Comparing electronic and printed dictionaries: Their effects on lexical processing strategy use, word retention, and reading comprehension

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This article reports the results of a study investigating the impact of pocket electronic dictionaries (EDs) compared with printed dictionaries (PDs) on the lexical processing strategies (LPSs; consult, infer, or ignore) (Fraser, 1999a, 1999b) used by Japanese university students to deal with unfamiliar words while reading. The study also examined the effects of EDs on word retention and reading comprehension. Both quantitative and qualitative data were collected through retrospective think-aloud protocols, a reading comprehension test, and two types of vocabulary tests. Overall, EDs do not appear to significantly influence students' LPS use, word retention, or reading comprehension. However, the use of EDs may result in an increase in the frequency of dictionary consultation, accompanied by varying degrees of decrease in the frequency of inferring. Frequent dictionary consultation may result in less interaction with the textual context, particularly for some low-proficiency students.

　本研究は、日本人大学生が、英文を読む際、未知語を扱うために使用するレキシカルプロセシングストラテジー（辞書を使用する、推測する、無視する）に電子辞書が及ぼす影響について、印刷辞書と比較して考察した。また、電子辞書が語彙の習得と英文読解に及ぼす影響についても考察した。研究方法としては、発話思考法、英文読解テスト、二種類の語彙テストを使用して、量的、および質的データを収集した。全体的に見て、電子辞書は、学生のレキシカルプセシングストラテジーの使用、英文読解、語彙の習得に大きな影響は及ぼしていないが、辞書を使用する頻度を増加させると同時に、推測する頻度を減少させている傾向があることがわかった。英語力の低い学生の場合には、辞書を使用する頻度の増加が、文脈の軽視につながっているケースもあった。

Pocket electronic dictionaries (EDs) are becoming popular among Japanese learners of English. For example, a recent study reports that as many as 96% of English majors at one university owned an ED (Bower & McMillan, 2006). Although the percentages of ED owners may be slightly lower among non-English majors, this study indicates that the vast majority of Japanese university students now own an ED.

Many educators and researchers are concerned about the pedagogical values of EDs due to perceived limitations, such as the possibility of discouraging contextual guessing, and the negative impact on word retention (Taylor & Chan, 1994; Koyama & Takeuchi, 2003; Tang, 1997), which highlights the need to investigate their effects on L2 learning. This study examined the effects of EDs on the lexical processing strategies (LPSs) (Fraser, 1999a, 1999b) used by Japanese university students when they encountered unfamiliar vocabulary while reading. It also examined the effects of EDs on reading comprehension and word retention.

Literature review

The use of dictionaries has drawn relatively little attention from L2 researchers (Fraser, 1999b). In particular, there is little research on how consulting a dictionary interacts with other lexical processing strategies (LPSs) (Fraser, 1999a, 1999b; Paribakht & Wesche, 1999). LSPs are strategies that an L2 reader uses when confronting an unfamiliar word while reading, such as ignoring and continuing to read, consulting a dictionary or another individual, and inferring word meaning on the basis of linguistic and contextual cues. Since a learner seems to combine the three LPSs when they

encounter unfamiliar vocabulary in natural contexts, it is important to reveal more about how these strategies work together.

Fraser (1999a) is one of the first who looked into dictionary use in relation to the use of other LPSs. Fraser (1999a) investigated the use of LPSs by Francophone ESL students while reading and also the effects of strategy use on vocabulary learning through a retrospective think-aloud method. Both a bilingual and a monolingual English dictionary were available for consultation. Fraser found that students inferred more frequently (55% of total encounters with unfamiliar words) than consulted (39%) or ignored (35%). They were generally successful in determining the word meaning when consulting or inferring; 78% of consults and 52% of inferences resulted in full comprehension and another 5% of consults and 20% of inferences resulted in partial comprehension. When students consulted or inferred alone, they recalled the word meaning that they had determined about 30% of the time. Moreover, when they inferred and then consulted, they had a higher retention rate (50%). This study suggests that consulting a dictionary facilitates comprehension and retention of words.

As L2 learners increasingly take advantage of EDs, several recent studies have focused on relative effects of EDs versus PDs on students' L2 learning. These studies have revealed complicated pictures of EDs on students' dictionary use (Aust, Kelley, & Roby, 1993; Iso & Osaki, 2003; Koyama & Takeuchi, 2003, 2004; Osaki, Ochiai, Iso, & Aizawa, 2003), reading comprehension (Aust et al., 1993; Iso & Osaki, 2003; Koga, 1995; Leffa, 1992; Osaki et al., 2003), and word retention (Iso & Osaki, 2003; Koyama &

Takeuchi, 2003, 2004; Osaki et al., 2003). For example, using a computer-based bilingual ED, Koga (1995) found that the students needed less time for dictionary consultation and read faster in the ED condition than in the PD condition. Also, the high-reading-ability group improved reading scores in the ED condition, although no differences were found in the low-reading-ability group, possibly due to the floor effect; that is, scores clustered at the low end because the test was too challenging for the students. Other researchers investigated the impact of handheld bilingual EDs on L2 learning. Koyama and Takeuchi (2003) found that college students in the ED and PD groups did not differ in respect to either the number of words searched or search time, although high school students in the ED group tended to look up more words. There were no significant differences in the rate of recall or the rate of recognition on the vocabulary tests given a week after the reading session. Similarly, Koyama and Takeuchi (2004) found no significant differences between the ED and PD groups in search time or the quantity of retrieved information. No differences were found between the ED and PD groups in the rate of recall, although the PD group scored higher than the ED group in the rate of recognition. Osaki et al. (2003) found that the ED groups outperformed the PD groups in the definition test and the reading comprehension test, although no differences were found between these two groups in the vocabulary tests administered immediately and two weeks after the reading session. Partially replicating this study with an easier text and easier tests, Iso and Osaki (2003) found no differences between the two dictionary groups in the definition test, the reading comprehension test, and the vocabulary test given after the reading session. Overall, these studies seem to indicate that EDs do not

significantly influence students' dictionary use, reading comprehension, or vocabulary learning. However, when students read a challenging text, due to its difficulty (e.g., Koga, 1995; Osaki et al., 2003) or students' low proficiency (e.g., Koyama & Takeuchi, 2003), EDs may have both negative and positive effects. Given the mixed results of these studies, more studies need to be conducted to draw conclusions that are more specific. In particular, since most previous studies are quantitative, more research using qualitative or mixed methods is needed to understand the effects of EDs on students' L2 learning in more detailed and more holistic manners.

The present study looked into the use of EDs compared with PDs in relation to other LPSs by Japanese university students. It also examined the impact of students' use of EDs on reading comprehension and word retention. Specifically, this study addressed the following research questions:

1. Are there any differences between users of EDs and those of PDs in terms of their use of dictionaries and other LPSs (i.e., inferring, ignoring, and asking others)?

2. Are there any differences between the users of EDs and those of PDs in terms of the retention of unknown or partially known words?

3. Are there any differences between the users of EDs and those of PDs in terms of reading comprehension?

Method

Participants

This study was conducted as the second phase of a study consisting of two phases. In the first phase, 279 Japanese students who attended one of the three universities in the western part of Japan (K University, T University, and N University) completed a questionnaire about their use of EDs, PDs, and other LPSs.

One of the items in the questionnaire asked students about the frequency of use of each type of dictionary. The students were classified into PD and ED users according to their responses on this item. Operationally, those who reported using an ED more often than a PD were considered ED users, whereas those who reported using a PD more often than or as often as an ED were considered PD users.

From 279 Phase 1 participants, 22 students were selected as Phase 2 participants. PD users constituted half of the 22 students, and ED users constituted the other half of the sample. The 22 students were chosen from those at K and T universities, to which the researcher had greater access, based on their responses to the questionnaire and their scores on the Vocabulary Levels Test (Schmitt, Schmitt, & Clapham, 2001) and the Reading Comprehension section of the Test of English as a Foreign Language (TOEFL). The students were chosen so that they represented the sample as much as possible in terms of school, dictionary use (ED or PD), vocabulary size, and reading proficiency.

Among the 22 students, six ED users and six PD users were chosen from K University, and five ED users and five PD users were chosen from T University. All of them were first-year students. The students' majors included agriculture (7), cross-cultural studies (5), and English (10). There were more female students (17) than male students (5) (see Appendix A for the demographic information of the students, as well as their test scores).

t-Tests were performed in order to examine whether differences existed between the two dictionary groups in their vocabulary size and reading ability. The results indicate that there were no differences between the two groups in their scores on the Vocabulary Levels Test, $t(15.916) = 1.079$, $p = .297$, or the TOEFL, $t(20) = -.195$, $p = .848$. However, the mean scores indicate that the PD group performed slightly better on the Vocabulary Levels Test than the ED group (93.91 and 82.36 out of 150).

The median split of the students' scores on the Vocabulary Levels Test was used to divide them into large- and small-vocabulary groups ($M = 106.83$ and 65.70 out of 150, respectively). Similarly, the median split of the students' scores on the TOEFL was used to divide students into high- and low-reading-ability groups ($M = 29.08$ and 12.00 out of 50, respectively).

ED and PD users appeared to differ in their experience or familiarity with their dictionaries. Most of the PD users reported buying their PDs when they entered high school. On the other hand, most ED users bought their EDs relatively recently—when they were in the second or third year of high school or when they entered college.

Instruments

Retrospective think-aloud protocols were collected from the 22 students during a reading session. Roughly the same set of questions was asked of all the students in Japanese (see Appendix B). For each unknown or partially known word, they were asked to report what LPS(s) they used, why they used it, and what meaning was determined when either inferring or consulting was used.

The text used in the reading session came from the *Shukan ST* (Hards, 2004; see Appendix C). The text discusses the impact of new diseases such as avian flu, BSE, and SARS, on society. It contains 517 words and has a readability level of 10.4 determined by the Fresch-Kincaid index.

Six open-ended comprehension questions in Japanese based on the reading passage were created by the researcher to measure the students' level of comprehension and to make sure that the students read the passage for comprehension. These questions aimed at assessing an overall understanding of the text rather than an understanding of individual words or structures.

In order to assess word retention, two types of vocabulary tests were administered. An open-ended vocabulary test required supplying definitions for all the words that each student indicated to be unknown or difficult in the reading session. Therefore, the test was tailored to individual students, and the words appearing on the test were different for each student. A multiple-choice vocabulary test consisted of 5 words that all the students indicated to be unknown or difficult in the reading session (i.e., *avian, fearmonger, level-headed, pneumonia,* and *squeal*), along with 8 other words appearing in the text, and required matching the 13 words to their Japanese equivalents by choosing from 20 alternatives.

Procedure

From late May to mid June in 2004, the 22 students met individually with the researcher for 60-90 minutes to participate in a training session and a reading session. They were asked to bring to the meeting the dictionary that they usually used, whether an ED or a PD. All instructions and prompts in the reading session were given in Japanese. Before the reading session, the students received 10-15 minutes of training, so that they could become familiar with the retrospective think-aloud procedure.

After the training, the students engaged in the reading session, where they first studied comprehension questions and then read the short passage within 40 minutes, using an ED or a PD. Although a monolingual dictionary was also available for some ED users, all of the students chose to use a bilingual dictionary. Next, they answered comprehension questions orally. Then, they were asked to circle unknown or partially known words that they encountered while reading the text. After this, they reported on their overall use of LPSs and reading strategies, such as how many times they read the text and when they consulted a dictionary (e.g., immediately, after reading the sentence containing un unknown word, after reading the paragraph containing it, after reading the entire text, etc.). Finally, they reported on the LPS(s) used for each unknown or partially known word. The reading session was audio-taped. The session took 50-70 minutes to complete.

A week later, a booklet consisting of the open-ended vocabulary test, the multiple-choice vocabulary test, and detailed instructions on how to complete each test, was mailed to the students. They were asked to complete the tests within three days of receiving them.

Analysis

The retrospective think-aloud protocol data were transcribed by the researcher. The researcher and a former Japanese EFL teacher separately coded the protocols in order to discover the LPS(s) that the students used to deal with each unknown or partially known word and evaluated a determined meaning when consulting and/or inferring was used. The researcher and the second coder resolved any disagreements through discussion with each other and another former Japanese EFL teacher, who was also a PhD candidate in TESOL.

Following the coding of the responses, the researcher calculated the rates of use of the three LPS options and the combined LPS options (i.e., consulting after inferring) based on the total number of unknown or partially known words. She also calculated the success rates (both the rates of full success and the rates of full or partial success) of determining word meanings associated with the use of the two LPS options (i.e., consulting and inferring) and the combined LPS options.

The researcher and the former Japanese EFL teacher also separately scored the reading comprehension test and the open-ended test. Raw scores were used for the reading comprehension test and the multiple-choice vocabulary test. The rates of recall based on the total number of test items (the rates of successful recall and the rates of successful or partially successful recall), however, were calculated for the open-ended vocabulary test (see Appendix D for the methods of scoring and coding for protocols and tests, along with inter-rater reliability).

In order to determine whether there were any differences between the ED and PD groups, t-tests were performed with dictionary type (ED and PD) as an independent variable and the mean score for each of these calculated scores and rates as a dependent variable. The alpha level was set at .05.

In addition to these statistical analyses, the researcher also coded the retrospective think-aloud protocols based on grounded theory in order to identify in what context the students used LPSs. Ground theorists attempt "to identify categories and concepts that emerge from text and link these categories into substantive and formal theories" (Ryan & Bernard, 2000, p. 782). For coding categories, the researcher consulted the literature on LPS use and vocabulary learning strategy use (e.g., Fan, 2003; Gu & Johnson, 1996; Kojic-Sabo & Lightbown, 1999; Schmitt, 1997); however, she was also receptive to categories or concepts that emerged from the data. The researcher read the transcripts line by line to identify concepts and themes. As coding categories emerged, she built models indicating the relationships among them. The models were tested against the data, including those that did not fit them, and made appropriate revisions.

Results

Results of quantitative analysis

A set of t-tests was carried out with dictionary type as an independent variable and each of the rates of use of LPS options and success rates of determining word meanings as a dependent variable. The results of the t-tests are shown in Table 1.

No significant differences were found between the two dictionary groups for any of the rates of use of LPS options and the success rates of determining word meanings. The ED group had a higher mean score for the rate of consulting than the PD group (.7699 and .6075). In contrast, the PD group had a higher mean score for the rate of guessing than the ED group (.5842 and .4568). In particular, the four ED users who belonged to the low-scoring groups in both vocabulary and reading guessed at less than 30% of unknown or difficult words (see Appendix E). However, the differences between ED and PD groups in the rate of consulting and the rate of guessing did not reach a statistically significant level.

A set of *t*-tests was carried out with dictionary type as an independent variable and each of the test scores (comprehension test scores, multiple-choice vocabulary test scores, the rate of correct answers for the open-ended vocabulary test, and the rate of correct or partially correct answers for the open-ended vocabulary test) as a dependent variable. No significant differences were found between the two dictionary groups for any of the test scores. Table 2 displays the results of the *t*-tests.

When examining individual scores, however, there appear to be some differences between the ED and PD groups in comprehension test scores (see Appendix E). The three low-proficiency ED users had very low comprehension test scores (0, 1.0, and 2.5 out of 6). These students also had low rates of guessing (.23, .16, and .26).

Table 1: Results of t-tests with dictionary type as an independent variable for rates of use of LPS options and success rates of determining word meanings

CTR	n	Mean	SD	t-Value	df	p
ED	11	.7699	.24044	-1.598	20	.126
PD	11	.6075	.23651			

CSR	n	Mean	SD	t-Value	df	p
ED	11	.8248	.12579	-.670	20	.510
PD	11	.7712	.23336			

CSPR	n	Mean	SD	t-Value	df	p
ED	11	.8728	.11835	-.626	20	.538
PD	11	.8339	.16843			

GTR	n	Mean	SD	t-Value	df	p
ED	11	.4568	.21252	1.604	18.327	.126
PD	11	.5842	.15559			

GSR	n	Mean	SD	t-Value	df	p
ED	11	.4755	.18867	-1.121	20	.275
PD	11	.3774	.22051			

GSPR	n	Mean	SD	t-Value	df	p
ED	11	.7773	.12260	.426	20	.675
PD	11	.8024	.15245			

COTR	n	Mean	SD	t-Value	df	p
ED	11	.2984	.19136	.290	20	.775
PD	11	.3221	.19146			

COSR	n	Mean	SD	t-Value	df	p
ED	11	.8588	.18118	-1.272	20	.218
PD	11	.7145	.32988			

COSPR	n	Mean	SD	t-Value	df	p
ED	11	.8902	.16823	-.908	20	.375

PD	11	.7991	.28674			
ITR	n	Mean	SD	t-Value	df	p
ED	11	.0744	.08520	1.095	20	.286
PD	11	.1325	.15384			

Note. CTR = rate of consulting; CSR = rate of successful consulting; CSPR = rate of successful/partially successful consulting; GTR = rate of guessing; GSR = rate of successful guessing; GSPR = rate of successful/partially successful guessing; COTR = rate of combined LPS use; COSR = rate of successful combined LPS use; COSPR = rate of successful/partially successful combined LPS use; ITR = rate of ignoring.

Table 2: Results of t-tests with dictionary type as an independent variable for test scores

Comprehension	n	Mean	SD	t-Value	df	p
ED	11	4.273	2.2064	.414	16.054	.685
PD	11	4.591	1.2810			
V1	n	Mean	SD	t-Value	df	p
ED	11	3.55	1.128	.000	20	1.000
PD	11	3.55	.820			
V2SR	n	Mean	SD	t-Value	df	p
ED	11	.5306	.22093	.362	20	.721
PD	11	.5630	.19908			
V2SPR	n	Mean	SD	t-Value	df	p
ED	11	.6001	.21125	1.063	20	.300
PD	11	.6880	.17483			

Note. Comprehension = comprehension test; V1= multiple-choice vocabulary test; V2 = open-ended vocabulary test; V2SR = rate of correct answers for the open-ended vocabulary test; V2SPR = rate of correct/partially correct answers for the open-ended vocabulary test.

Results of qualitative analysis

ED and PD users appeared to differ in the timing of consulting a dictionary. Compared with ED users, overall, PD users took more time before consulting a dictionary. All PD users, except for one, first read an entire text or a paragraph without a dictionary and used a dictionary in the second reading. Delaying dictionary consultation appeared to help some PD users remember or guess at the meaning of unknown or difficult words. On the other hand, all ED users, except for two, looked up unknown or difficult words either immediately, after reading the following few words, or after the rest of the sentence. In particular, some low-proficiency ED users appeared to look up unfamiliar words with little attempt to recall or guess the meanings of unknown words, immediately after encountering unknown or difficult words or after reading the following few words.

A PD user, H. K., read the entire text without using a dictionary for all unknown or difficult words except for one word for the first time, and then used a dictionary when reading through the text for the second and third time. Even when she did not come up with the meanings of words in her first reading, she kept reading, which appeared to help her remember or guess at them with the aid of context:

1. C. K. What did you think about when you first saw *air time*?
    H. K. When I saw it for the first time, I was not very sure about its meaning.
    C. K. Then what did you do?
    H. K. I kept reading the text and found that [this paragraph] is about TV or something like that. I realized that *on air* means "broadcasting," so

I figured that *don't get much air time* means "don't get broadcasted much."

On the other hand, a low-proficiency ED user, N. S. (male), did not appear to think carefully before consulting a dictionary. He sometimes consulted a dictionary immediately and realized that he had known the word after looking it up. In the following excerpt, he realized that *report* means "*repoto*" (a Japanese loanword that came from English) after looking it up:

2 . C. K. What did you think about when you first saw *reported*?
    N.S. I had no idea.
    C. K. Then what did you do?
    N.S. I looked it up and found that I knew it. I should have looked at it more carefully. I would have figured out its meaning.
    C. K. What did you find in the dictionary?
    N. S. It just means "*repoto*."

Some ED users, especially those who had been using their EDs for a while, took advantage of various functions of their EDs. These functions affected the students' searching behavior. All EDs had a function that displays the list of words containing the letters as a user types them. According to a user's guide, this function is supposed to enable a user to look up a word that he or she is not sure how to spell (*Denshi Jisho Keimei PW-9700*). However, the students used it for other purposes as well. For example, some students used the word lists to see if their dictionaries contain the word, or the form of the word that they were looking for. Y. A. found the meaning of the compound *level-headed* successfully by using this function:

3. C. K. [based on the field notes] Did you see the word *level-headed* in the list when you typed *level*?
    Y. A. Yes, I did. So I figured out this is one word.
    C. K. What did you find out?
    Y. A. Although it looked like it consisted of two words, it is one word, and it means "calm and sensible."

In summary, ED and PD users appeared to differ in the timing of consulting. On the whole, PD users appeared to take more time and effort to guess or remember words before consulting a dictionary. Also, some ED users took advantage of functions that were not available in PDs.

Discussion

Overall, EDs do not appear to significantly influence students' LPS use, word retention, or reading comprehension. The quantitative analysis did not find significant differences between the ED and PD groups in any of the rates of use of LPS options, the success rates of determining word meanings, and the test scores. One of the possible reasons for the lack of clear differences may be user experience. Many of the ED users had relatively limited experience with an ED, while they had extensive experience with PDs before using an ED. Therefore, they may have carried over their PD use habits to their use of EDs.

However, the qualitative and descriptive analyses of data indicate the tendency that the use of EDs results in an increase in the frequency of dictionary consultation, accompanied by varying degrees of decrease in the frequency of inferring. The descriptive analysis showed that despite no statistically significant differences, the PD group had

a higher rate of inferring, whereas the ED group had a higher rate of consulting, although the slight difference in vocabulary size between the ED and PD groups may partially explain this tendency. Also, the qualitative analysis showed that some low-proficiency ED users consulted a dictionary immediately, without much effort to recall or guess the meanings of unknown words. There is a possibility that the PD group might have processed words more deeply than the ED group. In particular, some low-proficiency students might have relied heavily on an ED, possibly at the expense of interacting with the textual context, which may have led to their low scores on the reading comprehension test.

This study suggests that EDs may not benefit all students equally. Frequent dictionary consultation may result in less interaction with the textual context, particularly for students who are not proficient enough in English or skilled enough in LPS use to take advantage of EDs. For these students, EDs may not necessarily have positive effects. One of the pedagogical implications of this study is the need for training in the use of EDs for these students.

The present study, in accordance with previous ones (e.g., Koyama & Takeuchi, 2003), yielded mixed results as to the effects of EDs on L2 learning, indicating the complex nature of the effects. In order to reach a more definitive conclusion about the effects of EDs, more research, especially that which includes more experienced ED users, should be conducted.

References

Aust, R., Kelley, M. J., & Roby, W. (1993). The use of hyper-reference and conventional dictionaries. *Educational Technology Research & Development, 41*(4), 63-73.

Denshi jisho keimei PW-9700 toriatsukai setsumeisho [User's guide for the electronic dictionary PW-9700]. (n.d.). Osaka: Sharp.

Bower, J., & McMillan, B. (2006). Learner's use & views of electronic dictionaries. Paper presented at the JALT 2006 Conference, Kitakyushu, Japan.

Fan, M. Y. (2003). Frequency of use, perceived usefulness, and actual usefulness of second language vocabulary strategies: A study of Hong Kong learners. *The Modern Language Journal, 87*(2), 222-241.

Fraser, C. A. (1999a). LPS use and vocabulary learning through reading. *Studies in Second Language Acquisition, 21,* 225-241.

Fraser, C. A. (1999b). The role of consulting a dictionary in reading and vocabulary learning. *Canadian Journal of Applied Linguistics, 2*(1-2), 73-89.

Gu, Y., & Johnson, R. K. (1996). Vocabulary learning strategies and language learning outcomes. *The Modern Language Learning, 46*(4), 643-679.

Hards, S. T. (2004, March 19). New ways to die. *Shukan ST.*

Iso, T., & Osaki, S. (2003, August). Denshi jisho to insatsu jisho ni miru eibun dokkai, goi kensaku, hoji no sai. [Differences between Electronic Dictionary and Paper Dictionary in Comprehension, Word Search, and Retention]. Paper presented at the meeting of the Japan

Society of English Language Education, Miyagi Kyoiku University, Sendai, Japan.

Koga, Y. (1995). The effectiveness of using an electronic dictionary in second language reading. *Bulletin of the Liberal Arts of Hiroshima University, 44,* 239-244.

Kojic-Sabo, I., & Lightbown, P. M. (1999). Students' approaches to vocabulary learning and their relationship to success. *The Modern Language Journal, 83*(2), 176-192.

Koyama, T., & Takeuchi, O. (2003). Printed dictionaries vs. electronic dictionaries: A pilot study on how Japanese EFL learners differ in using dictionaries. *Language Education & Technology, 40,* 61-79.

Koyama, T., & Takeuchi, O. (2004). Comparing electronic and printed dictionaries: how the difference affected EFL learning. *JACET Bulletin, 38,* 33-46.

Leffa, V. (1992). Making foreign language texts comprehensible for beginners: An experiment with an electronic glossary. *System, 20*(1), 63-73.

Osaki, S., Ochiai, N., Iso, T., & Aizawa, K. (2003). Electronic dictionary vs. printed dictionary: Accessing the appropriate meaning, reading comprehension, and retention. In Murata, M., Yamada, S., & Tono, Y. (Eds.), *Dictionaries and language learning: how can dictionaries help human and machine learning? Papers submitted to the Third ASIALEX Biennial International Conference.* (pp. 205-212). Urayasu: The Asian Association for Lexicography.

Paribakht, T. S., & Wesche, M. (1999). Reading and "incidental" L2 vocabulary acquisition: An introspective study of lexical inferencing. *Studies in Second Language Acquisition, 21,* 195-224.

Ryan, G. W., & Bernard, H. R. (2000). Data management and analysis methods. In N. K. Denzin & T. S. Loncoln (Eds.), *Handbook of qualitative research* (pp. 769-802). Thousand Oaks, CA: Sage Publications.

Schmitt, N. (1997). Vocabulary learning strategies. In N. Schmitt & M. McCarthy (Eds.), *Vocabulary description, acquisition and pedagogy* (pp. 199-227). Cambridge: Cambridge University Press.

Schmitt, N., Schmitt, D., & Clapham, C. (2001). Developing and exploring the behavior of two new versions of the Vocabulary Levels Test. *Language Testing, 18*(1), 55-88.

Tang, G. M. (1997). EDs for second language learning: Help or hindrance? *TESOL Canada Journal 15*(1), 39-57.

Taylor, A., & Chan, A. (1994). EDs and their use. *Euralex 1994 Proceedings,* pp. 598-605.

Appendix A

Demographic information of participants

Name	DT	Vocab	TOEFL	Gender	School	Major
Y. K.	PD	118	37	F	A	Agriculture
H. K.	PD	110	40	F	A	International Culture
T. T.	PD	96	20	F	A	Agriculture
S. F.	PD	115	31	M	A	Agriculture
N. S. (F)	PD	99	21	F	A	Agriculture
Y. Y.	PD	100	16	M	A	International Culture
S. T.	PD	96	13	M	B	English
M. S.	PD	71	18	F	B	English
Y. O.	PD	87	10	F	B	English
T. F.	PD	64	8	F	B	English
S. S.	PD	77	15	F	B	English
Y. H.	ED	114	38	F	A	International Culture
M. T.	ED	108	43	F	A	Agriculture
Y. N.	ED	106	18	F	A	International Culture
R. O.	ED	115	43	F	A	International Culture
Y. A.	ED	105	12	F	B	English
Y. M.	ED	80	19	M	A	Agriculture
K. Y.	ED	89	21	F	A	Agriculture
M. N.	ED	46	11	F	B	English
J. S.	ED	69	17	F	B	English
T. H.	ED	41	6	F	B	English
N. S. (M)	ED	33	12	M	B	English

Note. DT = dictionary type; Vocab = Vocabulary Levels Test. Maximum score for the TOEFL = 50; Maximum score for the Vocabulary Levels Test = 150.

Appendix B

English translation of prompts for the retrospective think-aloud interview

(At the beginning)

(These questions are asked based on the observation.)

1. Do you usually use a dictionary frequently? Did you use a dictionary in the reading session as frequently as you usually do?

2. Do you usually write down the meanings of unknown words after consulting a dictionary? Did you do so in the reading session?

3. Did you read the text several times?

4. When did you consult a dictionary, right after encountering a new word, after reading the sentence where the word appears, or after reading the paragraph where the word appears, or after reading the whole text?

(For each word)

5. What did you think about when you first saw [the word] x?

6. Then, what did you do? (Did you consult a dictionary? Did you guess the meaning of the word from context? Did you skip the word?)

7. Why did you use the lexical processing strategy (s) that you used?

(When the student consults a dictionary)

8. What is the determined meaning? (What did you find out?)

9. Did you find it easily? If you had difficulty, what kind of difficulty did you have?

10. Are you satisfied with the determined meaning? (Did you compare the determined meaning with the context?)

11. Did you find other information? (Did they find useful information about the item beyond that which had initially motivated the look-up?)

   (When necessary, for a few words, ask his or her to demonstrate the lookup for the researcher.)

(When the student guess the meaning of the word from the context)

12. What is the determined meaning?

13. How did you guess the meaning? (Did you analyze the structure of the word? Did you look at the other words in the same sentence? Did you consider the main idea of the text?)

14. Are you satisfied with the determined meaning? (Did you compare the determined meaning with the context?)

Appendix C

Reading text: New ways to die

By Scott T. Hards

The other day over dinner, a TV news story reported that eggs and meat from chickens with avian flu had been resold to restaurants and other businesses. The announcers read the story in a grave tone, suggesting a crisis had struck Japan's food supply. The story's impact on my mother-in-law was quick: "That's scary," she mumbled between bites of food. The fearmongers had done their work.

For the past several months, we've been bombarded with scary news stories about new ways to get sick and die. There's SARS and mad cow disease (or BSE) and now avian flu. Our entire food supply is in jeopardy, they tell us. The media reports their spread and the subsequent scramble by authorities to try to contain the crisis. But among all this, what frequently doesn't get reported, or not enough anyway, is a level-headed analysis of the actual risk.

After my mother-in-law's comment, I quickly reassured her: "The avian flu virus is easily killed if you cook the meat or eggs. In fact, there hasn't been a single case of avian flu spread to humans through eating infected chickens." But for some reason, these facts were missing from the TV report.

Likewise, Japan was quick to ban all imports of beef from the United States when a single cow was found to have BSE there - to squeals of delight from domestic cattle producers - but reports about BSE almost never point out that you cannot get sick by eating regular meat portions of sick cows. It's parts of their nervous systems that present a problem.

And reports from Taiwan about a sole researcher there getting a new case of SARS topped the news that day, but also failed to mention that there's never been a single case in Japan, let alone the fact that more people die from "regular" pneumonia and influenza every day than have died from the entire SARS outbreak globally.

Don't get me wrong: These new diseases do, of course, present a risk (especially to animal handlers and health professionals), but that risk is insignificant when compared to all the old, traditional risks we face daily.

Unfortunately, "news," as the roots of the word imply, needs to be something "new." Old-type stories, like "routine" deaths from car accidents, cancer, strokes and heart disease don't get much air time, even though the vast majority of all deaths are from one of these causes.

So the next time you find yourself getting disturbed or uptight over news reports about the latest rare disease, terrorism, or some horrible unsolved murder somewhere, just turn off the TV, put down your newspaper, or close that Web browser.

Try a self-imposed "news blackout" for a day or so and give yourself a break from the fearmongers. You may find it does wonders for your state of mind.

And while you're relaxing, keep the following in mind: If you live in Japan, watch your weight and blood pressure, and drive safely with your seat belt on, congratulations! You're living one of the lowest-risk lifestyles on the entire planet.

Now pass the chicken, please.

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Appendix D

Methods of scoring and calculation

	Scoring/Coding	Method of Calculation	Reliability
Rates of LPS use	One of the three LPS options (interring, consulting, or ignoring) or the combined LPS options (i.e., consulting after interring)	Number of occurrences of each LPS option divided by the total number of unknown words	.949
Success rates of determining word meanings	Comprehension, partial comprehension, or no comprehension	Number of successful and/or partially successful LPS use divided by the total number of LPS use	.879
Comprehension test	Correct, partially correct, or incorrect	Sum of score for the each of six items	.932
Multiple-choice vocabulary	Correct or incorrect	Sum of score for the each of five items	n/a
Open-ended vocabulary	Comprehension, partial comprehension, or no comprehension	Number of correct and/or partially correct answers divided by the total number of test items	.913

Appendix E

Individual scores

Name	DT	CTR	GTR	ITR	Comp	V1	V2SR	V2SPR
Y. K.	PD	.07	.40	.53	4.5	3	.47	.60
H. K.	PD	.65	.57	.04	6.0	3	.70	.83
T. T.	PD	.64	.50	.11	4.5	4	.75	.82
S. F.	PD	1.00	.50	.00	6.0	4	.75	.81
N. S. (F)	PD	.67	.53	.07	6.0	4	.60	.73
Y. Y.	PD	.63	.84	.00	6.0	4	.47	.74
S. T.	PD	.37	.63	.21	2.5	2	.32	.53
M. S.	PD	.63	.37	.15	3.0	5	.78	.81
H. O.	PD	.65	.65	.19	4.0	3	.42	.62
Y. F.	PD	.81	.85	.00	4.5	4	.74	.81
S. S.	PD	.56	.58	.16	3.5	3	.20	.27
Y. H.	ED	1.00	.35	.00	5.0	3	.50	.75
M. T.	ED	.63	.69	.06	6.0	4	.88	.88
Y. N.	ED	.44	.56	.13	6.0	5	.69	.75
R. O.	ED	.32	.68	.18	6.0	4	.68	.68
Y. A.	ED	.96	.68	.00	3.5	3	.61	.79
Y. M.	ED	.72	.56	.00	6.0	3	.17	.33
K. Y.	ED	.91	.64	.09	6.0	5	.73	.73
M. N.	ED	.62	.22	.26	5.0	4	.36	.36
J. S.	ED	.97	.26	.06	2.5	4	.59	.62
T. H.	ED	.92	.16	.04	1.0	3	.43	.47
N. S. (M)	ED	.98	.23	.00	0	1	.21	.25

Note. DT = dictionary type; CTR = rate of consulting; GTR = rate of guessing; ITR = rate of ignoring; Comp = comprehension test; V1= multiple-choice vocabulary test; V2 = open-ended vocabulary test; V2SR = rate of correct answers for the open-ended vocabulary test; V2SPR = rate of correct/partially correct answers for the open-ended vocabulary test. Maximum scores for the comprehension test = 6. Maximum score for the multiple-choice vocabulary test = 5.