Suitable Representations of Hyperlinks for Deaf Persons: An Eye-tracking Study

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ABSTRACT

This paper reports an eye-tracking experiment conducted to compare alternative representations of directories typically shown on web pages in search of a best representation for deaf persons. The experiment simulated a directory-based information search task to understand how it is performed when directories are represented in text, labeled-pictograms, or unlabeled-pictograms. Twenty-one deaf and 21 hearing participants were asked to select one of 27 directories represented in one of the three alternative formats for each of 38 queries. The result demonstrated that only in the labeled-pictogram representation, the hearing group and the deaf group performed equally well in terms of the eye movement measures.

Categories and Subject Descriptors

H.5.4 [**INFORMATION INTERFACES AND PRESENTATION (e.g., HCI)**]: Hypertext/Hypermedia, Navigation

General Terms

Human Factors

Keywords

Deaf, Eye-Tracking Experiment, Web Accessibility, Directory-Based Information Search, Pictogram

1. INTRODUCTION

The pervasiveness of the Web has been growing in line with continued advances in information technology, and an ever-growing amount of information has accumulated on the World Wide Web. At the same time, the need to make the information accessible to any person who needs it has become a serious issue. In the Web accessibility field, assuring accessibility not only for people with disabilities but also for elderly persons has become an important concern [2].

This paper addresses Web-content accessibility for deaf persons by taking up directory-based information search as a key task for getting access to information in the Web. Three alternative representations of hyper-links, *i.e.*, text, labeled-pictogram, and unlabeled-pictogram, are compared in terms of their utility for supporting directory-based information search tasks. Pictograms have been used at public spaces as a means for transmitting messages directly and instantly to passengers. Pictograms are intuitive visual representations of meanings and would have advantage over textual representation in those situations. We hypothesized that the advantage of pictograms may hold in directory selection tasks performed in web sites where quick navigability would be preferred.

This paper specifically focuses on the level of multimedia literacy of users concerning text and pictogram. Deaf persons use different cognitive processes than hearing persons when examining visual information [5] and they rely more heavily on visual representation than textual representation when examining the contents on web pages [4]. Therefore, this paper considers deaf persons as the representative users that uses visual information more heavily than textual information and hearing persons as the deaf persons' counterparts along the multimedia literacy spectrum characterized by text and image usage [1].

In the previous study [3], we reported that the labeled-pictogram and the text representations are equally good in terms of task performance times and consistency of directory selections. This paper supplements the previous results by making further analysis using the eye-movement data in order to investigate the anticipated differences between the labeled-pictogram and the text representations.

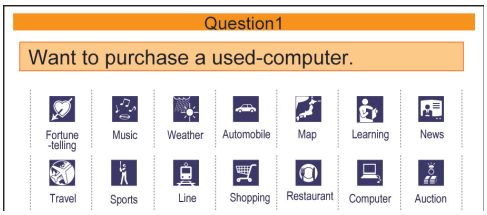

Figure 1: A screen-shot of the experimental web page with directories represented in labeled-pictograms.

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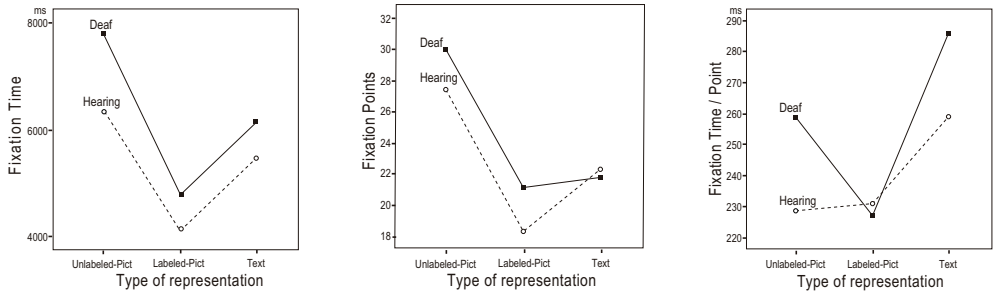

(a) (b) (c)

Figure 2: Results of the experiment: (a) the total length of fixations, (b) the total number of fixations, and (c) the average fixation time.

2. THE EYE-TRACKING EXPERIMENT

Twenty-one deaf persons and 21 hearing persons participated in the experiment. Each participant was shown one of the three representations, *i.e.*, text, labeled-pictogram, or unlabeled-pictogram. Figure 1 shows the screen shot of the display of the labeled-pictogram representation. Each participant was asked to select one of 27 directories for each of 38 queries. See [3] for details. Participants' eye movements and mouse events were recorded with a Tobii 1750 eye tracker. The eye movements data were analyzed by the parametric ANOVA to understand how the method of directory search adopted by the hearing group and the deaf group might be different under the influence of the differences in directory representations.

2.1 Total Length of Fixations

Figure 2 (a) demonstrates that the deaf group showed longer total fixations than the hearing group ($F(1, 37) = 11.33,\ p < .01$), and there were significant differences in the representations ($F(2, 74) = 19.20,\ p < .01$). The labeled-pictogram showed significantly shorter total fixations than the other two representations and the unlabeled-pictogram representation showed significantly longer total fixations than the other two representations.

2.2 Total Number of Fixations

Figure 2 (b) demonstrates that there were significant differences in the representations ($F(2, 74) = 17.76,\ p < .01$). The unlabeled-pictogram representation resulted in more fixations than the text or the labeled-pictogram representations. However, there was no significant difference between the groups.

2.3 Average Fixation Time

The average fixation time was derived by dividing the total length of fixations by the total number of fixations. This would measure the effectiveness of a representation for a participant group in terms of the quick gathering of information necessary for selecting a directory that best matches the query. Figure 2 (c) demonstrates that there were main effects of the groups ($F(1, 37) = 20.56,\ p < .01$) and the representations ($F(2, 74) = 50.54,\ p < .01$), and there was interaction between the two factors ($F(2, 74) = 12.20,\ p < .01$). However, in the labeled-pictogram representation, there was no significant difference between the groups. Both groups performed equally well. This indicates that the labeled-pictogram representation is the best for quick gathering of information for directory-based information search task.

3. CONCLUSION

The previous study [3] showed the superiority of the labeled-pictogram and the text representations over the pictogram representation; the formers showed shorter task completion time and more consistent directory selection for the queries. This study further showed that the labeled-pictogram representation has advantage over the text representation by showing that the former required the least total length of fixations, the least number of fixations, and most importantly, it required the least average fixation time and it showed no difference between the deaf group and the hearing group. This implies that both groups gathered information necessary to select a directory most efficiently and equally well when the directories were represented by labeled-pictograms. We conjecture that this is because pictogram is useful when quickly recognizing what is represented with limited preciseness and text can add information to make the meaning of the pictogram clearer.

4. REFERENCES

[1] M. M. Gentry, K. M. Chinn, and R. D. Moulton. Effectiveness of multimedia reading materials when used with children who are deaf. In *American Annals of Deaf Vol.149*, pages 394–402, 2004.

[2] S. Kurniawan and P. Zaphiris. Research-derived web design guidelines for older people. In *Proceedings of the 7th international ACM SIGACCESS Conference on Computers and Accessibility*, pages 129–135. ASSETS'05, October 2005.

[3] M. Namatame and M. Kitajima. Comparison of alternative representational formats for hyperlinks: Pictogram, labeled-pictogram, and text. In *Proceedings of the Workshop on Cognition and the Web: Information Processing, Comprehension and Learning*, pages 115–118. WCW2008, April 2008.

[4] M. Namatame, T. Nishioka, and M. Kitajima. Designing a web page considering the interaction characteristics of the hard-of-hearing. In *Proceedings of the 10th International Conference on Computers Helping People with Special Needs*, pages 136–143. ICCHP2006, July 2006.

[5] M. Wilson and K. Emmorey. A Ągword length effectĄh for sign language: further evidence for the role of language in structuring working memory. In *In Memory & Cognition, Vol. 26*, pages 584–590, 1998.