

## Early Acquisition of Palato-Alveolar Consonants in Japanese —Phoneme Frequencies in Child-Directed Speech—

Chiharu TSURUTANI\*

日本人幼児の後部歯茎子音の早期習得  
—母親の話しかけにおける後部歯茎子音の頻度—

鶴谷千春\*

**要旨:** 本研究は、幼児の音素習得の順序に影響を与えている言語に固有の要因を調査することを目的とした。各言語によって、音素の習得順序には差異があることが知られており、出現頻度やその言語における音韻的役割などが、その原因として挙げられる。日本人幼児の言語習得において、後部歯茎摩擦音／破擦音の習得は、言語一般に考えられているよりも早いことが知られているため、[ʃ] [tʃ] [s] に注目し、母親の子供への話しかけの中での出現頻度と、その音素の現れる環境を調べた。その結果、母親の発話の中では幼児に対して使う幼児語表現の多さから、異なり語数は少ないものの、後部歯茎摩擦音／破擦音の延べ出現数が高くなっていることがわかった。

**Key words:** palato-alveolar consonants, phoneme frequencies, child-directed speech, acquisition order, language-specific factor

### 1. Introduction

Segmental development in infants is inevitably governed by universal constraints due to infants' immature articulatory system, while auditory input builds up language-specific constraints. Since Jakobson (1968) first proposed the universal order of language acquisition, the universal tendency for children to acquire vowels, then nasals, glides (j, w) and labial consonants, followed by the consonants produced at the back of the oral cavity has been recognized. If the size of the tongue or the oral cavity is the only cause for children's mispronunciation, the order of language acquisition should be the same across languages. However, cross-linguistic differences in the order of phoneme acquisition has been reported in various studies (Rice and Avey 1995, Ingram 1999, Stokes and Wong 2002, Zhu 2002, Beckman et al. 2003, Tsurutani 2004). If we presuppose that the individual differences in children's physical development or traits are not linguistically significant, diverse patterns of development among languages of the world can be attributed to differences in the phonology of each language. Infants' linguistic skills are shaped by auditory input from the ambient language (Vihman 1996).

Their perception capacity to discriminate between speech sounds declines or is modified as they acquire the phonological system of the language (Wenker and Tees 1984). It is highly likely that the order of language acquisition is affected by language-specific factors in the input. Some studies (Pye et al. 1987, Vihman 1996, Beckman et al. 2003) have discussed the relevance of frequency of occurrence or phonological saliency to the order of phoneme acquisition. However, researchers have not reached a conclusive theoretical explanation.

We may presume, then, that the investigation of sounds acquired in the earlier stage of language acquisition than the universal order would provide some clarification on this issue. Japanese palato-alveolar consonants have been chosen for this study since Japanese language is linguistically quite different from English and most other languages, and early acquisition in Japanese could present an instructive contrast to early acquisition of other languages. This study investigates the frequency of palato-alveolar consonants in child-directed speech and the phonetic environments where these consonants are used. Findings from this empirical study are then used to consider language-specific factors that affect aspects of sound acquisition.

\* School of LAL, Griffith University, Nathan

## 2. Universality and variability in the language of infants

It is generally assumed that a language segment with less complex features or an unmarked segment will be acquired early. The original universal model for the order of segmental development along this line of argument was proposed by Jakobson (1968). He claimed the following acquisition order regarding manner and place of articulation for consonants based on markedness in adult languages: universally unmarked segments should appear developmentally earlier than marked segments;

- 1) Manner of articulation  
Stops>Fricatives>Affricates
- 2) Place of articulation  
Labials>Alveolars>Velars

It is true that cross linguistically there are overall similarities in the sequence of acquisition. However, the model generated from adult languages has some discrepancies with the empirical data acquired from studies of children, and the rigid order of acquisition is no longer favoured from cognitive points of view (Macken and Ferguson 1981, Vihman 1993). In other words, typological markedness across world languages is not adequate to explain the acquisition order of a language. More focus should be given to language-specific markedness to account for language specific acquisition order.

Some researchers (Pye et al. 1987, Stokes and Wong 2002, Beckman et al. 2003) attribute the different acquisition order of each language to the frequency of occurrence. As the acquisition of language involves learning vocabulary and expressions, frequently occurring sounds become familiar to children and are acquired early. Thus, in terms of the early acquisition of a phonetically marked sound, a lexicon-based frequency should have more explanatory power than cross-language frequency. However, high-frequency of occurrence does not always result in the early emergence in children's production as in the case of the late acquisition of [s] and [ʃ] relative to stops (Smit et al. 1990).

Pye et al. (1987), who investigated the early acquisition of [tʃ] by Quiche children, tried to explain the acquisition order from the concept of maximal opposition within the language which children try using to build phonemic contrasts, considering the fact that [tʃ]-[t] opposition in Quiche is more salient and important than in English. Phonological salience is a notion

suggested by other researchers as well (Vihman 1996, Zhu 2002). The definition of phonological aspects varies between languages and it is difficult to apply their value across all languages. It is, however, certain that language specific factors as well as language universal factors have to be incorporated in the acquisition theory to be able to account for segmental developments in various languages. In the next section, evidence of early acquisition of palato-alveolar consonants in Japanese children's production will be presented and its implication will be discussed.

## 3. Early acquisition of palato-alveolar consonants in Japanese

The acquisition of most consonants in Japanese abides by the universal model claimed by Jakobson. However, the acquisition of the palato-alveolars among Japanese children presents an interesting contrast to other languages. It has been reported that Japanese children acquire [tʃ] and [ʃ] early (Nakanishi et al. 1972, Ito 1990, Beckman et al. 2003, Kubozono 2003), whereas English children do not (Ingram 1981, Smit et al. 1990). Other Indo-European languages show an order of acquisition similar to that for English (Locke 1983). Ito (1990: 179) summarises the findings from various studies as follows:

Japanese	t->tʃ->ts->ʃ->s
English	t->ts->s->ʃ->tʃ

The acquisition of [s] is relatively late in many languages including English. Although [s] was one of the acquired sounds in Ingram's data (1981) on 15 English speaking children aged 17 to 26 months, [s] is acquired over a long period of time, when the speaker is between two and four years old (Prather et al. 1975). Ito (1990) attributes this to the fact that [s] requires more tension of muscle than palato-alveolars do, but that Japanese palato-alveolars are not as tense as the English equivalent. However, Ito has not provided empirical support for his claim, and the acoustic difference of [s] between Japanese and English is not observed when the frication of [s] from two languages are compared in spectrogram.

Early acquisition of palato-alveolar consonants is also evident in the pattern of substitution errors by children. Tsurutani (2004) investigated Japanese children's sound production and found a large proportion of substitution errors of the palato-alveolar affricate [tʃ] for [s] and [ʃ]. Figure 1 below illustrates the success

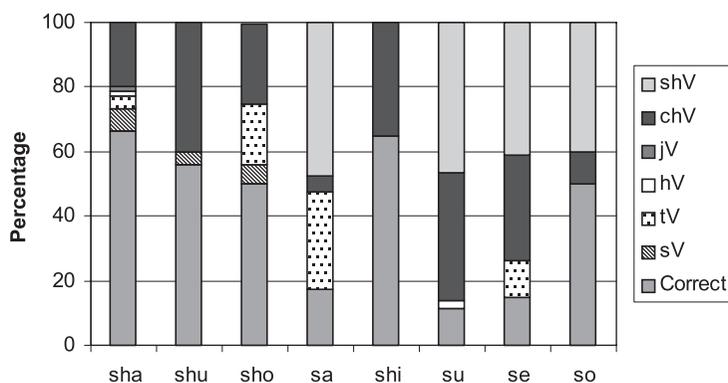


Fig. 1 Comparison of substitution error rates of the palato-alveolar affricate in [s] and [ʃ] (Tsurutani 2004: 42)

rate of production and the pattern of substitution errors in 37 monolingual children ranging in age from 2;3 to 3;9 (years;months) using object naming tasks.

The acquisition rate of [ʃ] is much higher than for [s] and most of the incorrect productions of [ʃ] appeared as [tʃ]. The acquisition rate of [tʃ] itself was close to 100 percent. It is noticeable that [ʃ] is substituted for [s] more often than [tʃ] is substituted for [s]. The high proportion of substitutions of [ʃ] and [tʃ] for [s] was also noted in the report by Nakanishi et al. (1972) which investigated 1800 children aged between four and six years. It suggests that [tʃ] and [ʃ] are acquired before [s], and [tʃ] is acquired before [ʃ].

In order to find factors that may contribute to the early acquisition of [tʃ] by children of the age groups mentioned in these studies, it is useful to investigate the occurrence of palato-alveolar consonants in the auditory input to Japanese children before they reach this age group. The auditory input in an ambient language could be provided by caretakers, peers, T.V. and other sources. Among these, caretakers' speech was considered to be a main source of input for young infants, and chosen as an object of investigation.

#### 4. Experiment

In this section, the occurrence of palato-alveolars in mothers' speech is examined in terms of frequency and phonetic environment. There are data available that have counted phoneme frequency in adult lexicon, however, it is commonly accepted that the frequency is highly affected by the source of data (i.e. phone conversation, newspaper, web site, public speech). It is necessary to examine the frequency of occurrence of each

sound in the speech directed to children in case the vocabulary that children hear is different from adult lexicons. When researchers (Ingram 1981, Pye, et al. 1987) counted frequency of consonants in Indo-European languages, the initial consonant of words was used because these are more frequent and easy to count. In the case of Japanese, the majority of syllables are CV syllables that are recognised as a Japanese phonological unit, a mora, and correspond with Japanese orthography, kana. Thus, counting frequency will be based on the combination of consonants and the five vowels in Japanese. This phonological construction allows us to identify consonants in any position in a word. In this experiment all occurrences of consonants in all word positions were counted.

##### 4.1 Aims

The experiment aims to investigate the frequency of occurrence of palato-alveolars in mothers' speech and the influence of the auditory input to L1 (first language) learners of the language. Two particular substitution errors, [tʃ] for [ʃ] and [ʃ] for [s] observed in the previous study (Tsurutani 2004), led us to choose the sounds "cha, chi, chu, cho" and "sha, shi, shu, sho" against "sa, su, se, so" for investigation ("che", "she" and "si" do not exist in the native Japanese vocabulary).

##### 4.2 Hypothesis

In Japanese child-directed speech, the occurrence of palato-alveolars is more frequent than alveolars due to distinctive expressions or vocabulary of this speech.

### 4.3 Methods

#### 4.3.1 Participants

Speech data for this study were collected from six mothers whose children's age ranged from 1 to 1;11. This age group of children was chosen as they are at the phonological stage of *the first 50 words (1;0~1;6)* (Ingram 1989), and thus, mothers are keen to talk to their children in an attempt to encourage them to speak. Six mothers who were Tokyo Japanese speakers living in the Tokyo metropolitan area participated in the study.

#### 4.3.2 Data collection

The researcher asked participants to record their speech while talking to their child in several different settings such as feeding, putting to bed, playing, and changing clothes to avoid the influence of the nature of activities on the vocabulary and expressions used by them. Mothers chose appropriate occasions and recorded their voice for 25~30 minutes in total over a few days. Mothers were instructed to interact and talk to their child but were not told the purpose of recording. A clip microphone and a walkman-type recorder equipped in a waist pouch were given to the participants with instructions. The length of recording by each participant is shown in Table 1. The researcher visited their home later and collected the tape and equipment.

#### 4.3.3 Data analysis

The recorded data were transcribed in kana and later typed up in romanized character to count phoneme frequency. The transcribed data were analysed in terms of phonetic environments of the palato-alveolars.

#### 4.3.4 Transcription

All recordings of mothers' speech were used for transcription except for two cases where a mother recorded more than 45 minutes. In those cases, only the first 45 minutes was used. A native Japanese listener transcribed the recording in Japanese orthography, kana, which captures sounds in the form of CV syllables. A few minutes of speech from each mother was randomly chosen and transcribed by the researcher to see the inter-transcriber reliability. The inter-transcriber reliability ranged between 99.8~100 percent as expected from the fact that adult native speakers' speech is transcribed by native listeners. Subsequently all transcription was used.

#### 4.3.5 Frequency count

Longman Mini Concordancer (LMC) was used to count frequency of morae. The LMC is a text handling tool that can count the word frequency and token/type ratio from text files. Texts to be counted have to be typed with a space between items so that the LMC recognizes as words. Transcribed data were typed up in romanized character in the form of mora (CV units) with a space between morae and fed into the LMC. Mothers' speech contains numerous repetitions in various situations. The type of repetitions are divided into two, a repetition of onomatopoeia which is mimicking the continuous action or motion (e.g. cleaning teeth, *'goshi, goshi, goshi, goshi ...*) and a repetition to teach the child a particular word or expression (*osuwari, osuwariyo, osuwari=sit, please sit, sit*). Articulations of the former were counted only up to four times as they are meaningless (and endless in some situations) repetition and have not directed children in an attempt to teach that particular sound, while all articulations for the latter were included in the data.

## 5. Results

### 5.1 Frequency

Frequency of articulation of the 12 kana sounds "*cha, chi, chu, cho*", "*sha, shi, shu, sho*" and "*sa, su, se, so*" were counted and calculated. One way ANOVA was used with 12 sounds as an independent variable and frequency of occurrence as the dependent variable. The difference between occurrence of the 12 sounds was statistically significant ( $F(1,11)=6.18, P<.001$ ). Frequency was recalculated in the proportion of occurrence against the total number of production in each informant, and was shown in the graph in Figure 2.

The frequency order of individual sounds was statistically examined using Multiple comparisons for the purpose of examining inter-informant variation. Multiple comparisons is an adequate statistical method to examine equality of the rank order of the 12 sounds across groups. The highest frequency of "*shi*" was found to be significant against all the other sounds, and the higher rank of "*cha*" over "*chu*", "*sha*", "*shu*" and "*se*" was supported for each informant. However, the ranking of frequency for the rest of the sounds could not be statistically supported because of individual differences, such as the frequent use of "*sa*" by Informant C due to the name of her child "*saachan*", and personal preference for particular expressions.

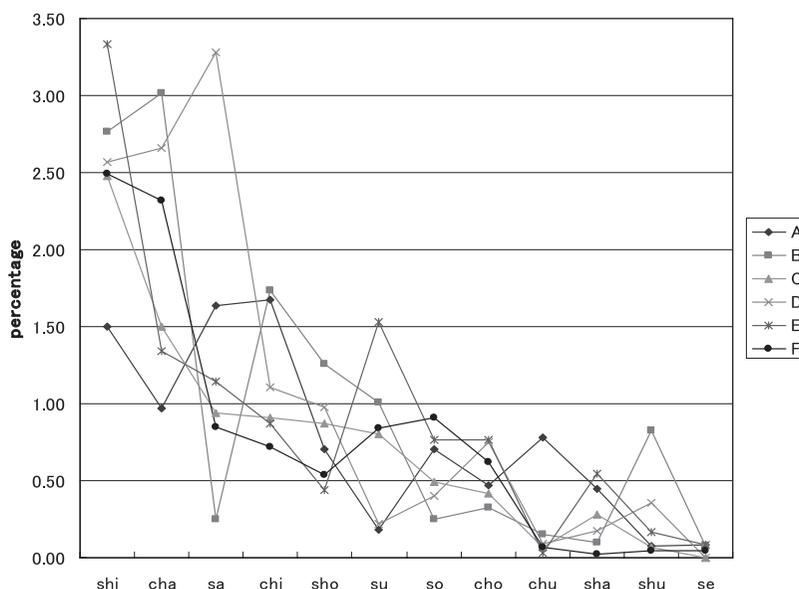


Fig. 2 Frequency of occurrence of “cha”~“so” in 6 mothers A~F  
\*Sounds are listed in descending order of frequency from “shi” to “se”

Statistically supported order:

*shi, cha > chi, chu, cho, sa, su, se, so*

When frequency was compared across the three phonemes as a sum of the four sounds (number of occurrence shown in brackets), the predicted frequency order, [tʃ] (1253), [ʃ] (1069) and [s] (806) was proved. This frequency of order is due to particular sounds in each group, “cha” and “shi”, that made the palato-alveolars outnumber the others. These two sounds had a high rate of frequency equally for all the informants. Typical expressions that contained “cha” and “shi” in mothers’ speech were request (*shite*), negative command (*chadame*), description of what a child has done (*chatta/chau*), and persuasion (*shiyō*). The following are common expressions where the target sounds “cha” and “shi” appeared.

<cha>

- 1) —chan (affectionate title) “—san” (Mr./Ms) is used for adults
- 2) cha—the shortened forms of verb conjugations “*teshimatta*”, “*tewa*”  
—chatta (you have done ...)/chatte (you have done and)/chau (you will have done)  
*chadame* (you must not do ...)
- 3) —chai A casual version of “—sai” used for children (i.e. *kusai, chiisai, ... kudasai*)

<shi>

- 4) shi—stem for the verb “do”

—shite (do it), *shi-yō* (let’s do), —*shi-ta* (did),  
—*shi-nakya* (have to do),

- 5) Ending of adjectives

*oishi* (yum), *suzushii* (cool)

The occurrence of “shi” largely owes to the frequent use of the verb “do” and the ending of adjectives, which are regularly observed in adult vocabulary as well. On the other hand, “cha” seems to appear in a different vocabulary from adult speech. Mothers quite often replace “sa” with “cha” supposedly as a cute sound suited for children.

In order to see type frequency of “cha”, the breakdown of “cha” production was tabulated below.

The number of occurrences in this table was manually counted, and thus slightly differs from the data counted by the concordancer that counts only one target item per line. The number of vocabulary is limited and the majority of occurrence are 1) *chan* and 2) *chatta/te*, which resulted in low type frequency for [tʃ]. Apart from actual Japanese words, 1) *chan*~3) *chai* are expressions often used for young children.

## 5.2 Vowel environment

The frequency of [tʃ], [ʃ] and [s] was collated according to vowel environment as shown in Table 2 below. The vowel sound most frequently articulated in

**Table 1** Frequency count of “*cha*” in the vocabulary that contained “*cha*”

Cha	1) <i>chan</i>	2) <i>chatta/te</i>	3) Adjective <i>chai</i>	Words	Otomatopoeia	Recording (mins)
Mother A (1:11)	44	2	66	0	91	45
Mother B (1:4)	133	55	0	23 <i>cha</i> (tea),	0	31
Mother C (1:9)	22	30	0	9 <i>cha</i> (tea), 4 <i>chanto</i> (properly)	16	30
Mother D (1:1)	83	12	0	0	6	25
Mother E (1:10)	43	17	0	2 <i>kabocha</i> (pumpkin), 2 <i>chaahan</i> (fried rice)	0	30
Mother F (1:0)	81	51	13	88 <i>cha</i> (tea), 1 <i>omocha</i> (toy)	20	45

( )=Age of the child

Japanese is [a], as is also true in other languages. The vowel sound [i] in palato-alveolars in this table is as frequent as [a]. This tendency is lost when frequency is added for the row of each vowel, as the frequency ranking becomes [a]>[o]>[i]>[e]>[u]. The distribution of sounds is obviously influenced by the vocabulary. Among alveolar consonants, the frequency ranking of “t→tʃ→ʃ→s” is observed, which matches with the order suggested by Ito (1990). It suggests that the phonological contrast between [t] and [tʃ] is established by the high frequency of [tʃ] before the phonological contrast between [s] and [ʃ].

## 6. Discussion

Frequency count of 12 kana sounds in the mothers’ speech to their child supported the predicted frequency order of three phonemes [tʃ]>[ʃ]>[s], which corresponds with the findings of previous studies (Nakanishi et al. 1972, Ito 1990, Beckman et al. 2003, Kubozono 2003). This suggests that the token frequency of phonemes in child-directed speech affects acquisition order of sounds. The frequent use of two sounds “*cha*” and “*shi*” particularly contributed to this order, but the occurrence of other kana sounds did not correspond with the predicted acquisition order due to the variation among speakers. This point needs to be investigated further in a future study. Nevertheless, the frequency of 12 kana sounds reflects some characteristic of mothers’ speech.

When we compare the results of this study of child-directed speech data with study of the adult speech data, the difference in frequency order is obvious. Frequency count in the transcription of a casual speech among three adults (one female and two males) who appeared in a TV talk show (Iba and Yoshikawa 1990) was used as comparison 1. Table 3 shows frequency ranking of top 12 consonants in the adult speech data and the child-directed speech.

The ranking of the three phonemes in the table highlights a difference between the two types of speech. In contrast to child-directed speech, the frequency of [tʃ] is the lowest among the three consonant sounds in the adult speech data. The high frequency of [tʃ] in child-directed speech is attributed to the abundant use of “*cha*”, found mostly in the expressions used for young children as shown in Table 1. The use of [tʃ] and [ʃ] in child-directed speech is very common in Japanese (*Yojigo*). A questionnaire conducted in a previous study revealed that some mothers use those sounds as substitutes for [s], because they think they are typical sounds children use and also sound cute (Tsurutani 2004). Mothers’ frequent use of palato-alveolars seem to be the causal factor of children’s speech acquisition, but at the same time could be a reflection of children’s usage. A distinctive style in child-directed speech is observed in English and other languages as well, but a particular vocabulary or substitution of sounds for children has not been reported. It is known that mothers tend to use prosodic modifications, such as an exaggerated pitch

**Table 2** Frequency of consonants in vowel environment

						← Alveolar consonants →							
w	r	y (j)	m	h	n	ch (tʃ)	t	sh (ʃ)	s	k	Single vowel		Total for each vowel
531	339	201	479	782	860	555	820	79	375	630	1943	a	8889
	284		190	76	287	366		707		348	2847	i	5313
	347	113	155	81	23	89	133 (ts)	60	213	401	789	u	2809
	486		283	32	953	12	731	0	18	118	713	e	3876
	94	636	319	108	457	165	541	223	221	730	1727	o	6009

N				b	p	j	d	z	g	
2041				168	262	173	478	11	203	a
				70	37	84	2		15	i
Q				174	25	15	0	114	77	u
1171				132	14	0	313	18	53	e
				67	40	122	252	87	220	o

Top ten high frequent sounds    
  10~20<sup>th</sup>    
  20~30<sup>th</sup>

\* The occurrence of less than 10 was omitted.  
 N=moraic nasal Q=a geminate consonant

pattern and slower tempo, and better articulation to make the speech clear and simple (Cooper and Aslin 1990, Grieser and Kuhl 1988). Thus, it appears that speech to children is a simpler, more grammatically “correct” version of the language than that spoken to adults. Further cross-linguistic study will be necessary to investigate the frequency of phonemes in child-directed speech.

In addition to the frequency of occurrence, the phonological salience of the sound in the language was suggested by some researchers to account for the early emergence of a particular sound (Zhu 2002, Vihman 1996). Zhu (2002) defines phonological salience as a syllable based component which is compulsory, capable of distinguishing lexical information, and has fewer permissible choices than less salient components. For

instance, tone has the highest saliency and is acquired early in Chinese. If we examine [tʃ] in the light of phonological saliency in Japanese, only one condition is satisfied; it has fewer permissible choices than less salient components. The contrasts of plain and palatalised consonants (e.g. [t] and [tʃ]) are fewer than the number of the whole consonants. However, “*cha*” in child-directed speech is not capable of distinguishing lexical information as another sound can be replaced with “*ch*”, (e.g. *chatta*->*teshimatta*). That means, it is not a compulsory sound, either. “*ch*” is a high frequency sound in child-directed speech, but not a phonologically important sound.

In child-directed speech, the “*a*” and “*i*” rows of palato-alveolars present much higher frequency of occurrence than the “*u*”, “*e*” and “*o*” rows in Table

**Table 3** Frequency ranking of top 12 consonants in adult speech data and child-directed speech data N=moraic nasal (Iba and Yoshikawa 1990: 70)

	Adult Speech		Child-directed Speech	
1	t	1503	n	2580
2	n	1456	k	2227
3	k	1332	t	2092
4	r	883	N	2041
5	s	861	r	1550
6	d	726	m	1423
7	m	716	tʃ	1253
8	N	562	h	1079
9	j	417	ʃ	1069
10	ʃ	323	d	1045
11	g	312	j	950
12	tʃ	227	s	806

2. However, the total of occurrence of all kana sounds across vowels shows frequency ranking of [a]>[o]>[i]>[e]>[u]. In the adult speech data collected by Iba and Yoshikawa, the frequency ranking of vowels in all kana sounds was in the order of [a]>[o]>[e]>[i]>[u]. Iba and Yoshikawa explain that the relatively high ranking of [e] is due to the common use of the final particle “*ne*” or the response “*ee*” in conversation, but that a high frequency of [a] and [o] is normally expected in adult lexicons. This means that the child-directed speech in this study has an appropriate distribution of Japanese sounds in terms of vowels. Although child-directed speech had many occurrences of “*ne*”, [i] still outnumbered [e]. The high frequency of occurrence in “*a*” and “*i*” rows of palato-alveolars in child-directed speech and the difference in the frequency ranking of consonants between the two groups must reflect a different nature of vocabulary used for children. The low type frequency in the data collection of this study is the result of the small size of vocabulary and repetition which are common features of speech directed to young children. Thus, the data of this study serve as an adequate example of child-directed speech.

## 7. Summary

The frequency of occurrence of [ʃ] and [tʃ] was higher than [s] in child-directed speech in the order of [tʃ], [ʃ], [s]. This can account for early acquisition of [tʃ] and [ʃ] before [s] by Japanese children. The particular lexicon in mothers’ speech to their children, such as addressing a child and use of light-verb construction (do-verbs), contributed to this result. It suggests that token frequency of phonemes in child-directed speech plays an important role in sound acquisition. After the alveolar stop [t] is acquired, the palato-alveolar affricate [tʃ] seems to be learned before the fricative [ʃ]. [tʃ] is not phonologically salient in an absolute sense, but is certainly a prevailing sound in child-directed speech due to the vocabulary used for small children in particular.

In sum, frequency of occurrence in Japanese mothers’ speech interferes with the acquisition order of phonemes, which reflects the language-specific expressions for young children. Children start acquiring words which are heard frequently in their ambient language, as reported in other studies on input frequency (Hart 1991, Naigles and Hoff-Ginsberg 1998). Although more data are required to find the relation between children’s phoneme acquisition and child-directed speech, the results of this study support the assumption that language-specific lexicon and its token frequency affect acquisition order. Further study on the phoneme frequency in child-directed speech in other languages will be useful to support these findings, to strengthen our conceptual knowledge of this aspect of language acquisition.

## Acknowledgements

I would like to thank Motohiko Sakka and Chiaki Kosaka for arranging data collection, and the families who participated in the study. I am also grateful to two anonymous reviewers for their valuable comments and suggestions. This study was supported by Griffith University Research Grant.

## [Note]

- 1) It was 23 minute recording from the NHK TV program “Studio L” broadcasted in 1987. Although it was recorded at a TV studio, the utterance was spontaneous and the atmosphere was intimate. (An actress, a photographer and an architect were talking about a house the architect

designed for himself.) Thus, the data suited the purpose of Iba and Yoshikawa's research, collecting informal spoken Japanese. More informal speech at home could be used as comparison with child-directed speech in a future study.

## References

- Beckman, M., Yoneyama, K. and Edwards, J. et al. (2003) "Language—specific and language universal aspects of lingual obstruent productions in Japanese-acquiring children," *Journal of the Phonetic Society of Japan* 7: 2, 18–28.
- Cooper, R. P. and Aslin, R. N. (1990) "Preference for Infant-directed Speech in the First Month after Birth," *Child Development* 61, 1584–1595.
- Grieser, D. L. and Kuhl, P. (1988) "Maternal Speech to Infants in a Tonal Language: Support for Universal Prosodic Features in Motherese," *Developmental Psychology* 24: 1, 14–20.
- Hart, B. (1991) "Input frequency and children's first words," *First Language* II 289–300.
- Iba, M. and Yoshikawa, M. (1990) "Nihongo no onsetsu to onso no choosa — sono shurui to shutugenhindo". In Roberge, C. and Kimura, M. (eds.) *Nihongo no hatsuonshidoo*. (pp. 64–78). Tokyo: Bonjinsha.
- Ingram, D. (1981) *Procedures for the phonological analysis of children's language*. Baltimore: University Park Press.
- Ingram, D. (1989) *Phonological Disability in Children*. London Jersey City: Whurr Publisher.
- Ingram, D. (1999.) "Phonological acquisition." In Barrett, M. (ed.) *The development of Language*. Hove, UK: Psychology Press.
- Ito, K. (1990) *Kodomo no kotoba*. Keiso Shobo.
- Jakobson, R. (1968) *Child language aphasia and phonological universals*. Mouton.
- Kubozono, H. (2003) "Acquisition of Phonology and Language Universals," *Journal of the Phonetic Society of Japan* 7: 2, 5–17.
- Locke, J. L. (1983) *Phonological Acquisition and Change*. Academic Press.
- Macken, M. A. and Ferguson, C. A. (1981) "Phonological Universals in Language Acquisition". In Winitz (ed.) *Native Language and Foreign Language Acquisition* (pp. 110–129). Annals of the New York Academy of Science.
- Naigles, L. R. and Hoff-Ginsberg, E. (1998) "Why are some verbs learned before other verbs? Effects of input frequency and structure on children's early verb use," *Journal of Child Language*, 95–119.
- Nakanishi, et al. (1972) "Koon Kensa to sono kekkani kansuru kousatu" [Tokushukyoku kenkyuushisetu houkoku] The research Institute for the Education of Exceptional Children Tokyo Gakugei University 1, 1–41.
- Prather, E. M., Hedrick, D. L., and Kern, C. A. (1975) "Articulation development in children aged two to four years," *Journal of Speech and Hearing Disorders* 40, 179–191.
- Pye, et al. (1987) "A comparison of initial consonant acquisition in English and Quiche." In Nelson, K. E. and Kleeck, A. (eds.) *Children's Language* volume 6 (pp. 175–190). Lawrence Erlbaum Associates Publishers Hillsdale, New Jersey.
- Rice, K. and Avery, P. (1995) "Variability in a deterministic model of language acquisition: A theory of segmental elaboration." In Archibald, J. (ed.) *Phonological Acquisition and Phonological Theory*. (pp. 23–42).
- Smit, A. et al. (1990) "The Iowa articulation norms project and its Nebraska replications," *Journal of Speech and hearing Disorders* 55, 779–798.
- Stokes, S. F. and Wong I. M. (2002) "Vowel and diphthong development in Cantonese-speaking children," *Clinical Linguistics and Phonetics* 16 (8), 597–617.
- Tsurutani, C. (2004) "Acquisition of Yo-on (Japanese contracted sounds) in L1 and L2 phonology," *Second Language* 3, 27–47.
- Vihman, M. M. (1993) "Variable paths to early language production," *Journal of Phonetics* 21, 61–82.
- Vihman, M. M. (1996) *Phonological development: The origins of languages in the child*. Cambridge, MA: Blackwell.
- Werker, J. and Tess, R. (1984) "Cross-language speech perception: Evidence for perceptual reorganization during the first year of life," *Infant Behavior and development* 7, 49–63.
- Zhu, H. (2002) *Phonological development in specific contexts: Studies of Chinese-speaking children*. Clevedon: Multilingual Matters Ltd.

(Accepted March, 2007)