

Performance Comparison of Readings using a Conventional Book and a Cell-phone

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Abstract

Cell-phone, including smart-phone, is one of the leading candidates of convenient medium for reading e-books. However, it is unknown if cell-phones are really as readable as conventional paper books. We are focusing on differences in performance of readings with a traditional paper book and a latest cell-phone. Comprehension, absorption, and required period were measured after completion of reading a novel by each subject who used paper book or cell-phone, respectively. Differences of the measured results on the two different medium are analyzed and discussed.

1. Introduction

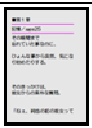
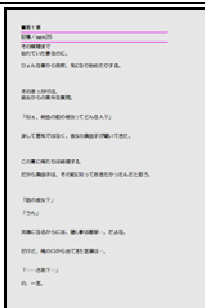
Recently, e-book has been gradually popularized. Cell phone is probably the most popular electronic medium now in Japan for reading novels. Smart phone, with larger screen, is now expected to replace the “traditional” cell phone as a popular medium for reading e-books.

It is important theme to study readability of electronic medium including e-paper; researches have been started recently¹⁾. We have already studied about the effect of screen size of electric medium for reading novels. Readers have shown better comprehension with reading on paperback size screen than with reading on cell phone size screen even they read so called “cell phone novels”, which are usually written using cell phones and read on cell phones²⁾ (Table 1).

Do cell phones really have no advantage as a medium for reading novels? On the other hand, we can expect cell phones obvious advantages; they must offer us frequent chance for reading novels including dark place and crowded train

Here we are focusing on difference of reading behavior between reading with conventional books and reading with cell phone.

Table 1 Our previous results on readability: dependence on screen size

| | Cell-phone size (3 inch) | Book size (7 inch) |
|----------------------------------|---|---|
| Correct answer rate | 70% | 81% |
| Absorption level (1 to 5) | 3.66 | 3.75 |
| Typical display of book contents |  |  |

2. Experimental Methods

We have compared behavior and performance between readings with cell phone and with conventional paper book. Table 2 shows the two media for reading. A smart-phone, iPhone 4, was used as an up-to-date cell phone. Figure 1 shows the smart phone and the conventional paper book used for our evaluation.

We prepared two groups of subjects (4 students for each group): the first group was requested to read a novel on paper book, and the other group was requested to read the same novel on the cell phone. The subjects were asked to read the novel in their daily life freely and also asked to record in what place they read. The format for recording their reading behavior is shown in Table 3.

The subjects were requested to answer to an examination for checking their comprehension level of the novel after their reading. They were also requested to answer inquiries for checking their absorption level for the contents of the novel. Comprehension lever was measured as a correct answer rate for 10 questions about the contents of the novel. A part of the comprehension test sheet is shown in Figure 2. Absorption level was measured with subjective answers for the questions asking absorption tendency in reading the novel. They were asked to choose their answer from level 1 to level 5 for each of the five questions; answer sheet is shown in Figure 3.

All the subjects were asked to answer the following general questionnaires before stating their reading tasks:

- 1) Do you hesitate to read novels using a smart phone (iPhone)?
- 2) Which medium do you want to use for reading novels, a conventional paper book or a smart phone (iPhone)?

Table 2 Experimental condition

| | Paper Conventional book | Cell phone iPhone |
|-------------------------|---|--|
| Media | Conventional book | iPhone |
| Display size (cm) | 13.4 × 9.4 | 7.7 × 5.2 |
| Contents | If a high school girl manager of a baseball team read “Management” by Drucker | |
| Character × Line number | 40 × 16 | (Standard font) 22 × 10 (Maximum font) 10 × 5 |
| Font size (pt) | 10 | (Standard font) 8.6 (Maximum font) 15 |
| Total page number | 272 | (Standard font) 664 (Maximum font) 2618 |
| Subjects (Students) | 4 | 4 |

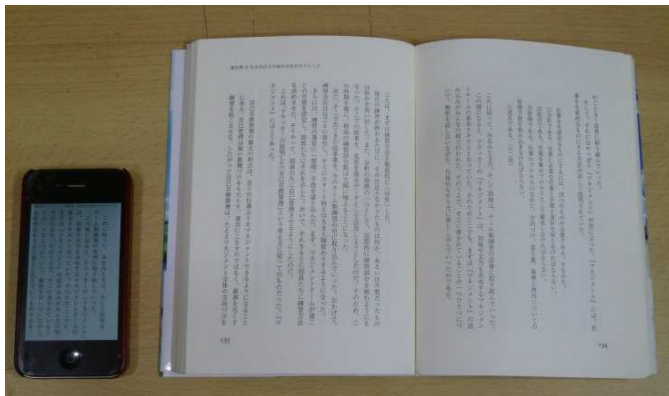


Figure 1 Smart phone and paper book used for the reading tasks

Table 3 Reading log sheet

| Date: | |
|------------------------|------------|
| Today's last page | p. |
| Reading place and time | |
| Place | Time (min) |
| Home (Room) | |
| Home (Bath room) | |
| Home (Other places) | |
| In a bed | |
| Public vehicles | |
| During walking | |
| In a school | |
| Outdoors | |
| Other places | |

Choose truths or false for the next 10 descriptions about the novel you have read

(Question)

1. Mr.Kaji is a teacher of Mathematics.
2. Yuhki is suffering from cancer.
- ⋮
- 10.

Figure 2 Comprehension test sheet

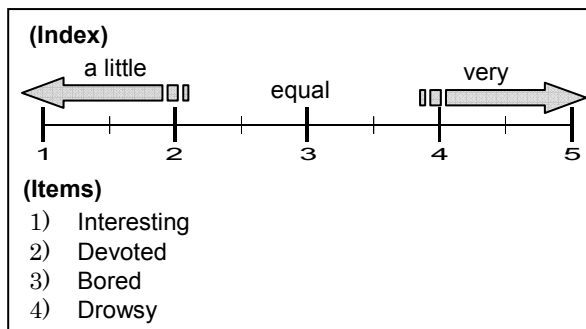


Figure 3 Four question items to subjects for measuring their absorption level and scale used for answering

3. Experimental Results

Figure 4 shows reading behavior: averaged time rate for each of various places used for reading. Average of required period and actual days used for reading are shown in Table 4. Smart phone and paper book showed almost the same results in actual days used for reading. Reading behaviors were, on the other hand, clearly different between the two media. "Home" (65%) is the major place for reading with the paper book. Moving situations, "Public vehicles" plus "During walking" (42%+14% =56%) are the major places for reading with the smart phone.

Figure 5 shows the averaged corrects answer rate. Conventional paper book showed greater correct answer rate, it means better comprehension, than that of smart phone. Figure 6 shows averaged result of subjective answer related to absorption. The vertical axis, absorption, was calculated as an average of subjective answers to the four questions listed in Figure 2. Absorption level was almost the same in the two medium.

Statistical significance was checked for the difference of correct answer rate and absorption level between the two mediums. We used "Student's t test" to evaluate the statistical significance of the difference between the mean values of two independent groups. "Student's t test" generally outputs probability p that confirms the null hypothesis that denies the difference in the mean values of two groups. A statistical significance is confirmed when $p < 5\%$: that is the null hypothesis should be denied.

Level of significance was 34% for correct answer rate and 85% for absorption level; the differences between the two medium were not proved as statistically significant both in correct answer rate and in absorption level.

Figure 7 and Figure 8 shows the averaged results of the answers asked before stating the reading tasks. The percentage of the subjects who felt hesitation for reading with smart phone was larger than the percentage who felt no hesitation. Furthermore, all the subjects answered that they prefer, for reading, conventional paper books than a smart phone.

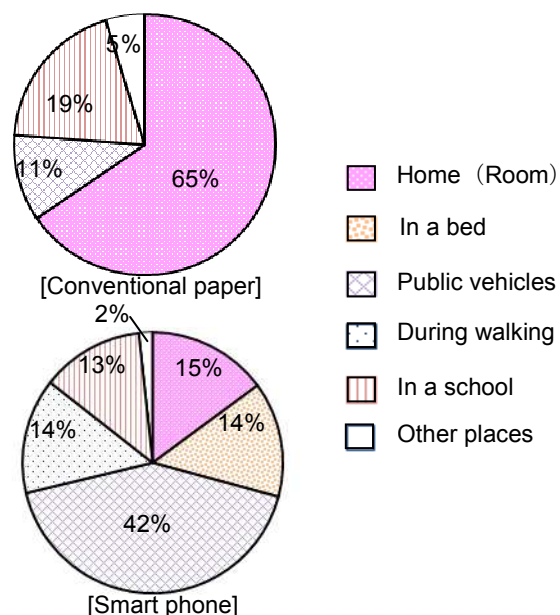


Figure 4 Percentage of various reading places for each media

Table 4 Resulted reading behavior of all the subjects

| Media | Subjects | Actual days for reading (days) | Required period (days) | (Actual days) / (Required period) | (Reading times) / day | Total reading times | Total reading time (min) | Reading time / day (min) |
|--------------------|----------|--------------------------------|------------------------|-----------------------------------|-----------------------|---------------------|--------------------------|--------------------------|
| Conventional paper | A | 3.0 | 3.0 | 1.0 | 1.3 | 4.0 | 155.0 | 51.7 |
| | B | 7.0 | 14.0 | 0.5 | 1.0 | 7.0 | 175.0 | 25.0 |
| | C | 4.0 | 7.0 | 0.6 | 1.3 | 5.0 | 286.0 | 71.5 |
| | D | 6.0 | 33.0 | 0.2 | 1.0 | 6.0 | 410.0 | 68.3 |
| | Average | 5.0 | 14.3 | 0.4 | 1.1 | 5.5 | 256.5 | 54.1 |
| Smart phone | E | 5.0 | 6.0 | 0.8 | 1.4 | 7.0 | 300.0 | 60.0 |
| | F | 6.0 | 16.0 | 0.4 | 1.5 | 9.0 | 180.0 | 30.0 |
| | G | 2.0 | 2.0 | 1.0 | 1.0 | 2.0 | 210.0 | 105.0 |
| | H | 3.0 | 4.0 | 0.8 | 1.0 | 3.0 | 165.0 | 55.0 |
| | Average | 4.0 | 7.0 | 0.6 | 1.2 | 5.3 | 213.8 | 62.5 |

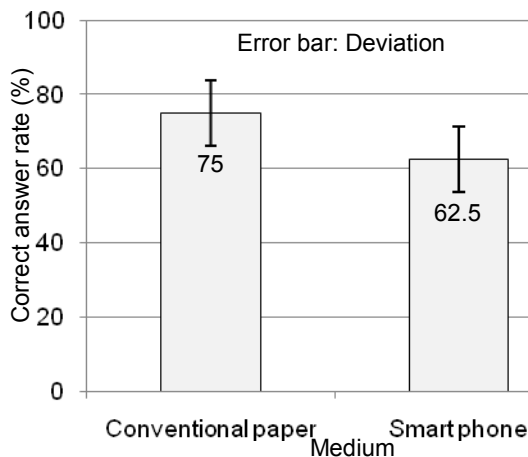


Figure 5 Result of objective evaluation (Comprehension level)

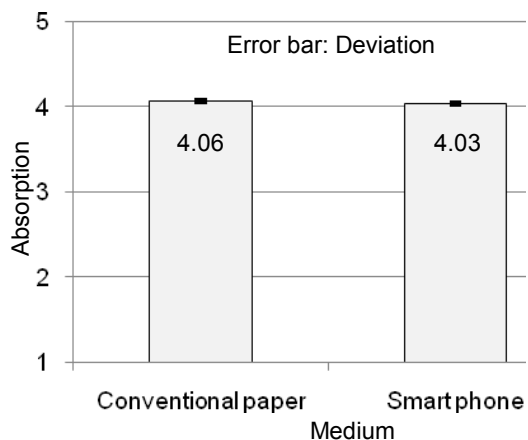


Figure 6 Result of subjective evaluation (Absorption level)

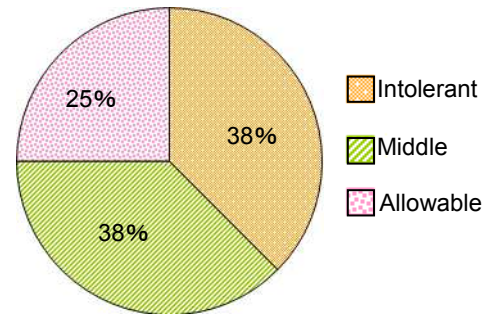


Figure 7 Preliminary survey of subjective tolerance to electronic reading media

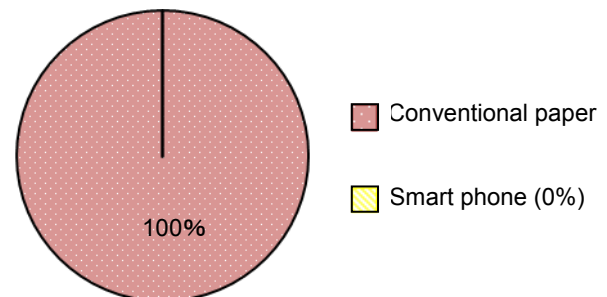


Figure 8 Preliminary survey of preference of medium for reading

4. Discussion

There was almost no difference in actual days for reading between the conventional paper book and the smart phone. It should be noted, however, that there is a significant difference between the two media in reading behavior. The dominant percentage of the moving situation shown as the place for reading with smart phone indicates that subjects could utilize their scraps of time. Readers with conventional paper books were, on the other hand, supposed to take their dedicated time for reading in their home.

We found interesting disagreement between preference reach before reading task and resulted reading performance. Although

the preliminary survey indicated the subjects preferred conventional paper books, the subjects showed the same level of absorption with the two media equally.

5. Conclusion

We have compared performance and behavior of the two type of reading: reading with conventional paper and reading with smart phone. Results and discussions are summarized as follows:

1) The actual days for reading were almost the same in the readings with paper book and with smart phone.

2) Conventional paper showed slightly higher comprehension level than that of smart phone; statistical significance of this result, however, has not been proved.

3) There was a significant difference between the two medium in reading behavior. Moving situations were the dominant places for reading with smart phone, while home was the dominant place for reading with the paper book.

Reference

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Author Biography

Junko Inada was born in 1988. She received her B.E. degree in 2011 from Tokai University. She is expected to receive her M.E.degree from the graduate school of Tokai University in 2013. She is now engaged in studies of readability as a target of Electronic Paper.