Improving Web Usability for the Hard-of-Hearing

MIKI NAMATAME Tsukuba University of Technology, Japan : miki@a.tsukuba-tech.ac.jp
MUNEO KITAJIMA National Institute of Advanced Industrial Science and Technology (AIST), Japan : kitajima@ni.aist.go.jp

Introduction

Recently, with continued advances in information technology, there is an ever-growing amount of information accumulated on the World Wide Web. At the same time, the need to make this information accessible to any person who needs it becomes a serious issue. This paper focuses on web content accessibility for the hard-of-hearing. This is motivated by the fact that the first author, who is engaged in educating hard-of-hearing persons through daily classes, felt that hard-of-hearing persons would interact with web pages differently than hearing persons. Using web-based interactive course materials seems effective since they allow the creator to control the presentation of the content. However, the issue of how the hard-of-hearing interact with the web has not been adequately studied.

How the hard-of-hearing browse the web

In previous studies [Namatame et al. 2004; Namatame and Kitajima 2005], we demonstrated differences in web-browsing behavior between hard-of-hearing persons and hearing persons in terms of the number of errors and the nature of scan paths used as they accomplished a task on an experimental web page that simulated a then-existing automotive site. The participants were asked to locate a page that described a designated car model and to choose a favorite color for it. We recorded their link selections and eye movements and analyzed the data from the site's top page. The results indicated that the hard-of-hearing made a significantly larger number of errors in link selections and adopted less consistent browsing patterns than the hearing participants. Figure 1 depicts the scan paths from one of the hard-of-hearing participants. It does not indicate a clear pattern of scanning. This is contrasted with scan paths from the hearing participants, which show vertically aligned scan paths consistent with the semantic structure of the page.

Redesigning and evaluation

We conjectured that the design of the experimental web page was not self-evident from the way the information was organized. The hard-of-hearing participants would have had difficulty in capturing the hidden semantic structure partly because written language is not their primary language. We redesigned the top page by adding vertical lines that effectively separated it into columns. We expected that this redesign should improve the site's usability for hard-of-hearing persons. This paper reports that this redesign was effective. Figure 2 illustrates an eye movement pattern typical of those from hard-of-hearing participants. It confirms that the redesign successfully improved usability for hard-of-hearing persons.

Conclusion

An important lesson is that what is obvious for the web-literate is not necessarily obvious for the hard-of-hearing. Hidden semantic structures resulting from fancy design ideas were not easily captured by the hard-of-hearing, resulting in a serious usability problem. Their eye movements told us clearly where the source of confusion was and suggested an effective design change. A small design consideration resulted in a large improvement in the usability of the web site.

References

NAMATAME, M., AND KITAJIMA, M. 2005. Differences in Web-interaction styles of hard-of-hearing and hearing persons. HCI International 2005.

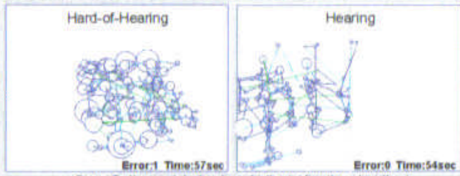
NAMATAME, M., KITAJIMA, M., NISHIOKA, T., AND FUKAMAUCHI, F. 2004. A preparatory study for designing web-based educational materials for the hearing-impaired. 9th International Conference on Computers Helping People with Special Needs (ICCHP2004), 1144-1151.

How the hard-of-hearing browse the Web

Contrasting hearing-impaired with normal-hearing subjects
(Scanning Patterns, Selected Links, Number of Errors, Processing Times per Page)

Differences in Scan Patterns

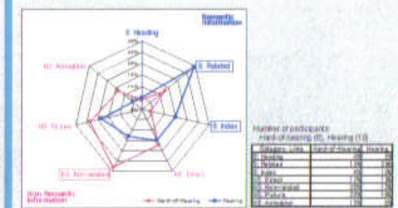
Feature of Scan Patterns
-Hard-of-hearing didn't show a coherent pattern.
-Hearing showed vertical scanning pattern.
(consistent with the semantic structure of the page)



Scan Patterns (circle sizes indicate fixation duration)

Differences in Link Selections

Hard-of-hearing selected semantic information less frequently than hearing.



Pattern of the types of selected links

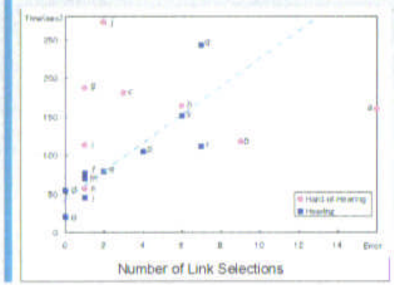
Differences in Number of Errors and Correct Link Selection Times

Hard-of-hearing selected wrong links more often than hearing.
Hard-of-hearing took longer time to select correct link than hearing.

	Hard-of-Hearing	Hearing
Average Number of Errors	4.9	2.6
Average Time to Select Correct Link	2 min 49 sec	1 min 27 sec

Differences in Processing Times per Link Selection

Hearing took a certain amount of fixed time before selecting a link.
Hard-of-hearing did not use such a strategic search method when selecting a link.



Web Content Accessibility Guidelines 2.0 (W3C Working Draft 11 March 2004)

Principle 1 : Content must be perceivable.
For non-text content, provide text equivalents that serve the same purpose or convey the same information as the non-text content.
Provide synchronized media equivalents for time-dependent presentations.
In auditory presentations, make it easy to distinguish foreground speech and sounds from background sounds.

Principle 3 : Content and controls must be understandable.
Organize content consistently from "page to page" and make interactive components behave in predictable ways.

Results

Successful Redesign

Redesign based on the understandings of web-interaction behavior of hard-of-hearing.

The small redesign resulted in a large improvement in the usability of the web site.

Contribution to Web Guideline

Add a success example for the Web Guidelines.
-Structure of contents should be visually understandable.
-Label expressions of hyperlinks should be understandable.

	Before Redesign	After Redesign
Average Number of Errors	4.9	0.8
Average Time to Select Correct Link	2 min 42 sec	0 min 42sec

Improvement of performance

Scan path of a hard-of-hearing

Before Redesign

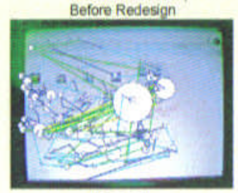


Figure 1

After Redesign

Figure 2

Experiments

Eye movement only (the head is stationary)

Method

Visual Image
1 Task images projected on a flat screen 150cm in front of a subject.
2 Projection window size of an internet browser: 90cm wide × 75cm high.
3 View angle for a subject: 33-degree horizontal angle, 27.5-degree vertical angle.

Eye Movement Measuring System
- Pupil/Corneal reflection method EMR-8 NAC Inc.
- Field view camera and the eye mark detection unit on the cap.
- Field view camera: 1/4 inch color image sensor, 44-degree horizontal angle, 512(H) × 492(V) pixels.
- Eye mark detection unit: 1/3 inch B/W image sensor, the right eye degree angle, 320(H) × 243(V) pixels, 60Hz sampling, eyeball movement 0.1 degree, pupil diameter 0.02mm.

Computer System
1 Windows NT computer system with eye-mark recorder (for researcher).
2 Windows XP Home Edition computer system with projector (for subject).
3 Internet browser: Internet Explorer ver.6.

Recording
The sampled data is superimposed in the image at a rate of 60 Hz.

Subjects

- 10 hearing (before redesign)
- 8 hard-of-hearing (before redesign)
- 5 hard-of-hearing (after redesign)
- 18-24 year old students

Experimental Procedure

- Task announcement using sign language and A4-size board
- One session only

Task

"Please choose your favorite color for the car model Z4"

- Step1* Locate a page that describes the designated car model Z4.
- Step2 Choose a favorite color for it.

* Eye movement data from Step1 were used for the analysis.

Redesign

Making visible the hidden semantic information by:
- Changing the language of label expressions of column titles to Japanese.
- Adding vertical lines for effectively separating the page into columns.

Before Redesign

Aftere Redesign