The Effects of Phonological Representation on Japanese Sixth-Grade Students' Recognition of English Words

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日本人小学 6 年生の英単語認知における音韻表象の効果

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本研究の目的は，英単語の音韻表象・正書法表象が，日本人小学生の英単語の意味理解にどのように影響するかを検証することである。実験参加者は，POGとOPGの 2 つの群に分かれ，それぞれの処遇を受けた。POGは，英単語の音韻情報のみを先に学習した後，文字情報を学習する群，OPGは，英単語の文字情報のみを先に学習した後で音韻情報を学習する群であった。処遇後の文字読み取りテストの結果から，日本人小学 6 年生が英単語の文字から意味を読み取ろうとするとき，英単語の音韻表象を利用している可能性のあることが明らかになった。本稿では，音韻表象と正書法表象が英単語文字の意味理解に与える影響について考察する。

キーワード：文字認識，音韻表象，正書法表象，日本人小学生

1. Introduction

Learning vocabulary entails learning linguistic forms of words, meanings of words, and usages of words (Nation, 2001[(1)]). The linguistic forms contain phonological information and orthographic information. When learners confront unknown words, both written and spoken, they endeavor to memorize the linguistic forms of the words including phonological information and orthographic information, as well as the meanings of the words. That is to say, learning unknown words means assembling the representations of phonological, orthographic, and semantic information in memory (Barron, 1986[(2)]).

With respect to visual word recognition, a good deal of research in first language (Barron, 1986[(2)]; Frith, 1985[(3)]) has been conducted. The research revealed that there are two routes to coordinate the orthographic representation with the semantic representation when we read a printed word and understand its meaning (Barron, 1986[(2)]; Samuels, 1994[(4)]; Samuelson, Gustafson, & Rönnberg, 1996[(5)]). Barron (1986)[(2)] states that the two routes to access semantic representation are direct access and indirect access. As for direct access, he argued that readers link the orthographic representation of a word to semantic representation in order to apprehend the meaning of the printed word directly. Learners notice the orthographic information and coordinate it directly with the orthographic representation in their memories. With regard to indirect access, for the purpose of constituting the phonological representation, learners need knowledge of sound-letter correspondence rules. The key to changing orthographic information into phonological representation depends on the ability to correspond the letters with their sounds. In this route, printed words are decoded by way of phonological representation. Barron (1986)[(2)] claimed that phonological information is used so as to access the semantic representation of the word to decode its orthographic information. For example, learners have to make the phonological representation out of orthographic information in indirect access first, based on letter-sound correspondence rules. After that, they look for the same phonological

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representation which already exists in their memory and check the phonological representation which they had made against that which has already been acquired. In sum, with a view to comprehending printed words, learners reconcile orthographic information with the meaning directly through the process of direct access, whereas they do this by utilizing phonological information when the access is indirect. However, no children can use both of these two decoding strategies simultaneously from the beginning. It is considered that the use of decoding strategies is developed step by step. Accordingly, the stage models for children's early reading development are devised grounded on the decoding strategy use.

There are two models for the development of orthographic decoding. Frith (1985)[3] proposed three phases of the reading acquisition process in a first language: a logographic phase, an alphabetic phase, and an orthographic phase. First, at the logographic phase, children regard printed words as salient graphic features. Children in this phase look upon the printed word as something like a shape when they confront it. Secondly, at the alphabetic phase, children consider the printed word as a string of letters. They use knowledge of letter-sound correspondence rules and phonological representation of words in order to acquire word meaning. At this phase, children make up the phonological representation of the printed word by utilizing letter-sound knowledge and matching the phonological representation with the meaning. At the third phase, the orthographic phase, children think of a printed word as a string of letters; however, they do not need its phonological representation in order to understand the meaning. At this phase, they can apprehend the printed word through direct access. Similar developmental stages were proposed by Høien and Lundberg (1988)[6], too. They[6] claimed that there are four stages for word decoding development: pseudo-reading, logographic-visual, alphabetic-phonemic and orthographic-morphemic. According to Frith (1985)[3] and Høien and Lundberg (1988)[6], the orthographic decoding strategy gradually shifted toward a more direct decoding strategy in reading development. Readers in the orthographic phase can manipulate both orthographic decoding and phonological decoding skills with complete control (Frith, 1985[3]; Høien & Lundberg, 1988[6]; Samuelson, Gustafson, & Rönnberg, 1996[5]). Beginners, who do not know letter-sound correspondence rules, are apt to have a look at a part or whole of the orthography of a word as a shape, resulting in their inability to make a phonological representation. On the other hand, learners who know letter-sound correspondence rules can assemble a phonological representation and use the direct and the indirect access routes. As for Japanese sixth-grade students, it is possible to consider that they are either in an alphabetic phase or at an alphabetic-phonemic stage and are able to use the direct and indirect access routes because they have already paid attention to the phonemes of the English alphabets and learned letter-sound correspondence rules of Romanized Japanese (Romaji) in Japanese classes. Although these rules differ slightly from the English rules, some of the letters have the similar sounds in the Romanized Japanese system. Consequently, on the whole, it seems that Japanese sixth graders can employ the two access routes with a phonological awareness of English words.

It should be noted here that phonological awareness is an important aspect of English printed word decoding. Phonological awareness is sensitivity toward the sound structures of vocabulary, and a good predictor of second language reading ability (e.g., Lesaux & Siegel, 2003[7]; Anthony & Lonigan, 2004[8]; Hu & Schuele, 2005[9]; Hu, 2008[10]; Ricketts, Bishop, & Nation, 2009[11]). Phonological awareness is measured by tests, such as rhyme matching tests, phoneme segmentation tests, phoneme blending tests, etc. Hu and Schuele (2005)[9] proposed that phonological awareness of one's native language had an influence on the acquisition of new words in a nonnative language. They demonstrated that Chinese-speaking third-grade elementary school students who had a poor phonological awareness of the sound structures of their native language were found to be poorer learners of nonnative words than the students who had a rich phonological awareness. Anthony and Lonigan (2004)[8] argue that young preschool children are less able to pay proper attention to smaller phonological linguistic units, whereas older preschool children can attend to both larger and smaller linguistic units. It seems that sixth

graders in Japanese elementary schools are mature learners with respect to phonological awareness because they learn the letter-sound correspondence rules of Romanized Japanese before they become sixth graders. In addition, they have paid attention to smaller linguistic units of romanized Japanese words. Furthermore, they have already segmented the words into phonemes in the classes of the Japanese language. Hence, the sixth graders may be able to extract phonemes.

There is some empirical research on English vocabulary learning in order to observe Japanese elementary school students' visual word recognition (e.g., Hatae, 2004[12]; Hotta, 2008[13]; Miyasone, 2009[14]). Hatae (2004)[12] explored Japanese elementary school students' visual word recognition. The experiments were executed in 2002 and 2003. The participants were 42 students in 2002 and 35 students in 2003. In each year, the participants were separated into two groups: lower graders and upper graders. The lower-grade group was composed of six-to-nine year-old students, while the upper-grade group consisted of 10-12 year-old students. The instructor told the students to repeat a selection of words after her in English looking at the picture cards in which the orthographic information was written. She did not tell them to read the orthographic information of target words. After the treatment, the participants were asked to read the printed words aloud in the posttest. The result showed that the upper-grade group performed statistically better in the word reading test in both years. Hatae concluded that the learners could read the printed words if the phonological information and the orthographic information were given simultaneously through flash cards, and that the upper graders performed particularly well. This study showed that elementary school students can read printed English words if phonological and orthographic information are provided. However, this study raises two challenges with regard to revealing the effects of phonological representation on reading comprehension. First, in this study, it was difficult to reveal the effects of phonological representation on the orthographic information decoding because the participants were simply requested to read the printed words, not to say the meanings of the words. Secondly, all of the participants were given phonological information at the same time during the treatment. It is not clear that the children made use of the phonological information only in order to decode the orthographic information, because they could have utilized either/both of the two access routes: the direct access and the indirect access in order to access the semantic representation.

Miyasone (2009)[14] investigated the effects of phonics training on reading comprehension. The participants were 20 Japanese elementary school students (Grade 3 to Grade 6) who learned English at an English conversation school. They were divided into two groups: Group A and Group B. Group A consisted of 13 students who had learned English for one or two years, whereas Group B was composed of seven children who had learned for over three years. Each group included sixth-grade participants. The students in both groups were instructed in phonics. The students were asked to learn letter-sound correspondence rules in English alphabets. Group A was given three kinds of correspondence rules, while Group B was presented with another rule. After the instruction, the participants were asked to say the meaning of five English written words. The results revealed that there was no significant difference between Group A and Group B in the reading comprehension test. This research did not yield an effect of phonological representation on written word decoding.

Moreover, very few studies have investigated the effects of phonological representation, and very little research on the effects of orthographic representation on English written words can be found. A great deal of researchers support the notion that listening and speaking activities should be presented prior to reading and writing activities in English classes at the beginning. The Ministry of Education, Culture, Sports, Science and Technology (2008)[15] maintained that listening activities should be addressed previous to reading activities in elementary schools. However, very little is empirically known about the positive effects of phonological representation on orthographic decoding. Therefore, what should be examined is whether phonological representation has a positive effect on orthographic decoding. In order to investigate the effects of phonological

representation, a comparison of two conditions is needed: Condition 1 would involve the learners studying the phonological information prior to the orthographic information; In Condition 2 the learners would learn the orthographic information before studying the phonological information. The learners in Condition 1 would have assembled the phonological representations of English words when they confront the written words. They would be able to make use of the phonological representation to comprehend the meanings of the printed words. On the other hand, the learners in Condition 2 would have no phonological representation when they decode the printed words. They would not be able to use the phonological representations of the written words. A comparison of these conditions is necessary to explore the effects of phonological representation, even though Condition 2 would be an unusual setting for learning vocabulary.

In fact, these two conditions were investigated by Hotta (2008)[13]. He attempted a comparison of these conditions in order to examine third-grade students' printed word decoding in a Japanese elementary school. Hotta examined whether the phonological information of English words has the potential to help Japanese third-grade elementary school students to decode the orthographic information and catch the meanings of written English words in vocabulary learning. The participants were 52 third graders in a public elementary school, who were divided into two groups: Group A and Group B. First, the students in Group A learned only the phonological information of eight English words; thereafter they learned only the orthographic information. After learning the orthographic information, they took a visual word recognition test. Since the students in Group A might have already assembled phonological representation before learning orthographic information, they were potentially capable of direct access and indirect access. On the other hand, the participants in Group B learned only the orthographic information first, and subsequently learned the phonological information. The visual word recognition test was administered to Group B shortly after they learned the orthographic information of the target words. The participants in both groups were exposed to the orthographic information 16 times. The result of the visual word recognition test showed that there was no significant difference between Group A and Group B with regard to orthographic decoding performance. If the students in Group A can exploit phonological information when they understand the meaning of the orthographic information, they should perform very well. In fact, Group A did not perform any better than Group B in the orthographic decoding, though Group A was able to make use of indirect access and direct access. It was concluded that phonological information did not facilitate the decoding of orthographic information. This study also brought to light a problem concerning the participants' age. The third-grade students did not have knowledge of letter-sound correspondence rules. If the participants had realized these rules, the result of this study might have been different.

As can be seen above, very little research has focused on the effects of Japanese elementary school students' phonological representation on orthographic information decoding and on the effects of their orthographic representation on phonological information decoding. To recapitulate, Hotta (2008)[13] found that phonological information did not facilitate the decoding of orthographic information of third graders in Japanese elementary school because the students did not yet have knowledge of letter-sound correspondence rules. Word recognition involves the interaction of activated orthographic, phonological, semantic and syntactic processes. A useful contribution will be made to effective second language vocabulary learning in Japanese elementary schools if we declare utmost importance of one of the aspects of the relationships among orthographic, phonological, and semantic representations.

Further experimental studies are necessary to investigate whether phonological representation plays an important role in orthographic information decoding to access the meaning, and whether orthographic representation facilitates phonological information decoding. Thus, the purpose of this study is to examine how phonological representation influences orthographic information decoding when Japanese sixth-grade students in a public elementary school understand the meanings of printed English words, and how orthographic representation affects the decoding of phonological information. It was assumed that the findings of the present study would

provide us with some insights into the pedagogical implications for teaching English vocabulary to Japanese sixth graders.

The following research questions were addressed:

(1) Do Japanese sixth-grade students in public elementary schools make efficient use of previously learned phonological information followed by orthographic information when they access the meanings of printed English words?

(2) Do Japanese sixth-grade students in public elementary schools make efficient use of the previously acquired orthographic information, which comes before phonological information when accessing the meanings of spoken English words?

Regarding Research Question (1), we assumed that the learning gain of the first group (i.e., the group exposed to phonological information followed by orthographic information, hereafter, the POG) will be significantly greater than that of the second group (i.e., the group exposed to orthographic information followed by phonological information, hereafter, the OPG) in a visual word recognition test if the POG can utilize the phonological information in printed word recognition.

Concerning Research Question (2), it was examined whether the learning gain of the OPG would be significantly greater than that of the POG in an auditory word recognition test. If the OPG performs better than the POG, it might be suggested that orthographic information is efficiently used for phonological information decoding.

2. Method

2.1 Participants

Initially, there were 46 participants, all sixth-grade students in a public elementary school (21 males, 25 females). They had taken English classes including listening and speaking for five years. They had never been taught reading, writing or phonics in English. The classes were held six times a year in the first and second grades, 10 times a year in the third and fourth grades, and 15 times in the fifth grade. One of the instructors asked the parents at the parents' association meeting and the participants to tackle the treatments before the experiment. Consent to participate in the experiment was secured in advance.

An alphabet test was administered in order to examine the participants' knowledge of Roman characters. They were asked about the names of all the English characters in the test. In addition, they took pretests involving a visual word recognition test and an auditory word recognition test before the experiment. Eleven participants were excluded from the experiment because some were from foreign countries and the others took extra lessons at private English schools after school. Moreover, nine students who did not take the two pretests or posttests and failed to attend all of the treatment lessons were eliminated. In the end, a total of 26 students participated. Table 1 displays the number of the participants in each group.

There was no significant difference between the POG and the OPG with regard to the alphabet test (F (1, 24) = 0.51, *ns*), the visual test (F (1, 24) = 0.52, *ns*) or the auditory test (F (1, 24) = 0.24, *ns*). Table 2 indicates the results of the alphabet test. Table 4 shows the results of the visual test and the auditory test.

Table 1 *Number of the Participants in the Experiment (N=26)*

The Phonological Information→Orthographic Information Group (POG)	n = 14
The Orthographic Information→Phonological Information Group (OPG)	n = 12

Table 2 *Results of the Alphabet Test*

Group	*n*	*M*	*SD*
POG	14	17.28	7.34
OPG	12	14.83	9.41

Note. Maximum score = 26.

2.2 Materials

2.2.1 Target Words Used in the Experiment

The following eight words, which were employed in Hotta (2008) [13], were used: purse, tweezers, broom, ladder, giraffe, camel, chimney and finger. The participants in the present study should have had little phonological and orthographic representations of the target words before the experiment. Hence, these eight words were selected

from the words because of the lowest percentages of their correct answers in listening and reading tests of Hotta (2003) [16]. In addition, the participants' familiarity with the meanings of the words should have had no influence on the word recognition; accordingly the eight target words were all in Peabody Picture Vocabulary Test (Dunn, 1965) [17] and in an everyday vocabulary list developed by Matsumura (2003) [18]. The list was composed of everyday words which children often listen to or see in their everyday life. Furthermore, the target words were restricted by the number of letters and syllables. The target words did not exceed eight letters in length and did not exceed three syllables.

2.2.2 A Visual Word Recognition Test

A visual word recognition test was developed in order to examine the participants' knowledge of orthographic information of the target words. In this test, the participants looked at the printed English words and then chose the best picture to describe the meaning of the word from four choices. The test included 16 items, which were made up of eight target words and eight distracters. The letters were printed in Microsoft Sans Serif in Microsoft Word because this font is similar to the letters taught in the lessons on Romanized Japanese. Eight minutes were allowed for the test. This test was conducted shortly after learning the orthographic information of the target words in each group. The participants took this test as a pretest and a posttest.

2.2.3 An Auditory Word Recognition Test

An auditory word recognition test was employed for the purpose of investigating the participants' knowledge of the phonological information of the target words. After they listened to each English word on a cassette tape, they were asked to choose the best picture to depict the meaning of the word from four choices. This test was also composed of 16 test words: the eight target words and the eight distracters. Each test word was read aloud twice by a female American speaker of English after an interval of 15 seconds. The total time for the test was 4 minutes. The participants took this test as a pretest and a posttest. The order of test items was not the same as that of the visual test. The children took this test immediately after learning the phonological information of the target words.

2.2.4 An Alphabet Test

An alphabet test was carried out before the treatments so as to examine whether the participants could distinguish the English alphabets. In this test, the participants were provided with the 26 alphabet letters and were asked to write the name of the alphabets in Japanese. The alphabet letters were printed in Microsoft Sans Serif in Microsoft Word. Lower-case letters were used in the test. The testing time was 7 minutes. The maximum possible score was 26.

2.2.5 Picture Cards, Letter Cards, Picture + Letter Cards and Small Picture Cards

The following four kinds of cards were adopted in the experiment (see Figures 1, 2, 3, and 4). The colors of the pictures in the cards were black and white. The letters were black and printed in Microsoft Sans Serif.

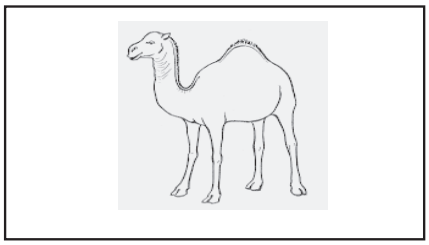

Figure 1. Picture Card (Card 1).
This was a card of 24 by 27 centimeters.

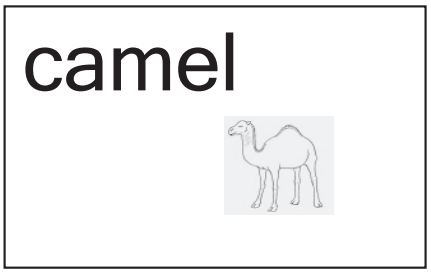

Figure 2. Picture ＋ Letter Card (Card 2).
This was a card of 24 by 27 centimeters.

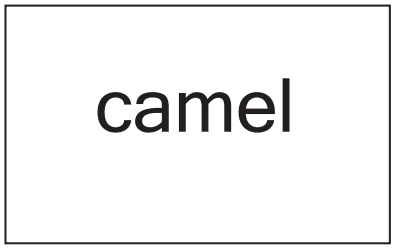

Figure 3. Letter Card (Card 3).
This was a card of 24 by 27 centimeters.

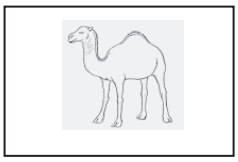

Figure 4. Small Picture Card (Card 4).
This was a card of 7.5 by 11 centimeters.

2.3 Procedure

The experiment continued for five days. Each group took two treatments: Treatment A and Treatment B. The participants learned the phonological information of the eight target words in Treatment A, while they were exposed to the orthographic information of the target words in Treatment B. However, there was a difference between the POG and the OPG with respect to the order of the two treatments administered to each group.

2.3.1 Data Collection Scheme

The POG worked through Treatment A on Days 2 and 3, and Treatment B on Days 4 and 5. The OPG received Treatment B on Days 2 and 3, and Treatment A on Days 4 and 5 (see Table 3). Each Treatment on Days 2, 3, 4 and 5 was conducted in a regular class hour (45 minutes) in their classroom. The tests on Day 1 were administered during a regular period in their school.

2.3.2 Treatments in the Experiment

Students in both groups underwent two kinds of treatments: Treatment A (phonological information only) and Treatment B (orthographic information only). Each treatment involved two phases, a learning phase and an activity phase. In the activity phase, they participated in a game called "*What's this*?"

(1) Treatment A (phonological information only)

(a) The Learning Phase (10 minutes): The instructor during the treatments was one of the authors. He told the participants in English, "Today, we will learn eight English words. We will use these words when we play a game later." First of all, the participants were asked to have a careful look at Card 1 (Picture Card), for example, the picture card for camel, and to say what it was. Some of the participants answered in Japanese, "*Rakuda*." The instructor said in English, "Yes! That's right. Please look at this (Card 1)." Pointing to Card 1, the instructor provided

Table 3 *Data Collection Scheme*

	Day 1 ⇨	Day 2 ⇨	Day 3 ⇨	Day 4 ⇨	Day 5
POG	Pretest (Visual Test) (Auditory Test)	Treatment A	Treatment A, Posttest (Auditory Test)	Treatment B	Treatment B, Posttest (Visual Test)
a)	0	8	8	0	0
b)	0	0	0	8	8
OPG	Pretest (Visual Test) (Auditory Test)	Treatment B	Treatment B, Posttest (Visual Test)	Treatment A	Treatment A, Posttest (Auditory Test)
a)	0	0	0	8	8
b)	0	8	8	0	0

Note. a) = number of times of exposure to phonological information (per word). b) = number of times of exposure to orthographic information (per word).

the phonological information of the target word twice, "Camel. Camel." After showing the card (Card 1) to the students, the instructor put it up on the blackboard. The instructor gave the participants similar instructions regarding the other target words.

(b) **The Activity Phase** (20 minutes): Using the phonological information of the target words, the participants played the "*What's This*?" game. The instructor split the students into six groups. He gave each group a set of the small picture cards (Card 4) and had the students spread the cards on their desks. Then the instructor told the participants in English, "Now, let's play the "*What's This*?" game. I will tell you a word twice. Please pick up a card (Card 4) from the cards on your desk. I will give you a command, '1, 2, 3, Go!' You can take the card (Card 4) the moment you hear 'Go!' OK?" The students picked up a card (Card 4) from the cards on their desks after the command. Then the instructor pointed at the correct card (Card 1) on the blackboard in order to show the correct answer to the students, and said once to them, "This is a camel." The same routine was repeated eight times. The participants played the game twice.

(2) Treatment B (orthographic information only)

(a) The Learning Phase (10 minutes): The instructor told the students in English, "Today, we are going to learn eight words. We will use these words when we play a game." First, the participants were requested to have a careful look at Card 2, for example, the picture + letter card for camel, and to tell the instructor what it was. Several students said in Japanese, "*Rakuda*." The instructor replied in English, "Yes! That's right." He also pointed towards the letters on the card (Card 2) and told the participants, "Please look at this (Card 2)." This direction was repeated twice. The instructor did not present the participants with the phonological information of the target word at all. After that, he hid Card 2 and put Card 1 on the blackboard. The same directions were given one after another for the eight target words.

(b) The Activity Phase (20 minutes): The participants played a different variation of the "*What's This*?" game in this phase. The instructor said to the

Table 4 *Mean Scores and Standard Deviations for the Visual and Auditory Tests (N=26)*

		Visual Test				**Auditory Test**			
		Pretest		Posttest		Pretest		Posttest	
Group	*n*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
POG	14	0.35	0.71	6.78	1.31	1.78	1.20	5.57	1.34
OPG	12	0.83	1.06	4.41	2.43	1.58	1.11	5.41	1.32

Note. Maximum score = 8 for each test.

Table 5 *Correct Answer Rate (Percentage) in Each Word*

	Pretest				**Posttest**			
	POG	OPG	POG	OPG	POG	OPG	POG	OPG
Word	Auditory Test	Auditory Test	Visual Test	Visual Test	Auditory Test	Auditory Test	Visual Test	Visual Test
finger	14	50	21	42	85	83	85	58
tweezers	14	16	0	0	71	83	100	58
giraffe	50	33	14	8	92	100	85	50
camel	36	41	0	8	100	100	71	75
broom	21	8	0	0	14	50	92	58
chimney	0	0	0	8	50	33	100	41
ladder	21	0	0	8	57	25	57	41
purse	21	8	0	8	85	66	85	58

students in English, "Now, let's play the "*What's This*?" game. I will show you a letter card (Card 3) twice. Please pick up a card (Card 4) from the cards on the desk. I will give you a command, '1, 2, 3, Go!' You can take a card (Card 4) the moment you hear 'Go!' OK?" The instructor showed a card (Card 3) to the students and hid Card 3. The instructor repeated it again. After listening to the command, the students picked up a card (Card 4). After that, the instructor showed the students Card 2 once in order to show the correct card. The instructor did not provide the participants with the phonological information of the target word at all. The same routine was repeated eight times. The game was conducted twice.

2.4 Data Analysis

The homogeneity of variances of the samples was verified by Levene's test. A three-way ANOVA, Group (the POG vs. the OPG) × Test (auditory vs. visual) × Pre-Posttest (pretest vs. posttest) was performed[1]. The interactions between Group and Pre&Posttest were analyzed for both the visual and auditory word recognition tests in order to investigate the two research questions. For the visual or the auditory word recognition test, if a significant interaction was observed, it could be assumed that there was a significant difference in the learning gain between the POG and the OPG.

3. Results

Table 4 presents the mean scores and standard deviations for the auditory and visual word recognition tests concerning the target words.

The results of the three-way ANOVA, 2 (OPG vs. POG) × 2 (auditory vs. visual) × 2 (pretest vs. posttest) revealed that the interaction of Group × Test × Pre&Posttest was statistically significant (F (1, 24) = 7.84, $p < .01$).

With regard to the visual test (Research Question 1), the interaction of Group × Pre&Posttest was significantly observed (F (1, 24) = 11.88, $p < .01$). As for the POG, the simple main effect of Pre&Posttest was significant (F (1, 24) = 120.53, $p < .01$); for the OPG, the simple main effect of Pre&Posttest was also significant (F (1, 24) =37.45, $p <. 01$). In addition, the simple main effect of Group was significant (F (1, 24) = 13.00, $p < .01$). Hence, although both groups improved significantly from the pretest to the posttest, the POG achieved higher scores than the OPG in the visual word recognition test (see Figure 5).

Regarding the auditory test (Research Question 2), the interaction between Group and Pre&Posttest was not significant (F (1, 24) = 0.00, *ns*). The simple main effect of Pre&Posttest was significant (F (1, 24) = 109.75, $p < .01$). However, the simple main effect of Group was not statistically significant (F (1, 24) = 0.24, *ns*). In other words, the scores on the auditory word recognition test in both groups improved significantly from the pretest to the posttest, but there was no significant difference between the POG and the OPG in the auditory test (see Figure 5).

In summary, for Research Question 1, the learning gain of the POG was significantly greater than that of the OPG in the visual test. With respect to Research Question 2, the learning gain of the OPG was not significantly greater than that of the POG in the auditory test.

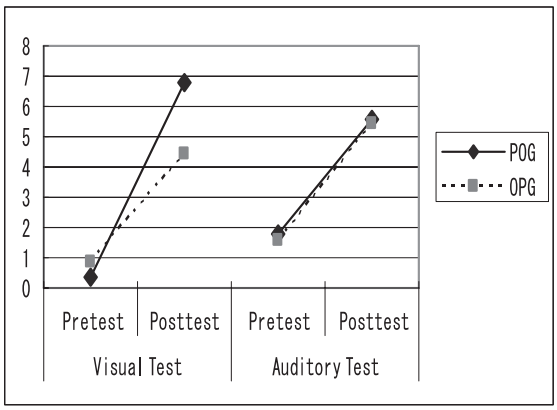

Figure 5. Comparison of learning gains in each test.

4. Discussion

There were two major findings in the experiment. First, in relation to Research Question 1, the POG performed better than the OPG in the visual test. Secondly, concerning Research Question 2, there was no significant difference between the POG and the OPG in the auditory test.

4.1 The Effect of Phonological Representation

For Research Question 1, the findings indicate that in contrast to the orthographic information, the phonological information of the target word

was effective in helping the sixth graders access the meaning of the printed word. In other words, it is considered that the POG made efficient use of previously learned phonological information followed by orthographic information for the printed word recognition.

One explanation for these results may be that it was possible for the POG to adopt both the direct and indirect access routes, whereas the OPG could use only the direct access route. In other words, it might be argued that the participants of the POG seemed to access the meanings of the printed target words more smoothly than the OPG.

On one hand, the POG performed better than the OPG in the visual recognition test because the students of the POG could make use of both access routes: direct access and indirect access. There might be two reasons why the POG achieved higher performance in the visual word recognition test. First, the sixth graders in the POG might have connected the orthographic representation to the semantic representation in their mind directly. They must have already built the orthographic representation in the process of Treatment B. In the visual test, it could be considered that they may check the string of letters, "chimney", with the orthographic representation (*chimney*) which they had already developed in Treatment B. They might have been able to link the orthographic representation (*chimney*) to the semantic representation directly. Secondly, the POG might have accessed the semantic representation indirectly. They may have realized the meanings of the words by way of the phonological representation when they faced the string of letters, "chimney". The POG had a chance to assemble the phonological representation utilizing the knowledge of letter-sound correspondence rules on the Romanized Japanese in the visual recognition test. They may have confirmed that the phonological representation which they had built in the visual test was similar to the phonological representation [tʃímni] which they had acquired in Treatment A. After that, they may have checked the phonological representation [tʃímni] with the semantic representation, "a pipe inside the house for smoke escaped from a fire." Finally, they may have understood the meaning of the written word, "chimney" through the phonological representation.

On the other hand, the sixth graders of the OPG were not able to accomplish the same achievement as well as the POG in the visual recognition test because the OPG could only use the direct access route. Some of the sixth graders in the OPG might have also built the phonological representations of the printed target words mentally; however, the OPG may not have been able to make the most of the phonological representations they had produced because they had no instruction on the phonological information of the target words when they took the visual recognition test. The OPG could not utilize both of the direct and indirect access routes; they could only use the direct access route. If the instructor had taught the phonological representation, the OPG would have improved the performance as well as the POG. To summarize, the different conditions between the POG and the OPG might have produced the results of the experiment. The phonological representation must have had a good influence on the visual word recognition. Furthermore, the results imply that the sixth graders were at the alphabetic phase for Frith's (1985) reading developmental phase. In short, the students who were able to use the phonological representation performed better than those who could not use the phonological representation in the visual word recognition test. In other words, the phonological representation advanced the performance of the POG. That is, it was confirmed that the phonological representation had a positive influence on the visual word recognition.

With regard to differences in the participants' ages, the result of the study was dissimilar from that of Hotta (2008)[13]. He argued that the third-grade students did not or were not able to use phonological representation effectively in comprehending the meanings of printed words. The reason is that the third-grade students in elementary schools had no knowledge of letter-sound correspondence rules. It seems reasonable to conclude that there is an age-related difference and the children who have not learned the letter-sound correspondence rules cannot utilize the phonological representation efficiently for visual word recognition.

4.2 The Effect of Orthographic Representation

Concerning Research Question 2, it was

suggested that the orthographic representation of the target words did not facilitate access to the meanings of the auditory words. Interestingly, with respect to the auditory test, there was no significant difference in the scores between the POG and the OPG. It should be noted that the OPG did not perform significantly better than the POG (having only phonological representation without orthographic representation), though the OPG was exposed to the phonological information after learning the orthographic information. This finding contrasted with the results of the visual test. The OPG must have acquired the orthographic representations of the target words and been able to utilize the orthographic information of the words when they listened to the auditory target words. If the orthographic information had helped them access the meanings of the spoken words, the scores of the OPG would have been higher in the auditory test than those of the POG.

The order of exposure to each type of information may be vital for the word recognition of Japanese sixth graders. One pedagogical implication may be that the phonological information of the words should be provided to sixth-grade students first, followed by the orthographic information because of the effectiveness of previously learned phonological information.

5. Conclusion

The present study aimed to ascertain whether the phonological representation which the sixth graders had learned in advance helped them to access visual word meanings and whether the orthographic representation which they had acquired beforehand aided their access to auditory word meanings. The findings demonstrated that the phonological information which was followed by the orthographic information facilitated the decoding of the orthographic information. However, the orthographic representation, which the sixth grade students had learned prior to the phonological representation, did not encourage the decoding for the phonological information. Thus, it was postulated that phonological information of English words succeeded by their orthographic information played an important role in the written English word recognition in the vocabulary learning of Japanese sixth grade public school students.

The findings of this study suggest that listening activities should be executed previous to reading activities in elementary schools. Listening activities prior to reading activities is more effective in apprehending the meanings of printed English words because the present study shows that the sixth graders might have reached the alphabetic phase and might exploit both the direct and the indirect access routes. It is very important for Japanese sixth graders to participate in listening activities in their classrooms in order to assemble the phonological representations of printed English words. In sum, sixth-grade students in Japanese elementary schools should be presented with listening activities prior to reading activities.

However, there were a few limitations of this study. First, the number of participants was not sufficient in the experiment. Second, the number of the target words was not large enough to investigate the effect of phonological and orthographic representations. Third, the results might have changed if other target words had been used in the experiment. For example, if all the target words employed in this experiment began with the letter other than “c”, and if the words consisted of more than eight letters, or if they contained over three syllables, different results may have been produced. In the future, the effects of phonological representation on word recognition should be investigated using a larger sample of elementary school students and more target words. In addition, the roles of phonological representation and orthographic representation should be examined through the comparison between the children who have enough knowledge of letter-sound correspondence rules and those who have little knowledge.

Footnote

[1]Nishida (1997)[19] asserts that a nonparametric test should be conducted if the number of participants is below 10. In this study, a parametric test was performed because the number of the participants was over 10.

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