Original Article

The Features of Japanese Kana Spelling in Deaf Children: Developmental and Related Psychological Factors

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The purpose of this study was to clarify the developmental change of accuracy in word spelling and related factors in deaf children. We conducted a word spelling test which included syllables with *dakuten* or special Japanese syllables with involving seventy deaf children aged 6 to 12 years. The participants' schools mainly used the auditory-oral method in daily communications. The results indicate that word spelling accuracy improved with participants' development, especially from 6–8 to 9–10 year-olds. Multiple-regression analysis of factors affecting the accuracy of spelling revealed that higher speech intelligibility and reading ability of the participants related to higher accuracy of word spelling.

Key Words: deaf children, speech intelligibility, reading ability, spelling accuracy, Japanese special syllable

Introduction

In order to provide better instruction for deaf students learning to read and write Japanese, many studies have been dedicated to clarifying the features of their vocabulary. These studies have indicated that their vocabulary is limited in total size, they have difficulty using appropriate words according to different contexts, and that large individual differences exist. It is also known that the syntactic ability of deaf children is poorer compared to hearing peers.

Due to these limitations, deaf children have difficulty in learning new words and sentences, especially those with abstract meanings and complex sentence structure (Itabashi & Hosoda, 1989; Ito, 1970; Seki, Kusanagi, & Tsuzuki, 1982; Seki, Tsuzuki, & Matsumoto, 1982; Tsukada, 1968; Yokkaichi, Saito, & Tan, 1995).

On the other hand, deaf students' spelling accuracy has been investigated in various ways. For example, Hanson, Shankweiler, and Fischer (1983) examined how deaf college students spell words using a test including 45 target words. In this test, 27 deaf partici-

pants were required to fill in the blanks in a sentence by guessing the target words from the context. The result showed that 11 participants made more than 15 misspellings which consisted mainly of omission of a consonant. Even the college-level deaf students made more misspellings than their hearing peers. Leybaert and Alegria (1995) examined the accuracy of word spelling in hearing and deaf children in French-speaking countries. Pictures and/or sentences that indicate meanings of target words were presented to participants along with the first letter of each target word, and they were asked to write the words with correct spelling. The results revealed that the scores of 10-year-old deaf children were lower than 7-year-old hearing children. In addition, deaf children could not spell words accurately even though they knew their meaning or usage.

In other research, studies on spellings of the words presented by pictures showed that deaf children aged 7 to 15 made more misspellings than hearing peers (Burden & Campbell, 1994; Harris & Moreno, 2004; Sutcliffe, Dowker, & Campbell, 1999). Deaf children also made more non-phonetic misspellings (e.g., "giffare" as "giraffe") than hearing children. From these findings, we deduced that deaf children have difficulties in spelling words due to their limited hearing. By a study on deaf children aged 8 to 16, Penny (2006) clarified different types of features in spelling among deaf children depend-

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Received October 18, 2012, Accepted January 7, 2014

ing on their hearing levels and daily communication modes. Other investigations using the same method indicated that spelling is related to speech intelligibility (Harris & Beech, 1998), reading ability (Harris & Moreno, 2004), and communication mode (Leybaert & Alegria, 1995).

Although there are some studies on the spelling of deaf students, only a few were found in Japan. Ito (1970) examined the accuracy of spelling in elementary school students with and without hearing impairment. The results indicated that hearing children tended to improve spelling accuracy with age, but deaf children continued to make a certain amount of misspellings even at an older age. Many word spellings by deaf children were so severely deformed that researchers couldn't guess the original words (misspell the word “てぶくろ/te-bu-ku-ro/(glove)” as (てぶろん/te-bu-ro-n/) or (てふく/te-fu-ku/)). Agatsuma (1985) examined the accuracy of spelling of hearing and deaf elementary children. The results showed that deaf children made more misspellings compared to hearing children, and from the analysis of misspelling in deaf children, many *dakuten*¹⁾ errors and Japanese special syllable²⁾ errors were found. Furthermore, Agatsuma (1991) examined the spelling accuracy of 6- to 12-year-old children in deaf schools. The words used in the test were familiar to 6-year-old hearing children. Even in fifth or sixth graders, the ratio of correct answers was 80% at most. Therefore, he suggested that deaf children could not spell words accurately even though they knew the meaning/usage of the word. Error analysis revealed that consonant errors reached 80%, in which syllables with *dakuten* and syllables with a different sound but same mouth shape were included. No significant relation between hearing level and accuracy of spelling was found in this study. Motegi, Sawa, and Yokkaichi (2012) investigated the development of word spelling based on compositions written by children in elementary schools for the deaf. *Dakuten* errors were most frequent among the total errors at all developmental levels, while the Japanese special syllable errors decreased with progress of the school grade. However, there were limitations in the study where they investigated the features of words in composition. The words written in composition are limited within its theme. Furthermore, since it was not restricted only to Kana letters but subjects were allowed to use Kanji as well, it was difficult to specif-

ically examine their Kana spelling. In Addition, they could not discuss the related psychological factors behind accurate Kana letter spelling.

In the present study, we prepared the spelling test to examine the developmental change in accuracy of kana spelling and its related psychological factors such as hearing level, speech intelligibility, and reading ability. Moreover, the method enables us to discuss correct rates by word as well as by special syllable.

In study 1, we examined the developmental change in accuracy of spelling syllables with *dakuten* and its related psychological factors in deaf school children.

In study 2, we examined the developmental change in accuracy of Japanese special syllables in both deaf school children and hearing peers, and discuss psychological factors related to accurate word spelling.

Study 1: Features of *dakuten* Spelling in Deaf Children and Related Psychological Factors

Purpose

The study was intended to investigate the features of *dakuten* spelling in deaf children and the development of its accuracy. Psychological factors relating to the accuracy of spelling were also analyzed.

Method

Participants

The participants were 69 deaf children in a school for the deaf, where the auditory-oral method was used in communication. The number of children in 1st to 6th grade was 11, 10, 13, 11, 12, and 12, respectively. Demographic information, hearing level, speech intelligibility, and reading test scores are shown in Table 1. These data were assessed in their school. Scores of speech intelligibility were the percentages of intelligible pronunciation evaluated by 5 hearing persons on 100 Japanese syllables pronounced by deaf participants.

Table 1 Profiles of Deaf Participants: Study 1

	Mean (SD)	Range
Pure tone average (dB)	100 (12)	65–125
Speech intelligibility (%)	48 (24)	5–85
Reading score*	55 (12)	29–81

* “Reading-Test” ©Toshobunka

Fig. 1 Example of Dakuten Spelling Task

Dakuten Test

Word selection. Sixty target words with *dakuten* spellings were selected from the National Language Research Institute (1989) and Fukuzawa, Ootsuki, Tsuchiya, and Kyouiku-Shuppan (1985), which contain more than 1,000 such words. Fifty percent of hearing first graders knew these 60 target words.

Procedure

Pictures of 60 target words and letters consisted in each word are presented to participants without the *dakuten* mark (゛) necessary in correct spelling (Fig. 1). Participants were instructed to put a *dakuten* mark on the appropriate letter of the test word. We also checked if they understood the meaning of the target word. When a participant didn't know the presented word items, s/he checked the mark "unknown" on the test item, and wasn't required to answer. Participants were asked to answer two sample items before beginning the test, thus confirming they understood how to answer. The percentage of unknown words was less than one percent, and was excluded from further analyses.

Results and Discussion

Accuracy of dakuten Spelling and its Developmental Change

To clarify precise features of *dakuten* spelling and its developmental changes, the participants were divided into three groups by age: lower (1st and 2nd grades), middle (3rd and 4th), and upper (5th and 6th) groups. The average percentage of correct answers in each grade group was 75% ($SD=17$), 88% ($SD=8$), and 88% ($SD=8$), respectively (Fig. 2). According to one-way ANOVA and Scheffe's test, the main effect of the grade group was significant, and differences between the lower and the middle grade groups, and the lower and the higher grade groups were significant ($F(2, 66)=7.29$, $MSe=0.05$, $p<.05$). Therefore, the accuracy of *dakuten* spelling in deaf children was thought to develop between the transition from lower to the middle grade level. However, the average score of the higher grade group was less

Fig. 2 Mean Average Score of Dakuten Spelling Test in Each Group (Deaf)

*: $p<.05$

than 90%, even though the target words were well known by first grader hearing children. As suggested in previous research, these results indicate that *dakuten* spelling is difficult for deaf children at the elementary school level (Agatsuma, 1991; Motegi et al., 2012).

We divided 60 target words into 4 groups based on the patterns of correct answers. The first group was named "consistently high," as the 43 words gained scores of over 80% accuracy in all grades. The words in this group were frequently used in daily conversation (e.g., "ありがとう/a-ri-ga-to/(thank you)" and "ともだち/to-mo-da-chi/(friends)"), and many of these words only included one *dakuten* letter.

The second group was named "developmental improvement." As for this word group, the lower grades achieved less than 80%, but the middle and upper grades gained approximately 100%. Fixed error patterns were found in some words in this group (e.g., "ふた/pu-ta/" as "ふた/bu-ta/(pig)," "かぎ/ga-ki/" as "かぎ/ka-gi/(key)").

The third group was the "low scores with a slight developmental improvement" group. The correct score of the lower grades was less than 60%, but the middle and upper grades achieved approximately 70%. The words in this group contained more than two *dakuten* letters in a word (e.g., "ふでばこ/fu-de-ba-ko/(pen case)").

The fourth group of 7 words is the "consistently low scores" group (every grade scored less than 60% correct). This group included the words with Japanese special syllable and the words with more than two *dakuten* letters in a word (e.g., "ベッド/be-ddo/(bed)," "ぶどう/bu-do/(grape)"). In short, it may be assumed that the factors such as familiarity of the word, the number of *dakuten* letters within a

word, and mixing of more than one *dakuten* letter and Japanese special syllable in a word makes spelling acquisition more difficult for deaf children.

Psychological Factors Related to Dakuten Spelling Accuracy

To analyze psychological factors relating to *dakuten* spelling in deaf children, stepwise multiple linear regression analysis was used. In this analysis, the score of the spelling test was the dependent variable, while psychological factors, such as hearing level, speech intelligibility, and standardized reading ability score, were independent variables. The grade of participants was the controlled variable. The criterion of the selected model was a VIF score less than 2. According to the beta score, speech intelligibility ($\beta=.43$, $p<.05$) and reading score ($\beta=.41$, $p<.05$) had significant and positive influence on the accuracy of *dakuten* spelling ($R^2=.58$). No significant relation between hearing level and the accuracy of spelling was found as with the results of Agatsuma (1991). Hearing level itself was not a key factor to spelling words accurately in children with severe hearing impairment such as the participants in this study. We found in this study that positive relations between spelling correctness and speech intelligibility, reading score. Harris and Beech (1998) indicated also that deaf children with higher speech intelligibility can read and write words precisely. As the speech intelligibility test used in Japan evaluate the clarity of each syllable pronunciation, the score of the test indicated the ability to pronounce every syllable with intelligibility. Deaf children with higher speech intelligibility may use their differentiated pronunciation effectively as cues to spell the words containing voiced and unvoiced sounds. Furthermore, the results of *dakuten* test showed that the ratio of correct answers was affected by the reading abilities. Furthermore, as the score of *dakuten* test was related to that of reading ability, reading may also contribute to accurate spelling. In addition, we found some participants who could spell *dakuten* accurately in spite of their poor pronunciation skill, which suggests that clear pronunciation would not be indispensable to spell words with *dakuten* correctly. The ability to spell words with *dakuten* in deaf children could be acquired through conscious everyday effort to spell and read every word accurately.

Study 2: Features of Spelling Japanese Special Syllables and Related Psychological Factors

Purpose

Spelling of Japanese special syllables in a word, such as soku-on, hatsu-on, you-on, and chou-on is difficult for both hearing and deaf children. The study investigated the developmental features of spelling these special syllables in deaf children compared to hearing peers, and discuss the effect of psychological factors affecting the accuracy of spelling these syllables.

Method

Participants

Deaf children. Sixty-eight deaf children in a school for the deaf participated in the research. The number of children in the 1st to 6th grades was 12, 10, 11, 12, 13, and 10, respectively. The auditory-oral method was used for daily communication in their school. Hearing level, speech intelligibility score, and the scores of the reading ability test were provided by the school of the participants (Table 3).

Hearing children. Eighty-seven hearing children in regular elementary school participated in the study; 39 children were 1st graders and 48 were 2nd graders.

Japanese special syllables test. Test words. The target 54 words were selected from the National Language Research Institute (1989) and Fukuzawa et al.

Table 2 Mean Average Score of Dakuten Spelling Test in Each Grade (Deaf)

Grade	Mean (SD)		Range
1st	71 (17)	75 (17)	38–95
2nd	80 (16)		52–95
3rd	87 (8)	88 (8)	70–95
4th	88 (9)		68–98
5th	90 (7)	88 (8)	78–100
6th	87 (9)		62–97

Table 3 Profiles of Deaf Participants: Study 2

	Mean (SD)	Range
Pure tone average (dB)	101 (12)	68–128
Speech intelligibility (%)	45 (21)	6–94
Reading score*	50 (11)	41–75

* “Reading-Test” ©Toshobunka

Fig. 3 Example of Japanese Special Syllables Spelling

(1985). These 54 target words were selected from about 1,000 words containing Japanese special syllables (chou-on, soku-on, hatsu-on, you-on), and the words were known by more than 50% of hearing first graders.

Procedure

Pictures and the first letters of target words were presented to participants (Fig. 3). Each participant was instructed to fill the blank of these words using “kana” (Japanese syllabic letter). When a participant didn’t know the presented word items, s/he checked the mark “unknown” on the test item, and wasn’t required to answer. Participants tried two sample test items before answering the test items. The percentage of unknown words was less than one percent, and was excluded from further analyses.

Results and Discussion

Accuracy of Spelling Japanese Special Syllables and its Development

The average percentages of correct answers of 1st and 2nd grade hearing children are shown in Fig. 4. The first graders’ score was 80%, and that of the second graders was 95%. The difference between these grades was significant ($t(85)=5.06, p<.05$), and the result is nearly the same as shown by Amano (1986) for hearing children and by Agatsuma (1985) concerning deaf children.

In order to clarify the developmental change of spelling in deaf children, we divided them into three groups by grades; lower (1st and 2nd graders), middle (3rd and 4th graders), and upper (5th and 6th graders). The average correct answer score of each group was 87%, 93%, and 96%, respectively (Fig. 4). According to one-way ANOVA and Scheffé’s test, main effect of grade level was significant and significant differences were found between the lower and middle grade groups, and the lower and the upper grade groups ($F(2, 65)=6.04, MSe=0.06, p<.05$). Therefore, the accuracy of spelling Japanese spe-

Fig. 4 Mean Average Score of Special Syllables Spelling Test in Each Group (Deaf and Hearing)

*: $p<.05$

Table 4 Mean Average Score of Special Syllabic Spelling Test in Each Grade (Deaf)

Grade	Mean (SD)		Range
1st	86 (13)	87 (13)	51–96
2nd	89 (13)		60–100
3rd	95 (7)	93 (12)	77–100
4th	91 (15)		52–100
5th	97 (5)	96 (5)	80–100
6th	96 (4)		87–98

Table 5 Mean Average Score of Each Japanese Special Syllables in Each Grade of Deaf and Hearing Children

Hearing Status	Grade	Cho-on	Soku-on	Hatsu-on	Yo-on
Deaf	Lower	84	89	89	89
	Middle	93	91	93	94
	Upper	95	95	96	96
Hearing	1st	80	76	91	90
	2nd	93	93	98	96

cial syllables improved from lower grades to middle grades, and this finding agrees with previous research (Motegi et al., 2012). In deaf children, the accuracy of spelling special syllables seemed to be delayed one or two years compared to hearing peers.

Differences in accuracy among special syllables are shown in Table 5. The data were analyzed using two-way ANOVA based on two factors: “grades” (lower, middle, upper) and “special syllables” (chou-on, soku-on, hatsu-on, you-on). The interaction of the two factors was significant ($F(6, 195)=2.83, MSe=0.02, p<.05$), and Scheffé’s multiple post comparison test revealed significant differences in lower grades, that is, the accuracy of chou-on was lower

than other special syllables.

Psychological Factors Affecting the Accuracy of Spelling Japanese Special Syllables

Japanese syllabic spelling (kana) usually corresponds to one syllable, but special syllables require specific rules of spelling. Therefore, first graders have difficulty in acquiring the spelling of special syllables regardless of their hearing level (Amano, 1986; Ito, 1970). In order to analyze the psychological factors related to spelling Japanese special syllables in deaf children, a stepwise method of multiple linear regression was used. The spelling test score was the dependent variable, while hearing level, speech intelligibility, and the reading scores of participants were independent variables. The grade of participants was used as a control variable. A VIF score of less than 2 was used as a model selection criterion.

The results revealed that speech intelligibility ($\beta=.44, p<.05$) and reading ability ($\beta=.44, p<.05$) had a significant positive influence on the accuracy of spelling of Japanese special syllables ($R^2=.59$). As for the effect of speech intelligibility, Harris and Beech (1998), Harries and Moreno (2004) also suggested its importance in acquiring reading and writing of words. On the other hand, average hearing level didn't show a clear relationship to the accuracy of word spelling as Agatsuma (1991) suggested.

As discussed in Study 1, accurate pronunciation provided important cues in acquiring proper spelling of syllables with *dakuten*, and the same relation was found in special syllable spelling. In study 1, we found accurate pronunciation would provide strong cues in acquiring proper spelling of syllables with *dakuten*. As for the writing of special syllables, we also found the same results indicating the contribution of clear pronunciation and reading ability to acquire correct spelling.

General Discussion

Acquisition of Correct Word Spelling and its Developmental Changes

The present study clarified the features of spelling acquisition of *dakuten* and Japanese special syllables in elementary age deaf group. The accuracy of spelling improved from lower to middle grades in deaf children. The accuracy in *dakuten* spelling in the deaf group was, however, delayed compared to hearing

peers. The causes for this difference were the difficulty for deaf children to distinguish a pair of similar sounds, the one voiced and the other voiceless, having the same mouth shapes in pronouncing them. For example, in pronouncing the kana letter [か]/ka/ and [か*]/ga/ the mouth shape is identical, so it would be difficult for deaf children to distinguish them only through auditory cues of voiced or voiceless sounds. For children with hearing impairment, differentiation between stops as voiced and voiceless consonants is difficult because of the difficulty to utilize frequency property (Benett & Ling, 1973).

Researches in French and English (Leybaert & Alegria, 1995; Padden, 1993) also indicated that in addition, children with hearing impairment in elementary school made misspellings especially by mistaking t for d and vice versa and f for v and vice versa. Those consonant pairs are pronounced with similar mouth shape or similar acoustic information.

As for the deaf children's spelling acquisition of Japanese special syllables, while a slight delay was found in lower grades compared to hearing peers, they attained the same level as hearing peers in the 3rd or 4th grade. "Chou-on" is characterized by prolonged vowel sound and suspended mouth shape, and "Soku-on" is characterized by a silent pause between a vowel and succeeding consonant. Prolonged vowel, auditory silent pause, and temporally fixed mouth-shape are effective auditory and visual cues for deaf children to distinguish, in comparison with the *dakuten* discrimination in which only auditory short cues are required.

Psychological Factors Related to the Acquisition of Accurate Word Spelling

For the psychological factors relating to the accuracy of spelling *dakuten* and Japanese special syllables, speech intelligibility and reading scores had significant influence, although hearing level did not have an apparent influence. However, as the hearing level of most subjects in the present study was rated severe to profound deafness, multiple regression analysis may reject the hearing factors. We have to analyze this factor further based on participants including slight to moderate hearing loss.

Higher speech intelligibility is thought to help deaf children to spell words accurately. However in this study, we found several children who obtained higher scores in spelling test but lower score in pronuncia-

tion. As Saito (1979) suggested, phonological awareness might be the base of accurate kana spelling in deaf children, so the clarity of pronunciation itself is not a key factor to acquiring correct spelling. If deaf children are aware of the phonological difference in those syllables, they can use their phonological awareness as cues to spell words accurately. Even if poor pronunciation does not contribute sufficiently to their accurate kana spelling, it is still possible for them to learn to spell words accurately through daily experience of reading and spelling. Development of phonological awareness is important for acquisition of Japanese special syllables for both hearing and deaf children (Amano, 1970; Saito, 1978, 1979). While hearing children acquire phonological awareness through hearing in communication, deaf children with profound speech intelligibility do learn it through everyday practices of precise reading and writing as well as hearing in communication with effective visual cues.

Endnotes

- 1) A voiced-sound-mark “゛” put on the upper right corner of the letter.
- 2) The Japanese special syllables that require special syllabic spelling are as follows: hatsu-on (nasal sound), expressed with Japanese letter “ん”), soku-on (a silent mora between 2 adjacent moras. double consonants, expressed with Japanese letter “っ”), you-on (contracted sounds; a syllabic sound created by palatalization, a syllable noted with two kana characters), and chou-on (long vowel, a syllable with a prolonged vowel or another related sound).

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