p(two tailed) $\leq .000$). Ranking data from individual children showed that 55 out of 80 children produced more accurate back rounded vowels, 22 children's data reflected the opposite tendency, and 3 children were equally successful with producing correct vowels in both categories. Overall, these findings suggest that children between the ages of 2;0 and 4;0 years are more likely to produce accurate back as opposed to front rounded vowels.

5. DISCUSSION

The major objective of the current study was to identify developmental tendencies in vowel accuracy in the speech of monolingual Hungarian-speaking children between the ages of 2;0 to 4;0 years. The results of perceptual and statistical analyses indicate that children's vowel production accuracy goes through major developmental changes throughout this age period. Inspection of the overall percentage correct results makes it clear that (a) accurate production of unrounded vowels, by and large, is

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established in the productions of the two-year-old children; and (b) development of accurate production of rounded vowels is slower than that of the unrounded vowels, in both genders and in all age groups. It follows then that the most important development in vowel accuracy takes place in the increasing mastery of rounded vowels during the examined age period.

The fact that vowel accuracy at the age of 2;0 years appears to reflect low levels of mastery in both back and front rounded vowels calls attention to the difficulties lip rounding constitutes in continuous speech. When prompted, many of the child participants were able to produce lip rounding (lip protrusion) as an isolated gesture, even at the age of 2;0 years. However, during the production of words, the ability to round the lips often vanished. It is reasonable to speculate that lip protrusion presents the child with additional tasks (e.g., proper activation and coordination of muscles that move the lips) that increase the complexity of the speech production task. Recent research [9] suggests that the coordination of lip-muscle activity in 2;0 year-old children is not yet sufficient.

The finding that children acquire back rounded vowels before front rounded ones is difficult to interpret at our current state of knowledge. Research [10] suggests that, during the process whereby children gain control over the speech apparatus, proper positioning of the jaw is acquired before the ability to effectively control lip movements. In other words, the maturation of jaw coordination precedes that of the lip function. However, the finding that speech production skills develop in a sequential fashion does not provide an explanation for the lesser ability of children to produce accurate front as opposed to back rounded vowels. Why is the coordination of lip protrusion easier during the production of a back rounded vowel than a front one, as our data suggest? Studies investigating the emergence of speech motor control in children should shed light on this question.

6. CONCLUSION

Major tendencies in vowel accuracy development in 2;0 to 4;0 year old children include the ability to produce more accurate unrounded as opposed to rounded vowels. Among rounded vowels, the ability to accurately produce back rounded vowels precedes that of front rounded ones. Gender and effects of phonemic vowel length on vowel accuracy are not statistically significant. Due to being confounded factors, our data set did not allow for the detailed examination of semantic/consonantal environment effects on vowel accuracy. Finally, the acquisition of the vowel system is not complete in the speech of four-year-old children acquiring Hungarian.

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