UTILITY OF LABELED PICTOGRAMS FOR IMPROVING PERFORMANCE IN DIRECTORY-BASED INFORMATION SEARCH TASKS AT E-COMMERCE SITES

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ABSTRACT

This paper reports an experiment conducted to compare alternative representations of directories for improving usability of e-commerce sites. The experiment simulated a directory-based information search task, typically carried out at e-shopping sites, to understand how it is performed when directories are represented in text, labeled pictograms, or unlabeled pictograms. We conjectured that the task performance would be affected by skills in processing text or images including pictograms. Twenty-one hard-of-hearing, who were skilled at processing pictograms, and 21 hearing participants, skilled at processing text, were asked to select one of 27 directories represented in one of the three alternative formats for each of 38 queries ranging from easy to difficult. The result demonstrated that it took more time to select a directory for the difficult queries than for the easy queries and that it took the least time when the directories were represented in labeled pictograms. In addition, the degree of variability in directories selected by each of the participant groups was greater for the difficult queries than for the easy queries and decreased monotonically for the hearing group as the format became more textual. However, it stayed approximately at the same level for the hard-of-hearing group. On the assumption that the degree of directory utility increases as the time to answer a query and the variability of the answers decrease, labeled-pictogram representation is the best except when easy queries were answered by hearing persons.

KEYWORDS

Web Usability, Representation of Directory, Labeled-Pictogram, Directory-Based Information Search

1. INTRODUCTION

Directory-based information search is a widely used method to access information buried in an information structure. At an e-shopping site, a visitor has to select a category that she thinks the item she wants to purchase should belong to. At an e-banking site, a visitor needs to select a transaction type she intends to initiate. Successful e-commerce sites should provide the visitors with easy-to-understand hyper-links to reach appropriate web pages for accomplishing their tasks. Alternative representations are available for the hyper-links: text, labeled pictograms, unlabeled pictograms, images, and so forth. For example, a directory that represents the concept "journey" can be represented in text by TRAVEL, a photo image featuring a traveler checking in at an airline counter, or its pictogram equivalence with or without the text label TRAVEL. The degree of utility of each representation might be influenced by the degree of understandability of the concept the hyper-link represents, and by the degree of literacy of the visitors for processing the visual representation, *i.e.*, multimedia information, of the concept. For example, the concept TRAVEL is easier for typical visitors, to understand than ODYSSEY; those who are skilled in reading text select hyper-links that include textual

information faster than those without, or those who are accustomed to using images would prefer pictograms to text.

This paper compares three alternative representations of hyper-links, *text*, *labeled pictograms*, and *unlabeled pictograms*, in terms of their utility for supporting directory-based information search tasks, a typical task performed at e-commerce sites. A pictogram is a symbol representing a concept, object, activity, place or event by illustration. Examples of pictogram are shown in Figure 1. Pictograms have been used at public spaces such as airports and train stations as a means for transmitting messages directly and instantly to passengers. Pictograms are intuitive visual representations of meanings and would have advantage over textual representations in those situations. The advantage of pictograms may hold in directory selection tasks performed in e-commerce sites where quick navigability would be preferred.

This paper specifically focuses on the level of multimedia literacy concerning text and pictograms. The level of multimedia literacy might be defined in various ways. However, this paper exclusively focuses on text and images. Hard-of-hearing persons use different cognitive processes than hearing persons when examining visual information (Wilson and Emmorey, 1998), and they rely more heavily on visual representation than textual representation when examining the contents on web pages (Namatame et al., 2006; Namatame and Kitajima, 2006, 2005; Namatame et al., 2007). This paper considers hard-of-hearing persons as the representative visitor group that uses visual information more heavily than textual information and hearing persons as the hard-of-hearing persons' counterparts along the multimedia literacy spectrum characterized by text and image usage.

This paper reports the result of an experiment that investigated the performance of a directory-based information search task from the viewpoint of speed of directory selection and the variability of the selected directories for given queries. If a representation of a directory is understood in various ways, *i.e.*, is ambiguous, or is selected slowly, it would not be useful as a representation of the hyper-link for digging into the web site.

(a) Bank, money, and exchange (b) Cash service

Figure 1. Examples of pictogram defined by JIS Z8210 (Japanese Industrial Standard).

2. DIRECTORY-BASED INFORMATION SEARCH TASK

2.1 Participants

Twenty-one hard-of-hearing persons and 21 hearing persons participated in the experiment. All the participants were regular internet users and had an adequate performance level for using the Japanese language.

2.2 Task

The participants were asked to select a directory that best matched a query such as "Want to buy a used computer" from the 27 directories displayed on an LCD monitor in one of three forms: 1) labeled pictogram, 2) unlabeled pictogram, or 3) text. These are shown in Figs. 1, a, b, and c. There were 38 queries (Table 1). For the purpose of further analysis, the queries were divided into three categories, difficult, easy, and moderate, by conducting a survey on the difficulty of the queries using a five-point subjective rating scale (5,

most difficult; 1, easiest) with a separate set of hearing participants. We identified 11 difficult queries and 11 easy queries. No time limit was set for this experiment.

2.3 Results

The average time necessary for a participant to complete the task measures the speed of task performance. The left portion of Fig. 3 plots the average time necessary for completing a query in terms of query difficulty, difficult vs. easy, and characteristics of participants, hard-of-hearing vs. hearing. The plots reveal that the difficult queries took more time than the easy queries for the participants, either hard-of-hearing or hearing, to answer; that the representation in unlabeled pictograms took the longest; and that the representation in labeled pictograms took the shortest to complete a query.

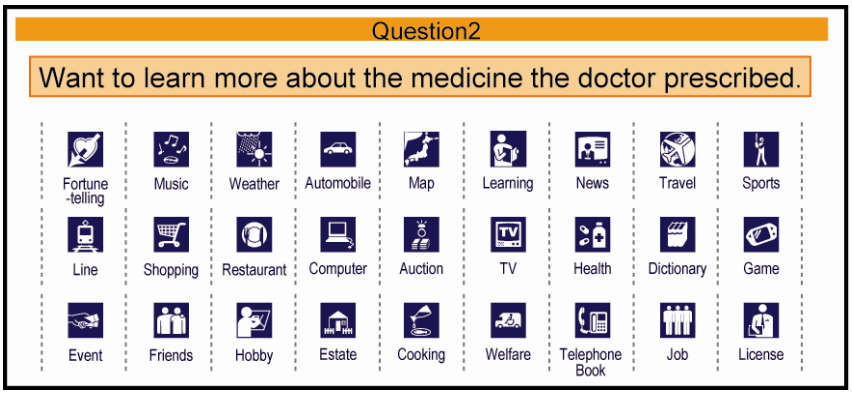
The distribution of the frequencies of selected directories for a query that a group of participants selected using one of the three representations measures the degree of consistency with which the group understands the meaning of the query with reference to the practical representations of the directories in the respective formats. A group selecting a single, unique directory for a query understands the query consistently using the representation format. In contrast, a group selecting a variety of directories for a query perceives the meaning of the query less consistently, *i.e.*, more ambiguously. We calculated the information theoretic entropy for measuring the degree of consistency. As the smaller the information theoretic entropy becomes, the more consistently the participant-group understands the query.

The procedure is as follows. Let $X_{r,g,k}(i)$ be the frequency of selecting the directory $i\,(1 \le i \le 27)$ for the query $k\,(1 \le k \le 38)$ in the representation form $r \in \{\text{unlabeled - pictogram}, \text{labeled - pictogram}, \text{text}\}$ by the participant-group $g \in \{\text{hard} - \text{of} - \text{hearing group}, \text{hearing group}\}$, then the probability of selecting directory i for query k by group g in representation format r is given by the following formula:

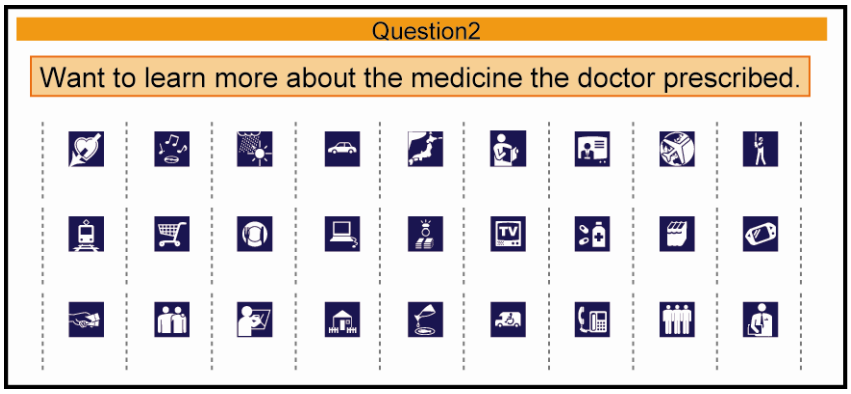
$$P_{r,g,k}(i) = \frac{X_{r,g,k}(i)}{\sum_{i=1}^{27} X_{r,g,k}(i)}$$

Table 1. Queries used in the experiment

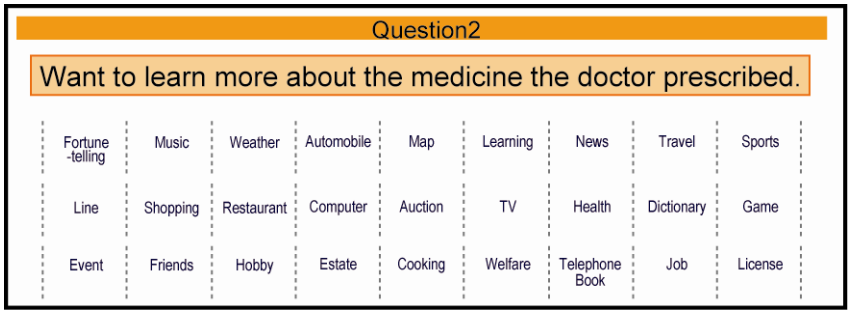
Easy Queries (Difficulty score < 2.70)	Difficult Queries (Difficulty score > 3.30)
1. Want to know tomorrow's weather (1.30) 2. Want to know typhoon information (1.60) 3. Want to know the results of preliminary matches for soccer world cup soccer (1.75) 4. Want to know the results of yesterday's professional baseball games (1.80) 5. Want to know how to transfer to a train for the Shibuya station (1.85) 6. Want to see next week's TV programs (1.95) 7. Want to go to see fortune-teller for niceness with a friend (1.95) 8. Want to purchase a bag made of Louis Vuitton (2.50) 9. Want to order flower arrangements for Mother's day over Internet (2.50) 10. Want to French restraints (2.50) 11. Want to purchase a used-computer (2.65)	1. Want to learn how to cook Thai curry (3.30) 2. Want to volunteer for something (3.35) 3. Want to obtain driver's license (3.45) 4. Want to study abroad in US (3.50) 5. Want to open a shop at flea market (3.60) 6. Want to learn hip-hop (3.85) 7. Want to learn more about the medicine the doctor prescribed (3.95) 8. Want to make friends with ,foreigners (3.95) 9. Want to play DVD with PC (4.10) 10. Want to join a tour accompanied by a sign language interpreter (4.25) 11. Want to obtain a hearing dog (4.50)
Moderate Queries (2.70 < difficulty score < 3.30)	
1. Want to know ZIP code by using postal address (2.70) 2. Want to know the location of a shop by using its postal address (2.75) 3. Want to request information about recruitment (2.80) 4. Want to confirm whether Shinkansen is operating normally (2.80) 5. Want to purchase a ticket for a J-league soccer match (2.80) 6. Want to know the timetable of the express highway bus (2.80)	7. Want to purchase discount airline flight ticket (2.85) 8. Want to move to a more larger room (2.90) 9. Want to make friends by using chat (3.05) 10. Want to know the meaning of "Mei-Kyou-Shi-Sui" (3.10) 11. Want to know the schedule of an art exhibition (3.10) 12. Want to search for a part time home-working job (3.10) 13. Want to play Japanese chess over Internet (3.10) 14. Want to know about the latest situation of the Iraq war (3.15) 15. Want to learn the Russian language (3.15) 16. Want to take examination for qualification of word processing skill (3.25)



(a)



(b)



(c)

Figure 2. Three alternative representations of directories. (a) Labeled pictogram. (b) Unlabeled pictogram. (c) Text.

By using this probability, information theoretic entropy of query k for participant-group g in representation form r, $H_{r,g,k}$, is given as follows:

$$H_{r,g,k} = -\sum_{i=1}^{27} P_{r,g,k}(i) \log_2 P_{r,g,k}(i) \text{ , where } 0 \le H_{r,g,k} \le 4.75 = \log_2 27$$

$H_{r,g,k}$ becomes smaller as the participant-group's responses become more consistent. It takes the minimum value, 0, when all the participants of the group g selected a common directory for the query k in representation form r. On the other hand, when the responses to the query k from the participant-group g distributed evenly to all the directories, it takes the maximum value, 4.75.

Finally, we can obtain the average information theoretic entropy for difficult queries, moderate queries, and easy queries in each representation form by averaging over the corresponding values of information theoretic entropy. The right portion of Fig. 3 demonstrates that difficult queries tended to have greater entropy values than easy queries for each participant group. The entropy values from the hard-of-hearing

group tended to be stable, but those from the hearing group for both the difficult queries and for the easy queries exhibited monotonic decreases as the hyperlinks became more textual, *i.e.*, from unlabeled pictograms, to labeled pictograms, to just text.

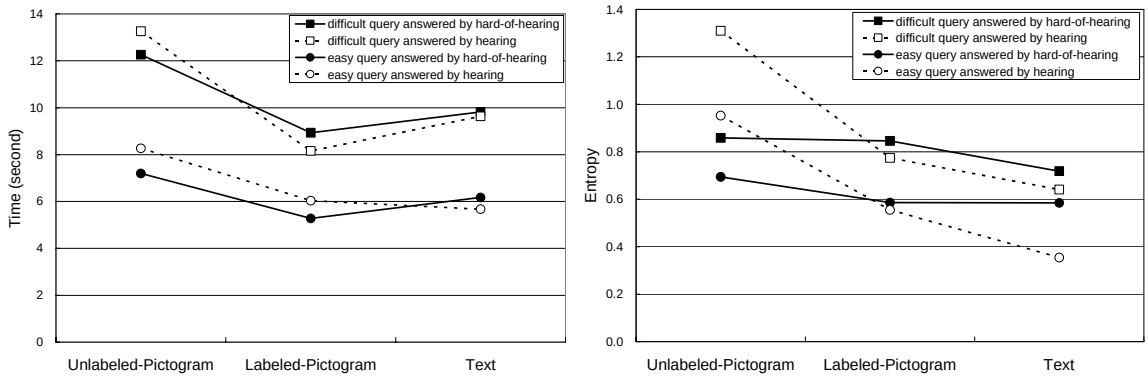


Figure 3. Experiment results. Left – selection time. Right – entropy.

3. CONCLUSION

Assuming that the degree of directory utility increases as the time to answer a query and the variability of the answers decrease, the experimental result suggests that labeled-pictogram representation is the best except for when the hearing group answers easy queries. However, we should recognize that the results are still tentative because most of the observed differences did not reach the level of statistical significance. The spectrum of media literacy is wide and affects the degree of utility of hyperlinks used in e-commerce sites. We will continue on this direction of research to seek optimal multimedia representations for individual visitor groups with specific multimedia literacy.

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