

## Quantity contrasts in Japanese and Finnish: Differences in adult production and acquisition

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### Abstract

Geminate consonants have been discussed in relation to the subsyllabic unit mora because geminate consonants and their single counterparts minimally contrast with respect to their underlying moraic status. This study investigates the acquisition of single/geminate nasal contrasts (n vs. nn) and thus the acquisition of minimal moraic contrasts in Japanese and Finnish. A striking difference was found between the two languages in the acquisition experiment; it appears that Finnish children are mastering the contrast by age three, while in Japanese, quantity contrasts may not be clearly established among children so young. Differences between the two languages were also found in adult production data; Finnish adults are making clearer distinction between [n] and [nn] than Japanese adults. The data suggest that the difference between the two languages in acquisition may originate from differences in adult production; Finnish children are acquiring the distinction earlier than Japanese peers because they are provided clearer distinctions in the input.

### 1. Introduction

Length contrasts<sup>1</sup> in consonants are not very common among languages (Ladefoged, 1993:250), and Japanese and Finnish are among those languages that have such contrasts. Single and geminate consonants<sup>2</sup> minimally contrast with respect to their underlying moraic status (see Broselow, 1995); geminates are underlyingly moraic while their single counterparts are not.

Although both Finnish and Japanese have long vowels and geminate consonants, there are differences between the two languages in how many of their vowels and consonants can occur as long or geminates. Finnish has eight vowels (/a, e, i, o, u, y, æ, ø/) and all of them can occur either as short or

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<sup>1</sup> I refer to them as ‘quantity contrasts’.

<sup>2</sup> I use the term *geminate* both in Finnish and Japanese although, in Japanese, [nn] as in *minna* ‘everyone’ is commonly analyzed as a sequence of so-called mora nasal /N/ in the coda followed by /n/ (e.g., Vance 1987). I analyzed the Japanese coda nasal as alveolar /n/ (Aoyama 1999); in either analysis, the resulting phonetic sequence is [nn], and a pair such as *Hana* and *Hanna* contrasts minimally with respect to their underlying moraic status.

long (Aaltio 1963:13).<sup>3</sup> It has thirteen consonants /d, h, j, k, l, m, ŋ, n, p, r, s, t, v/, and nine of them, /p, t, k, m, ŋ, n, s, l, r/, can occur as geminates (Sulkala and Karjalainen 1992:365-371). Japanese has five vowels /i, e, a, o, u/, and all of them can occur as short or long. There are fifteen consonants /p, b, m, n, d, t, č, z, s, r, h, g, k, y,<sup>4</sup> w/ (Jouo 1977:112), and five of them, /p, t, k, s, n/ (phonetically some more, e.g., [m]), can appear as geminates. In addition, it is reported that /b, d, g, z, r/ can also appear as geminates occasionally (Nakajo 1989:86). Thus, Finnish allows more segments to occur as long or as a geminate. In addition, a frequency count based on short Finnish and Japanese texts revealed that quantity contrasts occur more frequently in Finnish than in Japanese (Aoyama 2001, chapter 3).

This study investigates the difference in how quantity contrasts are acquired in these two languages. It also investigates adult production in each language in order to examine the phonetic nature of the input to children in each language. Experiment 1 was conducted to examine if there was any crosslinguistic difference in the course of the acquisition of quantity contrasts between Japanese and Finnish; it investigated production and perception of single and geminate nasals ([n] and [nn]) among Japanese and Finnish children aged three to five. In experiment 2, adult productions of the same contrast in each language were examined; the adult production data revealed phonetic differences in the input between the two languages.

## 2. Experiment 1: The acquisition of nasal quantity contrast

### 2.1. Method

#### 2.1.1. Japanese

Twenty-nine Japanese children and adults participated. There were seven 3-year-olds (mean age 3;6), seven 4-year-olds (mean age 4;4), eight 5-year-olds (mean age 5;6) and seven adults (mean age 36;6).<sup>5</sup> This is a subset of the data reported in Aoyama (2000); there were more participants in each group, but here I only report the data from subjects whose productions I analyzed acoustically. In addition, the data from 6- and 7-year-olds were excluded since no Finnish children at those ages participated. The experiment was conducted in Osaka, Japan.

The target words were two names, *Hana* and *Hanna*, that minimally contrast with respect to the length of the medial nasal. *Hana* is a girl's name in

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<sup>3</sup> According to Sulkala and Karjalainen, however, only /aa, ææ, ii, yy, uu/ occur as 'genuine' long vowels and mid vowels /ee, oo, œæ/ occur only as a consequence of contractions of vowels (1992:372-373).

<sup>4</sup> /y/ stands for a glide [j] in case of Japanese phonology, rather than a front rounded vowel [y] in case of Finnish phonology.

<sup>5</sup> I thank children and teachers at Kanshinji Kindergarten, Circle English school, Angel Daycare, and Nankai Aijien in Osaka, Japan for their cooperation.

Japanese, and *Hanna* is a girl's name in Finnish. Pictures of two girls were prepared, and one was identified as *Hana*, and the other was identified as *Hanna*. Three tasks (imitation, production and perception) were administered to each subject. In the imitation task, the subjects were introduced to the target names, and then asked to repeat each name three times after the experimenter. In the production task, they were asked to answer questions for which the expected answers were either *Hana* or *Hanna*. For example, a picture of *Hana* was shown, and the experimenter asked the subject '*What is the name of this girl?*'. The subjects produced the names in isolation without a carrier sentence; however, the two girls in the pictures were referred to as *Hana-chan* and *Hanna-chan* both by the experimenter and the subjects during the experimental sessions since it is common to add an ending *-chan* to girls' names in Japanese. The two names were introduced with an initial accent by the experimenter, and they were produced with an initial accent by both the experimenter and the subjects throughout the experiment. Six or more tokens each of *hana* and *hanna* were elicited from each subject in the imitation and production tasks.

In the perception task, pictures of the two girls were shown at the same time, and the subjects were asked to point to the appropriate picture when asked, for example, which one was *Hanna*. Each session was audio-recorded.

A total of 152 tokens of *hana* and 153 tokens of *hanna* from 29 subjects were analyzed acoustically using Signalyze.<sup>6</sup> Wide-band spectrograms were produced for each word, and the duration of the medial nasal and the duration between the onset of the first vowel and the end of the second vowel ([ana] and [anna]) were measured. The duration of [h] was not measured; thus when whole-word duration are discussed, they actually correspond to the durations of [ana] and [anna]. Since only a few 3-year-olds completed the production task, there were fewer tokens, all of which were from the imitation task. The results of the perception task were recorded and checked by means of observation notes and audio-recordings, and analyzed in terms of the number of matching responses.

### 2.1.2. Finnish

Thirty-four Finnish children and adults participated. There were eight 3-year-olds (mean age 3;6), eight 4-year-olds (mean age 4;7) eight 5-year-olds (mean age 5;3) and ten adults (mean age 27;8). The target names and tasks were the same as in 2.1.1. In Finnish, the primary stress is on the first syllable of a word (Sulkala and Karjalainen 1992:381), and thus, the two names were produced with an initial stress.<sup>7</sup> The words were produced in isolation by the

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<sup>6</sup> Signalyze is a product of the InfoSignal company and is a speech analysis program for the Macintosh with spectral analysis tools.

<sup>7</sup> Few adult subjects sometimes produced the names with a rising pitch in their production tasks. However, the experimenter produced the names with an initial stress

subjects throughout the experiment. Those tokens that were produced in a sentence, or with a case marker, were not analyzed.

All the interactions were in Finnish; a female native speaker interacted with all the children, and adults did the tasks in pairs. All the children were living in Jyväskylä, Finland. Adult subjects were from various parts of Finland, including Uusimaa (3), Ostrobothnia (3), Lapland (1), Savo (1) and Häme (1). Each session with children was audio-recorded and videotaped. Adult sessions were audio-recorded.

A total of 218 tokens of *hana* and 229 tokens of *hanna* from 34 subjects were analyzed acoustically. The results of the perception task were recorded and checked by means of observation notes, and audio-, and video-recordings, and analyzed in terms of the number of matching responses.

## 2.2. Results

### 2.2.1. Production

All Japanese and Finnish subjects' mean absolute durations of [n] and [nn] were submitted to an ANOVA in which Age (4 levels)\*Language (2 levels) served as between-subjects factors and Nasal contrast (2 levels) as within-subject variables. It yielded a significant three-way interaction ( $F(7, 55) = 4.45$   $p < 0.01$ ), which suggests that the contrast between [n] and [nn] was significantly different among the age groups in Japanese and Finnish. The age factor is partly due to the longer absolute durations among younger children's productions because of their slower speech rate, but three-way interaction suggests that there is a difference between Japanese children and Finnish children in the nasal quantity contrasts.

Table 1 summarizes the production data in Japanese. It shows the mean absolute durations of [n], [nn], [ana] and [anna], and the average proportion of the nasal in each target word. The adults made the clearest distinction between [n] and [nn]; the mean durations were 65 ms. and 135 ms. respectively and the nasal portion consisted of 24.8% in [ana], and 37.6% in [anna] on average (see also Figure 1). Each subjects' mean absolute durations of [n] and [nn] were submitted to an ANOVA, in which Age (4 levels) served as a between-subjects factor and quantity contrasts (2 levels) as within-subject variables, and it yielded a statistically significant difference ( $F(3,25)=3.95$   $p < 0.05$ ). In the children's productions, [ana] had a larger nasal proportion and [anna] had a smaller nasal proportion compared to adults. For example, among the 3-year-olds, the mean absolute durations of [n] and [nn] were 102 ms. and 139 ms. respectively, and the nasal portion consisted of 28.7% in [ana], and 32.9% in [anna] on average. This means the distinction between [n] and [nn] was not as clear in Japanese children's productions as in Japanese adults' productions.

A paired *t*-test conducted on the absolute durations of [n] and [nn]

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with a falling pitch throughout the experiment, and I do not believe the pitch provided additional cues for the names to the children.

revealed that the durations of [nn] were significantly longer than those of [n] in all Japanese groups (3-year-olds,  $t(20) = 3.129$   $p < 0.005$ ; 4-year-olds,  $t(41) = 7.111$   $p < 0.001$ ; 5-year-olds,  $t(44) = 12.303$   $p < 0.001$ ). The duration of [anna] was also significantly longer than the duration of [ana]; (3-year-olds,  $t(20) = 3.084$   $p < 0.01$ ; 4-year-olds,  $t(41) = 6.485$   $p < 0.001$ ; 5-year-olds,  $t(44) = 9.921$   $p < 0.001$ ). This suggests that Japanese children are making systematic quantity distinctions in their productions, although the contrast is not as clear as in adult production.

Table 1 The production data: Japanese  
Average durations of [n], [nn], [ana] and [anna]. Standard deviations in parentheses.

	Nasal (ms.)	Whole word (ms.)	Proportion of the nasal in the word
Adults: [ana]	65 (17)	262 (51)	24.8%
Adults: [anna]	135 (24)	359 (57)	37.6%
5-year-olds: [ana]	101(32)	335 (52)	30.1%
5-year-olds: [anna]	161 (25)	438 (58)	36.8%
4-year-olds: [ana]	97 (24)	368 (59)	26.4%
4-year-olds: [anna]	149 (36)	449 (65)	33.2%
3-year-olds: [ana]	102 (40)	356 (68)	28.7%
3-year-olds: [anna]	139 (32)	422 (81)	32.9%

Figure 1 shows the average proportion of the nasal in each target word in the Japanese data. In the adult productions, the nasal portion consisted of 24.8% in [ana], and 37.6% in [anna] on average. The difference between the nasal portion in [ana] and [anna] was the smallest among the 3 year-olds, with the 4- and 5-year-olds in between.

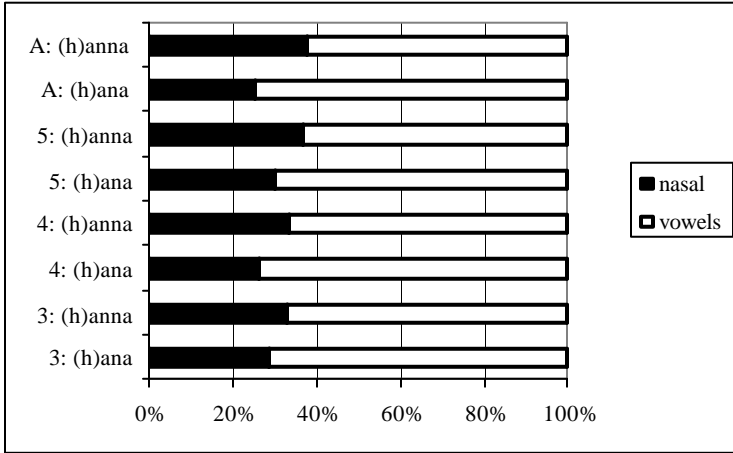


Figure 1 The proportion of the nasal in [ana] and [anna]: Japanese

Table 2 summarizes the production data in Finnish; it shows the mean absolute durations of [n], [nn], [ana] and [anna], and the average proportion of the nasal in each target word (see also Figure 2). The mean duration of [nn] was at least twice as long as that of [n] in every group (e.g., 150 ms. vs. 305 ms. among the 3-year-olds). The difference between [ana] and [anna] in terms of the proportion of the nasal was the largest among adults (23.8% in [ana], 49.3% in [anna]), but it was also clearly differentiated even in the youngest group (32.5% in [ana], 51.9% in [anna]). Each subjects' mean absolute durations of [n] and [nn] were submitted to an ANOVA, in which Age (4 levels) served as a between-subjects factor and quantity contrasts (2 levels) as within-subject variables, and it did not yield a statistically significant difference ( $F(3,30)=2.60$   $p > 0.05$ ). This suggests that single and geminate nasals were clearly differentiated from each other in all age groups in Finnish, although the adults made the clearest distinction between the two.

Table 2 The production data: Finnish

Average durations of [n], [nn], [ana] and [anna]. Standard deviations in parentheses.

	Nasal (ms.)	Whole word (ms.)	Proportion of the nasal in the word
Adults: [ana]	62 (12)	261 (42)	23.8%
Adults: [anna]	178 (30)	361 (39)	49.3%
5-year-olds: [ana]	122 (48)	389 (111)	31.4%
5-year-olds: [anna]	225 (54)	457 (100)	49.2%

4-year-olds: [ana]	100 (40)	365 (101)	27.4%
4-year-olds: [anna]	224 (69)	445 (123)	50.3%
3-year-olds: [ana]	150 (98)	461 (151)	32.5%
3-year-olds: [anna]	305 (103)	588 (205)	51.9%

Figure 2 shows the average proportion of the nasal in each target word in the Finnish data. In every group, the nasal portion consisted of about 50% in [anna]. Although the proportion of the nasal in [ana] varied from 27.4% (4-year-olds) to 32.5% (3-year-olds), the difference between [ana] and [anna] seems to be clearly distinguished in all Finnish groups in terms of their nasal proportion.

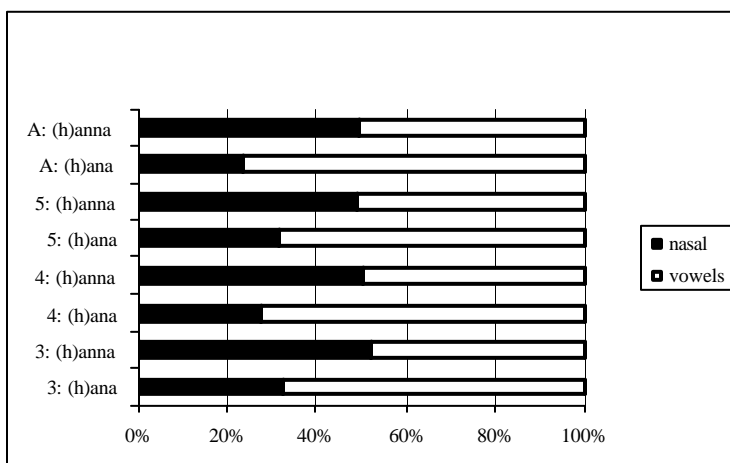


Figure 2 The proportion of the nasal in [ana] and [anna]: Finnish

Figure 3 shows the difference in production between Japanese and Finnish 3-year-olds. In Japanese 3-year-olds' productions, the proportion of the nasal in [ana] was 28.7%, and it was 32.9% in [anna] (the difference between the two was about 4%). In Finnish 3-year-olds' productions, the proportion of the nasal in [ana] was 32.5%, and it was 51.9% in [anna], and the difference in proportion was almost 20%.

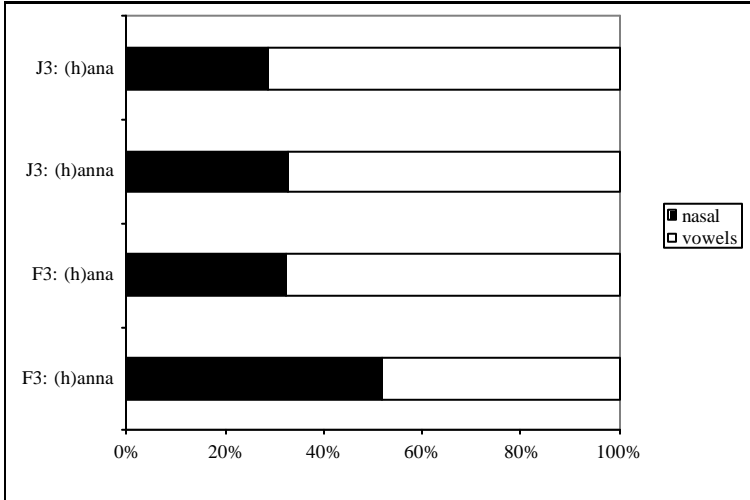


Figure 3 Comparison of the production data: Japanese and Finnish 3-year-olds  
2.2.2. Perception

Figure 4 shows the difference in perception between the two groups. Although the percentages of the matching responses were 100% among Japanese and Finnish adults, the percentages were much higher among the Finnish children as compared to the Japanese children. In Finnish, even 3-year-old children's responses matched the designated names 90% of the time. An ANOVA [Age (3 levels)\*Language (2 levels)] examining all the children's matching responses yielded significant main effects of language ( $F(1,44)=7.49$ ,  $p < 0.01$ ), but not age ( $F(2,43)=1.13$ ,  $p > 0.1$ ) nor a significant interaction of age and language ( $F(5,40)=0.44$ ,  $p > 0.5$ ). This suggests that the percentages of the matching responses did not differ among children in each language, but Finnish children's percentages were higher than Japanese children's percentages overall.



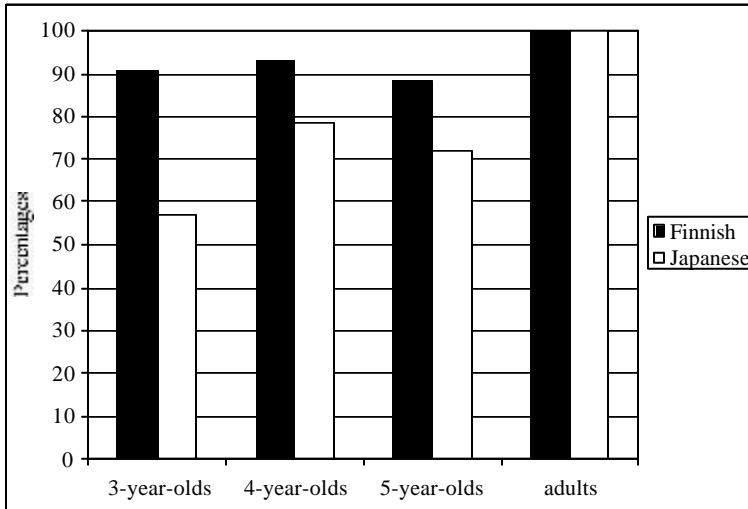


Figure 4 Comparison of the percentages of matching responses: the perception data

Table 3 shows the percentages of the responses matching the designated pictures in the perception task in Japanese. Adults' responses matched the designated picture 100% of the time. The percentage among the Japanese 3-year-olds (57.1%) was at chance-level both in this group ( $t(6) = 0.548, p > 0.1$ ) and in the larger sample ( $N = 16$ ) ( $t(15) = 1.099, p > 0.1$ ), while the 4-year-olds' responses were significantly better than chance ( $t(6) = 3.361, p < 0.01$ ). The percentage was lower among the 5 year-olds than the 4-year-olds, and in fact it was at chance level ( $t(7) = 1.825, p > 0.1$ ). I believe this was due to the size of the sample analyzed here; in the larger sample ( $N = 26$ ), it was significantly better than chance among the 5-year-olds ( $t(25) = 7.042, p < 0.001$ ) (for the larger sample, see Aoyama, 2000).

Table 3 The perception data: Japanese

	Number of subjects	Matching responses
Adults	7	100%
5-year-olds	8	71.9%
4-year-olds	7	78.6%
3-year-olds	7	57.1%

Table 4 shows the percentages of the responses matching the designated pictures in the perception task in Finnish. Adults' responses matched the designated picture 100% of the time. A paired t-test shows that responses in

all groups were better than chance (e.g., among 3 year-olds,  $t(7) = 5.612$ ,  $p < 0.001$ ).

Table 4 The perception data: Finnish

	Number of subjects	Matching responses
Adults	10	100%
5-year-olds	8	88.4%
4-year-olds	8	93.0%
3-year-olds	8	90.6%

### 2.3. Summary of experiment 1

The results from experiment 1 suggest that there is a considerable difference between Japanese and Finnish in the acquisition of quantity contrasts. In Japanese, differences among the age groups were found both in production and perception. The distinctions between [n] and [nn] were not clear in children's productions compared to those in adults' productions, and the percentage of the matching responses were lower among children compared to adults. The results suggest that quantity contrasts may not be clearly established among children at three years and that developmental changes are still occurring among children age three to five in Japanese. In Finnish, on the other hand, the results suggest that Finnish children as young as three clearly distinguish the contrast between single and geminate nasals, both in production and perception, although there are some differences between children and adults.

The results from experiment 1 were consistent with the previous studies. In Japanese, it has been reported that children at around two to four have some difficulty in perceiving and producing contrasts between a word containing a single consonant and a word containing a geminate consonant (e.g., Tamekawa et al. 1997, Ota 1999, see Aoyama 2001 Chapter 6 for a review). In Finnish, it has been reported that the contrast is mastered by children before or around the beginning of their third year (Argoff 1976, Dasinger 1997).

In summary, Finnish children from age three appeared to be distinguishing contrasts between single and geminate nasals both in production and perception. In Japanese, on the other hand, quantity contrasts do not yet seem to be clearly distinguished at three years of age.

### 3. Experiment 2: Production of nasal quantity contrasts: Adult Finnish and Japanese

The results from experiment 1 suggest that there is a considerable difference between Japanese and Finnish in the acquisition of quantity contrasts. Finnish children from age three clearly distinguish contrasts between single and geminate nasals both in production and perception, while developmental changes are still occurring among Japanese children between three and five.

The purpose of experiment 2 was to have a closer look at adult productions of these quantity contrasts in order to examine the phonetic nature of the target contrast in each language. For a better cross-linguistic comparison with Finnish adults, Japanese adults were asked not to add the ending *-chan* when producing the two names.

### 3.1. Method

The subjects of experiment 2 were ten adult Finnish speakers (mean age 27;8) and ten Japanese adult speakers (mean age 30;5). The procedures were kept consistent with experiment 1, except that Japanese subjects were specifically asked to say the names without *-chan* in this experiment. Data from adult Finnish subjects were the adult data in experiment 1. Japanese data were not used as adult data in experiment 1, since the target names were uttered without the ending *-chan* in this experiment. Japanese subjects are from various areas in Japan: Kantoo (4), Kinki (3), Chuubu (2), Kyuushuu (1). None of the subjects were from the areas where ‘syllable-dialects’ may be spoken (Jouo 1977). A total of 240 tokens of *hana* and *hanna* (six tokens each from 20 subjects) were analyzed using the programs Signalyze and Speech Analyzer.<sup>8</sup> Wide-band spectrograms were produced for each word, and the durations of each segment except [h] were measured in milliseconds.

### 3.2. Results

Table 5 shows the mean durations of the vowels and the medial nasal, as well as their proportion in each word. The quantity contrasts were clearly differentiated in adult productions in both languages; however, the distinction seems to be clearer in Finnish than in Japanese. Geminate nasals were very similar between the two languages in terms of the proportions (49.3% of [anna] in Finnish and 50.8% in Japanese on average).

The absolute durations of [nn] was not significantly different between the two languages (mean 172 ms. in Japanese, 178 ms. in Finnish,  $F(1,118) = 1.98$ ,  $p > 0.1$ ). However the durations of [n] were significantly shorter in Finnish than in Japanese (mean 62 ms. in Finnish and 68 ms. in Japanese) ( $F(1,118) = 7.57$ ,  $p < 0.01$ ) and the proportion of the nasal in [ana] was much smaller in Finnish (23.8%) than in Japanese (32.8%).

Table 5 The comparison of the vowels and the medial nasal in [ana] and [anna] in the adult productions

F: Finnish, J: Japanese. Standard deviation in parenthesis.

	Vowel 1	Vowel 1	Nasal	Nasal	Vowel 2	Vowel 2	Whole
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<sup>8</sup> Speech Analyzer is distributed by the Summer Institute of Linguistics, and is a speech analysis program for IBM-compatible computers with the Windows operating system.

	duration (ms.)	proportion	duration (ms.)	proportion	duration (ms.)	proportion	word (ms.)
F: [ana]	90 (17)	34.5%	62 (12)	23.8%	109 (30)	41.8%	261 (42)
J: [ana]	53 (14)	25.5%	68 (13)	32.8%	87 (27)	41.8%	208 (33)
F: [anna]	102 (14)	28.3%	178 (30)	49.3%	81 (23)	22.4%	361 (39)
J: [anna]	77 (21)	22.8%	172 (22)	50.8%	90 (20)	26.6%	338 (36)

Moreover in Finnish, it appears that differences in the duration of the vowels contribute to the distinction of the quantity of the medial consonant.<sup>9</sup> An ANOVA in which Language (2 levels) served as a between-subjects factor and Vowel 1-Vowel 2 contrast (2 levels) as within-subject variables, yielded a significant interaction of Language and Vowel 1-Vowel 2 contrasts in both [ana] ( $F(1, 118) = 8.48, p < 0.01$ ), and in [anna] ( $F(1, 118) = 57.94, p < 0.001$ ). This indicates that the vowel durations, as well as the durations of nasals, differed in [ana] and [anna] in Japanese and Finnish. In Finnish, the first vowel was significantly shorter than the second vowel in [ana] (vowel 1 = 90 ms., vowel 2 = 109 ms.,  $t(59) = 4.582, p < 0.001$ ), but it was *longer* than the second vowel in [anna] (vowel 1 = 102 ms., vowel 2 = 81 ms.,  $t(59) = 6.654, p < 0.001$ ). In Japanese, on the other hand, the second vowel was longer *both* in [ana] (vowel 1 = 53 ms., vowel 2 = 87 ms.) and in [anna] (vowel 1 = 77 ms., vowel 2 = 90 ms.). Thus in Finnish, relatively short vowel duration following a medial consonant indicates that the preceding consonant was a geminate. The relative vowel durations may serve as a secondary cue in Finnish, but probably not in Japanese, because the vowel after singleton and geminates are both longer than the vowel preceding them (see also Figure 5).

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<sup>9</sup> Richardson (1998) emphasizes the importance of adjacent vowel duration as a secondary cue in Finnish.

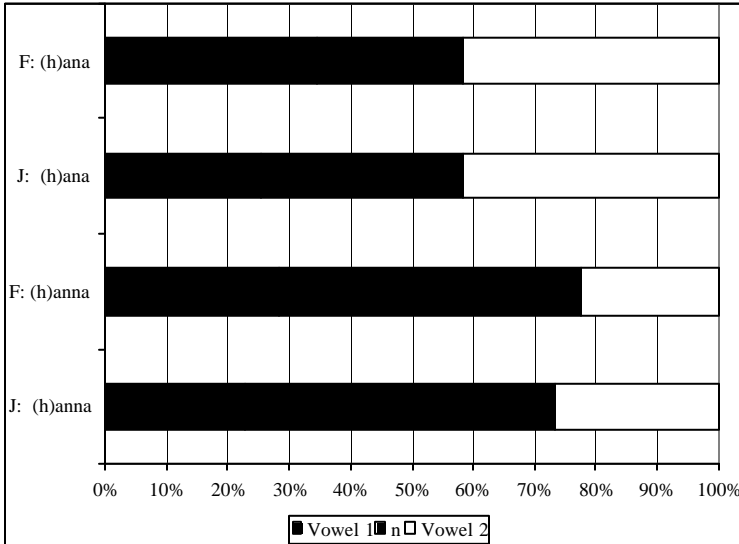


Figure 5 Comparison by proportion of segments: Experiment 3

It is worth noting that the proportion of the nasal in [ana] and [anna] in the Japanese data in experiment 3 (32.8% vs. 50.8%) is different from the adult data in experiment 1 (24.8% vs. 37.6%). This was probably due to the fact that all utterances were followed by *-chan* in experiment 1, but not in experiment 2. It is important, however, that the durational difference between single and geminate nasals in Japanese was not as big as in Finnish in both experiments 1 and 2.

Table 6 and Figure 6 show the frequency distribution of *(h)ana* and *(h)anna* tokens by the nasal proportion. First, the proportion of the nasal was calculated in each token of *(h)ana* and *(h)anna*. Then the distribution of the *(h)ana* and *(h)anna* tokens were plotted according to their proportion of the nasal. For example, 26 tokens of *(h)ana* tokens had 20-24% of nasal proportion, and 6 tokens of *(h)anna* had 35-39% of nasal proportion in Finnish. This analysis also reveals that the quantity distinctions were clearer in Finnish than in Japanese. In Finnish, there were 13 tokens of [ana] whose medial nasal consisted of less than 20% of the whole word, while in Japanese there was no token of [ana] which had that small a nasal proportion. Eighteen tokens of [ana] had about 35-39% of nasal proportion, while in the Finnish data, only one token had such a large nasal proportion in [ana]. The overlap between the two was also much larger in Japanese than in Finnish; there were 23 tokens of [ana] and 11 tokens of [anna] that had about 35-44% of nasal proportion in Japanese.

Table 6 The frequency distribution of (h)ana and (h)anna tokens by their nasal proportion in Finnish and Japanese

**Finnish**

% of the nasal	11-1	16-1	20-2	25-2	30-3	35-3	40-4	45-4	50-5	55-5	60-6	65-
(h)ana	2	11	26	14	6	1	0	0	0	0	0	0
(h)anna	0	0	0	0	0	6	9	16	19	7	3	0

**Japanese**

% of the nasal	11-1	16-1	20-2	25-2	30-3	35-3	40-4	45-4	50-5	55-5	60-6	65-
(h)ana	0	0	8	10	17	18	5	0	2	0	0	0
(h)anna	0	0	0	0	0	2	9	17	17	10	5	0

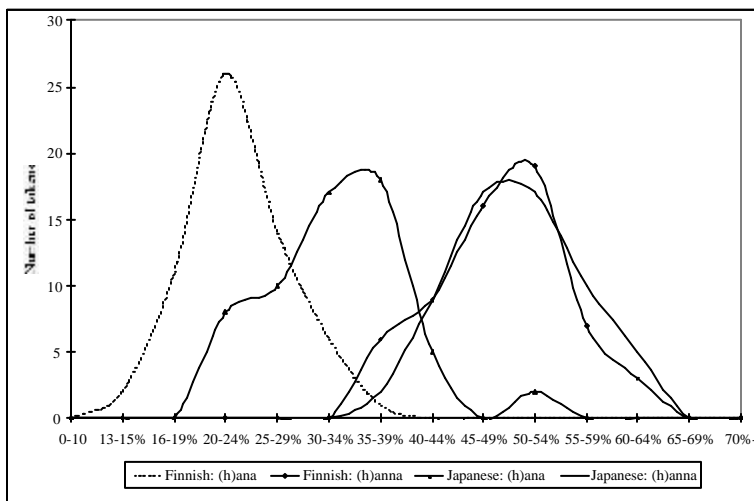


Figure 6 The distribution of tokens by the nasal proportion: Experiment 2

In summary, single and geminate nasals seem to be more clearly distinguished from each other in Finnish than in Japanese in adult production. Analyses of their absolute durations as well as the proportion of the nasal in the whole word revealed the difference between the two categories to be larger in Finnish. Moreover in Finnish, but not in Japanese, vowel durations seem to be contributing to the quantity contrast of the medial consonant as well.

**4. Summary and conclusion**

A striking difference was found between Japanese and Finnish in how

quantity contrasts are acquired; Finnish children are mastering the nasal quantity contrast by age three, while such contrasts may not be clearly established among Japanese children at the same age. It is worth noting that in Finnish, *hana* is an existing word which means a ‘water faucet’, and *Hanna* is also a fairly common name. In Japanese, on the other hand, *Hanna* is a potential foreign name that young children may not have heard before. Although this difference suggests that Finnish children may have had some advantage in the experimental tasks, I believe that the differences found between the two groups are more fundamental. There is some evidence that Japanese children around age three and four have some difficulties distinguishing between short and long segments, while Finnish children are able to use suffixes involving the quantity contrasts productively by age two (see Aoyama 2001 for a review). I suggest that the difference in acquisition originates from differences in adult production; there are fine differences in how the quantity distinction is phonetically realized in the two languages as pinpointed in experiment 2. Finnish children are acquiring the distinction earlier than Japanese peers because in adult production in the input they are given clearer distinctions in the target contrast with an additional cue in vowel length.

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