The Acquisition of Phonological Vowel Length in Children Acquiring Hungarian

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Abstract

The aim of this study was to explore the acquisition of contrastive phonological vowel length in 2;0, 3;0 and 4;0 years old monolingual Hungarian-speaking children, by using a cross-sectional study design. The duration of children's stressed word medial vowels in tokens that were elicited by the caregivers' production in a naturalistic setting were examined. Results show that young children differentiate phonologically short vs. long vowel durations reliably during this age period. By 4;0 years of age, children produce significantly shorter vowel durations for phonologically short target vowels. No significant difference can be detected in the duration measures of phonologically long vowels during this age period. The results emphasize the importance of taking into consideration the emerging nature of oral motor control skills during development that is reflected by the increased ability to produce phonologically short vowels with shorter durations.

1 Introduction & rationale

Previous research has shown that children acquire language-specific vowel qualities relatively early [1, 2, 3]. Results suggest that young children's vowel qualities are more adult-like when producing unrounded as opposed to rounded vowels [4].

In addition to producing relatively adult-like vowel qualities, children also have to learn to produce language-specific speech timing patterns to generate intelligible speech. To date, little research has been done to uncover the acquisition process of language-specific speech timing patterns in young children. This study set out to explore the acquisition of contrastive phonological vowel length in monolingual children acquiring Hungarian. In adult Hungarian, there is a pronounced durational difference between phonologically short and long vowels in conversational speech [5, 6] which uses at least 70% longer vowels in phonologically long positions as opposed to short ones. Thus, this language environment is ideal for studying the acquisition processes of contrastive phonological vowel length in children.

2 Method

Data was collected from 30 monolingual Hungarian-speaking children (n=10 (5 boys) at each age of 2;0, 3;0 and 4;0 years). Subjects produced /pipi/ {baby chicken} and /pi:pi:/ {animal/chicken calling word} tokens as elicited by their caregivers in a naturalistic setting. The tokens were used as puppet names in a conversation.

The speech samples were digitially recorded in a sound attenuated room by using the SoundForge acoustic software (Version 7.0) with recording attributes set to 32 kHz, 16 bit, mono. The tokens were perceptually identified, cut and analyzed through taking duration measures (in ms) of the first (stressed) syllable vowels (/i/ vs. /i:/) by using the PRAAT acoustic analysis software. From each child, two or three vowel duration samples of each token were recorded.

Results were arrived at by using linear logistic regression and analysis of variance methods for statistical analyses of vowel duration measures.

3 Results

3.1 Duration of phonologically short vowels

Boxplots depicting the durations of the first vowel in /pipi/ are shown in Figure 1. A fitted line plot for the durations of /i/ is shown in Figure 2. Table 1 contains the description of the data set. For the first vowel embedded in /pipi/, results of linear regression show that age (but not gender) significantly predicts vowel duration measures (β = -14.45, $t(28)$ = -3.10, p <.01). For vowel durations in this position, age also explains a significant proportion of variance, R^2 = .255, $R^{2\ (adj)}$= .229. While no statistically significant difference can be detected between the data sets of the two younger age groups, results suggest that 4;0 years old children produce significantly shorter /i/ vowels than 3;0 year olds (one way ANOVA results; df=1, F=15.17, p<.001).

Overall, it appears that children acquire the ability to produce phonologically short vowels with shorter durations between 3;0 and 4;0 years of age.

3.2 Duration of phonologically long vowels

Boxplots depicting the durations of the first vowel in /pi:pi:/ are shown in Figure 3. A scatterplot with two fitted line plots are shown in Figure 4. Table 2 contains the description of the data set. For the first vowel embedded in /pi:pi:/, results of linear regression show that gender (but not age) predicts vowel duration measures. Results of a one-way ANOVA suggest that 3;0 years old girls as opposed to boys produce significantly shorter /i:/ durations. The girls' mean vowel duration is 143.9 ms (SD=27.1 ms) while the boys' is 219.0 ms (SD=32.6 ms) (ANOVA df=1, F=15.64, p<.004). Importantly, no statistically significant differences can be detected among the durations of the long /i:/ vowels in children at 2;0, 3:0 and 4;0 years of age.

3.3 Long/short oppositions

Results of a two-way analysis of variance test suggest that the durations of phonologically short vs. long vowels are differentiated reliably by children between the ages of 2;0 vs. 4;0 years (df=1, F=103.71, p<.000; age is a non-significant factor, but the interaction of age and phonological vowel length status is significant: df=2, F=5.87, p<.005). Overall, the mean vowel duration for short vs. long vowels is 102.76 ms (SD=23.75ms) vs. 192.33 ms (SD=45.53 ms). Vowel duration measures in the data set of all short and long vowels reflect a long/short vowel duration ratio of 1.91 during this two year period.

3.4 Developmental tendencies in long vs. short vowel durations and their ratios

The results of a one way analysis of variance test show that the differentiation of the phonologically short vs. long vowels is present in the youngest (two years old) children (df=1, F=15.26, p<.001). Children's mean durations of phonologically short /i/ vs. long /i:/ vowels at this age are 112.97 ms (SD=27.33 ms) vs. 179.35 ms (SD=46.28 ms). It is noteworthy that the ratio of long vs. short mean vowel duration is 1.59. Thus two years old children are already capable of reliably differentiating the duration of phonologically short vs. long vowels by producing significantly shorter vowel durations for the phonologically short /i/ vowels.

The results of a two way analysis of variance test suggest that three years old children also produce statistically significantly shorter /i/ vowel durations as opposed to the duration of /i:/ (df=1, F=43.07, p<.000). The results from the two genders are significantly different (df=1, F=15.79, p<.001; with significant interaction of phonological vowel length status and gender; df=1, F=9.24, p<.008) showing that boys as opposed to girls generate significantly longer vowel durations when producing phonologically long /i:/ vowels at this age. Boys produce a mean vowel duration of 116.23 ms (SD=13.94 ms) for the /i/ vowel and 219.0 ms (SD=32.6 ms) for the /i:/ vowel. Girls' phonologically short mean vowel duration, 106.23 ms (SD=17.17), is contrasted with the mean duration of 143.9 ms (SD=27.1 ms) for long /i:/ vowels. Thus, the ratios of long vs. short mean vowel durations are 1.35 for girls and 1.88 for boys at this age.

The results of a one way analysis of variance test suggest that four years old children also produce significantly shorter /i/ vowel durations as opposed to

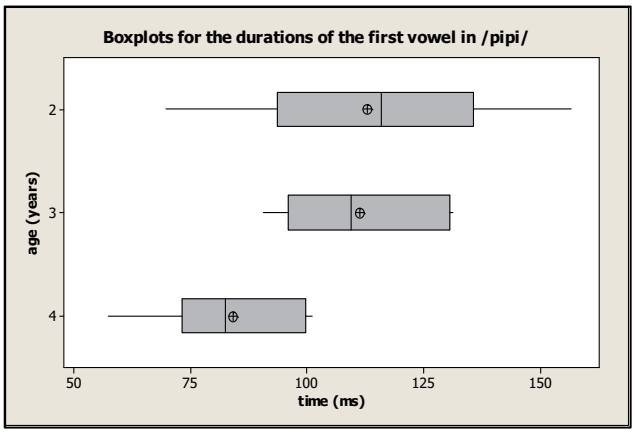

Figure 1: *Box plots for the duration of the first vowel in /pipi/(in ms) at 2;0, 3;0 and 4;0 ys*

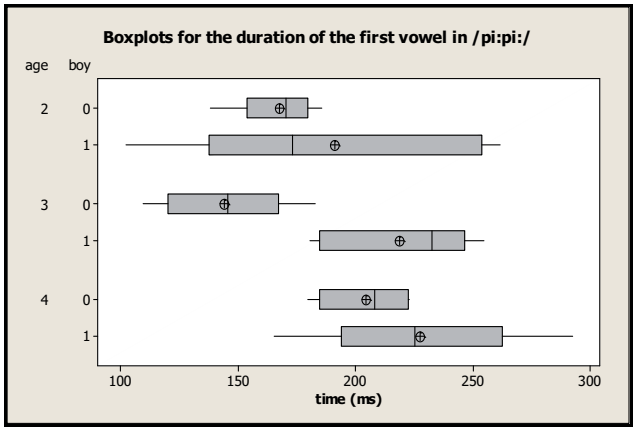

Figure 3: *Box plots for the duration of the first vowel in /pi:pi:/(in ms) at 2;0, 3;0 and 4;0 ys in each gender*

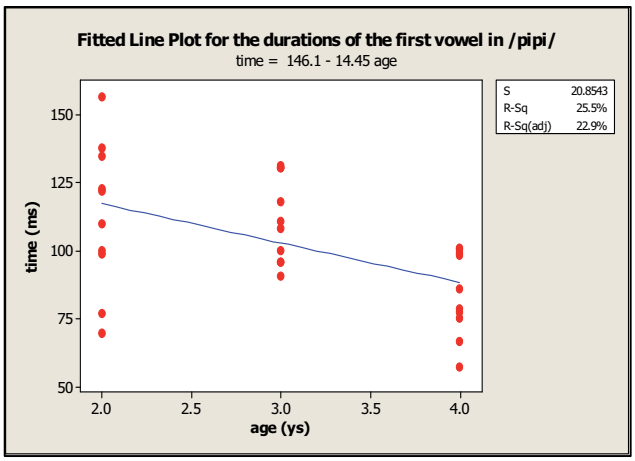

Figure 2: *Fitted line plot for the durations of the first vowel in /pipi/ (in ms) at 2;0, 3;0 and 4;0 years*

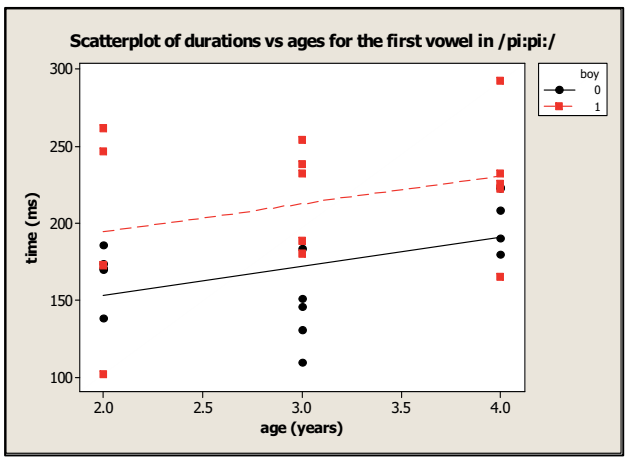

Figure 4: *Fitted line plots for the duration of the first vowel in /pi:pi:/ (in ms) at 2;0, 3;0 and 4;0 ys in each gender*

Table 1. *Means, medians and SDs of durations with range min and max values for the first vowel in /pipi/.*

Age Group	Mean	Median	SD	Range min	Range max
2;0	112.97	116.00	27.33	69.67	156.67
3;0	111.23	109.50	15.66	90.67	131.33
4;0	84.07	82.33	15.53	57.33	101.00

Table 2. *Means, medians and SDs of durations with range min and max values for the first vowel in /pi:pi:/ in each gender.*

Age Group	Mean	Median	SD	Range min	Range max
2;0 (b)	167.50	170.50	17.69	138.00	185.67
3;0 (b)	143.90	145.70	27.10	109.50	183.00
4;0 (b)	204.63	208.33	19.43	179.50	223.00
2;0 (g)	191.20	173.00	64.50	102.00	261.50
3;0 (g)	219.00	232.50	32.60	180.30	254.70
4;0 (g)	227.70	225.30	45.20	165.30	292.70

the duration of long /i:/ (df=1, F=119.18, p<.000). The mean durations for the phonologically short vs. long vowels are 84.07 ms (SD=15.53) vs. 216.18 ms (SD=34.98). At this age, the ratio of long vs. short mean vowel durations is 2.57.

4 Discussion

For all children, developing language-specific adult-like speech timing characteristics is important to achieve the ability to produce intelligible speech. One aspect of learning to use speech timing patterns that support effective communication is the need to acquire the use of perceptual and motor capabilities that allow for the generation of increasingly adult-like vowel durations.

Recent evidence suggest that, by 18 months of age, infants reared in a language environment with contrastive vowel durational properties have figured out the fact that duration differences in these languages code meaning [7]. This evidence provides a basis for the speculation that it is production constraints rather than perception limitations that stand in the way of younger children producing adult-like vowel duration.

An important finding of this study is the presence of substantial individual variability in especially younger (but also older) children when it comes to speech timing properties. While variability decreases with age, it is still a major characteristic of the data set examined even in the oldest age group. Thus, individual variability in the production of vowel duration constitutes a challenge when trying to interpret the findings.

Taken together, our results show that even 2;0 years old children differentiate the duration of phonologically short vs. long vowels reliably, reflecting their well developed ability to perceive and, to a great extent, code changes in meaning in their production. However, the durational properties of phonologically short vowels are substantially longer in 2;0 year olds as opposed to 4;0 year olds. This finding suggests that the speech production capabilities of older children have gone through maturation. That is, the results can potentially indicate the availability of higher level oral motor control in older children that allows for the production of phonologically short vowels with shorter duration.

In contrast, no detectable difference can be seen in the production of phonologically long vowels during the age period examined. This finding may suggest that children acquire language-specific long vowel durations earlier, potentially indicating the availability of sufficient oral motor skills that allow for changing oral positions efficiently when a longer time period is allowed for carrying out oral movements. Alternatively, the substantial amount of individual variability may hide steps in the acquisition process. Thus, there may be several potential interpretations for the observed changes (e.g., increase) in long/short vowel ratios with development.

As a further step in mapping out speech timing processes in children, a more detailed future study will have to compare this data with the durational properties of 'caregiverese' and adult Hungarian.

5 References

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