Printed Dictionaries vs. Electronic Dictionaries: A Pilot Study on How Japanese EFL Learners Differ in Using Dictionaries

Printed Dictionaries vs. Electronic Dictionaries: A Pilot Study on How Japanese EFL Learners Differ in Using Dictionaries*

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Two empirical studies were conducted, in which Japanese EFL learners' searching behavior was compared in using an electronic dictionary (ED condition) with using a conventional one (PD condition). In the first study, to clarify how learners differ in using dictionaries, the authors focused on the learners' searching behavior such as search time, retention of words, and impressions or comments on dictionaries. The results indicated that, between the two conditions; 1) there were no significant differences in respect to either the number of words they looked up or the time they needed for a search in a dictionary in comparison between the printed dictionary group and the electronic dictionary group; 2) no significant differences in the learners' retention of words were found. In addition, 3) some differences were shown in the comments on dictionaries between college and high school students; and 4) most students highly evaluated an electronic dictionary in respect to its handiness and its ease of use, while they considered that, owing to its interface design, it did not provide sufficient information to them, as did a printed dictionary. To provide some supportive evidence to the results found in the first study, the think-aloud procedure was employed in the second study, and influences of dictionaries' interface design on their searching behavior were confirmed.

1. Introductory Remarks

Dictionaries are indispensable for Japanese EFL learners to comprehend materials written in English. Approximately 140 years have passed since their first compilation in printed form was used in Japan (Ohtani, 1993). With the recent development of digital technology, however, types of dictionaries have been diversified. Digital dictionaries in the type of CD-ROMs or on the Internet have been rapidly used by EFL leaners. A compact, easy-to-carry electronic dictionary has also become popular

with them.

Through the spread of these new types of digital dictionaries, some empirical studies have been conducted to prove their relative advantages over printed ones. For example, Bhatia (1991) compared students' searching behavior in a computer-based Kanji dictionary with a traditional paper one and offered a tentative conclusion in which a computer-based dictionary might be more effective in learning Japanese than a printed one. Koga (1995a, 1995b) argued that the use of an electronic dictionary on a PC in understanding materials on CAI (Computer Assisted Instruction) / CAL (Computer Assisted Learning) was more efficient than a printed one. He focused on a text-reading process of EFL learners and arrived at the conclusion that a computerized retrieval system did not cause interference to learners while they were reading.

Inami, Nishikata, Nakayama, and Shimizu (1996) compared English-Japanese CD-ROMs and printed dictionaries in terms of search time for the target words and concluded that a CD-ROM dictionary was more efficient than a printed one. Takeda and Nittono (1997, 1998) also investigated search time of an electronic dictionary in learning Chinese characters and found the search time of an electronic dictionary was shorter than that of printed one. Inami *et al.* (1997) studied search time, percentage of correct answers to the spelling, and the meaning of the target words in each group using a CD-ROM and a printed dictionary. They argued that the result of the CD-ROM dictionary group was better than that of the printed one. They also examined five factors of students' impressions on a CD-ROM dictionary and reported that a significant correlation between a factor of "easy to memorize" and a test score. A study on a comparison between a compact, easy-to-carry electronic dictionary and a conventional one was made by Iwamoto (1998). She investigated search time reduction in using an electronic dictionary (SII TR-6700) and concluded that an electronic dictionary was effective for those who were not accustomed to consulting a printed one in comprehending sentences written in English.

All studies described above came to the conclusion that CD-ROM or electronic dictionaries were more useful than conventional printed ones. The conclusion, however, was based mainly on the reduction in search time and did not sufficiently discuss the short-term and long-term retention of words, which could be more important for learning EFL. In addition, they did not examine the impressions or comments on dictionaries from learners, which might be informative in revealing their learning process or behavior. More studies, therefore, are needed to determine the relative advantages of digital dictionaries over printed ones in learning EFL.

2. Study 1

2.1 Purposes

The purpose of Study 1 is to clarify empirically how Japanese EFL learners differ in their searching behavior when using a compact, easy-to-carry electronic dictionary and a conventional one. The authors focused on the following three points;

1. The subjects' searching behavior while reading a text (*i.e.* search time / time until search / the number of words they looked up in a dictionary)
2. The subjects' retention of words
3. The subjects' responses to a questionnaire and their free comments about a dictionary

2.2 Method

2.2.1 Subjects

The subjects of Study 1 were 26 female college students (19-20 years old) majoring in English language and literature. In addition, to investigate the influence of age, 16 female high school students (15-16 years old) were selected as subjects. [1]

To divide each age group into the PD (printed dictionary) and the ED (electronic dictionary) groups with the same proficiency, a cloze test was administered (See Table 1). Subjects were also asked to answer a questionnaire which attempted to investigate their daily dictionary use and contact with digital media.

Table 1. Results of a Cloze Test

College Students			
Group	*n*	*M*	*SD*
PD	13	25.08	4.75
ED	13	25.31	4.53
High School Students			
Group	*n*	*M*	*SD*
PD	8	15.88	6.66
ED	8	15.38	4.34

2.2.2 Dictionaries Used

Two types of learners' dictionaries were used in this study. One was *Taishukan's Genius English-Japanese Dictionary (2nd edition)*, which is one of the most popular, conventional printed-type dictionaries.[2] The other was CASIO EX-word XD-2500, a compact and easy-to-carry electronic dictionary, in which the same edition of *Taishukan's Genius English-Japanese Dictionary* was adopted. The same number of words and usage examples were included in both dictionaries.

Before the experiment, subjects of the ED group were given an abridged version of the user's manual and were provided enough time to get used to the dictionary.

2.2.3 Reading Materials

The text used for the college students in this study was selected from a book on applied linguistics which subjects had not yet studied (Appendix 1). Its Flesch Reading Ease was 15.8 and Fresch-Kincaid Grade-level was 12.0, which is regarded as comparatively difficult for most Japanese college students.

The text read by the high school student group was selected from a written examination of the pre-2nd grade test of STEP (The Society for Testing English Proficiency, Inc.) (Appendix 2). Its Flesch Reading Ease was 58.4 and Flesch-Kincaid Grade-level was 9.4, which is considered a reasonable level for Japanese high school students.

2.2.4 Procedure

Each group (the PD and the ED groups) was instructed to read a text in 20 minutes. Subjects were allowed to consult the designated dictionary while reading. They were also instructed to underline the words in the text they looked up in a dictionary. The experiment was conducted on a one-by-one basis, and video recording of each session was made.

To measure the subjects' degree of understanding of the text, they were given a ten-item quiz after reading the text. The quiz was made up of five comprehension questions and five vocabulary items on the text they had read. Each question had one point. Therefore, ten indicates full points. While answering the quiz, none of the subjects was allowed to use any dictionaries.

To investigate the retention of the words they had consulted, subjects were given two tests on the seventh day after the experiment. The first test asked subjects to recall the words they had looked up in a dictionary in the experiment. One point was given to each word recalled in this test. Minor spelling mistakes were overlooked in scoring. In the second test, recognition of the words they had consulted was examined. This test consisted of the words each subject had looked up in the dictionary and of some dummy words from the text.

To assess the subjects' impressions on the dictionary they had used, they were asked to answer a questionnaire and to make some free comments about the dictionary.

2.3 Results

2.3.1 Subjects' Behavior

Table 2. Descriptive Statistics of the Searching Behavior: College Students

Printed Dictionary Group

Subject #	Gross Words	Net Words	Time until Search (sec.)	Search Time (sec.)
PD 1	18	18	10	448
PD 2	26	26	2	736
PD 3	28	25	10	635
PD 4	27	26	22	776
PD 5	17	15	28	731
PD 6	20	20	1	947
PD 7	18	18	5	736
PD 8	33	30	62	770
PD 9	15	15	5	764
PD10	17	17	1	857
PD11	26	26	1	785
PD12	21	21	11	668
PD13	13	12	10	594
M	21.46	20.69	12.92	726.69

Electronic Dictionary Group

Subject #	Gross Words	Net Words	Time until Search (sec.)	Search Time (sec.)
ED 1	21	21	192	461
ED 2	22	18	146	658
ED 3	16	16	3	732
ED 4	24	23	8	706
ED 5	19	18	20	712
ED 6	24	24	17	717
ED 7	21	21	1	767
ED 8	19	19	14	803
ED 9	16	16	18	745
ED10	41	41	1	815
ED11	28	24	20	779
ED12	20	18	28	761
ED13	31	27	1	751
M	23.23	22.00	36.08	723.62

Table 2 shows a comparison of the searching behavior between the PD and the ED groups of college students. The number of words subjects looked up in a dictionary and the time they needed for a search in the experiment are shown in Table 2.

"Gross Words" in the table indicates the total number of words they actually looked up, while "Net Words" means the number of the different words they consulted in a dictionary. The same word that subjects had looked up twice was thus counted as two in "Gross Words" but one in "Net Words."

"Time until Search" means time until subjects began to search for a word in a dictionary after a text was given to them. "Search Time" is defined as time until

subjects jotted down a Japanese translation of a text or stopped looking up a word and began to read a text again after they began to consult a dictionary in the case of the PD group. As for the ED group, it is defined as an interval from the point when subjects began to touch the keyboard of the dictionary to the point when they took their eyes off the screen and began to read the text again. Search time was measured with a stopwatch by the authors while watching the subjects.

Table 3 shows the results of statistical analysis based on the non-parametric Mann-Whitney *U*-test. As the table shows, there is no significant difference at $p < .05$ between the PD and ED groups in terms of "Gross Words", "Net Words", "Time until Search", and "Search Time".

Table 3. Results of Mann-Whitney *U*-test: College Students (*N1*=*N2*=13)

	Gross Words	Net Words	Time until Search	Search Time
U value	73	76	70	82

All values are NS

Table 4. Descriptive Statistics of the Searching Behavior: High School Students

Printed Dictionary Group

Subjects #	Gross Words	Net Words	Time until Search (sec.)	Search Time (sec.)
PD 1	9	9	10	918
PD 2	9	9	16	931
PD 3	6	6	27	787
PD 4	20	19	23	802
PD 5	11	11	18	674
PD 6	16	16	0	782
PD 7	11	11	19	800
PD 8	19	19	51	841
M	12.63	12.50	20.50	816.88

Electronic Dictionary Group

Subjects #	Gross Words	Net Words	Time until Search (sec.)	Search Time (sec.)
ED 1	15	15	0	898
ED 2	18	17	30	697
ED 3	7	7	32	872
ED 4	37	37	11	702
ED 5	24	24	16	573
ED 6	15	15	13	885
ED 7	20	19	24	620
ED 8	17	17	16	828
M	19.13	18.88	17.75	759.38

The same tendency is seen in Table 4, which shows a comparison of the searching behavior between the high school PD and the ED groups. The mean values of "Gross Words" and "Net Words" in each group were nearly identical; this was because the same word did not appear repeatedly in the high school students' text

compared with the text read by the college students.

Table 5 reveals that no significant differences in "Gross Words", "Net Words", "Time until Search", and "Search Time" were found at the .05 level in the Mann-Whitney *U*-test. According to Siegel (1983), however, in case of $N_1=N_2=8$ and $U=17$, the probability value in the test was .065, which almost reaches the pre-set critical value of .05. We thus can maintain that the observed difference in the number of words might be larger if more subjects could be included in this experiment.

Table 5. Results of Mann-Whitney *U*-test: High School Students (*N1=N2=8*)

	Gross Words	Net Words	Time until Search	Search Time
U value	17	17	28	25

All values are NS

2.3.2 Subjects' Retention

Table 6. Descriptive Statistics of the Retention of Words: College Students

Printed Dictionary Group

Subject #	Q	Recall Test	Rate of Recall (%)	Recognition Test	Rate of Recognition (%)
PD 1	7	1	5.6	8	44.4
PD 2	8	0	0.0	14	53.8
PD 3	4	0	0.0	11	44.0
PD 4	5	1	3.7	7	26.9
PD 5	8	1	5.9	9	60.0
PD 6	5	0	0.0	4	20.0
PD 7	5	3	16.7	7	38.9
PD 8	6	0	0.0	16	53.3
PD 9	7	1	6.7	6	40.0
PD10	8	5	29.4	14	82.4
PD11	7	0	0.0	10	38.5
PD12	8	0	0.0	16	76.2
PD13	4	0	0.0	4	33.3
M	6.31	0.92	5.2	9.69	47.1

Electronic Dictionary Group

Subject #	Q	Recall Test	Rate of Recall (%)	Recognition Test	Rate of Recognition (%)
ED 1	6	2	9.5	11	52.4
ED 2	5	1	4.5	4	22.2
ED 3	7	1	6.3	6	37.5
ED 4	5	2	8.3	11	47.8
ED 5	5	2	10.5	5	27.8
ED 6	7	0	0.0	8	33.3
ED 7	8	1	4.8	11	52.4
ED 8	4	0	0.0	10	52.6
ED 9	6	0	0.0	7	43.8
ED10	8	1	2.4	16	39.0
ED11	7	1	3.6	12	50.0
ED12	8	1	5.0	11	61.1
ED13	7	2	6.5	11	40.7
M	6.38	1.08	4.7	9.46	43.1

Table 6 shows a comparison of the retention of words between the PD and the ED groups of college students. "Quiz (Q)" means the subjects' scores on the test after they read a text in the experiment. "Recall Test" indicates the number of the words which subjects were able to recall and "Rate of Recall" was calculated by using the following formula: Recall Test / Gross Words = Rate of Recall (%). "Recognition Test" means the number of words which they could recognize and "Rate of Recognition" was calculated by using the following formula: Recognition Test / Gross Words = Rate of Recognition (%).

As seen in Table 6, the mean scores of "Quiz (Q)" are almost the same in the two groups. At the same time, the mean scores of the PD group are higher than those of the ED group in "Rate of Recognition," while those of the PD group are lower in "Rate of Recall."

Table 7 shows the results of statistical analysis at the .05 level in the Mann-Whitney *U*-test. It shows that the scores of the PD group do not significantly differ from those of the ED group in college students.

Table 7. Results of Mann-Whitney *U*-test: College Students (*N1*=*N2*=13)

	Rate of Recall	Rate of Recognition
U value	70	77

All values are NS

Table 8. Descriptive Statistics of the Retention of Words: High School Students

Printed Dictionary Group

Subject #	Q	Recall Test	Rate of Recall (%)	Recognition Test	Rate of Recognition (%)
PD 1	5	0	0.0	5	55.6
PD 2	3	0	0.0	4	44.4
PD 3	7	2	33.3	5	83.3
PD 4	6	2	10.5	10	52.6
PD 5	7	3	27.3	4	36.4
PD 6	8	0	0.0	5	31.3
PD 7	6	2	18.2	6	54.5
PD 8	5	1	5.3	5	26.3
M	5.88	1.25	11.8	5.50	48.1

Electronic Dictionary Group

Subject #	Q	Recall Test	Rate of Recall (%)	Recognition Test	Rate of Recognition (%)
ED 1	3	2	13.3	4	26.7
ED 2	8	3	17.6	6	35.3
ED 3	5	2	28.6	4	57.1
ED 4	9	4	10.8	12	32.4
ED 5	7	5	20.8	5	20.8
ED 6	6	2	13.3	7	46.7
ED 7	5	2	10.5	16	84.2
ED 8	2	3	17.6	10	58.8
M	5.63	2.88	16.6	8.00	45.3

A similar tendency is seen in Table 8, which shows a comparison of the retention of words between the PD and the ED groups of high school students.

The results of the statistical analysis using the Mann-Whitney *U*-test can be seen in Table 9. Again, as presented in the table, the retention rates of the PD group do not significantly differ from those of the ED group in high school students.

Table 9. Results of Mann-Whitney *U*-test: High school Students (*N1*=*N2*=8)

	Rate of Recall	Rate of Recognition
U value	21	31

All values are NS

2.3.3 Subjects' Impressions and Free Comments

A 20-item questionnaire, which was given just after reading a text, was administered to assess their impressions of the dictionary they had used in the experiment. In the questionnaire the subjects rated their impressions on a scale of one to five, in which five meant they expressed complete agreement on that item. Figure 1 graphically summarizes the responses to the questionnaire by the two groups of college and high school students. The results are shown in percentages, as the number of subjects between the college and high school students was different.

Compared with college students, high school students generally gave a low evaluation of the printed dictionary they had used in the experiment. This tendency is observed as well in item (8) "*I am willing to use this dictionary*," item (15) "*I can get further information besides the target word*," and item (20) "*I enjoy using this dictionary*." On the other hand, as contrasted with the responses of college students, the differences between the PD and the ED groups of high school students were considerably large in item (3) "*I can search for the target word easily*," item (6) "*This dictionary is handy*," item (9) "*I like this dictionary*," item (18) "*This dictionary is accessible to everyone*," and item (19) "*I can look up one word after another in this dictionary*." An interesting finding in Figure 1 is the high school students' responses on item (12) "*The words I looked up impressed themselves in my memory*". They seem to have considered that an electronic dictionary was not suitable for memorizing words, while they highly esteemed it on other items, such as (3), (6), (9), (18), and (19).

After they answered the questionnaire in the experiment, they were asked two supplementary questions: "*Do you have more than two dictionaries and use them each in its proper way?*" and "*Which dictionary do you prefer, if you use the different*

dictionaries on campus and at home?" These questions were given because almost all the college students in this experiment answered in advance that they had more than two dictionaries. In addition, they wrote free comments about dictionaries in general.

Some excerpts from subjects' comments and opinions are shown in Tables 10a and 10b. As almost all the high school students possessed one dictionary, only a few comments are indicated in Table 10b.

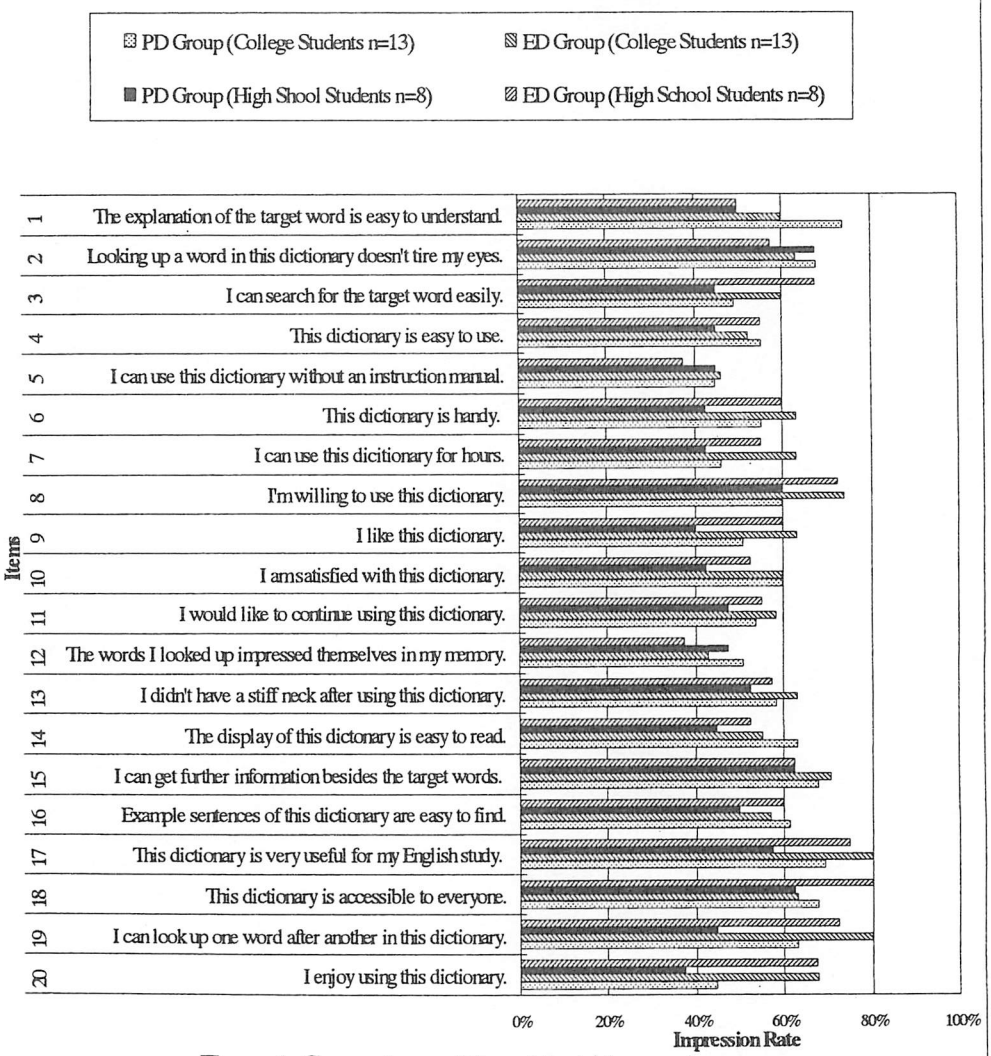

Figure 1. Comparisons of the subjects' impressions of the dictionary they had used

Table 10a. Comments on Dictionaries: College Students

Printed Dictionary Group

Subjects	Comments
PD 1	I like printed dictionaries and I have two kinds. Because they are heavy to carry, I keep one of them in my locker on campus.
PD 2	It's very convenient to keep a printed dictionary on campus. Carrying dictionaries is really troublesome for me.
PD 7	I use an electronic dictionary in class because a printed dictionary is heavy to carry. The electronic dictionary is much easier to use.
PD 8	I have a few dictionaries. Usually I use a printed dictionary when I need a detailed explanation of the target word at home.
PD11	I use an electronic dictionary in class because a printed dictionary is heavy to carry. At home, I use a printed dictionary because time to consult a dictionary isn't limited as in class. I think an electronic dictionary is convenient, but it seems to me that I easily forget the words I looked up in the dictionary.

Electronic Dictionary Group

Subject #	Comments
ED 1	I have two printed dictionaries and choose them in class and at home according to my purpose. I use a big dictionary, which is useful for English composition, when I study English at home.
ED 3	I used a pocket-sized English-Japanese and Japanese-English dictionary before. But, as it doesn't have a detailed explanation for the target word, I use a big printed dictionary now.
ED 7	An electronic dictionary is very useful for looking up a word quickly and it doesn't exhaust me.
ED 8	I think an electronic dictionary is easy to use. But if I need more information for a word, I use a printed one.
ED10	I use the same printed dictionary both in class and at home. I think an electronic dictionary is not suitable for English study because I think I easily forget a word I look up in the dictionary.
ED13	I want to keep up with class, so I don't have enough time to use a printed dictionary. That's the main reason to use an electronic one in class. Moreover, as it is useful for me to look up a word quickly, I use an electronic dictionary very often, but I think it doesn't have enough example sentences.

Translation ours.

Table 10b. Comments on Dictionaries: High School Students

Printed Dictionary Group

Subject #	Comments
PD 2	I have two printed dictionaries, so I use one dictionary in class and the other one at home because to carry them is troublesome.
PD 3	I hardly consult a printed dictionary in class. At home, it's easy to use an electronic dictionary. But I think a Japanese-English dictionary should be printed on paper.
PD 5	Carrying a printed dictionary is troublesome for me, so I use two different dictionaries in class and at home.

Electronic Dictionary Group

Subjects #	Comments
ED 4	I have two printed dictionaries and choose them according to my purpose. Printed dictionaries are very heavy to carry.

Translation ours.

According to Tables 10a and 10b, some common tendencies that many students showed in their descriptions were:

1. They highly evaluated an electronic dictionary in respect to its handiness and its ease of use. However, they considered that an electronic dictionary did not provide sufficient information to them, as did a printed dictionary.
2. They thought that a printed dictionary was not suitable to carry.
3. They considered that a printed dictionary was more suitable for learning EFL than an electronic one.

2.4 Discussion

Three points are to be discussed in this section. First, from the results in 2.3.1, a comparison of the subjects' behavior between the PD and the ED groups of college students indicated no significant differences in respect to either the number of words they looked up in a dictionary or the time they needed for a search in a dictionary. As described in 2.3.1, in the case of high school students, the probability value in $N_1=N_2=8$ and $U=17$ was .065 in both "Gross Words" and "Net Words"; this meant the U value almost reached the critical level. In other words, the ED group tended to look up more words in a dictionary than the PD group in high school students. A typical comment in Table 10a, made by the college student ED 7 on an electronic dictionary, "*An electronic dictionary is very useful for looking up a word quickly and it doesn't exhaust me*" also backed up this result. These findings supported the conclusions of the studies reviewed in the introductory remarks of this paper (Inami, *et al.*, 1997; Iwamoto, 1998; Koga, 1995a and b).

Second, significant differences in the "Rate of Recall" and "Rate of Recognition" were not found at the .05 level in the Mann-Whitney U-tests. The results of this statistical analysis suggested that students who could look up more words in a dictionary could not get good results of "Rate of Recall" and "Rate of Recognition" in the ED group of high school students.

Third, as mentioned in 2.3.3, some differences in their impressions on dictionaries between college and high school students were observed. Two reasons can be considered. One is that high school students might have a greater sense of closeness to digital media than college students have. The responses to the 20-item questionnaire in Figure 1 indicates that high school students did not evaluate a printed dictionary as highly as college students did. They ranked a printed dictionary low in their responses to the following items: (4) "*This dictionary is easy to use*," (6) "*This*

dictionary is handy," (9) "*I like this dictionary*," (10) "*I am satisfied with this dictionary*," (14) "*The display of this dictionary is easy to read*," (19) "*I can look up one word after another in this dictionary*," (20) "*I enjoy using this dictionary*." On the other hand, the high school students highly evaluated an electronic dictionary, as in items (3) "*I can search for a word easily*," (5) "*I can use this dictionary without an instruction manual*," (18) "*This dictionary is accessible to everyone*". The other reason is that high school students might have a lesser sense of closeness to a printed dictionary than college students have. Like the high school student "PD 3" in Table 10b, who indicated that she hardly consulted a printed dictionary in class and used only an electronic dictionary at home, most first-year students of high school have not become accustomed to using a printed dictionary, while second-year college students, majoring in English language and literature, have to consult a printed dictionary for their daily study.

In addition, as observed in 2.3.3, most students considered an electronic dictionary did not provide sufficient information to them, although they highly evaluated its handiness and its ease of use. As described in 2.2.2, both types of dictionaries used in this experiment were the same edition and were edited by the same lexicographers. The same number of words and usage examples were included in both types. In spite of these facts, most students considered that quantity of information in an electronic dictionary was smaller than that of a printed one. This wrong impression of the electronic dictionary might be explained by the limitation of its interface design. Since one of the most important things for an electronic dictionary is regarded as its portability, its screen is quite small. Therefore, students were able to get nothing but limited information about the target word at once, while they could obtain sufficient and other related information about it from a printed dictionary. In other words, an electronic dictionary might oblige students to push one button after another to obtain further information about the target word. Compared to a printed dictionary, this searching behavior might be considered the cause of wrong impressions about an electronic one. Hence, more investigations are needed to clarify how each interface design influences students' searching behavior between an electronic and a printed dictionary.

3. Study 2

3.1 Purpose

The purpose of Study 2 was to provide some supportive evidence to the results

obtained in Study 1 through the think-aloud procedure, which allowed the authors to explore the inner process concerning the searching behavior of Japanese EFL learners. The authors particularly focused on the influence of the interface design on searching behavior in Study 2.

3.2 Method

3.2.1 Subjects

Four graduate students (majoring informatics) were selected as the subjects for this study. They were familiar with the think-aloud technique. To divide the subjects into two groups (the PD and the ED groups) of the same proficiency, a cloze test was administered in the same way as in Study 1 above (*mean*: PD=29.0, ED=27.5). Subjects were also asked to answer a questionnaire which attempted to investigate their daily dictionary use and contact with digital media.

3.2.2 Dictionaries and Reading Material Used

The same dictionaries used in Study 1 were adopted (*Taishukan's Genius English-Japanese Dictionary* and CASIO EX-word XD-2500). Subjects of the ED group were given enough time to get used to the dictionary before the experiment. The text used for the college students in Study 1 was utilized in this study.

3.2.3 Procedure

In the area of cognitive psychology, the think-aloud procedure is considered to be effective to explore invisible inner processes. The concurrent and retrospective verbal report using the think-aloud technique is now generally recognized as a major source of data on subjects' cognitive processes in a specific task (Ericsson and Simon, 1993). Thus we employed this technique to confirm the results in Study 1.

Subjects were instructed to read the text explained above in 20 minutes. Their behavior and verbal descriptions in consulting the designated dictionary were recorded one by one on a DVD camera and a portable MD recorder with a standard microphone. Verbatim transcripts of their think-aloud protocols were made by the authors.

To measure the subjects' degree of understanding of the text, they were given a ten-item quiz after reading the text in the same procedure as in Study 1. To assess the subjects' impressions of the dictionary they had used, they were asked to answer a questionnaire. Recall and recognition tests were given to them in the same way as

3.3 Results

Table 11 shows some excerpts of subjects' verbal descriptions of their cognitive processes and experiences while consulting a dictionary. Samples 1 and 2 indicate that Subject A using a printed dictionary made good use of example sentences in the dictionary. Subject A seems to have been able to obtain sufficient information from the printed dictionary when he found the target words. On the other hand, Samples 3, 4, and 5 indicate that Subjects C and D using an electronic dictionary often failed to find information of the target word. They seem to have got stuck again and again, and to have been impatient and frustrated with the interface of the dictionary. Therefore, those subjects could not take full advantage of an electronic dictionary, as they had to push one button after another to get necessary information for them.

Table 11. Excerpts from Think-aloud Protocols

Sample 1 (Printed Dictionary: Subject A)

Hmmm..."corpus"...I usually don't use such a word...Oh, Great! "*SHITAI*"...It may be fun looking into a dictionary in reverse order like this ... "*RANSO NO OHTAI*"... This word has such a meaning..."Christi Trinity Sunday"...it doesn't matter...Oh...indeed. "*GENGO SHIRYOU*"...but another meaning is "*SHITAI*". Why do these Japanese translations link up?

Sample 2 (Printed Dictionary: Subject A)

Oh, well..."lexicography"...What's this? It reminds me...the lecture on "suffix" and "prefix". If we study "suffix" and "prefix" enough, they say we don't need to consult a dictionary at all...but we absolutely need a dictionary! Ah.."*JISYOGAKU*" "*JISYO*"... "lexicon" means "*JISYO*"..."lexis" means "*GOI*". "Lex" is an abbreviation... I know "lex" has a meaning relative to "law"...but what does it matter? "lexicon"..."lexicology"... "-graphy" doesn't make any sense to me... Honestly speaking, I don't know "*JISYOGAKU*" itself.

Sample 3 (Electronic Dictionary: Subject C)

"disco"...I've typed only "disco". Oh, no, no, no...What? How can I get to backward...? What should I do? Hmmm, try it again... Oh, no...again! A wrong spelling...Oh, this makes me sick!..."discourse". Oh, here comes... "*SEKKYOU*"

Sample 4 (Electronic Dictionary: Subject C)

"resource"..."*SHIGEN*". What is a suitable Japanese translation for this? What?! "Resourceful" has come out! Hmmm...I want to go back the former screen. "*MAEMIDASHI*" is such a key? Oh, I'm lost..."re"...let me type it again...

Sample 5 (Electronic Dictionary: Subject D)

"identification". I don't know the exact meaning of this, 'cause I'll look up in a dictionary only for an exam...This dictionary doesn't have "identification"?...oh, no! it's gone!! "identify"..."denfi"..."identi"...Hmmm, I made a mistake...Well, so many translations are there..."*DOUITU NO MONOTO MINASU*" is a Japanese translation to "identify"?

Translation ours.

According to the questionnaire, Subjects A and B using a printed dictionary gave high marks to the items: (14) "*The display of this dictionary is easy to read,*" (15) "*I can get further information besides the target word,*" and (16) "*Example sentences of this dictionary are easy to find,*" which were related to the specific characteristics of a printed dictionary, while Subjects C and D using an electronic dictionary gave low marks to these items. As for the results of "Quiz", "Recall Test", and "Recognition Test", no differences were observed.

3.4 Discussion

As was described in 3.3, the results in this study, which was a qualitative comparison of searching behavior using a printed and an electronic dictionary, seem to support the results of Study 1. As Table 11 shows, the verbalized protocols of the subjects reveal the differences in each interface design between a printed and an electronic dictionary. A printed dictionary seems to be highly regarded in terms of its sufficient information. Subject A was able to make the most of its information. On the other hand, an electronic dictionary seems to cause stress for Subjects C and D, as the presented information on its screen was quite limited. Therefore, Subjects C and D might have wrong impressions of the electronic dictionary.

In addition, the results of the questionnaire in Study 2, which indicated subjects' impressions of each dictionary they had used, also show these differences. As mentioned in 3.3, Subjects A and B using a printed dictionary rated their impressions of the dictionary highly in items: (14), (15), and (16), which were related to the specific characteristics in the interface design of a printed dictionary, while Subjects C and D using an electronic dictionary evaluated these items low.

4. Concluding Remarks

As our studies were one of the first attempts to compare the searching behavior between a printed and an electronic dictionary, the number of subjects in both studies was comparatively small. With this limitation in mind, the authors would like to summarize the two studies described above.

The following findings were made in the first study. First, there were no significant differences in respect to either the number of words they looked up or the time they needed for a search in a dictionary as compared to the PD group with the ED in the case of college students. However, a tendency for high school students to look up more words in an electronic dictionary was observed. Second, no significant

differences in either "Rate of Recognition" or "Rate of Recall" were found in the two age groups. This might indicate that the number of words they looked up in a dictionary was not proportional to their retention of words. Third, some differences were shown in the comments on dictionaries between college and high school students. These differences seem to indicate that high school students have a greater sense of closeness to digital media than college students have, and also have a lesser sense of closeness to a printed dictionary than college students have. Fourth, most students highly evaluated an electronic dictionary in respect to its handiness and its ease of use, while they considered that, owing to its interface design, it did not provide sufficient information to them, as did a printed dictionary.

In the second study, some supportive evidence to the results in Study 1 was provided. The fourth finding above, which particularly focuses on the influence of interface design of each dictionary on their searching behavior, was backed up by subjects' verbal descriptions in Study 2.

As has been discussed above, one of the most promising aspects we shall focus on is not the reduction of search time or the number of words searched, but the influence of dictionaries' interface design on searching behavior and consequently on the retention of words searched. Studies in this respect have just begun. More quantitative and qualitative studies, therefore, should be conducted.

Notes

1. According to Potter (1998), learning environments of students have changed with the spread of new media for the last several years. He pointed out that we truly live in a media saturated culture.

2. Although sales data on dictionaries are not open to the public due to an agreement between the publishers, the authors asked them directly and received reliable information. According to the data in 2000, the most popular English-Japanese dictionary was *Taishukan's Genius English-Japanese Dictionary,* and *Kenkyusha's Lighthouse English-Japanese Dictionary* was ranked second. *Oubunsha's New Sunrise English-Japanese Dictionary* was ranked third.

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Appendices

1. This book is about investigating the way people use language in speech and writing. I introduce the corpus-based approach to linguistics, based on analysis of large databases of real language examples stored on computer. Each chapter focuses on a different area of linguistics, including lexicography, grammar, discourse, register variation, language acquisition, and historical linguistics. The chapters follow the same progression of topics, beginning with the identification of important research questions, the steps followed for corpus-based analysis, and finally the interpretation of the findings. Example analyses are presented to provide concrete descriptions of the research methods and advantages of corpus-based techniques.

Ten methodology boxes provide clear and concise explanations of the issues involved in doing corpus-based research and reading corpus-based studies, and there is a useful appendix of resources for corpus-based investigation. This lucid and comprehensive introduction to the subject will be welcomed by a broad range of readers, from undergraduate students to professional researchers.

Biber, D, Conrad, S., and Reppen, R. 1998. *Corpus Linguistics.* Cambridge University Press.

2. It is believed that there were over 100,000 tigers in the world at the beginning of the 20th century. They ranged over most of Asia, from the shores of the Caspian Sea east into Siberia, and all the way south to Indonesia. But of the original eight species of tiger, only five remain alive today. It is now thought that the number of tigers in the wild ranges from a low of 5,000 to a maximum of 7,000.

The major threat to the tiger has come from human beings. The forests where the tigers live and hunt have been cut down to make farmland and to obtain wood for fuel. Illegal hunters collect tiger bones, organs, and other body parts for traditional medicines, even though there is no scientific proof of any benefits.

Since humans are responsible for the tragic situation of these noble animals, it is up to us to preserve and protect the few wild tigers that are left. Two urgent tasks face us now. One is creating special areas for the tigers to live. The other is making sure those areas are defended from illegal hunters. Private organizations must work together with national governments to increase public interest and raise funds for protection. If a determined effort is made now, there may still be hope for the long-term survival of the tiger.

Save the Tiger" from the written examination of the pre-2nd grade test of STEP, 1998