

Languages & Literatures

English Language & Literature fields

Okayama University

Year 2007

What relationships do the efficiencies of
phonological coding and lexical access
have with reading comprehension for
Japanese learners of English?

Nobuyoshi Miyasako*

Shigenobu Takatsuka†

*Joint Graduate School, Hyogo University o/Teacher Education

†Okayama University, eng_taka@cc.okayama-u.ac.jp

This paper is posted at eScholarship@OUDIR : Okayama University Digital Information Repository.

http://escholarship.lib.okayama-u.ac.jp/english_languages_and_literature/3

What Relationships Do the Efficiencies of Phonological Coding and Lexical Access Have with Reading Comprehension for Japanese Learners of English?

Nobuyoshi MIYASAKO

Joint Graduate School, Hyogo University of Teacher Education

Shigenobu TAKATSUKA

Okayama University

Abstract

This study examined the relationships between the efficiencies of phonological coding and lexical access of written words and reading comprehension for Japanese senior high school students of English. The primary objective was to verify the speculations on how oral reading practice helps to develop reading comprehension skills: (a) it improves the efficiency of phonological coding; and (b) it enhances the efficiency of lexical access. The efficiencies of phonological coding and lexical access were measured as the articulating speed of written words and as Stroop interference (Stroop, 1935) respectively.

The results showed that there was a significant relationship between the efficiency of phonological coding and reading comprehension, which supported speculation (a), but that there was no significant relationship between the efficiency of lexical access and reading comprehension, which refuted speculation (b). Some pedagogical implications were also suggested.

1. Introduction

When we seek to develop learners' reading comprehension skills through oral reading, our assumptions about oral reading (Miyasako, 2002) include: (a) it raises grammatical consciousness; (b) it expands vocabulary; (c) it strengthens letter-sound association; and (d) it improves the efficiency of working memory in the phonological loop and the central executive (Baddeley, 2000).

Assumptions (c) and (d) have relevance to decoding components at the lower level of the reading process: orthographic processing, phonological coding and lexical access. Orthographic processing here means recognizing letter forms, miscellaneous line shapes of letters, letter groups and spelling patterns (Grabe, 1999).

Phonological coding means converting written information into phonological form so that it is held in the phonological store for further processing such as lexical access and syntactic parsing (Baddeley, 2000). Since the representation in the phonological store decays in about 2 seconds without articulatory rehearsal (Baddeley, et. al., 1998), the efficiency of phonological coding, which is often automatic for fluent readers, matters to the processing of written information.

Lexical access means retrieving the meaning of written information through phonological coding or directly from the visual information (Grabe, 1999; Stanovich, 2000). Whether fluent readers may take the direct route or may access meanings through automatic phonological coding, it has been consented that non-fluent readers usually depend on the lexical access through phonological coding (Carver, 1998; Gathercole & Baddeley, 1993; Stanovich, 2000).

A major role of these decoding components in the reading process has been acknowledged in L1 reading field. Researchers criticizing the top-down view of reading process have shown that poor readers depend on the context and inference much more than fluent readers who can understand the text based on the bottom-up processing (Stanovich, 2000; Snow, et, al., 1998; Nicholson, 1999). Other germane research findings are: (a) decoding ability is related with reading comprehension for adults as well as children (Stanovich, 2000); and (b) the teaching of decoding skills has significantly favorable effects on the development of reading comprehension skills for young learners (Grabe & Stroller, 2002; Snow, et, al., 1998; Castle, 1999). Their main claim is that the mastery of decoding skills and the practice of extensive reading, which is often triggered by the former, develop learners' reading fluency.

However, EFL reading pedagogy in Japan, where the bottom-up approach has been traditionally the mainstream, has shown a tendency to ignore the teaching of decoding skills. One reason for this may be that the mastery of decoding skills is taken for granted except for true beginners like first-year junior high school students. This lack of teaching the lower-level processing skills may be partly responsible for Japanese learners' difficulty in achieving reading fluency.

L1 reading research suggests that developing decoding skills can also help to improve L2 reading comprehension. One means for this may be oral reading, which is counted on as developing decoding skills for L1 learners (Grabe & Stroller, 2002; Snow, et, al., 1998). Thus, the speculation that oral reading practice can improve Japanese learners' reading comprehension is also made from the viewpoint of the lower-level reading processing.

This speculation naturally requires an empirical validation, but little research has been done concerning this point with Japanese learners. There are some exceptions: Miyasako, (2002), Suzuki (1998) and Watanabe (1990) report that the efficiency of phonological coding, measured as the speed of oral reading, can be improved by oral reading practice for senior high school students. Therefore, in the present study, with a view to integrating this finding with the speculation, we investigated the relationships between the two decoding components, phonological coding and lexical access, and reading comprehension for Japanese senior high school students of English. The other component, orthographic processing, which we judged the participants had already mastered, was excluded from the experiment.

Research questions of the present study concerning Japanese senior high school students were set up as follows: (1) what would be the relationships between the efficiencies of phonological coding and lexical access and reading comprehension?; and (2) what effects would the efficiencies of phonological coding and lexical access have on reading comprehension?

2. Method

2.1. Participants

The participants were originally 75 second-year senior high school students in Okayama. However, those who had negative values in Stroop interference for measuring the efficiency of lexical access due to color blindness or for other reasons, were excluded as invalid for the analyses, which reduced the number of the participants analyzed to 48.

2.2. Instruments

(1) *Efficiency of Phonological Coding.* For the efficiency of phonological coding, the articulating speeds of English and Japanese words were respectively measured as the number of syllables and moras articulated in two seconds, following Tamai (2001). The participants read aloud 40 English words consisting of 116 syllables and 40 Japanese words consisting of 197 moras (Appendix A). Formulae for each participant's articulating speeds (ASs) in English and Japanese were as follows:

English AS = 116 (syllables in 40 words) x 2.0 / time for articulating 40 words (sec.)

Japanese AS = 197 (moras in 40 words) x 2.0 / time for articulating 40 words (sec.)

(2) *Efficiency of Lexical Access.* The efficiency of lexical access was gauged with Stroop color-naming tasks (Stroop, 1935), where the participants named colors of a series of patches and read aloud a series of color words that were printed differently from the words, e.g., "red" printed in green. The gap in time between the participants' visual accessing of the colors and their lexical accessing of the words was measured as Stroop interference (Dyer, 1971). The

features of the tasks, following Osaka (1990), were: (a) the card was horizontally set A4 in size (Appendix B); (b) the number of stimuli was 48 in 8 rows and 6 columns; (c) the kinds of stimuli were color patches (red, blue, yellow and green), Kanji words (“赤”, “青”, “黄” and “緑”), Kana words (“あか”, “あお”, “き” and “みどり”) and English words (“red”, “blue”, “yellow” and “green”); and (d) the response languages were English and Japanese.

In the Stroop tasks each color appeared twice in a row, not positioned consecutively, and so did each stimulus. The participants named both in English and Japanese the colors of 48 stimuli in each of four different cards. Stroop interference (IF) was calculated within Japanese and English respectively as follows:

$$\text{Stroop IF} = (\text{color-naming time for a word card}) - (\text{color-naming time for the patch card})$$

(3) *Reading Comprehension.* The participants’ reading comprehension was measured in terms of their scores in the reading section (20 points) of the past version of *Assessment of Communicative English* (ACE; Association for English Language Proficiency Assessment).

2.3. Procedure

The assessments of phonological coding, lexical access and reading comprehension were conducted in this order during a regular class. In the Stroop tasks, five different cards for each stimulus were made and randomly assigned to the participants. They were directed to “try to name colors of the patches or read aloud words on the cards as accurately and as soon as possible.” For phonological coding and lexical access, the participants measured the time they spent with stopwatches by themselves. The order in measuring the phonological-coding speed was English and Japanese, and the order of the Stroop tasks was color patch (Japanese and English), Kanji (Japanese and English), English (Japanese and English) and Kana (Japanese and English).

For the analyses, descriptive statistics for the constructs were computed, and then, a correlation analysis, a regression analysis and analyses of variance (ANOVAs) were performed to answer the research questions.

3. Results

3.1. Phonological Coding, Lexical Access and Reading Comprehension

Table 1 shows the descriptive statistics for the efficiency of phonological coding measured as Japanese and English articulating speeds and reading comprehension in terms of the scores in the reading section of ACE with its mean, 10.333. The means for Japanese and English articulating speeds were 16.798 and 5.969 respectively. Clearly, phonological coding was much faster in Japanese than in English for the participants, $F(1, 94)=615.314$, $p<.01$.

Table 1. Means of Japanese and English Articulating Speeds and ACE

	Japanese AS	English AS	ACE*
Mean	16.798	5.969	10.333
SD	2.864	.972	3.497

n=48. * α = .689, $p < .01$. AS represents articulating speed.

Table 2. Means of Color-naming Time (sec.)

Response	Color patch	Stimulus		English
		Japanese		
		Kanji	Kana	
Japanese	23.188 (3.535)*	36.104 (5.058)	38.562 (6.408)	35.562 (5.787)
English	31.250 (6.207)	37.979 (6.019)	39.208 (6.748)	43.729 (7.405)

n=48. *() = SD. Stroop interference: Kanji-Japanese=12.917 (SD=5.102), Kana-Japanese=15.375 (SD=5.995), English-English=12.479 (SD=6.668)

Table 3. Correlation Matrix
for English Articulating Speed, English Stroop Interference and ACE

	English AS	English Stroop IF	ACE
English AS	-		
English Stroop IF	.011	-	
ACE	.438**	.014	-

n=48. AS and IF represent articulating speed and interference respectively. ** $p < .01$.

Table 2 shows the means of color-naming time for all the stimulus cards responded in English and Japanese. Based on the data, Stroop interference for the efficiency of lexical access was calculated within Japanese and English respectively as the color-naming time the participants spent for a word card minus the color-naming time they spent for the patch card. Stroop interference was greatest in Kana words (15.375), followed by Kanji words (12.917), then English words (12.479). There was a significant difference in the means between the three interferences, $F(2, 141)=3.297$, $p < .05$. However, the stringent Scheffe's post hoc test showed just a tendency that the interference from Kana words was greater than that from English words, $p < .10$.

3.2. Relationships between Three Constructs

Pearson product-moment correlation coefficients were calculated between English articulating speed for phonological coding, English Stroop interference for lexical access and ACE for reading comprehension. The correlation matrix shows that ACE had a significant

correlation with English articulating speed ($r=.438, p<.01$), but no significant correlation with English Stroop interference (Table 3). The regression analysis confirmed this result, and revealed that English articulating speed explained 19.2% of the variance of ACE (Table 4).

3.3. Effects of Phonological Coding and Lexical Access on Reading Comprehension

In order to examine how the efficiencies of phonological coding and lexical access affected reading comprehension, first, the participants who had T-scores above 55 and below 45 in each of English articulating speed and English Stroop interference were assigned to upper and lower groups respectively. The means of English articulating speed and English Stroop interference for the upper and lower groups were shown in Tables 5 and 6.

Next, the means of ACE for reading comprehension were compared between the upper and lower groups of English articulating speed and English Stroop interference. The upper English-articulating-speed group had a greater mean of ACE than the lower group

Table 4. Regression Analysis on ACE
with English Articulating Speed and English Stroop Interference

	β	t-value	p-value	R^2
English AS	1.577	3.272	.002	.192
English Stroop IF	.005	.067	.947	.000

$Y = .863 + 1.577 * X_1 + .005 * X_2$; $R^2 = .192$; $F(2, 45) = 5.359, p < .01, n=48$. AS and IF represent articulating speed and interference respectively.

Table 5. Means of English Articulating Speed and ACE
for Upper and Lower English-articulating-speed Groups

	English AS		ACE	
	Upper	Lower	Upper	Lower
n	17	16	17	16
Mean	6.998	4.874	11.412	8.750
SD	.367	.510	3.726	3.088

Table 6. Means of English Stroop Interference and ACE
for Upper and Lower English-Stroop-Interference Groups

	English Stroop Interference		ACE	
	Upper	Lower	Upper	Lower
n	16	15	16	15
mean	20.000	5.067	10.500	9.933
SD	3.830	2.604	3.464	3.693

(upper=11.412, lower=8.750; Table 5), and this was statistically supported by the ANOVA, $F(1, 31)=4.958$, $p<.05$. However, there was not much difference in the means of ACE between the upper and lower English-Stroop-interference groups (upper=10.500, lower=9.933; Table 6), which was statistically confirmed, $F(1, 29)=.194$, ns.

4. Discussion

4.1. Research Question (1)

The first research question inquired about the relationships between the efficiencies of phonological coding and lexical access and reading comprehension for Japanese senior high school students. The results showed: (a) there was a significant correlation between the efficiency of phonological coding in terms of English articulating speed and reading comprehension; (b) there was no significant correlation between the efficiency of lexical access measured as English Stroop interference and reading comprehension; and (c) the efficiency of phonological coding was a significant predictor of reading comprehension, explaining 19.2% of its variance. These are the answers to research question (1).

Next, the contrast between the results (a) and (b) above is impressive. The result (a), if integrated with the previous finding that oral reading practice can improve the efficiency of phonological coding for senior high school students (Miyasako, 2002; Suzuki, 1998; Watanabe, 1990), supports that oral reading practice can improve reading comprehension by enhancing the efficiency of phonological coding. Moreover, the variance of reading comprehension that phonological coding accounted for, 19.2% [result (c)], underlines its critical role in the reading process. Contrary to this, the result (b) suggests that there is no role of lexical access in reading comprehension.

Such a great contribution of phonological coding to reading comprehension requires attention. Although the role of decoding, composed of orthographic processing, phonological coding and lexical access, has been admitted in L1 reading (Section 1), it is astonishing that just one decoding component, i.e., phonological coding, was involved in reading comprehension to a great degree. This may be interpreted as supporting that the efficiency of phonological coding means not only better processing of written information but also sparing processing resources in the working memory for higher-level processing like comprehension (Nicholson, 1999; Stanovich, 2000).

On the other hand, the result regarding the relationship between the efficiency of lexical access and reading comprehension needs caution. It is hard to accept that lexical access did not have a role to play in the reading process, especially when the involvement of phonological coding was so great. It is conceivable that the Stroop tasks used in the experiment did not measure the efficiency of lexical access properly. The result concerning Stroop interference, where the Scheffe's post hoc test showed no significant mean difference

between Kana, Kanji and English stimuli (Section 4.1), can be interpreted in two ways. One interpretation is that Stroop tasks are to measure the automaticity of lexical access, not the efficacy. Another is that the color words used as stimuli in the tasks were too easy and more difficult stimuli would have measured the efficiency more properly. Thus, the relationship between the efficiency of lexical access and reading comprehension should be re-examined by adopting revised Stroop tasks with more difficult stimuli, e.g., color-associated words such as blood, ocean and forest, or by other measures of lexical access.

4.2. Research Question (2)

The second research question asked how the efficiencies of phonological coding and lexical access affected reading comprehension for Japanese senior high school students. The results showed: (a) learners with more efficient phonological coding in terms of English articulating speed had a significantly better reading comprehension; and (b) the efficiency of lexical access measured as English Stroop interference had no significant effects on reading comprehension. These results are congruous to those for the first research question and confirm the favorable effect of efficient phonological coding and little effect of efficient lexical access on reading comprehension for the participants.

5. Conclusion

This study was conducted primarily to examine the relationships between the efficiency of two decoding components, phonological coding and lexical access, and reading comprehension for Japanese senior high school students. The motive for this was to verify the assumptions relevant to these components in the development of reading comprehension skills through oral reading practice: (a) strengthening letter-sound association; and (b) improving the efficiency of working memory in the phonological loop and the central executive.

The major finding of the present study was that there was a significant relationship between the efficiency of phonological coding measured as English articulating speed and reading comprehension, which indirectly confirmed the favorable effect of oral reading practice on the improvement of reading comprehension. On the other hand, the relationship between the efficiency of lexical access in terms of Stroop interference and reading comprehension was refuted. This point should be re-examined with revised Stroop tasks or other measures of the construct.

These findings drew implications to EFL reading pedagogy in Japan: (a) we should appreciate the critical role of decoding, especially phonological coding, in the reading process; (b) we should acknowledge the importance of oral reading in developing decoding skills; and (c) we should assign oral reading to a more central and systematic role in our

regular instruction of English as well as in our reading instruction.

Finally, we should continue to empirically verify the other assumed roles of oral reading practice in the development of learners' reading comprehension skills, i.e., raising grammatical consciousness and expanding lexical items.

Acknowledgement

We express our gratitude to Association for English Language Proficiency Assessment for permitting us to use the past version of *Assessment of Communicative English* in this study.

References

- Baddeley, A. D. (2000). The episodic buffer: a new component of working memory? *Trend in Cognitive Science*, 4, 417-423.
- Baddeley, A. D., Gathercole, R. & Papagno, C. (1998). The phonological loop as a language learning device. *Psychological Review*, 105, 158-173.
- Carver, R. (1998). Predicting reading level in grades 1 to 6 from listening level and decoding level: Testing theory relevant to the simple view of reading. *Reading and Writing*, 10, 121-154.
- Castle, J. M. (1999). Learning and teaching phonological awareness. In Thompson, G. B. & Nicholson, T. (eds.), 55-73.
- Chalhoub-deVille, M. (ed.). (1999). *Issues in Computer-adaptive Testing of Reading Proficiency (Studies in Language Testing 10)*. Cambridge: Cambridge University Press.
- Dyer, F. N. (1971). Color-Naming Interference in Monolinguals and Bilinguals. *Journal of Verbal Learning and Verbal Behavior*, 10, 297-302.
- Gathercole, S. E. & Baddeley, A. D. (1993). *Working Memory and Language*. Hove: Psychology Press.
- Grabe, W. (1999). Developments in reading research and their implications for computer adaptive reading assessment. In Chalhoub-deVille, M. (ed.), 11-47.
- Grabe, W. & Stroller, F. L. (2002). *Teaching and Researching Reading*. London: Longman.
- 宮迫靖静. (2002). 高校生の音読と英語力は関係があるか? *STEP Bulletin*, 14, 14-25.
- Nicholson, T. (1999). Reading comprehension processes. In Thompson, G. B. & Nicholson, T. (eds.), 127-149.
- 菅坂満里子. (1990). バイリンガルとストループ効果. 『大阪外国語大学論集』, 4, 77-87.
- Snow, C. E., Burns, M. S. & Griffin, P. (eds.). (1998). *Preventing Reading Difficulties in Young Children*. National Research Council. Washington, DC: National Academy Press.
- Stanovich, K. E. (2000). *Progress in Understanding Reading: Scientific Foundations and New Frontiers*. New York: The Guilford Press.
- Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18, 643-662.

- 鈴木寿一. (1998). 音声教材中のポーズがリーディング・スピードに及ぼす影響に関する実証的研究. 『ことばの心理と学習』, 311-326. ことばの科学研究会.
- 玉井健. (2001). リスニング指導法としてのシャドーイングの効果に関する研究. 未発表博士論文. 神戸大学.
- Thompson, G. B. & Nicholson, T. (eds.). (1999). *Learning to Read: Beyond Phonics and Whole Language*. New York: Teachers College Press.
- 渡辺浩行. (1990). 音読再考－黙読の速読化を促す音読指導の意義を在り方. *Leo*, 19, 101-130. 東京学芸大学大学院英語研究会.

Appendix A. Words Used for Measuring Articulating Speed

1. *English*. someone, difficult, yesterday, communicate, airplane, grandfather, beautiful, question, hometown, computer, welcome, language, Christmas, newspaper, Spanish, international, remember, elephant, baseball, yourself, usually, vegetable, Japanese, Southeast, hamburger, important, American, birthplace, difference, Indonesia, dictionary, mountain, Halloween, restaurant, however, tomorrow, breakfast, overseas, understand, December
2. *Japanese*. 名人, 動物園, 博物館, 連勝, 一般的, 冒険小説, 西洋医学, 記憶力, 剣道, 空想, フェスティバル, 結果, じゅうたん, 原子炉, ドイツ語, 心理学, 少額, 共産主義, 大統領, 奇数, 天然記念物, 将棋, 駐車場, 友愛, 同盟, 宇宙船, 太平洋, 焼き肉, 大衆の面前, 憎悪, オムライス, 競艇, ソーラン節, 地下鉄, 林業, 臓器移植, 満足, 脱力感, 肉体, 優勝

Appendix B. Stroop Task

The following is an example of English stimulus table. Words in brackets show the ink colors of the stimuli. 48 items (8 rows x 6 columns) are printed horizontally on a A4 sheet.

red	yellow	green	blue	yellow	green	red	blue
(yellow)	(blue)	(red)	(green)	(blue)	(red)	(yellow)	(green)
green	blue	red	yellow	green	blue	yellow	red
(red)	(yellow)	(green)	(blue)	(yellow)	(green)	(red)	(blue)
				.			
				.			
				.			