Exploring Language Threshold Effect and Its Differential Manifestation in Different Measurement Tools

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The language threshold effect on comprehending an L2 (second language) text was experimentally examined, using two types of measurement tool, multiple-choice & true/false questions and a recall task for L2 reading comprehension. Cognitive processes implicated in each measure were delineated to allow a finer analysis on the role of L1 reading competence and L2 proficiency in comprehending an L2 text. In order to observe how one aspect of L2 proficiency, vocabulary knowledge, is related to language threshold effect, thirty-two 9th grade Korean students in Korea were given a vocabulary knowledge acquisition activity in a treatment condition between a pretest and a posttest. The relative contributions that L1 reading competence and L2 proficiency made to L2 reading comprehension were analyzed before the treatment and after the treatment using multiple-regression analysis technique. The findings of this repeated measure design were consistent with previous correlational studies showing that the role of L1 reading competence became stronger as L2 proficiency operationalized via vocabulary knowledge improved. What is elaborated in the present study is the fact that cognitive processes, initiated by a recall task, are more sensitive to the weakening of language threshold effects.

I. INTRODUCTION

How different kinds of knowledge and cognitive components explain individual differences in L2 reading comprehension has been one of the major foci for investigation among L2 researchers. Out of many variables considered playing significant roles in comprehending an L2 text, individual differences in L1 reading competence and L2 proficiency have drawn more attention than other factors. Gelderen et al.’s (2004) summary of three approaches to explaining L2 reading comprehension helps us see key issues involved: (1) L2 reading comprehension primarily as a function of the higher order
L1 reading strategies and metalinguistic knowledge (Goodman, 1971), (2) the necessity of enough L2 linguistic knowledge for successful text comprehension (Alderson, 1984; Clarke, 1979; Cummins, 1979), and (3) the importance of automatized processing of linguistic information for successful L2 reading comprehension (Favreau & Segalowitz, 1983; Koda, 1996; Segalowitz, 2000).

The present study investigated the first two approaches in a finer grain size. The first approach, also known as linguistic interdependence hypothesis, postulates that L2 readers’ L1 reading competence is transferred to L2 reading comprehension, making different levels of competence in L1 reading an influential factor. The second approach, on the other hand, maintains that individual differences in L1 reading competence would not be observed among L2 readers unless they reach a certain level of L2 proficiency, commonly called the language threshold level. Even though this language threshold effect was investigated in relation to different levels of L2 proficiency in previous studies, how this is manifested in different measurement tools has not been studied yet.

What this study contributed to the existing body of knowledge on the issue is twofold. First, two kinds of instrument (a recall task and true/false & multiple-choice question) were used to measure L2 reading comprehension. Each instrument was explicated in terms of cognitive processes involved. This in turn made it possible to explore the cognitive process of how L1 reading competence became instrumental during L2 reading comprehension. Secondly, unlike the previous studies that adopted correlational analyses and thus did not inform us of any causal relationships between the lack of L2 linguistic knowledge and language threshold effect, the present study adopted an experimental design. A condition of improved L2 proficiency was operationalized through a vocabulary acquisition activity; participants were asked to study words that appear to-be-read reading texts as a treatment. After the acquisition of vocabulary knowledge necessary to read the texts, the participants were less constrained to their limited L2 proficiency. This experimental design made it possible to observe a direct impact of acquiring vocabulary knowledge or enhanced L2 proficiency on L2 reading comprehension.

II. REVIEW OF THE PREVIOUS STUDIES

There are four studies (Benhardt & Kamil, 1995; Bossers, 1991; Brisbois, 1995; Carrell, 1991) that specifically investigated the relative contribution of L1 reading competence and L2 proficiency to L2 reading comprehension. They also compared the contribution patterns between L2 readers with lower and higher levels of L2 proficiency. The use of the same statistical analysis technique made the interpretation of the results across the studies easier. Carrell (1991) analyzed the variances explained by L1 reading competence and L2
### TABLE 1
Summary of the Studies on Language Threshold Effects

<table>
<thead>
<tr>
<th>Participants</th>
<th>Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrell (1991)</td>
<td>· 45 native speakers of Spanish learning English and 75 native speakers of English learning Spanish in college</td>
<td>· Multiple-choice questions on two reading passages in Spanish and English</td>
</tr>
<tr>
<td>Bossers (1991)</td>
<td>· 50 adult native Turkish speakers learning Dutch as a 2nd language</td>
<td>· Multiple-choice questions on L1 and L2 reading passages · Dutch as a 2nd language battery (vocabulary &amp; grammar)</td>
</tr>
<tr>
<td>Benhardt &amp; Kamil (1995)</td>
<td>· 167 adult native English speakers learning Spanish</td>
<td>· L1 reading: Nelson-Denny Reading Test (comprehension and rate) &amp; English ABLE (adult basic learning examination, 48 multiple choice questions) · L2 reading: Spanish ABLE tests (48 multiple choice questions)</td>
</tr>
<tr>
<td>Brisbois (1995)</td>
<td>· 131 adult English native speakers learning French</td>
<td>· L1 Reading: Nelson-Denny reading test and recall · L2 linguistic knowledge: vocabulary &amp; grammar · L2 reading: free recall protocols</td>
</tr>
</tbody>
</table>
proficiency in two different language groups (Spanish speakers learning English and English speakers learning Spanish). It was found that L2 proficiency and L1 reading competence both significantly contributed to L2 reading comprehension. However, L1 reading competence was a stronger predictor for Spanish speakers learning English than L2 proficiency, and vice versa for English speakers learning Spanish. This pattern is attributed to a more advanced level of L2 proficiency found among Spanish speakers learning English. It is interpreted that they were able to transfer their L1 reading competences more easily with relatively more advanced L2 proficiency. Thus, the result supports both the linguistic interdependence hypothesis and the language threshold hypothesis.

Bossers’ (1991) study also confirmed this pattern. In the comparison of less skilled L2 readers with more advanced ones, L2 proficiency was observed to be the only significant variable among less skilled readers, whereas L1 reading competence was the only significant predictor for more advanced L2 readers. The data from Benhardt and Kamil’s (1995) study favored the language threshold effect in that L2 proficiency explained more variances than L1 reading competence. This is the same pattern found in Carrell’s (1991) study; for English speakers learning Spanish, L2 proficiency was stronger predictor for L2 reading comprehension. What Brisbois (1995) found also supported the general pattern of weakened language threshold effect or the emergence of linguistic interdependence as L2 proficiency improved. The relative contribution of L1 reading competence was found to be doubled for students with more advanced L2 skills.

Thus, the general finding of the studies was that L2 proficiency or L2 linguistic knowledge was the only significant predictor for L2 reading comprehension for less proficient L2 learners, whereas L1 reading competence gained its significant role in more advanced L2 learners’ data. However, as Bernhardt and Kamil (1995) mentioned, this finding needs to be interpreted more cautiously for two reasons. First, the types of measure for L1 reading competence, L2 proficiency, and L2 reading comprehension slightly differed among the studies. Secondly, unequal samples sizes were also problematic; a greater number was used in lower proficiency groups in all of the studies.

More recent studies (Fecteau, 1999; Lee & Schallert, 1997; Pichette, Segalowitz, & Connors, 2003) investigated the same issue with a similar correlational analysis technique but with additional questions. Lee and Schallert (1997) not only confirmed the results of the previous studies but also found that the data collected among 809 Korean 9th and 10th grade students reflected a threshold view rather than a continuous rise. That is, the correlation between L1 reading and L2 reading steeply increased at a specific proficiency level after almost no correlation between them over a range of L2 proficiency. After this threshold level of L2 proficiency, the correlation between L1 reading and L2 reading gradually increased. Fecteau (1999) investigated the same issue but used a different genre
for L2 reading, literary texts instead of expository texts. The analysis of the data on forty-two English speaking college students reading French philosophical narratives by Voltaire showed that L2 proficiency did not play a significant role but L1 reading competence did. Fecteau attributed this observation to the advanced level of the participants’ French and a strong effect of top-down reading strategy.

A more recent work by Pichette, Segalowitz, and Connors (2003) investigated not only the language threshold effect but also the impact of maintaining L1 reading skills on the development of L2 reading skills in a longitudinal research design. Fifty adults, immigrants to Quebec, Canada, were given cloze reading tests in L1 (Serbo-Croatian) and L2 (French) at two different times with a one year gap in between. The analyses of the data supported the language threshold effect in that L2 knowledge was the only significant predictor for L2 reading at time one, but both L1 reading and L2 knowledge became significant at time two. For the high L2 knowledge group at time two, L1 reading ability was the only significant predictor for L2 reading comprehension, whereas L2 knowledge was still the only significant predictor for the low L2 knowledge group.

Classifying the participants as active readers (more than one hour per week) vs. nonactive readers (less than one hour per week) based on the time spent reading in their L1, Pichette, Segalowitz, and Connors (2003) analyzed the impact of maintaining L1 reading on L2 reading comprehension. The result showed that active maintenance of L1 reading was a significant predictor to the increase in L2 reading ability even after controlling for L2 knowledge and time spent reading in L2. However, this conclusion about the impact of L1 reading maintenance should be made cautiously because the sample size was reduced to fourteen when only the data from the group whose membership did not change from time one to time two were analyzed.

Even though the evidence may not be conclusive in favor of language threshold effect, the studies reviewed above certainly suggest that in order for L1 reading competence to be manifested in L2 reading comprehension, there is a certain level of L2 proficiency that L2 readers should go beyond. That is, a limited level of L2 proficiency is likely to bring about a bottleneck effect in which the functioning of L1 cognitive resources in L2 reading comprehension is blocked by the threshold level of L2 proficiency. This cognitive phenomenon was instantiated in the latest study by Ardasheva, Tretter, and Kinny (2012). It provided some practical data that showed how language threshold plays a role for ELLs in the U.S. Ardasheva, Tretter, and Kinny compared the performance in reading and mathematics of (1) former ELLs who have mainstreamed after the ESOL program (n = 500), (2) current ELLs (n = 558) taking ESOL classes, and (3) native English speakers (NES) of the similar grades or age (n = 17470). As expected, former ELLs and NES performed better on the state reading and mathematics tests than current ELLs. Furthermore, former ELLs significantly outperformed NES. Since the classification for
former ELLs or current ELLs was made based only on L2 proficiency not ELLs’ academic contents, Ardasheva, Tretter, and Kinny argued that the stark difference in their performance of the reading and mathematics tests between former ELLs and current ELLs is attributed to L2 proficiency. The bottleneck effect was so dominant among current ELLs that they could not resort to their underlying academic skills.

Even though the study by Ardasheva, Tretter, and Kinny (2012) confirmed the two hypotheses under investigation, specific cognitive processes involved in the transition from language threshold to language interdependence has not been explored yet. In order to understand this cognitive phenomenon of language threshold effect in a finer grain size, cognitive processes involved in the measurement tools of L2 reading comprehension need to be considered. Understanding specific cognitive processes implicated in different kinds of measure for L2 reading comprehension can enable us to identify cognitive processes more responsible for the weakening of language threshold effect after the enhanced condition of L2 proficiency, the acquisition of vocabulary knowledge contained in a to-be-read English text.

III. COGNITIVE PROCESSES INVOLVED IN EACH MEASURE

The present study used two types of measure that have distinct features in drawing different cognitive processes for the successful completion of each task; a recall task and true/false & multiple-choice questions. To complete a recall task successfully (Rec hereafter), readers need to remember a given text. Considering the limited capacity of working memory, however, what actually makes readers remember the contents of an approximately 200-300 word-long text is not a function of simple working memory capacity but rather an ability to organize information into coherent structures. Such structures in readers’ mental space in turn subsume details of the content for the task of recall. Ericsson and Kintsch (1995) identified this phenomenon as a function of long-term working memory, the representation of propositions activated in the reader’s long-term memories in relation to text information. Thus, the recall task relies heavily on readers’ ability to build coherent structures of the text and to use them to elaborate and retrieve details from memory.

As far as multiple-choice & T/F questions (MC hereafter) are concerned, the focus is on the ability to evaluate detailed information according to the perspective provided in each question. Unlike completing a recall task, readers taking MC can refer back to the text whenever they need, resulting in the decrease of the cognitive load for remembering; that is, they have no need to capitalize on an ability to build coherent structures of the text to a great degree. What is critical in providing good responses to MC is that readers need
to evaluate pieces of information given in the questions in relation to their understanding of the main text and then to distinguish true information from false one; note that readers do not need to afford their cognitive capacity to remembering the text in MC to a great degree because they can refer back to the main text as needed. Thus, this feature of MC leads readers to rely more on their evaluative ability rather than remembering or building coherent structures of the text.

Thus, it was proposed that each measurement tool taxes distinct cognitive features. How language threshold effects are differentially manifested in these different measurement tools was investigated in two conditions, before and after the acquisition of vocabulary knowledge; note that the acquisition of vocabulary knowledge was a way to operationalize enhanced L2 proficiency in the present study. The hypotheses to be explored were:

1. The effect of individual differences in L1 reading competence upon L2 reading comprehension before the acquisition of vocabulary knowledge will be minimal due to the language threshold effect.
2. The language threshold effect will be differentially shown in multiple-choice & T/F questions and a recall task.
3. The acquisition of vocabulary knowledge will weaken language threshold effect.

IV. METHODOLOGY

1. Participants

Participants were 9th grade Korean students recruited from three Korean public middle schools (n = 32) in Korea: six participants from A middle school, sixteen participants from B middle school, and ten participants from C middle school. These three middle schools were chosen based on their willingness to participate in the study by the request of the researcher. Basic information concerning the procedures of the study was given to all of the 9th grade students in these three schools; compensation for participating in the study was their being able to take the TOEIC Bridge for free. Even though forty-five students (six from A, 24 from B, and 15 from C) were recruited in total and took the TOEIC Bridge, thirty two students of them completed the entire process of the study. Those with missing data (thirteen students) were excluded from the analysis.

2. Instrument

The instrument included (1) a test of L2 proficiency (TOEIC Bridge), (2) an L1 reading
comprehension test (multiple-choice & T/F questions and a recall task), (3) three L2 reading comprehension tests (multiple-choice & T/F questions and a recall task), (4) materials for two treatment activities (vocabulary and schematic knowledge), and (5) quizzes on these two treatment activities. Three English tests were developed because the participants had to go through three different conditions (vocabulary acquisition, schematic knowledge acquisition, and control) in this repeated measure design; the test forms were counterbalanced in the vocabulary knowledge and schematic knowledge acquisition conditions.

TOEIC Bridge is a standardized test developed by the Educational Testing Service (ETS) and measures emerging English competence; it consists of listening comprehension and reading comprehension questions. The Korean reading test was developed by the researcher. A 406-word long text about blood circulation was extracted from a Korean biology textbook, used in high schools in Korea. The reason why the high school textbook was used was to make sure that the participants comprehend the text not only from their background knowledge but also from new information. Since learning by reading was considered an ideal condition for the purpose of reading, the use of high school textbook was deemed to be acceptable. Sixteen True/False questions and four multiple-choice questions were developed. The concept was deemed to be somewhat familiar but with new information on lymph. The familiar topic was covered in the curriculum that the target population had been in over their previous school years. The text on the new information (lymph) was 124 words long. To make sure that the test does not function as a test for background knowledge only and measures L1 reading comprehension, new information on lymph was extracted from a high school text book.

Three English texts (517, 530, and 558 words) were extracted from the textbook, Cells and Heredity, which is used in American middle schools. The topics of the texts were photosynthesis, respiration, and cancer. It was determined that 9th grade students had already learned the topics photosynthesis and respiration, in 7th and 9th grades respectively in the Korean curriculum (http://ncic.kice.re.kr/nation.dwn.ogf.inventoryList). The choice of science text was intentionally made because the focus of the entire study was to investigate not only the role of L2 proficiency but the role of L1 reading competence, which the researcher hypothesized is connected to schematic knowledge and background knowledge. Knowledge on science was deemed to be informative and schematic relatively at a greater degree than that on other fields.

The material for the acquisition of vocabulary knowledge included a list of words extracted from the texts (42 words from photosynthesis and 44 words from respiration; the topic of cancer was used for a control condition requiring no treatment), an English definition of each word in the list, one English example sentence, and a translation of the example sentence. The Korean translation for the target word was filled with a blank...
instead so that the participants could infer the meaning of the target work, resulting in learning. A Korean translation of each example sentence with the meaning of the target word included was also provided in the last page. After this learning activity, a 15 minute-long quiz was given; the same vocabulary list was presented with blanks to be filled in with the Korean translation.

3. Procedures

The data analyzed in this paper were part of a larger study that explored a theoretical model of L2 reading comprehension (Construction Integration model for L2 reading comprehension). For this reason, the participants went through not only a vocabulary acquisition condition but also a schematic knowledge acquisition condition. With a control condition added, there were three groups compared. In addition, since the present study adopted a repeated measure design to increase statistical power by removing within-subject variations not caused by treatments (Lomax, 2001), all the thirty two participants went through the three conditions. The data collected in the schematic knowledge condition will not be further discussed in the present paper except for the description of procedure because they were not relevant to the investigation of the language threshold effect.

The study was conducted over four consecutive days, which is summarized in Table 2.

(1) Day One
Administration of the TOEIC BridgeOne staff member from an ETS vendor in Korea came to each school on July, 14 in A middle school, July, 29 in B middle school, and July, 27 in C middle school to supervise the implementation of the test. The participants were given instructions for the test and asked to fill out forms on the background information. The test of listening comprehension was given in the first section for 25 minutes, consisting of fifteen questions on picture description, twenty on responses, and fifteen on conversation. Without any break, the reading comprehension section followed for 35 minutes. Thirty questions on grammar and vocabulary and twenty on reading comprehension were administered. When the test was finished, the staff collected response sheets in order to score them. The test scores were sent to the researcher two weeks later and to individual students two months later.

(2) Days Two and Three: Treatment Conditions
Each session consisted of four phases: (1) a pretest (50 minutes), (2) intervention (35 minutes), (3) a quiz on the intervention (15 minutes), and (4) a posttest (50 minutes). Two ten-minute breaks were given; one between phases one (pretest) and two (intervention)
and the other between phases three (intervention) and four (posttest). The pretest and the posttest had the same format and the same time allotment except that, during the posttests, the participants were allowed to refer to the treatment materials: either a vocabulary list with Korean translations or a concept map with Korean explanation.

Each participant during the first and second days was given a test set in a paper and pencil form. The pretest began with the first page asking the participants to fill in their names and email addresses and describing the organization of the test and time allotments: reading the whole text (5 minutes), recall (5 minutes), reading the first half again (5 minutes), recall (5 minutes), reading the second half again (5 minutes), recall (5 minutes), and answering fifteen T/F and three multiple-choice questions (20 minutes). Following the instruction, the participants were asked to read the whole text for global understanding for five minutes and asked to recall whatever they can remember during the five-minute long recall session. They were then asked to read the first half of the test again in more detail for five minutes followed by the five-minute long recall session. They went through the same procedure with the other half of the test. After this reading-recall session, they answered fifteen T/F and three multiple-choice questions for 20 minutes. They were not allowed to go back to a previous step or go forward to a following step within these time frames. After the pretest, either a vocabulary knowledge acquisition activity or a schematic knowledge acquisition activity was given (30 minutes), followed by a quiz (15 minutes) on each activity that the participants participated in. After each treatment, the participants took the same test as the pretest within the same time frame.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Day One</th>
<th>Day Two</th>
<th>Day Three</th>
<th>Day Four</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration of TOEIC Bridge</td>
<td>Pretest</td>
<td>Pretest</td>
<td>Pretest</td>
<td>9:00-9:50</td>
<td></td>
</tr>
<tr>
<td>(photosynthesis or respiration)</td>
<td></td>
<td>(photosynthesis or respiration)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BREAK</td>
<td></td>
<td>BREAK</td>
<td>BREAK</td>
<td>9:50-10:00</td>
<td></td>
</tr>
<tr>
<td>Treatment &amp; Quiz</td>
<td>Treatment &amp; Quiz</td>
<td>Treatment &amp; Quiz</td>
<td>Test</td>
<td>10:00-10:50</td>
<td></td>
</tr>
<tr>
<td>(blood circulation and lymph)</td>
<td></td>
<td></td>
<td>(cancer)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BREAK</td>
<td></td>
<td>BREAK</td>
<td>BREAK</td>
<td>10:50-11:00</td>
<td></td>
</tr>
<tr>
<td>Posttest</td>
<td></td>
<td>Posttest</td>
<td>Posttest</td>
<td>11:00-11:50</td>
<td></td>
</tr>
<tr>
<td>(photosynthesis or respiration)</td>
<td></td>
<td></td>
<td>(cancer)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The treatment of vocabulary knowledge acquisition was administered over a two-day period because there were two treatment conditions in the entire study, and the order effect had to be prevented; the test forms and the order effect of different treatment had to be counterbalanced. For this reason, half of the participants received the vocabulary acquisition activity on Day Two and the other half on Day Three.

(3) Day Four: Control Condition and Korean Reading Test

The control condition had the same format as the treatment conditions except that there was no treatment activity or quiz between the pretest and the posttest. Instead, a Korean reading test was administered. The Korean reading test had the same format as the three English tests except that two questions were added in the last section (one true/false question and one multiple-choice question). Thus, the overall structure of the test was: reading the whole text (5 minutes), recall (5 minutes), reading the first half of the text (5 minutes), recall (5 minutes), reading the other half of the text (5 minutes), recall (5 minutes), and answering fifteen T/F and three multiple-choice questions (20 minutes). A possibility of carryover effect was excluded because there was no relevant knowledge in the Korean test to the topic of “cancer” covered in the English test; that is, the participants could not benefit from reading the Korean test on the topic of “blood circulation” and “lymph” to understand the English text better.

4. Scoring Procedures

The data collected for the study included (1) the scores of the TOEIC Bridge (LC and RC) as a measure of general L2 proficiency, (2) two sets of scores (multiple-choice & T/F questions and recall data) on Korean reading comprehension, and (3) two sets (multiple-choice & T/F questions and recall data) of scores on English reading comprehension for all of the English pretests and posttests.

The scoring procedures for each instrument are described as following:

(1) TOEIC Bridge
The test was administered, scored, and reported by an ETS vendor in Korea

(2) Recall Data
Three English texts (photosynthesis, respiration, and cancer) and one Korean text (blood circulation and lymph) were used for the recall task. The original texts for the three English tests and the one Korean test were analyzed for the identification of propositions. A single subject/predicate relationship was counted as one proposition. Since verbs always accompany a subject in English, each verb in the three English texts was counted as one
proposition whether or not it belonged to a main clause or dependent/embedded clauses. An infinitive, such as *to make* in the sentence *These organisms use the energy in sunlight to make their own food*, was also counted as one proposition because it means that *these organisms make their own food*, which contains a subject/predicate relationship. A prepositional phrase, such as *in the sunlight*, was also counted as one proposition because it means that *the energy is in the sunlight*, which indicates a subject/predicate relationship as well.

The scores for recall in photosynthesis, respiration, and cancer were converted into a total score of 100 respectively because the number of propositions in each English text differs slightly (80 for photosynthesis, 89 for respiration, and 85 for cancer).

(3) Multiple-Choice and True/False Tests

Three English tests and one Korean test were used for multiple-choice and true/false tests. The three English tests had 18 questions (15 true/false and 3 multiple-choice) each; students’ responses to the questions in the test were scored dichotomously as right (1) or wrong (0) answers. The total right answer scores were the sum of these values over all the questions in each test set. The Korean text had 20 questions (16 true/false and 4 multiple-choice); students’ responses to the questions were scored dichotomously as right (1) or wrong (0) answers. The scores were the totals of these values over all the questions in the Korean test. The reliability for each test (Cronbach’s $\alpha$) was .66 (Korean reading test), .60 (photosynthesis, pretest), .66 (photosynthesis, posttest), .43 (respiration, pretest), .69 (respiration, posttest), .55 (cancer, pretest), and .71 (cancer, posttest).

(4) Scores for Vocabulary Knowledge

42 English words were tested in the “photosynthesis” text, and 44 words in the “respiration” text. Student responses were dichotomously scored; the correct translation of the English words into Korean was given 1, and incorrect translation or no response was given 0. The total score was the sum across all the items. The scores were converted into the total score of 40 respectively by proportionate rescaling.

V. RESULTS

The results of schematic knowledge condition will be excluded in this section. As shown in Table 3, the two English pretests were of a similar level of difficulty for the participants; the mean score of the multiple-choice & T/F questions was 10.91 ($SD = 2.91$) for the control condition and 11.34 ($SD = 2.95$) for the vocabulary knowledge condition; and the mean score of the recall task (L2Rec) was 21.75 ($SD = 11.35$) for the control
condition and 21.72 (SD = 14.21) for the vocabulary knowledge condition. The mean for each predictor variable was 144.13 for L2 proficiency (TOEIC Bridge), 14.06 for L1MC, 32.81 for L1Rec, and 46.88 for L1, the combined score of L1MC and L1Rec.

### TABLE 3
**Descriptive Statistics**

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L2</td>
<td>144.13 (19.78)</td>
</tr>
<tr>
<td>L1MC</td>
<td>14.06 (2.51)</td>
</tr>
<tr>
<td>L1Rec</td>
<td>32.81 (9.27)</td>
</tr>
<tr>
<td>L1</td>
<td>46.88 (10.61)</td>
</tr>
</tbody>
</table>

### TABLE 4
**Differences Between the Pretests and the Posttests**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean Difference</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control L2MC</td>
<td>0.13</td>
<td>1.73</td>
<td>0.416</td>
<td>30</td>
<td>.680n.s.</td>
</tr>
<tr>
<td>Control L2Rec</td>
<td>1.44</td>
<td>5.32</td>
<td>1.503</td>
<td>30</td>
<td>.143n.s.</td>
</tr>
<tr>
<td>Vocabulary L2MC</td>
<td>1.22</td>
<td>2.12</td>
<td>3.250</td>
<td>31</td>
<td>.003*</td>
</tr>
<tr>
<td>Vocabulary L2Rec</td>
<td>6.75</td>
<td>8.81</td>
<td>4.303</td>
<td>31</td>
<td>.000*</td>
</tr>
</tbody>
</table>

L2MC: the scores on the multiple-choice questions & T/F questions in the English test
L2Rec: the scores on the recall task in the English test

To make sure that the vocabulary knowledge acquisition made a significant contribution, paired samples t-tests were run using the data in the control condition and the vocabulary knowledge acquisition condition. As shown in Table 4, the participants who reread the text...
and recalled and answered T/F & multiple questions did not improve in their understanding significantly ($p = .680$ in L2MC and $p = .143$ in L2Rec). However, the participants who went through the vocabulary knowledge condition improved in their scores of L2MC ($p = .003$) and L2Rec ($p = .000$).

In order to see the relative contributions of L1 reading competence and L2 proficiency to L2 reading comprehension, multiple regression analyses were run, using the scores of L2 reading comprehension tests measured by multiple-choice & T/F questions (hereafter L2MC) and the scores of L2 reading comprehension measured by a recall task (hereafter L2Rec) as criterion variables in each condition (see Table 5). The model of L1 reading competence (a composite score of L1 reading comprehension test, measured by multiple-choice and T/F questions, hereafter L1MC, and L1 reading comprehension test, measured by a recall task, hereafter L1Rec) and L2 proficiency (composite score of listening comprehension and reading comprehension in TOEIC Bridge) as predictor variables accounted for 32~45% of the variances in L2MC across the two pretest conditions, whereas the variance that L1 reading competence and L2 proficiency accounted for increased in L2Rec, which is 58~63%.

### Table 5

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>Criterion Variable</th>
<th>Parameter Estimate</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$R^2$</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control condition</td>
<td>L1 RC L2MC</td>
<td>.075</td>
<td>.288</td>
<td>2.086*</td>
<td>.45</td>
<td>11.798***</td>
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<tr>
<td></td>
<td>L2 P L1 RC L2MC</td>
<td>.083</td>
<td>.587</td>
<td>4.246*</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>L1 RC L2Rec</td>
<td>.570</td>
<td>.571</td>
<td>5.041*</td>
<td>.63</td>
<td>24.646***</td>
</tr>
<tr>
<td></td>
<td>L2 P L2 Rec</td>
<td>.285</td>
<td>.516</td>
<td>4.557***</td>
<td></td>
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<tr>
<td>VocaK condition</td>
<td>L1 RC L2MC</td>
<td>.027</td>
<td>.097</td>
<td>0.629n.s.</td>
<td>.32</td>
<td>6.900*</td>
</tr>
<tr>
<td></td>
<td>L2 P L1 RC L2MC</td>
<td>.081</td>
<td>.544</td>
<td>3.510***</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>L1 RC L2Rec</td>
<td>.569</td>
<td>.424</td>
<td>3.470*</td>
<td>.58</td>
<td>19.838***</td>
</tr>
<tr>
<td></td>
<td>L2 P L2 Rec</td>
<td>.407</td>
<td>.566</td>
<td>4.631***</td>
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</tbody>
</table>

Notes. $Df = 2$ for all models  
* $p < .05$, *** $p < .001$

VocaK: vocabulary knowledge acquisition condition  
L1 RC (scores of L2 reading comprehension test) is the composite on L1MC and L1Rec.  
L2 P (proficiency) is the composite scores on listening comprehension and reading comprehension in TOEIC Bridge.

In the measure of L2MC, L2 proficiency was the only significant predictor in the vocabulary knowledge condition, whereas both L1 reading competence and L2 proficiency
were significant predictors in the control pretest condition. The significant contribution of L1 reading comprehension in the control condition is deemed to come from the lack of background knowledge and will be discussed in the limitation of the study; the topics of photosynthesis and respiration used for the vocabulary condition had been covered in the previous curriculum for the participants, whereas cancer had not. In the measure of L2Rec, both L1 reading competence and L2 proficiency were significant predictors in both of the conditions (see Table 5). Thus, the language threshold effect was confirmed in the Voca L2MC model because L1 reading did not play a significant role. On the contrary, this threshold effect was loosened in the L2Rec models because L1 reading competence in addition to L2 proficiency was a significant predictor in both of the conditions.

The same multiple regression models as those analyzed with the scores of the pretests were run with the scores of posttests in the VocK condition; the two models were L2MC = L1Read + L2Proficiency and L2Rec = L1Read + L2Proficiency, and the results are presented in Table 6. The general pattern found after the acquisition of vocabulary knowledge is the same as the pattern observed before the treatment. L1 reading competence was not a significant predictor in an L2MC model but a significant predictor in an L2Rec model. However, the magnitude of contribution that L1 reading competence and L2 proficiency made changed after the acquisition of vocabulary knowledge.

### Table 6

<table>
<thead>
<tr>
<th>Condition</th>
<th>Predictor Variables</th>
<th>Criterion Variable</th>
<th>Parameter Estimate</th>
<th>β</th>
<th>t</th>
<th>R²</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>VocK</td>
<td>L1 RC</td>
<td>L2MC</td>
<td>.083</td>
<td>.289</td>
<td>1.870</td>
<td>.32</td>
<td>6.927*</td>
</tr>
<tr>
<td></td>
<td>L2 P</td>
<td></td>
<td>.069</td>
<td>.445</td>
<td>2.877*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1 RC</td>
<td>L2Rec</td>
<td></td>
<td>.753</td>
<td>.589</td>
<td>4.507***</td>
<td>.52</td>
<td>15.578***</td>
</tr>
<tr>
<td>L2 P</td>
<td></td>
<td></td>
<td>.026</td>
<td>.330</td>
<td>2.257*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes. df = 2 for all models

* p < .05, *** p < .001

L1 RC (scores on L1 reading comprehension test) is the composite on L1MC and L1Rec.

L2 P (proficiency) is the composite scores on listening comprehension and reading comprehension in TOEIC Bridge.

The dependence on L2 proficiency decreased in both models of L2MC and L2Rec after acquiring vocabulary knowledge; the regression coefficient (β) changed from .544 (t = 3.510*** to .445 (t = 2.877*) in the L2MC model and from .566 (t = 4.631*** to .330 (t = 2.257*) in the L2Rec model. On the contrary, the dependence on L1 reading competence
increased: the regression coefficient (β) changed from .097 (t = .629) to .289 (t = 1.870) in the L2MC model and from .424 (t = 3.470*) to .589 (t = 4.507***) in the L2Rec model. Even though L1 reading competence failed to reach a significant level in L2MC as in the pretests, the trend clearly indicated the direction of change. In the L2Rec model, the relative contributions of L1 reading competence and L2 proficiency were reversed from the pretest to the posttest; βs for L1 reading competence and L2 proficiency were .424 (t = .3470*) and .566 of (t = .4631***) in the pretest, while βs for L1 reading competence and L2 proficiency became .589 (t = 4.507***) and .330 (t = 2.257*) in the posttest.

In summary, it was found that as L2 proficiency became enhanced thanks to the acquisition of vocabulary knowledge, the dependence on L1 reading competence increased along with the decreased dependence on L2 proficiency. This result from an experimental design is consistent with what has been found about language threshold effect in the previous correlational studies.

VI. DISCUSSION

The first hypothesis explored whether language threshold effects were observed before any treatment; The effect of individual differences in L1 reading competence upon L2 reading comprehension before the acquisition of vocabulary knowledge will be minimal due to the linguistic threshold effect. My prediction for this hypothesis was that due to the linguistic demand of the texts and their conceptual difficulty (science texts), the participants would not be able to utilize their L1 reading competence. That is, language threshold effect would dominate L2 reading comprehension in the pretests to the extent that individual differences in L1 reading competence would not be reflected in the scores of the pretests. This prediction was confirmed in the L2MC model but not in the L2Rec model because L2 proficiency was the only significant predictor in the L2MC model, whereas L1 reading competence as well as L2 proficiency was a significant predictor in the L2Rec model (see Table 5). Even though differential manifestation of language threshold effect was not anticipated in the pretests, the result confirmed the second hypothesis in the scores of the pretests as well; The language threshold effect will be differentially shown in multiple-choice & T/F questions and a recall task.

The interpretation of this result needs to be made based on the different characteristics of each measure. In the measure of L2MC, readers were given not only the main text but also questions about it in English, which taxed L2 proficiency to a greater degree. In addition, readers did not need to rely greatly on their memory of the text in L2MC because they could refer back to the text as needed. This condition that required readers to build more text-based comprehension and to evaluate specific details in the text without needing
to remember it resulted in a strong dependency on L2 proficiency. On the contrary, this particular cognitive condition did not allow room for individual differences in L1 reading competence to play a significant role in comprehending the L2 text.

In the L2 Rec model, however, the language threshold effect was weakened because the cognitive processes necessary to complete a recall task turned out to require greater use of L1 reading competence. Due to limited L2 proficiency, readers tended to translate the text into L1 and to build a mental representation of the text in Korean. Thus, the text recall was also likely to occur in L1, which was confirmed by the result that twenty five students recalled entirely in Korean, five in Korean and English, and only two students entirely in English in the present study. It is deemed that the initial process of translation forced readers to form macropropositions of the text in L1 and use them to retrieve micropropositions for text recall in L1 as well, resulting in thinking in L1. This recalling process in L1 explains how L1 reading competence was a significant predictor in L2Rec in each of the pretest conditions.

As far as L2 proficiency is concerned, it was a significant predictor as expected in L2Rec. Readers still needed to understand the English text in the first place in order to translate or build a text-based mental model in L1. That is, the quality of initial mental representation of the text was determined by L2 proficiency. In this respect, a significant contribution of L2 proficiency observed in each of the two L2Rec conditions came with no surprise; note that even though L1 reading competence was a significant predictor in L2Rec, L2 proficiency made greater contribution to L2Rec in the pretests (See Table 5).

How the acquisition of vocabulary knowledge influenced L2 reading comprehension in relation to L1 reading competence and L2 proficiency was explored in the third hypothesis; The acquisition of vocabulary knowledge will weaken language threshold effect. In order to see whether vocabulary knowledge acquisition significantly improved comprehension in the posttests, paired samples t tests were conducted. The result of the analysis showed that a significant difference was found in the vocabulary knowledge condition ($p = .003*$ in L2MC and $p = .000*$ in L2Rec) but not in the control condition ($p = .680$ in L2MC and $p = .143$ in L2Rec) (see Table 4). This indicated that the acquisition of vocabulary knowledge indeed significantly improved participants’ comprehension.

Since the acquisition of vocabulary knowledge was used to operationalize a condition of enhanced L2 proficiency in the present study, the prediction concerning the language threshold effect was that the role of L2 proficiency will weaken, whereas that of L1 reading competence will become stronger after the acquisition of vocabulary knowledge. This prediction was confirmed by the results in that the direction of change in the magnitude that each predictor explained clearly indicated the weakening of language threshold effect and the emergence of linguistic interdependence effect. The regression coefficient for L2 proficiency became smaller after the acquisition of vocabulary
knowledge in both of the measure: from .544 to .445 in the measure of L2MC and from .566 to .330 in the measure of L2Rec (See Table 5 and Table 6). This confirms the weakening of linguistic threshold effect after enhanced L2 proficiency. On the contrary, the role of L1 reading competence became more influential in the scores of posttests in both L2MC and L2Rec models. The regression coefficients changed from .097 to .289 in L2MC and from .424 to .589 in L2Rec. This result of increased dependence on L1 reading competence in comprehending an L2 text after the acquisition of vocabulary knowledge supports the linguistic interdependence hypothesis.

The results confirmed by the experimental study makes robust the relationships among one important aspect of L2 proficiency, linguistic threshold effect, and L1 reading competence. That is, the casual relationship between improved L2 proficiency and the weakening of language threshold effect or the emergence of linguistic interdependence effect, which had been only suggested by previous correlational studies, was verified in the present experimental study.

Concerning cognitive processes responsible for explaining how L1 reading competence becomes instrumental in L2 reading comprehension as L2 proficiency increases, ones involved in the recall task turned out to play important roles because it was the recall task that allowed the emergence of linguistic interdependence in both of the pretest and the posttest. As explicated, major cognitive processes involved in this task were identified to be forming macropropositions from a given text, activating relevant background knowledge to help form better macropropositions, and using these structures to retrieve the details of the text in the recall task. Thus, one route through which individual differences in L1 reading competence find their way for manifestation during L2 reading comprehension could be these recalling processes. Considering a significant correlation between the scores of L2Rec and L2MC (.741 in the pretests and .678 in the posttests), figuring out how these recalling processes play a role in evaluation-focused activities of L2MC can shed some light on how L1 reading competence becomes instrumental in L2 reading comprehension in a finer grain size.

VII. CONCLUSION

One line of research that could help understand the cognitive processes involved in forming macropropositions comes from the studies on L1 reading comprehension; readers interested in how a macrostructure is formed and influences the subsequent comprehension processes should refer to theories of L1 reading comprehension such as Structure Building theory by Gernsbacher (1990), Construction Integration model by Kintsch (1998), and Landscape model by van den Broek, Young, Tzeng, and Linderholm
In the field of L2 reading comprehension, studies on a language for thinking during L2 reading comprehension (Cohen, 1998; Guerrero, 2005; Leontiev, 1981) can inform us of some details concerning recalling processes in that recalling inevitably involves some form of thinking. Since thinking in L2 assumes that L2 readers access meanings of surface structure directly without activating their L1 equivalents, studies on bilingual lexical processing can also be of some value in understanding how thinking in L2 begins to take place.

With the increased emphasis on higher-order second language skills, it has become a more relevant issue to investigate how individual differences in L1 reading competence interact with varying levels of L2 proficiency. In order to address this issue, what L1 reading comprehension is needs to be considered more systematically using theories of L1 reading comprehension. Specific factors that differentiate less advanced L2 proficiency from more advanced one also needs to be delineated (Hulstijn, 2012).

One inadvertent finding from the control condition is the relationships among L1 reading competence, background knowledge, and L2 reading comprehension. Unlike the other two experimental conditions where students read familiar science topics (photosynthesis and respiration), the control condition used a more general but unfamiliar topic (cancer). The role of L1 reading competence turned out to be stronger in this background knowledge-lacking condition; L1 reading competence was a significant predictor in both models of L2MC and L2Rec, whereas it played a significant role only in L2Rec in the vocabulary knowledge condition (Table 5). Whether the variances explained by background knowledge in the vocabulary knowledge condition weakened the role of L1 reading competence needs to be investigated in another study by including a measure for background knowledge.

REFERENCES


Applicable Level: All levels
Key words: language threshold, reading comprehension, vocabulary knowledge, measurement tools

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