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The Acquisition of Finnish Vowel Harmony

Abstract

This study investigates the acquisition of vowel harmony by Finnish children. In Finnish, there are five front vowels (/i/, /e/, /y/, /ø/, /æ/) and three back vowels (/u/, /o/, /a/). In Finnish vowel harmony (FVH), back vowels (/u/ /o/ /a/) and front vowels (/y/ /ø/ /æ/) cannot occur together within a native and non-colloquial word, unless it is a compound. Phonologically 'neutral' unrounded front vowels (/i/ /e/) can occur with all vowels in a word, whereas front rounded vowels (/y/, /ø/) can occur with front vowels only. It was hypothesized that phonological status of the five front vowels regarding FVH may cause difficulty in the acquisition of FVH. The data of this study were words produced by 196 Finnish children at age 2;6. The data showed that most of Finnish 2;6-year-olds' productions do not violate FVH, suggesting early mastery of FVH. When there were errors in children's productions, they were mostly substitutions of back vowels for the front rounded vowels.

1. Introduction

It has been reported that vowels are acquired earlier than consonants in English, and that English-learning children master the vowel system by age 2;0 or 2;6 (Bernhardt & Stemberger 1998). Among the English vowels, the basic triangle (/i/, /ɑ/ and /u/) appear to be mastered first, followed by back and central vowels (Bernhardt & Stemberger 1998). The front non-low vowels (/e^{I}/, /ɛ/, /ɪ/) and r-colored vowels (/ɝ/, /ɚ/) are reported to be the last vowels to be acquired in English (Bernhardt & Stemberger 1998, see also Davis & MacNeilage 1990; Otomo & Stoel-Gammon 1992).

A similar course of development was documented in case studies in the acquisition of Finnish. Iivonen (1993) reported that his two sons developed a low vowel (/ɑ/ and /æ/ merged), a high vowel (either /i/ or /u/) and a mid vowel (schwa) at around 1;5 and 1;9. Other vowels, such as /e/ and /o/, developed during their second year of life, and both of the children mastered all eight vowels by age 2;5 (Iivonen, 1993). Itkonen (1977) also

A Man of Measure
Festschrift in Honour of Fred Karlsson, pp. 149–161

reported that /ɑ/ and /æ/ developed at around age 2 through a merged low vowel category, and /i/ and /u/ developed at around the same time. In Itkonen's case study, /y/ and /ø/ were not documented until the two boys were 2;4.

The Finnish vowel system contains eight monophthongs /i y e æ ø u o a/.[1] Phonetically, there are four mid and high front vowels, /y ø/ (front rounded) and /i e/ (front unrounded). The two low vowels (/æ a/) are unrounded, and mid and high back vowels (/u o/) are rounded. There is no contrast in rounding in back vowels. In Finnish vowel harmony (FVH), there are three front harmony vowels, /y ø æ/, and three back harmony vowels /u o a/. Front and back harmony vowels never occur together in the same word stem (internal harmony) or in the same non-composed word (suffix harmony) in native non-colloquial lexemes (Karlsson 1983: 98–104). In his classical compendium of Finnish phonology and morphophonology, Karlsson (1983: 100) formulated the internal harmony constraint as "if [+syllabic, αround, -αlow] then [βfront] inside the morpheme boundary". The front vowels /i/ and /e/ are called 'neutral' vowels, because they can occur with both back and front vowels in the same stem or word. Word stems with /y ø æ / always have front vowels in suffixes (e.g., *pöydä* + *llä* 'on the table'), and word stems with /u o a/ always have back harmony vowels or neutral vowels in suffixes (e.g., *suklaa* + *ta* 'some chocolate') (suffix harmony). When the word stem has only neutral front vowels (/i e/), the inflectional suffixes have front vowels (*vede* + *ssä* 'in water').

There are some exceptions to FVH. In colloquial words, suffix-like endings with back vowels may accompany word stems with front harmony vowels (e.g., *Sörkka* < *Sörnäinen*, 'a district of Helsinki') (Karlsson 1983: 102–104). Internal harmony is also violated in some recent multisyllabic loanwords such as *analyysi* 'analysis' and *symposium* 'symposium' (Karlsson 1983: 160–161, Ringen & Heinämäki 1999). There are practically no exceptions in the suffix harmony, except in loanwords with disharmonic stems.

Violations of FVH have also been described in several studies of the acquisition of Finnish (Leiwo 1977; Leiwo, Turunen, Koivisto & Korhonen 2000; Leiwo, Turunen, Koivisto, Korhonen & Richardson 2001; Leiwo, Turunen & Koivisto 2002; Lieko 1997; Toivainen 1997). These studies

[1] In Finnish orthography {ö} refers to a round mid front vowel /ø/, and {ä} refers to an open front vowel /æ/. In this paper we use /a/ for the low back vowel that is /ɑ/ in IPA.

reported that young children often substitute back harmony vowels for the front harmony vowels, especially in non-initial syllables and in suffixes, and these substitutions may result in a violation of FVH (e.g., *nena* for *nenä* 'nose', *veikea* for *veikeä* 'funny', and *tyhma* for *tyhmä* 'stupid', from Lieko 1997). Leiwo (1977) also found similar substitutions that resulted in violations of FVH in delayed and deviant language development of two boys aged 7 and 8 (e.g. *kylla* for *kyllä* 'yes', *nälja* for *neljä* 'four', *pöörimaa* for *pyöri+mään* 'to roll'). Toivainen (1997) studied the acquisition of question particle *-ko*, *-kö* and found that *-ko* was sometimes used in words with front vowels, which resulted in a violation of FVH.

Front vowels may be the primary reason for children's errors in FVH, because they may simply be acquired late and be substituted by back vowels at the early stage of acquisition. It was reported that front vowels were acquired later than back vowels in the acquisition of English (Bernhardt & Stemberger 1998; Otomo & Stoel-Gammon 1992), and they were occasionally replaced by back vowels ([u] for /i/, [a] for /æ/, Davis & MacNeilage 1990). In Finnish, the rounded front vowels (/y/ and /ø/) might be particularly problematic for children. They were the last vowels to develop in three children in Iivonen (1993) and Itkonen (1977), and one child was reported to avoid words with front harmony vowels due to the production difficulty (Itkonen 1977). Leiwo (1977) also reported that two children with delayed and disordered language development rarely produced /y/ and /ø/ correctly.

In addition to acquiring each individual vowel, Finnish children also need to learn the phonological status of the vowels with regard to FVH. Finnish children need to acquire that FVH is, in general, based on the distinction between front and back vowels, but that two front vowels (/i/ /e/) can occur with back vowels. In this study, it was hypothesized that this difference in phonological status of the four mid and high front vowels (/y/, /ø/, /i/, /e/) is particularly difficult for Finnish children. We also studied whether Finnish children treat all the front vowels as harmony vowels before learning the phonological status of the unrounded front vowels (/i/ and /e/).

2. The subjects, the data and the procedure

Word production data from 196 Finnish children at age 2;6 were examined to investigate the acquisition of Finnish vowel harmony in this study. The

subjects of this study were from a longitudinal project being conducted at the University of Jyväskylä in cooperation with Jyväskylä Longitudinal Study of Dyslexia (see Lyytinen & al. 2006, Richardson 1998; Turunen 2003 for studies from this project). Nearly 200 children have been followed from birth until school age in the project. Approximately half of the children were considered at risk for becoming dyslexic based on the family history of difficulty in reading and writing. The other half of the children were born to the families that had no history of reading and writing difficulties (control participants). Between 1993 and 1996, questionnaires, interviews and assessments were administered to expecting parents regarding their skills in reading and writing in order to locate the participants for the project. After the children were born, assessments were conducted at ages 6, 14, and 18 months and at ages 2;0, 2;6, 3;6, 4;6, 5;0, 5;6 and 6;6. The follow-up assessments will continue to first, second and third grade. This study is based on the data from the assessment when the children were at age 2;6.

In this study, the data from a picture naming task of 19 words[2] in Turunen's study (2003) was used. The original aim of the naming task was to study the production of complex syllable and word structures. The stimulus words were selected to be familiar content words for a 2;6-year-old child, and the pictures were presented within a story frame. The words in the task varied in their length as well as in syllable and phonotactic structure, such as bisyllabic *avain* 'key' and foursyllabic *appelsiini* 'orange'.

For the analysis, eight words from Turunen's (2003) data at age 2;6 were selected. These words had four different types of vowel structures: The words *juusto* and *matto* have back harmony vowels (BHVs) only. The words *pöytä* 'table' and *pyörä* 'bike', have front harmony vowels (FHVs) only. In *lintu* and *kissa*, there is a back harmony vowel and a phonologically neutral front vowel /i/. In *(liuku)mäki* and *kenkä*, there is a front harmony vowel and a phonologically neutral front vowel /i/ or /e/. For the compound words *liukumäki* and *polkupyörä*, only the latter part was analysed. If all front vowels were treated as front harmony vowels, FVH may be violated in *lintu* and *kissa*. On the other hand, if the front rounded

[2] The whole naming task consisted of 33 words which were transcribed for 60 children. Due to the large number of subjects (N=196), 19 words with varying phonological structures were chosen for the analysis of all the subjects. Six words (*juusto*, *matto*, *pöytä*, *pyörä*, *liukumäki*, *kenkä*) which were selected for the present study were transcribed from all the children, and two words (*lintu*, *kissa*) only for 63 children.

vowels were acquired later than other front vowels, words containing them (e.g., *pöytä*, *pyörä*) would be more difficult for the children.

The children looked a storybook with an experimenter and named the pictures they saw in the book. After finishing the book once, the children named the same pictures again. The productions of both the first and second naming round were included in the data of this study. A total of 387 to 394 productions per word by 196 children were analyzed, including less target-like forms and word searches. The number of productions varied slightly because some children repeated the words, others refused to name the picture and sometimes the production was whispered or unclear. The word production data were transcribed using audio- and video-recordings. Ten percent of the data were transcribed by another transcriber for reliability. Overall agreement was 89% and it was 93% in vowels (see Turunen 2003 for details). In the following section, the most advanced production of each word from each child will be presented, followed by analyses of all the productions of the words.

3. The results

Tables 1, 2 and 3 show the overall results for word production by children at age 2;6. Categories such as 'back harmony vowels only' and 'front harmony vowels only' included the target-like productions as well as productions that differed from the target that did not violate FVH. For example, [pø:ræ] for *pyörä* and [pøitæ] for *pöytä* were included in the class 'front harmony vowels only', because they had front vowels only and the other component of the diphthong was front harmony vowel or a neutral front vowel /i/ or /e/ and the form did not violate FVH. If the child produced a form that violated FVH and a form that had only back vowels for the front vowels, the form with violation was considered as the most advanced production. The focus in this study was on the vowels, and errors in consonants were not systematically documented. Stress was on the first syllable (as in the adult target) unless it was marked otherwise. The category 'other words' included tokens when children named other words than were intended in the picture. For instance, Finnish words for 'butter', 'chocolate', 'eggs' and 'mouse' were named for the picture of *juusto* [ju:sto] 'cheese'.

Table 1a shows the most advanced production and Table 1b all the productions of the words with back harmony vowels (BHVs) only (*juusto*

'cheese' and *matto* 'rug'). It shows how many children produced a form that does not violate FVH or a form that violates it.

Table 1a. The percentages of vowel realizations of the most advanced productions of the target words *juusto* 'cheese' and *matto* 'rug'

	Juusto %	*matto %*
BHV's only	84.2 (165)	90.3 (177)
Violation of FVH	0	0
Unclear/Monosyllabic	1.0 (2)	1.0 (2)
No production/Other word	14.8 (29)	8.7 (17)
Total	100 (196)	100 (196)

All of the children's best productions for *juusto* and *matto*, respectively, had BHVs only. Some of these productions were different from the targets. For example, a diphthong (e.g., /ui/ /ou/ /uo/) was produced for /u:/ in *juusto* in some cases.

Table 1b. The percentages of vowel realizations of all productions of the target words *juusto* 'cheese'and *matto* 'rug'.

	Juusto %	*matto %*
BHV's only	71.3 (281)	81.4 (317)
Violation of FVH	0 (1)	0
Unclear/ Monosyllabic	0	0
No production/Other word	27.6 (108)	19.1 (75)
Total	100 (390)	100 (392)

In all productions there is only one unclear form that violated FVH, the form [hu:tø] for *juusto*, which the child immediately self-corrected to [hu:to:]. The 'neutral' front vowels /e/ and /i/ were substituted for final back harmony vowels in 3 tokens (e.g., [hu:t:e] for *juusto*, and [mat:i] for *matto*). These forms do not violate FVH. The number of words with BHVs only is lower in all productions than in most advanced productions. We do not think that the difference is due to difficulties in vowel productions but that it is due to difficulties in naming the pictures. The numbers in the class "no production or other word" were the highest in the data. The pictures of a rug (*matto*) and cheese (*juusto)* seemed to be difficult to name for many children, and they either did not name them or produced another word in 15% of the time for *juusto* and 9% of the time for *matto*.

Tables 2a and 2b show the productions of the two words that have front harmony vowels only (*pöytä* and *pyörä*). Even in these words, FVH

was violated only in a few productions: 86–90% of the most advanced productions had front vowels only and only 4–6% of the most advanced productions violated FVH. Both front vowels were substituted by back vowels in a few productions of *pyörä*.

Table 2a. The percentages of vowel realizations of the most advanced productions of the target words *pöytä* 'table' and *pyörä*' bike'.

	Pöytä %	*pyörä %*
FHV's only	86.2 (169)	89.7 (174)
Violation of FVH	2.0 (4)	3.1 (6)
BHV's only	0	2.0 (4)
Unclear/Monosyllabic	2.6 (5)	2.0 (4)
No production/ Other word	7.1 (14)	4.1 (8)
Total	100 (192)	100 (196)

In the data of all productions, 83% for *pyörä* and 87% for *pöytä* had FHVs only. BHVs were substituted for the FHVs in about 3% of the most advanced productions for both *pöytä* and *pyörä*. About 4% of the productions had BHV's only.

Table 2b. The percentages of vowel realizations of all productions of the target words *pöytä* 'table' and *pyörä* 'bike'.

	Pöytä %	*pyörä %*
FHV's only	82.5 (288)	87.0 (302)
Violation of FVH	3.4 (12)	3.6 (12)
BHV's only	4.0 (14)	3.7 (13)
Unclear/One syllable	7.2 (25)	5.8 (20)
No production/ Other word	11.4 (45)	10.8 (42)
Total	100 (384)	100 (389)

In addition to target-like productions ([pøytæ] and [pyøræ]), children's productions with FVHs only in the total data included forms like [pæijæ], [pøipæ], [pyætæ], [pø:tæ] for *pöytä* and [pø:py], [py:py], [pøijæ], [pø:ræ] for *pyörä*. All productions also included substitutions of long vowels for the diphthongs and six substitutions of unrounded diphthongs for round diphthongs (e.g. [peikæ] and [peitæ] for *pöytä*, and [pierɑ], [pieræ] for *pyörä*, and in eight cases the dipthongs were classified as "unclear". The forms also include a few examples with BHVs in the first and FHVs in the second syllable, e.g. [po:tæ], [poutæ].

The words for *kissa* (‘cat’) and *lintu* (‘bird’) were the two first words in the picture naming task. The aim of these two pictures was to introduce the children to the test situation with familiar pictures and easy words. As expected, the production of these words and the BHVs in the second syllable after neutral front vowel /i/ did not cause any problems and they were not fronted. In the data, these two easy words were transcribed only in the productions of 63 children. For the first target the children produced words *kissa* ‘cat’ and *kisu* ‘pussy cat’. In the case of *lintu* several children named the bird as *harakka*, ‘magpie’.

Table 3. The number of productions of the back harmony vowels in the target words *kissa* ‘cat’ and *lintu* ‘bird’.

	kissa, kisu	*lintu*
Correct	61	56
FHV’s	0	0
Unclear	0	1
No production/ Other word	2	7
Total	63	63

Table 4a shows the children’s most advanced productions of words consisting of a front harmony vowel and a neutral vowel (*(liuku)mäki* and *kenkä*).

Table 4a. The percentages of vowel realizations of the most advanced productions of the target words *(liuku)mäki* ‘hill’ and *kenkä* ‘shoe’.

	Mäki %	*kenkä %*
/æ/ not substituted	88.3 (173)	94.8 (184)
/a/ substituted for /æ/	1.5 (3)	2.0 (4)
Unclear/Monosyllabic	1.5 (3)	0 (1)
No production/ Other word	8.7 (17)	3.6 (7)
Total	100 (196)	100 (196)

Most of the productions had front vowels only in both *mäki* (88.3%) and *kenkä* (94.8%). The back vowel /a/ was substituted for /æ/ in 2% of the productions in the first syllable of *mäki* and in the second syllable of *kenkä*.

Table 4b. The percentages of vowel realizations of all productions of the target words *(liuku)mäki* 'sliding slope' and *kenkä* 'shoe'

	Mäki %	*kenkä %*
/æ/ not substituted	77.7 (300)	83.9 (329)
/a/ substituted for /æ/	2.6 (10)	4.8 (19)
Unclear/Monosyllabic	1. 8 (7)	0
No production/ Other word	17.9 (69)	11.2 (44)
Total	100 (386)	100 (392)

Tables 4a and 4b show that the number of substitutions for /æ/ is slightly lower in the first syllable. The variation in the production of *kenkä* included forms such as [keŋkɑ], [kentɑ], [tentɑ], [(h)ek:ɑ], [ken-kɑ]), and the vowel /æ/ was sometimes centralized, e.g., [ken:ɑ<] [keŋkæ>].

There were fewer namings of *(liuku)mäki* 'a sliding slope' than a familiar word *kenkä* 'shoe'. This may be because *(liuku)mäki* is a compound consisting of four syllables and more difficult to depict. In order to compare the number of target-like productions in the first and in the second syllable (317 for *mäki* and 348 for *kenkä*), we also counted the number of correct productions of the produced forms only (i.e., excluded no productions and other words from the numbers). The phoneme /æ/ was produced correctly in the first (stressed) syllable in 94.6% of the productions and in the second syllable in 94.5% of the cases, i.e. in these two words the production does not seem to depend on whether the vowel occurred in the first or second syllable.

In summary, the results suggested that 2;6-years-old children manage to produce forms that do not violate FVH, although there are variations in their productions. Even when children produced forms that were different from the adult targets, their productions seldom violated FVH. FVH was never violated in words with back harmony vowels only (*juusto* and *matto*). Back vowels were substituted for front vowels most often in *pöytä, pyörä*, *(liuku)mäki* and *kenkä*. The number of problems in vowel productions (the number of FVH violations and other vowel substitutions, unclear and monosyllabic productions) was highest in the words *pöytä* and *pyörä*. The percentages of forms that violate FVH or have BHVs only were more than 7% for both words. Thus, it appears that these were phonologically the most difficult words for children to produce among the eight words analyzed in this study.

4. Discussion

This is the first quantitative study of the acquisition of FVH. The main finding of this study is that FVH is not violated in general in the speech of 2;6-year-old children. The violations were rare and the share of most advanced productions that violate FVH is 2.1% to 3.1% depending on the word. Even in all productions, only 3.4% to 3.6% of the forms (for *pöytä* and *pyörä*) violated FVH. In this aspect, the variation in the forms is small.

In cases where FVH was violated, the violations are due to problems with front rounded vowels /y/ and /ø/. These vowels and /æ/ were substituted by the corresponding back vowels /u/, /o/ and /a/. The back harmony vowels were never substituted by front vowels. This might also be related to the fact that the phonemes /y/, /ø/ and /æ/ are the most infrequent vowels in Finnish. The front rounded vowels /y/ and /ø/ are the two least frequent Finnish vowel phonemes and they seldom appear in the second syllable (Pääkkönen 1990: 9). Their frequency (in written text) is only 1.8% and 0.5%, respectively, of all vowel phonemes. The frequency of /æ/, which is the third least frequent, is 10.0% of all vowels, and it is about the same as the frequency of /o/ (11.1%) and /u/ (10.4%). The most frequent of vowels is /a/ (24.2%).

The hypothesis that the "neutral" front vowels /i/ and /e/ might behave as harmonizing vowels in early development was not supported by our data in the "easy" words *kissa (kisu)* and *lintu*. These vowels behave neutrally and do not cause fronting of the following vowel in the speech of 2;6-year-old children. Instead, /a/ was substituted for /æ/ in *kenkä* in our data.

Only very few children had problems with FVH. The problems are often related to problems in language development. The data includes seven late talkers (Leiwo & al. 2002), and four of them had problems with FVH or substituted back vowels for front vowels in the words *pyörä* and *pöytä*. Three of them did not produce the words at all, and the group only produced 12 forms of the total of 28 trials. The problems in learning FVH and the evident avoidance of the production of these phonologically complex words are also connected with the learning of front harmony vowels, especially with the acquisition of front rounded vowels. These problems are in accordance with the findings of Zajdó (2002a: 195) that Hungarian speaking children have problems especially with front rounded vowels at ages 2;0 and 2;6. The production of front vowels, especially the diphthongs /yö/ and /öy/ (Honkola 2003), and the mastery of FVH may be

good candidates for a diagnostic tool for problems in language development.

According to Leiwo (1977), back vowels substitute for the front harmony vowels more often in the second syllable, and Toivainen (1997) noted that /ø/ in the question particle suffix *-kö* was often substituted with /o/ even in the words that had front harmony vowels. To study the role of syllabic position in substitutions a more comprehensive test would be needed. Our findings are, however, in accordance with a general trend of avoiding FHVs later in the word (Nahkola 1998). For example, there are no bisyllabic words with /e/ and /i/ in the first syllable and FHVs in the second syllable in contemporary Finnish vocabulary, and BHVs are productive in this position (Karlsson 1983: 103–104). In Leiwo & al. (2000), it is hypothesized that the development of FVH could be described as a competition between the spreading of front vowel harmony and a trend to neutralize the back–front opposition in word final positions. It has to be added that, in present Estonian, there is no front vowel harmony because only the back harmony vowels appear later in the word (on Estonian vowel harmonies see, e.g., Wiik 1988). Wiik also emphasizes the role of intermittent consonants in the spreading of vowel harmonies, and Zajdó (2002b) reports that consonantal environment has a strong effect on vowel accuracy at the age of 2;0. In our data, consonant clusters such as /nk/ [ŋk] and phonemes such as /r/ might have increased the difficulty of the words.

In summary, the results of this study suggested that Finnish children's productions seldom violate FVH at age 2;6. When children's productions differed from adult targets, back vowels were substituted for front vowels. The number of errors in vowel productions were highest in the words *pöytä* and *pyörä*. Therefore, it appears that front rounded vowels were acquired late compared to front unrounded vowels and back vowels. The phonologically neutral front vowels, /i/ and /e/, did not seem to cause problems for the acquisition of FVH as it was originally hypothesized.

To study the role of context and syllabic position in vowel acquisition, vowel substitutions and in the acquisition of FVH, we need a more comprehensive and systematic test. Especially the syntagmatic aspect of vowel acquisition seems to offer challenges to phonological studies as well as to the development of diagnostic tools for the early diagnosis of language problems.

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