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<th>The Effects of Focusing, Proficiency, and Working Memory Capacity on Text Comprehension of Japanese EFL Learners: A Psycholinguistic Study Based on Eye Movement Data (キーワードへのフォーカス、達度、ワーキングメモリ容量が日本人英語学習者の文章理解に及ぼす影響: 視線計測を指標にした心理言語学実験による検討)</th>
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PDF issue: 2019-06-14
The Effects of Focusing, Proficiency, and Working Memory Capacity on Text Comprehension of Japanese EFL Learners: A Psycholinguistic Study Based on Eye Movement Data

キーワードへのフォーカス、熟達度、ワーキングメモリ容量が日本人英語学習者の文章理解に及ぼす影響—視線計測を指標にした心理言語学実験による検討—

SAKAKIBARA Keiko
榊原　啓子

概要
日本人英語学習者の文章理解には大きな個人差がある。その要因を調査し、有効なリーディング指導・学習への示唆を得ることを目的として、日本人大学生・大学院生を対象に、言語熟達度テスト、リーディングスパンテスト、キーワード探索課題の有無を操作した日本語・英語文章読解時の視線計測を行った。その結果、英語熟達度と再認課題を用いた文章理解度の間に相関が見られ、言語処理能力、特に下位処理の自動化の重要性が示唆された。一方、ワーキングメモリ容量を測定するリーディングスパンテストのスコアと文章理解度の間には相関が見られず、ワーキングメモリ容量の違いが文章理解度の違いを直接説明できるものではないことが明らかとなった。この結果は、読み手は不足している処理容量を補償的ストラテジー（中條・中尾, 2005）や、経験による効率的処理（Wells et al,2009）によって補うという考え方に合致するものと考えられる。また、文章中のキーワードにフォーカスするタスクを課した群は、統制群に比べて、英語の文章読解時に眼球の停留回数および停留時間の減少の度合いが高かった。このようなリーディング行動の向上から、タスクによって文章理解が促進される可能性が示された。

Keywords
text comprehension, individual differences, eye movement
I INTRODUCTION

1.1 Background

A text consists of smaller units, such as sentences, phrases, or words. However, text is not a mere aggregate of isolated words or sentences. To gain a better understanding of a text, readers have to connect the meaning of each word or phrase and, at the same time, integrate the meanings of sentences efficiently. Forming coherent representations of texts at both local and global level is essential to skilled reading.

Yet, even though the ability to understand English texts is an important component of English as a foreign language (EFL) education, there is a wide range of individual differences in the reading comprehension performance attained by Japanese EFL learners. The degree of variability in EFL reading ability seems to be far greater than that in their first language (L1) reading. Why are such large individual differences observed? While some learners attain a high level of reading comprehension, others have a hard time reading English texts even after same period of schooling. There are various determinants of individual differences in general reading ability, and the factors related to L2 learning present an added dimension of complexity.

1.2 Purpose of this study

This study focuses on adult EFL reading in English. Specifically, it investigates the sources of individual differences in reading ability among Japanese EFL learners. In previous researches, language skills and domain knowledge have been emphasized as the factors that differentiate skilled and less skilled reading. Another factor that has been considered as a determining factor of reading comprehension performance is working memory capacity. Based on these previous researches, we take up L2 proficiency and working memory capacity as factors of individual differences and investigate whether these differences affect the reading comprehension performance. We also examine whether keyword detection task is an effective means to improve reading comprehension performance and enhance memory.

II PREVIOUS STUDIES

2.1 Text comprehension

2.1.1 Coherence and structure building

To comprehend a text well, readers have to integrate partially assembled information and build coherence. Text is generally organized in such a way as to convey its message to readers effectively. According to Kintsch model (Kintsch, 1998; van Dijk & Kintsch, 1983), text information is comprehended incrementally and represented in the mind in three levels: surface form, propositional textbase, and situation model. The surface form
consists of the text’s literal wording and represents syntactically and semantically interpreted words. It is generally stored until the end of the sentence and may be lost rapidly thereafter. The textbase refers to an interconnected network of semantic information directly derived from the text. The situation model is a construction that integrates the textbase and relevant aspects of the comprehender’s knowledge. It is considered to be the longest lasting component of memory trace. The mental representation of a text a reader constructs includes the textbase plus knowledge elaborations and knowledge-based interpretation of the text — the situation model. The textbase and situation model have two structures: microstructure and macrostructure. The macrostructure organizes the propositions of the microstructure hierarchically. Text elements that repeatedly signal to be of local importance become important for the macrostructure. A gist of the text expressed by macrostructure is the content that matters most for text comprehension and memory (e.g., van Dijk & Kintsch, 1983). To form coherent representation, readers must draw various types of information from long-term memory (Baddeley, 2000; Ericsson & Kintsch, 1995). Retrieval cues activating in working memory mediate access to these hierarchical structures which readers have generated from the previously read text and held in long-term memory. Text representation in long-term memory functions as a retrieval structure (Ericsson & Kintsch, 1995; Kintsch, 1998). In this way, coherent representations of texts are formed.

2.1.2 Focus and reading comprehension

Sentence understanding is facilitated by the reader’s identification of focused information (Cutler & Fodor, 1979). A focus word is defined as the most important word for comprehending a sentence. Thus, any strategy or task that helps to identify the sentence focus facilitates understanding. Less skilled readers are unable to suppress irrelevant or inappropriate information efficiently (Gernsbacher & Faust, 1991). Birch and Garnsey (1995) investigated the effect of focus on memory for words in sentences and found that focusing on a word enhances memory. As readers’ comprehension draws on limited resources, including working memory, attention, and time, they have to determine what to process in detail and what to underspecify or treat in a shallow fashion (Sanford, 2002; Swets et al., 2008; Ferreira et al., 2002). Sanford (2002) argued that material cued as foregrounded and focused is likely to be that which the writer intends to be most important, and readers will devote the most effort to process it. According to Baddeley (1996), the central executive of working memory is responsible for the allocation and coordination of the brain’s attentional resources. When it comes to discourse comprehension, important words or information are much likely to be encoded than insignificant details. According to Kintsch (1998), integration of meaning is performed whenever a new element is added to the network under construction. However, except for in the processing of short sentences, working memory will usually be loaded to capacity and must be cleared to make room for the
next sentence. Whatever has been constructed so far is transferred to long-term memory. Consequently, except for one or two central propositions that are retained in the focus of attention due to their importance, all that has been constructed up to this point in working memory is lost from consciousness. However, in a normal text, this information is still readily retrievable because it is likely that the following sentence contains retrieval cues that facilitate the retrieval. If a reader constructs a coherent hierarchical text representation in long-term memory, the representation also facilitates the effective retrieval process. However, poor readers’ textbase is not good enough to establish mental focus and cannot create sufficient constraints for deactivating irrelevant information. Therefore, poor readers are more susceptible to incomplete understanding and misinterpretation, and they have difficulty in constructing appropriate mental representations (Kintsch, 1998; Gernsbacher & Faust, 1991; Osaka et al., 2002). These findings suggest that focus in the sentence plays an important role in text comprehension.

2.2 Working memory

2.2.1 The role of working memory in language processing

Unlike the traditional concept of short-term memory that passively stores information, working memory is considered to be more dynamic, and is assumed to be engaged in processing and storage activities simultaneously. Carpenter and Just (1989) explained the role of working memory as follows. Working memory plays a central role in all forms of complex thinking and its necessity in language comprehension is especially evident. It plays a central role in storing the partial and final products of a reader’s computations as they process a text. It allows the reader to mentally connect ideas mentioned separately in the text.

2.2.2 A capacity theory of comprehension

Because the total amount of activation available in working memory is fixed for each person, working memory resources are limited. Its two functions — storage and computation — compete for this limited capacity. In a complex task, simultaneously activated operations impose a heavier computational burden, leaving little room for the storage function. A computationally demanding task leaves less capacity for storing information and vice versa. Thus, capacity limitations affect performance when the resource demands of the task exceed the available supply. An excessive burden on working memory creates a trade-off between computation and storage (Just & Carpenter, 1992). Researchers suggest that working memory capacity is particularly important in complex cognitive tasks (King & Just, 1991). Individual differences in complex cognitive task performance are influenced by differences in working memory capacity.
2.2.3 The relationship between L1 and L2 working memory capacity

Osaka and Osaka (1992) investigated the relationship between L1 and L2 working memory capacity among Japanese college students, using English and Japanese versions of reading span tests. They found a remarkably high correlation between L1 and L2 working memory scores. They interpreted this outcome as suggestive that working memory resources, in large part, are shared across languages, and working memory capacity is somewhat independent of linguistic knowledge.

2.3 The effects of a task on reading

In Swets et al. (2008), the type of question was manipulated among participants who read sentences with ambiguous relative clause attachment to test whether goals can influence reading/parsing strategies. The experiment revealed an ambiguity advantage in reading time only when participants expected superficial comprehension questions. When participants expected questions about relative clause interpretation, they read with more care. This finding supports the assumption that the end result of comprehension is susceptible to task manipulation. Therefore, the language comprehension system determines what information to analyze in detail and what information to treat shallowly to preserve limited resources.

Few studies have analyzed the effects of tasks on L2 text comprehension. Izumi, Hirai, Yokokawa and Yoshida (2010) investigated the effects of tasks on reading comprehension. They guided university students in their English reading classes using picture drawing task and writing opinion task. After half a semester of practice, the learners’ reading comprehension and speed improved. This result shows that reading tasks can facilitate learners’ reading comprehension.

III EXPERIMENT

This experiment was conducted to investigate the effects of language proficiency, working memory capacity and keyword detection task on text comprehension performance of Japanese EFL learners.

3.1 Hypotheses

The following three hypotheses guided this study.
1. Proficiency is highly correlated with reading comprehension performance.
2. Reading span scores correlate with comprehension performance.
3. The keyword detection task (in which participants are required to look for the keywords of the text as they read) will serve as a retrieval cue or provide focus words, thereby improving reading comprehension performance.
3.2 Methods

3.2.1 Participants

A total of 46 Japanese undergraduate and graduate students participated in this experiment. They consist of 22 males and 24 females, and all were native Japanese speakers who had studied English for more than six years. Participants’ ages ranged from 18 to 25 years. They had normal or corrected-to-normal vision.

3.2.2 Apparatus

The apparatus used in this experiment was NAC EMR-AT VOXER, an eye tracker. The eye tracker monitored the movements of the right eye of each participant. At the beginning of the experiment, the eye-tracking system was calibrated for the participant. Participants were seated 50-70 cm away from a computer screen connected with the eye tracker and read a text in a Power Point. Another computer was used to measure the participants’ reading span scores.

3.2.3 Materials and design

An English text titled “A Cultural Difference: Being on Time” and a Japanese text titled “People of Today are Tone-Deaf” written by Takeshi Yoro were used as materials (Appendix A and B). “People of Today are Tone-Deaf” contains 1,080 characters, and “A Cultural Difference: Being on Time” contains 438 words. With regard to the readability of the English text, the Flesch Reading Ease Test score and Flesch-Kincaid Grade Level Test score were 50.6 and 9.9, respectively. The Flesch Reading Ease Test evaluates the readability of texts on a scale of 0 to 100. In this test, higher scores indicate material that is easier to read, and lower numbers mark passages that are more difficult. The result of Flesch-Kincaid Grade Level is a number that corresponds to a grade level. The score of 9.9 indicates that the text is expected to be understandable by the average student in the 9th or 10th grade. The two texts in this study were selected because they are considered to be at the level of independent reading for the participants and can be understood without the use of dictionary. The titles of the texts were not displayed so as to avoid giving comprehension cues beforehand.

3.2.4 Procedure

The experiment consisted of four sessions: proficiency test, reading span test in English and Japanese, reading session 1, and reading session 2.

Proficiency Test

Participants first took the Oxford Quick Placement Test (QPT), Parts 1 and 2 (paper version) to measure their English proficiency. This test assesses reading, vocabulary, and grammar. Participants were given 30 minutes to complete the test. All scores are reported on a scale of 0 to 60.

Reading Span Test

The English and Japanese versions of the reading span test (Nakanishi, 2007) were administered to measure the participants’ working memory capacity. The reading span
test is a memory test designed to measure both processing and storage functions during reading. In this test, sentences were presented on the computer screen. They are arranged in three sets, each of which comprised two, three, four, or five sentences. Within a set, the sentences were not related to each other. Participants were asked to read each sentence aloud at their own pace. As soon as they finished reading a sentence orally, the next sentence was presented on the screen, and the participants continued reading aloud. After reading all the sentences in a set, the participants were asked to recall the last word of each sentence within the set for the English version and the underlined word in each sentence for the Japanese version. The order of reporting these words was based on the free recall procedure. Participants were prohibited from reporting the last target word first within each set to avoid recency effect. A participant’s reading span was calculated as the total number of correctly recalled words from all the trials. The total number of the sentences was 42 in both English and in Japanese versions. Each version of the reading span test took approximately 15 minutes to complete.

**Reading Session 1**

Participants were randomly divided into four groups. Groups 1 and 2 read the English text, while Groups 3 and 4 read the Japanese text. Participants read the text at their own pace. Six or seven lines of text were presented on one screen, and the participants could proceed with the text by pressing the space key. They were told not to go back to the previous slides. They were also asked to read as fast as they could as long as they could understand the contents of the text. As they read, their eye movements were monitored and recorded by the eye tracker. After reading the text, each participant was instructed to answer forced-choice comprehension questions regarding the text contents (total points were 20). The answering of the comprehension questions was untimed.

**Reading Session 2**

After a short interval, reading session 2 was conducted. The materials used in this session were the same as those in session 1. In this session, participants who read the English in session 1 read the Japanese text and vice versa. Group 1 read the Japanese text this time. After reading through it at their own pace once, they were instructed to reread it. Group 2 also read the Japanese text, but after the normal reading, they were instructed to reread the text looking for keywords (keyword detection task). Group 3 read the English text twice at their own pace. Group 4 also read the English text, once at their pace and again given the keyword detection task. As they read the text, the eye tracker monitored their eye movements and collected the eye movement data. After reading the text, the participants answered forced-choice comprehension questions regarding the text contents.
IV RESULTS AND DISCUSSION

4.1 The effects of proficiency on reading comprehension

The data of participants’ comprehension scores were divided into two groups based on their proficiency levels. Participants whose scores were higher than the average (the average QPT score of all participants was 38.11) are referred to as the proficient group, and those whose scores were lower than the average are referred to as the less proficient group.

<table>
<thead>
<tr>
<th>Table 1. Mean Comprehension Test Scores and SD of Proficient Readers and Less Proficient Readers</th>
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<tbody>
<tr>
<td>N</td>
</tr>
<tr>
<td>Proficient reader</td>
</tr>
<tr>
<td>Less proficient reader</td>
</tr>
</tbody>
</table>

The average comprehension score of the proficient group was 19.36, while the average of less proficient group was 17.86. This difference was evaluated with ANOVA. The result was $F(1, 23) = 8.404, p < .01$. There was a significant difference between the mean comprehension scores of the two groups. As a result, the effect of proficiency on reading comprehension was confirmed.

4.2 The effects of reading span on comprehension

First, descriptive statistics of the English and Japanese reading span scores were calculated. At the same time, a statistical analysis of the correlation between English and Japanese reading span scores was conducted. These results are shown below in Table 2 and Table 3.

<table>
<thead>
<tr>
<th>Table 2. Descriptive Statistics for English Reading Span Test Scores and Japanese Reading Span Test Scores</th>
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</thead>
<tbody>
<tr>
<td>Reading Span Test</td>
</tr>
<tr>
<td>English</td>
</tr>
<tr>
<td>Japanese</td>
</tr>
</tbody>
</table>

The correlation coefficient was calculated for the English and Japanese versions of the reading span test scores of 46 participants. The correlation coefficient was .633, which is statistically significant ($p < .001$), as shown below.
Table 3. Correlation between English and Japanese Reading Span Scores

<table>
<thead>
<tr>
<th>Reading Span Test</th>
<th>Japanese</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japanese</td>
<td>1</td>
<td>0.633</td>
</tr>
<tr>
<td>English</td>
<td>0.633</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 1. Scatter Diagram (Correlation between Japanese and English RST Scores)

This result was quite similar to that of Osaka and Osaka (1992). It shows that there is a considerably high correlation between the two sets of reading scores. As Osaka and Osaka interpreted, this result suggests that working memory resources, in large part, are shared across languages, and working memory capacity is language independent. If an individual has a high reading span in their native language, they will be able to develop a high reading span in a second language as well (Osaka & Osaka, 1992). That is, if a reader has a lower reading span in the native language, they will have difficulty to develop a high span in the second language.

Correlation coefficients between English reading span scores and comprehension scores in English and correlation coefficient between Japanese reading span test scores and comprehension scores in Japanese was $r = .151$, n. s., and $r = .202$, n. s., respectively. Thus, there was no correlation between reading span test scores and comprehension scores in either English or Japanese versions of the test.

4.3 The effects of task on reading comprehension

The mean values of both English and Japanese reading comprehension scores of the task group were higher than those of the non-task group. However, the differences
between the average comprehension scores in the task and non-task conditions were not statistically significant.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
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<tr>
<td>English</td>
<td></td>
<td></td>
</tr>
<tr>
<td>without task</td>
<td>18.27</td>
<td>1.49</td>
</tr>
<tr>
<td>with task</td>
<td>18.90</td>
<td>1.45</td>
</tr>
<tr>
<td>Japanese</td>
<td></td>
<td></td>
</tr>
<tr>
<td>without task</td>
<td>17.77</td>
<td>1.48</td>
</tr>
<tr>
<td>with task</td>
<td>18.67</td>
<td>1.56</td>
</tr>
</tbody>
</table>

4.4 Analysis from the perspective of eye movement

4.4.1 The effects of proficiency on reading behavior

In Eye-Mind Hypothesis, it was hypothesized that the interpretation of each word is immediate and the interpretation of the word occurs while the word is being fixated. In other words, readers can take in information at a pace that matches their internal comprehension processes. Therefore, we can use eye movement measures to infer moment-to-moment cognitive process in reading.

Fig. 2. An eye movement protocol (proficient reader)

Fig. 3. An eye movement protocol (less proficient reader)

Figures 2 and 3 are the eye movement protocols of a proficient reader (QPT score is 55) and a less proficient reader (QPT score is 37). The comparison between the eye movements of a proficient reader (Fig. 2) and those of a less proficient reader (Fig. 3) shows that the proficient reader fixated fewer words, spent less time on them, and made less regressions to earlier words. On the other hand, the less proficient reader fixated the same word or the phase repeatedly, which means the reader was in confusion. The characteristics of the less proficient reader are assumed to reflect the reader’s inefficiency in lower level processing, such as word recognition or parsing.

Another characteristic which deserves special mention is that the proficient readers in this experiment fixated keywords or discourse markers (e.g., *punctual, however*)
without exception. This means the advanced EFL readers know the importance of coherence building and focusing. They can make connections between ideas in the text. Proficient readers can afford to allocate their capacity to coherence building owing to their efficiency in lower-level processing, whereas less proficient readers have no capacity left to take global text structure into consideration.

As Koda (2004) pointed out, less proficient readers’ resources are completely taken up by lower-level processing and local-information extraction. Therefore, their reading processes remain unaffected by text structure, at least until their lower-level processing becomes sufficiently automated. As Figure 2 and Figure 3 show, automaticity of lower-level processing leads to the efficiency in higher-level processing.

4.4.2 The effects of a task on reading behavior

We can use eye movement measures to infer the moment-to-moment cognitive process of reading. Using computer based instruments, we can precisely see which word is being fixated and how long it is fixated. In this study, mean fixation frequencies and mean total fixation durations of sentences shown in Fig 2 and 3 were used to examine the effects of keyword detection task on reading behavior.

Mean fixation frequencies and mean total fixation durations of the participants in the task and non-task conditions of both in English and Japanese were calculated to investigate the influence of the keyword detection task on their reading behavior, from the viewpoint of eye movements during reading.

| Table 5. Mean Fixation Frequency and Mean Total Fixation Duration (in sec.) in English |
|---------------------------------|-----------------|-----------------|-----------------|
|                                 | Fixation Frequency(1st) | Total Fixation Duration(1st) | Fixation Frequency(2nd) | Total Fixation Duration(2nd) |
| Reading without task           | 77.4             | 21.6             | 54.6             | 15.7             |
| Reading with task              | 66.9             | 18.3             | 46.3             | 12.7             |

| Table 6. Mean Fixation Frequency and Mean Total Fixation Duration (in sec.) in Japanese |
|---------------------------------|-----------------|-----------------|-----------------|
|                                 | Fixation Frequency(1st) | Total Fixation Duration(1st) | Fixation Frequency(2nd) | Total Fixation Duration(2nd) |
| Reading without task           | 63.6             | 15.7             | 33.7             | 8.18             |
| Reading with task              | 64.2             | 15.9             | 33.9             | 8.57             |

Mean fixation frequencies (1st and 2nd time) and mean total fixation durations (1st and 2nd time) for the non-task condition of the Japanese text are almost identical with those of the task condition. However, mean fixation frequencies of the second time reading in the task condition of the English text decreased by 30.8%, and mean total fixation durations in the second time reading decreased by 30.6%. These figures are
larger than their counterparts of 29.5% and 27.3% in the non-task condition, respectively, though the differences are not statistically significant.

According to the Eye-Mind Hypothesis (Just & Carpenter, 1987) cited earlier, the interpretation of a word occurs while the word is being fixated. In other words, fewer fixations and shorter fixation duration mean that the reader has little or no difficulty reading the text. Considering the results of previous researches, the results of this experiment show that EFL readers who are assigned a keyword detection task might read more skillfully than those who are not given such a task.

4.5 Hypotheses verification

Based on the results described in Section 4.1—4.4, the hypotheses listed in Section 3.1 will be verified.

**Hypothesis 1: Proficiency is highly correlated with reading comprehension performance.** The findings in Section 4.1 verified Hypothesis 1. As mentioned, the difference in the comprehension scores between the comprehension of proficient readers and that of less proficient readers was statistically significant. Readers who were proficient in English comprehended better than less proficient readers, indicating that English proficiency plays an important role in reading and comprehending English texts.

**Hypothesis 2: Reading span scores correlate with comprehension performance.** The results of this experiment showed that there were no significant correlations between reading span test scores and text comprehension performance both in English and in Japanese.

**Hypothesis 3: The keyword detection task (in which participants are required to look for the keywords of the text as they read) will serve as a retrieval cue or provide focus words, thereby improve the reading comprehension performance.** The mean value of both English and Japanese reading comprehension scores of the task group were higher than those of non-task group. However these differences were not statistically significant. Regarding eye fixation duration and eye fixation frequency, the behavior of the task group was better than that of non-task group in English. Mean fixation frequencies in the second time reading deceased by 30.8% and mean total fixation durations in the second time reading decreased by 30.6%. These figures are larger than their counterparts of 29.5% and 27.3%, respectively, in the non-task condition. This means that the group which was given the keyword detection task behaved more like skilled readers than the group which was not assigned the task. Taking these findings into consideration, the keyword detection task might exert a positive influence on EFL reading.

Moreover, what is of great interest is that as far as the reading behavior is concerned, keyword detection task did not influence the participants’ reading behavior in Japanese.
As all the participants were native speakers of Japanese who have substantial reading experience, they seem to have used their own strategies to build coherent mental representations.

V GENERAL DISCUSSION

There are not so many Japanese EFL learners who can read English texts as fluently as L1 English readers do. This experiment was conducted to identify the sources of individual differences in text comprehension performance among Japanese learners. In this experiment, the correlation of language proficiency and reading comprehension test scores were examined. The results showed that there was a significant difference in the mean value of English comprehension test scores between the high and low proficiency group. It was confirmed that L2 specific knowledge, such as vocabulary or grammatical knowledge, had considerable effects on L2 reading comprehension. Thus, we reconfirmed the importance of acquiring fundamental English competence which leads to the automaticity of lower-level processing in reading English texts.

Regarding working memory, the correlation coefficient for the English and the Japanese reading span scores was calculated. There was considerably high correlation between English and Japanese reading span test scores, which is consistent with the findings reported by Osaka and Osaka (1992). This result suggested that working memory is independent of linguistic knowledge and provides a shared cognitive resource across language. Miyake and Friedman (1998) hypothesized that working memory capacity influences one’s ability to comprehend structurally complex sentences correctly and efficiently. Moreover, they suggested that working memory capacity for language may be an important component of language aptitude.

However, in this study, no correlations were found between text comprehensions both in English and in Japanese and reading span scores. The correlation coefficient for reading span scores and reading comprehension scores on the English and Japanese texts were $r = .151$, n.s., and $r = -.202$, n.s., respectively.

Several explanations for the lack of correlation are possible. First, the material used in this experiment was relatively easy for the participants, as is apparent from the high scores on the comprehension test. Further, the participants could reread the sentences on the screen at their own pace, so long as they did not go back to the preceding screen. According to the Capacity Theory of Comprehension (Just & Carpenter, 1992), both processing and storage are mediated by activation, and the total amount of activation available varies among individuals. When the task demands are high enough to strain capacity, individuals with a smaller working memory capacity are less able to perform computations quickly or store intermediate products. In other words, as far as the
relationship of working memory capacity and language processing is concerned, what matters most is whether the task demands exceed their capacity or not. As participants read the relatively easy text at their own pace, it is considered that the task demands were not high enough to strain working memory capacity.

Second, there is a possibility that the participants used strategies to compensate for their insufficient working memory capacity. According to Chujo and Nakao (2005), who investigated the relationship between reading comprehension and working memory capacity using an eye tracker, readers read in small chunks or read repeatedly when their working memory capacity is running short. Based on the results of their experiment, they concluded that readers can use a compensatory strategy to make up for the shortage of working memory capacity and minimize the reading span differences.

Finally, factors other than working memory capacity might have played a more significant role in the participants’ text comprehension. An alternative approach to analyzing individual differences in language comprehension was proposed by MacDonald and Christiansen (2002). Contrary to the traditional view, they emphasized the learning side, rather than capacity limit. They contended that variations in experience or practice lead to individual differences in reading comprehension. Based on this experience-based approach, Wells et al. (2009) manipulated the reading experience of adults over a period of several weeks. They used object relative clause as the study material, because object relative clause is difficult to understand because of their low-frequency word order. The group that received relative clause experience increased reading speed for object relatives more than for subject relatives, whereas a control experience group did not. Therefore, the results supported MacDonald and Christiansen's claim that variation in reading experience is the major source of individual differences. The degree of differences in processing efficiency among Japanese EFL learners is greater than that of L1 readers. The efficient and automatic processing of the experienced readers appeared to minimize the span differences in this experiment.

Ericsson and Kintsch (1995) shares this appreciation for the importance of experience, asserting that text comprehension is an acquired skill. During the encoding and storage of the current sentence, the relevant information from the previously read text must remain accessible. Retrieval cues to the hierarchical organization of the encoded text provide access to the information, and this skill is also acquired through experience. Given that reading is a complex skill consisting of various component processes, individual differences in text comprehension might stem from the interaction of multiple factors, including working memory capacity, use of strategy, and experience-based language skill.
Regarding the keyword detection task, I hypothesized that learners can establish coherence of the text using keywords as retrieval cues to utilize the long-term working memory or as focus words to create good mental representation. Mean comparisons were made and ANOVA was used to analyze the difference between mean values of comprehension scores in English and Japanese between the task group and non-task group using the data from Session 2. The mean value of the participants’ comprehension score in the task condition in English and in Japanese outperformed the mean value of the non-task group, although the differences were not statistically significant. What is more, regarding the comparison of fixation frequency and fixation duration between the two groups in English, the task group’s eye fixation frequencies in the second time reading decreased more than that of the non-task group. From the perspective of eye movement protocols, participants who were given the keyword detection task behaved more like skilled readers. Consolidating these findings, it can be concluded that reading tasks such as the keyword detection task might serve to improve the reading performance in English, especially in cases where readers are overloaded with capacity demand. Although the participants read with keyword detection task only once in this experiment, their comprehension performance and reading behavior improved to some extent. Therefore, it seems reasonable to assume that repeated practice in reading with focusing task will lead to further improvement.

As mentioned, unlike the results in English, the average fixation frequencies and the average total fixation durations of the task group in Japanese were almost the same as those of the non-task group. This can likely be attributed to the relatively low degree of variability in the participants’ L1 proficiency. As the participants were all native Japanese, they could read in their own way without relying on the keyword detection task. In other words, reading tasks may have a greater effect on EFL learners reading behavior. To read a text skilfully, readers have to reorganize the incoming information and integrate it with their ongoing textual interpretation. As EFL learners are in the process of development, they are inclined to be preoccupied with lower-level processing and cannot afford to direct enough attention to integration process. With the help of a reading task such as the keyword detection task, EFL learners might improve in their processing skill.

Long-term empirical studies of the effects of reading tasks on EFL reading comprehension in English are suggested. Additional studies on reading tasks will offer further implication for the methods used to teach EFL reading.

As a byproduct of the task experiment, one point worth noting was found: Rereading leads to good reading behavior and good comprehension. Mean fixation frequencies decreased from 77.4 to 54.6 in the non-task condition of the English text and from 66.9 to 46.3 in the task condition. Mean total fixation durations decreased from 21.6 sec. to 15.7 sec. in non-task condition of the English text and from 18.3 sec. to 12.7 sec. in task
condition. In the Japanese text, both mean fixation frequencies and mean total fixation durations in the second time of both conditions decreased to almost half the value of the first time. This finding highlights the importance of rereading texts, especially in the EFL classroom.

VI CONCLUSION

Judging from the findings that the average comprehension score of the high proficiency group was significantly higher than that of the low proficiency group and eye movement behavior of the high proficiency group was better than that of the low proficiency group, it was confirmed that proficiency is a main predictor of reading comprehension performance. Accordingly, it is evident that language proficiency and L2 specific knowledge, such as knowledge of vocabulary and grammar, play important roles in text comprehension. Furthermore, if readers have high language proficiency, they can form appropriate mental representations, which then lead to effective retrieval and integrating processes. As this study confirmed that lower-level processing competency is vital to successful text comprehension, the importance of automatization of lower-level processing must be recognized.

Compared with proficient readers, less proficient readers are unable to carry out lower-level processing fluently and automatically. This problem prevents them from using their cognitive resources effectively. Processes become automatic if they are used extensively. The total amount of time spent on reading is one of the largest determinants of reading performance (Just & Carpenter, 1987; Segalowitz, 2003). Repeated practice for enhancing lower level language processing (such as word recognition or syntactic parsing) and extensive reading will contribute to the improvement of L2 reading ability. In conclusion, the results of this study demonstrated the importance of fundamental English proficiency in EFL reading comprehension.

(Doctorate Program, Graduate School of Intercultural Studies, Kobe University)

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APPENDIX

A. A Cultural Difference: Being on Time

In the United States, it is important to be on time, or punctual, for an appointment, a class, a meeting, etc. However, this may not be true in all countries. An American professor discovered this difference while teaching a class in a Brazilian university. The two-hour class was scheduled to begin at 10 A.M. and end at 12 P.M. On the first day, when the professor arrived on time, no one was in the class room. Many students came after 10 A.M. Several arrived after 10:30 A.M. Two students came after 11 A.M.
Although all students greeted the professor as they arrived, few apologized for their lateness. Were these students being rude? He decided to study the students' behavior.

The professor talked to American and Brazilian students about lateness in both an informal and a formal situation: lunch with a friend and in a university class, respectively. He gave them an example and asked them how they would react. If they had a lunch appointment with a friend, the average American student defined lateness as 19 minutes after the agreed time. On the other hand, the average Brazilian students felt the friend was late after 33 minutes.

In an American university, students are expected to arrive at the appointed hour. In contrast, in Brazil, neither the teacher nor the students always arrive at the appointed hour. Classes not only begin at the scheduled time in the United States, but they also end at the scheduled time. In the Brazilian class, only a few students left the class at noon; many remained past 12:30 to discuss the class and ask more questions. While arriving late may not be very important in Brazil, neither is staying late.

The explanation for these differences is complicated. People from Brazilian and North American cultures have different feelings about lateness. In Brazil, the students believe that a person who usually arrives late is probably more successful than a person who is always on time. In fact, Brazilians expect a person with status or prestige to arrive late, while in the United States lateness is usually considered to be disrespectful and unacceptable. Consequently, if a Brazilian is late for an appointment with a North American, the American may misinterpret the reason for the lateness and become angry.

As a result of his study, the professor learned that the Brazilian students were not being disrespectful to him. Instead, they were simply behaving in the appropriate way for Brazilian students in Brazil. Eventually, the professor was able to adapt his own behavior so that he could feel comfortable in the new culture.
つまり「同じ」にするということの性質がもっとも良く出ているのが「言葉」なのです。 言葉というのは、別のものでも「同じ」だとして話を進めるのに便利な道具です。「そりゃ細かく見れば、どのリンゴも違うに決まってるさ。でも、そこは目をつぶって同じものだってことにしようよ」と皆で了解して「リンゴ」という言葉を使うわけです。

便利といえば便利ですが、感覚的に世界をとらえている動物からすれば乱暴な話だとなるかもしれません。

実は人間は動物と比べると「音痴」だということはわかっています。たとえば人間の場合、絶対音感の持ち主というのは非常に少ない。ところが動物は感覚でとらえていますから、音に関しては敏感で、彼らは絶対音感の持ち主です。

だから「ホーホケキョ」はどの土地でも同じメロディなのです。人間のように「音が少し外れているけど、きっとホーホケキョって言いたいんだな」という大雑把な捉え方は通用しません。

概念的に考えることが出来るおかげで、人間は複雑な言語を使えるようになり、それが現在の文明を築いたのは間違いありません。

しかし、それでも私は概念的な考えの比重を置くことは健全ではないと思います。つまり「リンゴはどれも同じ」と簡単にまとめて考えない面を持つ人の方がまっとうではないかと思うのです。

もちろん何もいちいち「『A=B』って何だ？」と疑問を持てというのではありません。 それでは大人として問題があります。その調子で会話していたら、喧嘩になるか相手にされなくなるかのいずれかです。

しかしあんたは最近の人は概念的な思考ばかりが優先して感覚的な思考が出来なくなっていることです。感覚が鈍くなっているのです。

平たく言えば、頭でっかちになって、目の前のことに鈍くなってしまっている人が増えています。

C. Recognition Task (A cultural difference)

以下の文を読んで、その内容が文中にあったと思うものには○、なかったと思うものには×を( )の中につけて下さい。

( ) アメリカでは時間に正確であることは大切ではない。
( ) すべての国で、時間に正確であることが大切というわけではない。
( ) アメリカ人の教授がブラジルでの授業の初日、時間通りに行ったら、学生はほとんど全員定刻に来ていた。
( ) 全ての学生が来ると教授にあいさつした。
( ) 教授はアメリカ人とブラジル人の学生に友人とのランチや大学の授業の遅刻に対してどういう反応をするか尋ねた。
( ) アメリカ人は決められた時間より19分遅れると遅刻だと考えた。
( ) ブラジル人は5分おそくても遅刻と考えた。
( ) アメリカの大学では、学生は必ず定刻に来るものだと考えられている。
( ) ブラジルでは教師も学生も必ず定刻に来る。

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ブラジルでは遅刻することはたいした問題ではないが、遅くまで居残ることは良くないと考えられている。アメリカでは授業は定刻に終わる。ブラジル人と北米の文化圏の人は遅刻について異なる感情を持っている。アメリカ人の教授はブラジルの学生がブラジル流に行動していただけだと分かった。アメリカ人は地位のある人は遅く来るものだと思っている。ブラジルでは時間に正確な人は、遅刻する人より偉いと考えられている。アメリカ人の教授はブラジル人の学生が自分に敬意を払っていないわけではないと分かった。アメリカ人の教授は新しい文化に慣れることが出来た。

D. Recognition Task (People of Today are Tone-Deaf)
以下の文を読んで、その内容が文中にあったと思うものには○、なかったと思うものには×を( )の中につけて下さい。
( ) 感覚的思考の代表例が言葉だ。
( ) リンゴが目の前に2個あると、「りんご」などという大雑把なくくりで同じものというのは無理があると考える人は多い。
( ) 人間は概念的に考えることが出来る。
( ) 人間は感覚では別のものを「同じ」と捉えて考えることはできない。
( ) 人間はどのリンゴも全く同じだと確認して、「リンゴ」という言葉を使う。
( ) 「同じ」にするということの性質が最も良く出ているのが「言葉」だ。
( ) 言葉というものは別のものでも「同じ」だと考え、話をするのに便利な道具だ。
( ) 動物は概念的にものを考える。
( ) 動物は人間と比べると「音痴」だ。
( ) 動物は絶対音感の持ち主だ。
( ) 「ホーホケキョ」はどの土地でも同じメロディだ。
( ) 概念的に考えることが出来るので人間は複雑な言語を使えるようになった。
( ) 最近の人は概念的な思考を優先しながらも感覚的な思考も出来るようになってきている。
( ) 人間は感覚的に考えることが出来るので現代の文明を築いた。
( ) 概念的な考えのみに比重をおくことは健全ではない。
( ) 「リンゴをどれも同じ」と簡単に丸めないで考えた方がまっとうだ。
( ) いちいち「A=B」って何だと疑問を持つべきだ。
( ) 何でもかんでも疑問を持つ大人の方が人から相手にされる。
最近の人は感覚が鈍くなってきている。
頭でっかちになって目の前にすることを鈍くなってしまっている人が増えている