Undergraduate Honors Program

Computer Science

# An Eye-Tracking Evaluation of Multicultural Interface Designs

by

**Daniel Shaw**

submitted in partial fulfillment of the requirements
the degree of

B.A.

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**Abstract**

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# An Eye-Tracking Evaluation of Multicultural Interface Designs

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Daniel L. Shaw

Advisor: Professor Jim Gips

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*To my grandparents.*

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## Chapter I - Introduction

The growth of the Internet and other forms of computer-mediated communication was both gradual and global. Today, users have embraced the ability to interact with individuals across the world, sharing information beyond borders at a level never before realized in the history of the human experience. While developers have long applied usability guidelines for domestic products, the international community has not received appropriate attention in the design of multicultural interfaces. Many international companies apply bare-minimum localization to their websites, translating content without regard to the multitude of other factors that affect interface usability. This is not to say that resources are not available for developers – in fact, quite the opposite is true. An assessment of published literature reveals that concepts such as localization and globalization have been researched and reviewed at length, ready for implementation in real-world situations.

The objective of this study is to examine the cultural impact of interface layout design on usability in order to promote the implementation of multicultural design guidelines in web and software development. Through the use of an eye-tracking system, this study will consider usability differences between American and Japanese websites as representatives of many possible examples of multicultural interfaces. Eye-tracking allows for an in-depth evaluation of usability through search tasks, and subsequent latency and visual scanning analysis. By examining how a user finds their way through a website, one can

look to explain why many users claim that interfaces designed in their native culture are easier to navigate. Consequently, if cultural interface preferences correspond with real-world usability, then there is certainly reason to justify implementation of such design strategies for websites and software applications. Users across the world would greatly benefit from an increased movement toward internationalization of interface design, and developers would benefit from increased usability of their products. This study aims to unite and strengthen those causes through an eye-tracking analysis of multicultural interface designs.

## Chapter II – Literature Review

### Global Differences

The Internet was originally funded and developed by the U.S. Department of Defense as a medium that would allow English-speaking users to communicate with other English speakers [1]. While the Internet was always intended to be a global communication channel, it was not specifically designed to be multilingual, or multicultural. Although there was not a compelling case for early internationalization, the expansion of the Internet during the 1990s was felt around the world and forced developers to consider global users. Generally, until the early 1980s, US-based software publishers did not demonstrate recognition of the need for internationalized and localized products [2]. As a result, early attempts to internationalize software (and, later, websites) did not follow consistent rules among different developers. In 1990, the Localization Industry Standards Association (LISA) was founded in order to create a set of globalization guidelines for software developers and localization service providers [2]. A special group of the International Standards Organization (ISO) is also working to standardize icons and signs found within software and online graphical user interfaces [3]. During the late 1990s, some software developments allowed for the production of multilingual content without additional international support or add-ons [2].

Of course, there would be no need to create standardized guidelines without an international population looking to utilize software and web services

developed outside of their native region or language. While economics have driven much of the internationalization movement, social, cultural, and political factors have also contributed to the growing industry [3]. The difficulty for developers comes in the understanding that while most customers won't ask for internationalized products, they still expect software or websites to operate in their language and local customs [4]. Developers can choose to ignore this demand, but in doing so, they would neglect an international community that includes millions of computer users. A web developer that adds support for French, Italian, German, and Spanish languages increases their potential audience by 200 million users. Adding Japanese and Chinese language support provides for another 200 million potential customers [1]. In fact, while English was once the dominant language of the Internet, less than half (32%) of the current online population considers English their first language. The greatest expansion of the Internet is currently projected to come from the Middle East, Eastern Europe, Latin America, and Africa, areas which have not traditionally been the focus for software and web developers [1].

In terms of software development, globalization (or internationalization) is the methodology of creating products that are general enough to be used by both domestic and international audiences [5]. Localization involves taking a general or location-specific product and creating custom versions for each other culture [5]. As a stand-alone solution, localization is not always practical because of the difficulty of defining the specific characteristics embodied by a user of a

particular culture. In the same way that there is no such thing as an "average web user," there is no "average American user" or "average Japanese user," and a software developer interested in localization needs to carefully recognize the subtle differences between individual users of the same culture [1]. As such, it is generally considered more practical for developers to globalize products and then localize as needed [5]. One approach involves choosing several "typical" markets for initial development and then expanding localization based on successes and failures within those early trials. As an example, Microsoft develops the English, German, and Japanese versions of its operating systems at the same time, as representing specific target markets [6]. English is the largest language market for Windows, and most of the development team members are native speakers. German is the largest European-language market, and provides a good example of European ease of functionality and translation. Japanese is a good representation of the translating difficulties of the languages of East Asia, which also happens to be Microsoft's second-largest market [6].

It is important to recognize the underlying role of the human-computer interface when globalizing or localizing software or online services. In addition to facilitating communication between the user and the processor (server, etc …), computer-mediated communication is also used to share information among human users [3]. Even in the case of a street sign (one of the success models of multicultural interface design) which does not allow a driver or pedestrian to communicate with other users, the original developer of the sign is able to use the

medium to transmit safety warnings and other messages [3]. This method of sharing knowledge is most successful if developers have a general understanding of the differences between different groups of people, whether they are considered to be individual or cultural. Generally, people want to have the ability to communicate with other users, without having to learn additional languages or the specific cultural details pertaining to the other users. In addition, users don't want to be short-changed when it comes to localized software, and expect the same features and options as the developer's native version [6]. This desire places the burden of cultural usability on the developer to make sure that the software or website allows users to communicate with others in a multilingual or multicultural context, with the same ease as communication within the user's own language and culture.

**Multicultural Design Issues**

While localization requires software or web customization that extends beyond language, translation is nonetheless a crucial component of internationalization. Given the complexity of human language, machine translation is extremely challenging and, in general, requires that a human review the final translation [3]. This brings additional time and expense considerations to the process. In addition, some languages are more difficult to localize than others, based on the complexity of the language, availability of translators, and the tools required. The most difficult languages to translate from English (US) are Arabic, Japanese, Chinese, and Russian, while the easiest are Spanish, French, Italian, and

German [1]. Computers have long had difficulty with multilingual communication, dating back to attempts to reproduce the cursive handwriting of Arabic on early monitors and dot matrix printers [3]. Other difficulties with internationalization stem from the fact that Internet connection speeds are not globally consistent [1]. Users in North America, for instance, tend to have greater access to broadband service than Eastern European users. Developers need to take connection speeds into account when using graphics, videos, or sound online. In addition, it is also important to recognize that while a website may be designed for German users, in most cases there is no way to make sure that only German users visit the site [1]. This, again, calls for developers to first globalize their software or website, making sure that their product has a consistent image for both branding and usability, before applying changes to localize content.

In addition to text translation, localized software also requires attention to the impact of color, graphics, and icons presented in the user interface. While graphics cannot completely replace words, well-designed graphics can reduce the number of versions of a product, reduce translation costs, ease learning, improve comprehension, and take advantage of an already existing body of recognizable symbols [5]. Carefully designed graphics can enhance the usability of multilingual and multicultural user interfaces. In certain cultures, icons are an especially powerful way to communicate information [1]. When using internationalized icons, it is important to avoid extremes, maintain neutrality, and make the graphic multipurpose [5]. Using an icon of a rodent to symbolize a

computer mouse would not be effective for a user whose native language does not include that word association. Graphics that include hand gestures, verbal analogies, embedded text, religious symbols, and national emblems should all be avoided [5]. Flags are generally not a good way to represent a language, unless the audience can be defined purely by geographic boundaries [1]. The flag of Spain should not be used to represent the Spanish language if Latin American users are expected to use the software or website. Even the United States flag does not necessarily represent English for many American citizens. To avoid these regional faux pas, it is best to maintain neutrality when using graphical symbols to represent a language or culture.

Customizing the visual display is not limited to graphics, as there are cultural differences in the general presentation of color as well. Developers, especially on the web, need to carefully balance the accepted cultural use of color, with the marketing goals of information exchange [1]. Different cultures have different psychological associations for color, and it would be easy for developers to misrepresent their message based on the choices of colors used [3]. The color red, for example, has different connotations based on the cultural context in which it appears. In China, red signifies celebration, happiness and luck; however, in India, red symbolizes purity. In the United States, the color red is often interpreted as a signal of danger, or to stop, due to the common use in North American traffic lights. American users would generally accept the color green as safe for passage, while some tropical countries associate green with the dangers of the jungle [4].

Thus, the simple use of red or green would be a potentially hazardous situation for users if the developers did not take local color customs into account during the design process. One approach to avoid (or reduce) misunderstandings is to design in black and white first, and add color to enhance as necessary [5]. Color schemes should be clearly defined, and color codes made explicit across product variations. Developers need to understand the symbolism that accompanies a particular color, and selected appropriate colors for each locale [4].

The presentation of information must also be consistent based on the particular preferences of each locale. Beyond translation, text needs to be appropriately formatted for dates, time zones, currencies, etc … [3]. While American users may interpret 03-04-05 as signifying March 4, 2005, European users would read the date as April 3, 2005, and Japanese users would see April 5, 2003. Such formatting errors could have a critical impact on intercultural communication, potentially disastrous in a global economy. When a digital time is displayed, it needs to conform to the user's local time zone or be properly designated otherwise, with clear and consistent labeling [3]. In the same way that time zones are properly noted when used within the United States, information regarding a specific time becomes especially vital when working with international users who may be several time zones away. These concepts also apply to the use of music, as the "Jeopardy" theme song will not adequately signify to all users that the program or website is currently calculating an equation [6]. If the developer anticipates these issues ahead of time and adapts the software

or website to the user, rather than expect the user to adjust to a culturally-limited interface, intercultural communication can be significantly facilitated.

**Cultural Models**

In order to apply the most appropriate usability standards to localized software or websites, a developer needs to first have the ability to examine a culture and determine the specific characteristics that will have the greatest impact on those standards. Identification of key international variables requires understanding the various cultural models, through which a developer can isolate those specific variables that affect usability. While there are many different cultural models to choose from, some of the most common include the Iceberg Model, the Pyramid Model, and the Onion Model, each of which considers different aspects of a particular culture [3]. These models allow for the directed study of fundamental cultural dimensions, which can further target unique international variables. In one particular model, cultural analyst Geert Hofstede identifies five specific dimensions of culture, based on a study of hundreds of IBM employees in 53 countries from 1978-1983 [5]. He describes Power Distance as the "extent to which people of a culture accept large of small distances of power in social hierarchies." According to Hofstede, Individualism versus Collectivism "measures the orientation to individual or group achievements." Masculinity versus Femininity "measures the degree to which a culture does or does not separate traditional gender roles." Uncertainty Avoidance "measures the degree to which a culture is uncomfortable with uncertainty and seeks to reduce

uncertainty, often in the pursuit of the truth." Finally, Long-Term Time Orientation "grows out of a long-term basis of some cultures in Confucian thought, which emphasizes patience."

Of the 53 countries surveyed, the responses from the United States and Japan are particularly interesting. Aside from Power Distance, in which the US ranked 38th and Japan ranked 33rd (more employer-employee distance) the other categories demonstrate marked differences between the countries. The United States was ranked as the most individualistic country, while Japan was found to be 22nd (more collective). However, Japan was listed as the most masculine country, whereas the United States was 15th (more feminine). Japan was the fourth-highest ranked country for Long-Term Time Orientation, while the United States was 17th (less patient). The greatest difference between the United States and Japan came in Uncertainty Avoidance, where the US ranked 43rd and Japan ranked 7th (less comfortable with uncertainty). These variations have a significant impact on the differences in user interface design among software and websites produced for American and Japanese users. This, in turn, has gradually influenced the user experience, from both a social and technological perspective. Generally, in Japan, if the user cannot use the system, they blame themselves for not reading the instruction manual carefully [3]. Users tend to believe that the developer created the interface in the best possible way, and will work to adapt to the system, rather than configure the setup based on personal preferences. In the United States, users are much less patient (Long-Term Time Orientation), and

often attempt to alter the system to their individual desires, placing the blame on the product designer for a poorly constructed interface [3].

In looking at the layout differences between American and Japanese user interfaces, one of the most important variations involves the way that text is formatted and displayed. It can be taken for granted that English appears visually distinct from the traditional Japanese character sets (Kanji, Hiragana, and Katakana). When translated from one language to another, these visual differences lead to major problems with formatting, due to the increased or decreased text length. The text-stretching can alter the required size of the user interface controls that include text, and necessitate moving and reshaping the controls [6]. When translating from English to German, it is common for the text to expand by 30%, and as much as 300% for short strings [4]. In general, East Asian languages use larger font sizes than other language groups and require expanding text boxes, buttons, and static controls vertically [6]. The larger font allows for Chinese characters to remain the same size as the number of strokes increase, unlike English words which differ in length, in height, and form [8]. Bidirectional languages such as Arabic and Hebrew also require mirroring user interface controls to satisfy the right-to-left reading order of those languages, which will be discussed in further depth later [6]. Some languages require different justification based on the spacing between characters, words, and lines [7]. In fact, some East Asian languages will combine characters and lines within the same row as part of a top to bottom writing system where columns run from

right to left. An additional visual issue results from the fact that highlighting important information is often done with fonts that may not be available internationally, and colors which have already been shown to cause cultural confusion [3]. Westerners also tend to use bold text, while Chinese or Japanese users often prefer dots or accent-like symbols above or below each character [7]. The use of italics to emphasize text is also less appropriate in some scripts, and the ability to change text case – such as uppercase to stress a particular phrase – becomes impossible in non-case scripts.

**Visual Search**

Beyond text translation, the most consistent and most noticeable variation among American and Japanese user interfaces is the position of text and graphics. This distinction is overwhelmingly based on the difference between the visual search pattern of American and Japanese users. When evaluating scanning techniques, it is important to be mindful that those patterns which are generally applied to a selection of users in a particular culture, do not necessarily apply to an individual user from that group. Still, there have been some consistent theories relating cultural – especially linguistic – principles of visual search tendencies. It has been shown, for example, that native English-speaking users have an effective visual field that ranges four characters to the left and fifteen characters to the right of the current letter being read [9]. In regards to visual search, this is evidenced in the natural right-to-left scanning techniques of English readers. Jakob Nielsen, generally regarded as the leading authority on usability, has argued that language

experiences directly influence different scanning patterns, and thus affect the user's visual search performance [10]. Additional studies have found that the language experiences of young children strongly influence their preferred scanning direction [11]. Again, it is important to consider that language experiences are not universal, even within a group of users who share the same native language. Early exposure to other reading patterns, whether in school or as a result of growing up in a bilingual family, will affect natural scanning tendencies. Within the current global climate, it has been increasingly necessary for non-native English speakers to learn English as a second (or third) language, as the prevailing use of English in commercial transactions can require the mastery of several varying scanning techniques. As such, traditional preferences that may have been commonplace several decades ago have been gradually altered, and will almost certainly continue to evolve over the years to come.

While most usability studies that focused on cultural navigation have found some connection between language and scanning preference, there have been other theories regarding visual search. One study that used an eye tracking system to measure search performance for click-down menus found that users tend to search via clustered graphics and icons (where there are quality icons), and not necessarily left-to-right (among English users) [12]. Anthony Hornof argues for the existence of several different types of visual searches, based on the amount of graphical information presented [13]. Hornof explains that a *systematic search* "works when there is one group being searched." A *noisy systematic search* says

that “people will try to search in a regular and systematic manner, examining each item only once, but that random noise will interrupt the process.” According to Hornof, because of the noise, some items will be missed in a visual sweep and it will often take several visual sweeps to locate a particular item. After the layout is searched once without success, the search is repeated starting from the beginning. This would explain some variation in the search trail, but does not specifically prohibit a left-to-right trend for English readers, or a right-to-left trend for Japanese users. Where these studies may find their greatest relative strength is in the comparatively different search strategies for interfaces that are particularly oriented toward the use of graphics or text. This research appears to suggest that interfaces that rely heavy on text will tend to support visual search patterns that mirror innate reading strategies, based on the user’s native language. On the other hand, software and websites that include an abundance of graphics would require a rather different set of skills, and thus result in the properties of a noisy systematic search, as described above.

Currently, in software and web interface design, text- or graphics-only layouts tend to be the exception, as most programs and webpages are created with a balance of each. When culture is taken into account, it has been found that the language experience can strongly influence design guidelines [14]. Subsequently, both the English and Japanese languages have a powerful impact on the way that a particular user interface is arranged, with special emphasis on the location of interactive elements. Previous research has determined that the layout or

orientation of these elements is directly responsible for the usability of the system [15]. A real-world study of Middle Eastern websites designed in Arabic and Hebrew found that such sites frequently oriented text, links, and graphics from right-to-left, in accordance with the traditional writing systems of those languages [16]. The researchers suggested that while American users would initially focus on the left side of a website, Middle Eastern users would initially focus on the right side, and that the most important information should be presented appropriately. They also noted that by manipulating the orientation of the display, the user's "comfort zone" is also changed, which thusly affects the way that they view information. A separate study by Charles Sheppard and Jean Scholtz tested the ability of North American users to find and retrieve information on a set of websites with left-oriented navigation, and another set with right-oriented navigation [17]. When asked to answer specific questions about the content of the pages, the North American users answered 100% of the questions correctly on the left-oriented pages. However, the North American users were only able to answer 40% of the questions correctly on the right-oriented pages. The study additionally tested Middle Eastern users, and found that while they performed better than North American users on the right-oriented pages, they also scored 100% on the left-oriented pages. Although Sheppard and Scholtz credited this unexpected result to flaws in the experimental design, it is possible that the Middle Eastern users also had more familiarity with left-oriented pages than the North American users had with right-oriented pages. Regardless, there is a clear connection between a user's language, and the usability of interface designs that have been

localized to the scanning tendencies associated with that language.

## Chapter III – Approaches to Internationalization

The objective of this study is to examine the cultural impact of interface layout design on usability in order to promote the implementation of multicultural design guidelines in web and software development. Specifically, this study looks to compare the effect of manipulating the navigation menu based on traditional right-to-left and left-to-right reading patterns. Previous research [15, 16, and 17] has suggested that personal language skills influence the scanning tendencies of users interacting with websites and other software interfaces. One way to investigate the current approach toward multicultural interface design is to look at the websites and software applications available today. A careful search reveals that both globalization and localization are implemented, though without the consistency that one might expect. Recall that globalizing websites leads to interfaces which are general enough to be used by any individual, regardless of culture [5]. Localized websites take a general interface and create a customized version for other cultures. While both approaches have supporting theorists, it may still be surprising to find that there does not seem to be a set of common guidelines as to when globalization is preferable to localization, and vice-versa. Various genres of websites – sports, entertainment, technology, etc … – do not share a consistent methodology for handling various languages and cultures. This seems to be true regardless of the country that the main site is based out of.

Often, globalization involves the creation of a basic layout template for one cultural version of a website. In constructing additional cultural versions of


Figure 3.1 - US IBM Website Homepage

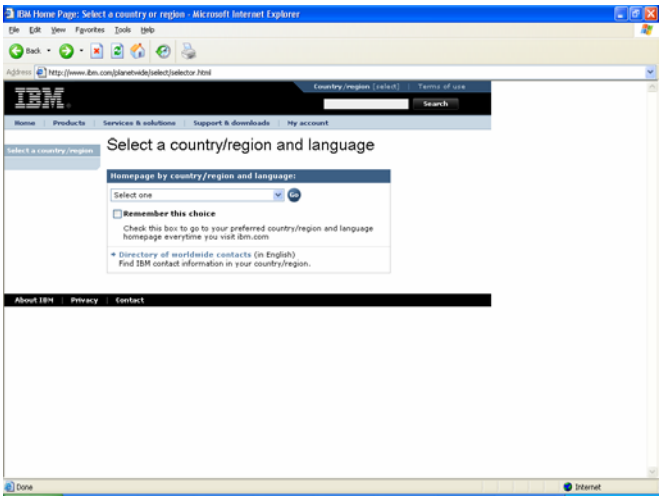


Figure 3.2 – US IBM Website Global Portal

the site, the main content is usually translated into another language, while graphics and icons may or may not be modified from the original. Figure 3.1 shows the IBM homepage (www.ibm.com, 3/29/05) for users in the United States. The interface design is fairly standard for a high-tech corporation, with navigation at the top of the page, and a large search box prominently displayed in the upper-right corner. In order to view the IBM websites for other countries, a user must find the text above the search box that reads: "United States [change]" and recognize that "[change]" is a hyperlink to a 'select-your-country' page. It would most likely be difficult for a user that could not read English to navigate to the secondary portal, unless they were already familiar with the IBM page of their home country. International usability does not improve on the next page (Figure 3.2), which invites users to "Select a country/region and language." IBM includes a dropdown menu with a list of countries to select from, as well as a link to a Directory of Worldwide Contacts (Figure 3.3). While it's admirable that IBM includes an extensive list of country-tailored websites, there are some clear usability issues for international users that cannot read English. Additional

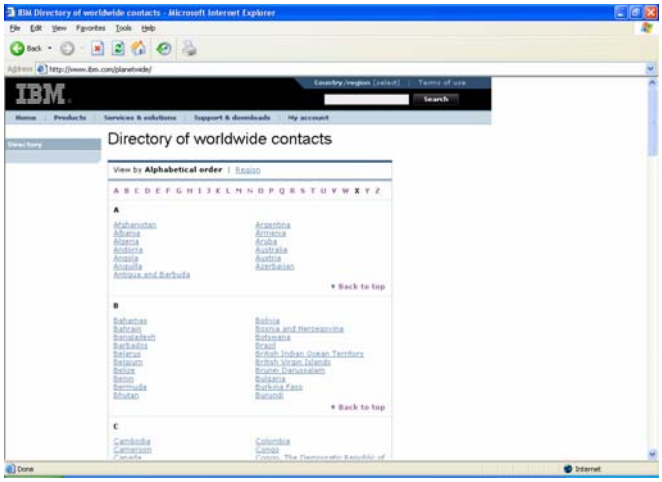


Figure 3.3 – US IBM Website Directory of Worldwide Contacts


Figure 3.4 – Japanese IBM Website Homepage

oversights include the particular choices for the countries and languages selected. For example, IBM offers to users the ability to view their Belgian website in three languages – English, French, and Dutch – however the US page is only visible in English. This is particularly noteworthy because while there are an estimated 33 million Spanish-speakers in the United States, the entire population of Belgium is less than 11 million [18, 19]. IBM already offers a Spanish version of their website for users in Argentina, Chile, and Mexico (among others), so it would seem reasonable to adapt that content to a Spanish version of the United States site.

Still, the most interesting comparison on the IBM pages occurs between the United States and Japanese websites. The homepage for IBM in Japan (Figure 3.4) is essentially a translated version of the United States IBM homepage. The navigation bar at the top of the Japanese page also roughly translates to: “Home | Products | Services & solutions | Support & downloads | My account.” English-speaking users will find similar difficulty in recognizing the Japanese characters

above the search box as a link to select another country or language. There is a recognizable link in the bottom-right section of the page: “About IBM Japan (English),” which provides contact information (in English) for the Japanese IBM headquarters. Aside from translated text and several different graphics, the US and Japanese versions of the IBM websites are virtually identical. It is likely that users who were already familiar with one version of the site would be able to more quickly identify links and other defining characteristics on additional sites, even in languages that they do not read. However, if a Japanese-speaking user stumbled onto the US IBM homepage, it would clearly be difficult to both understand the content of the site, and navigate to the Japanese version of the page. In terms of positive multicultural interface design, IBM grants the user the ability to view their site in many languages tailored to numerous countries. The main drawback is that users who are unfamiliar with their home version of the IBM website may find particular difficulty in navigating among pages in multiple languages.

The home furnishing manufacturer IKEA (www.ikea.com, 3/29/05) has chosen to localize their web pages, presenting an entirely different approach toward multicultural interface design. The US IKEA website (Figure 3.5) closely resembles the US IBM site, with a navigation bar at the top of the page, and a similar layout structure overall. Unlike the US IBM site, the US IKEA site does not include a direct link to IKEA sites from other countries and languages. However, IKEA includes a global portal (Figure 3.6) that users generally pass

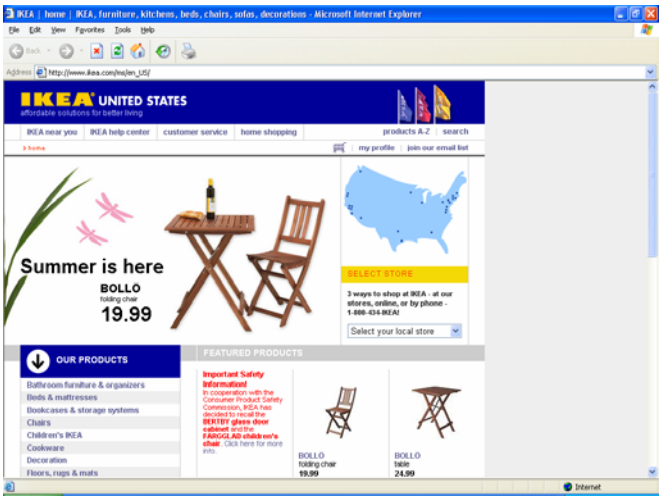


Figure 3.5 – US IKEA Website Homepage

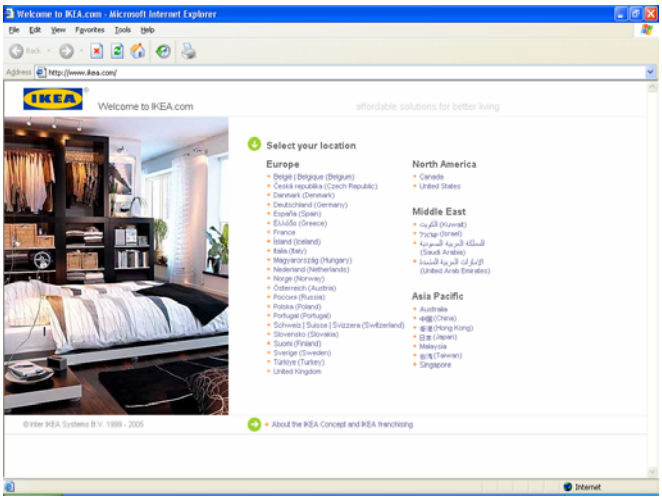


Figure 3.6 – IKEA Website Global Portal

through before they are directed to their local IKEA website. The IKEA portal divides the individual IKEA sites into four regions: Europe, North America, Middle East, and Asia Pacific. Beneath each subheading, IKEA lists the available countries in both English and the native language(s) of that nation. Interestingly enough, IKEA includes both French and Dutch translations for their Belgian pages, though, again, only English is available for the United States site. Compared to the IBM strategy, the IKEA pages already appear more usable for an international audience. It generally takes more than a global portal, however, for a successful model of localized interfaces, and IKEA has taken measures to customize their website by country. Although it would seem appropriate to again compare the IKEA websites for the United States and Japan, IKEA will not open their first Japanese store until 2006, and, understandably, have yet to completely localize the Japanese pages. However, IKEA opened their first store in Saudi Arabia in 1983 – two years prior to their first US opening – and have localized their Saudi Arabian site.

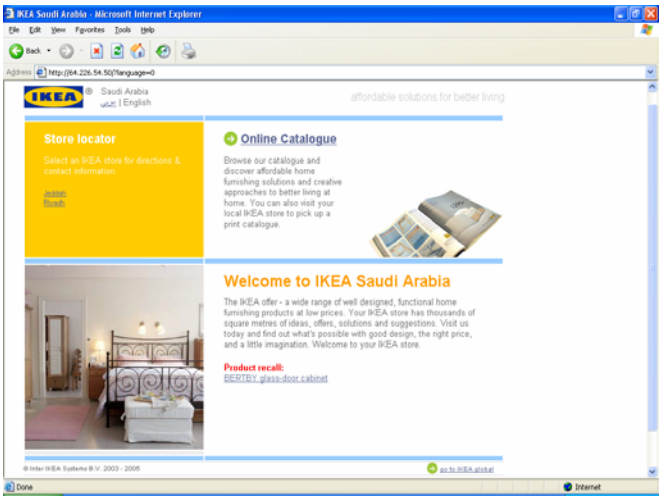


Figure 3.7 – Saudi Arabian IKEA Website (English)

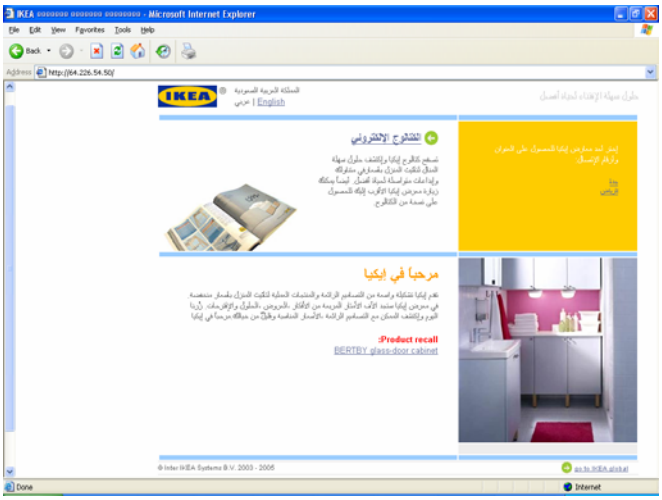


Figure 3.8 – Saudi Arabian IKEA Website (Arabic)

The IKEA Saudi Arabian site offers the ability to view the site in both English (Figure 3.7) and Arabic (Figure 3.8). The English version includes a link (in Arabic) to the Arabic version at the top of the page, as well as a link (in English) to the IKEA global portal in the bottom-right corner. Although there is no distinct navigational menu on the English homepage, the layout features a left justification, with the "Store locator" at the top-left section of the page. The design appears to appropriately correspond with the left-to-right reading characteristics of the English language. This can be directly contrasted with the Arabic version of the website, on which the items have a clear right justification, satisfying Saudi Arabian users that read right-to-left. The English and Arabic pages are virtual mirror images of each other, with the same links to the online catalog and product recall information. The Arabic page also includes a link (in English) to the English version, as well as a link to the global portal at the bottom-right corner. Although the screenshots of the Arabic and English pages include different pictures of IKEA furnishings – a bedroom and a kitchen – the difference is merely coincidental as each site features a set of the same rotating graphics.

Essentially, there are only two major differences between the sites: the translation, and the justification. The reasoning for having two language choices to represent the Saudi Arabian websites is simply to reach additional users who speak one, but not both, of the languages. It is the layout choice on the IKEA pages – left-justification for English, and right-justification for Arabic – that provides for the most interesting analysis.

On the surface, it may appear obvious that the difference in justifications is based on the reading strategies for the English and Arabic languages. Yet, it would also have been possible to display the Arabic text in the traditional right-to-left manner if the Arabic page was left-justified. In the same way, the English text would still have been legible if it were written in the standard fashion, but right-justified with the IKEA graphics and links. From a usability standpoint, there must have been a specific reason for justifying the text and graphics in accordance with the characteristics of each language. Assuming well-intentioned web designers, it would be reasonable to conclude that these choices were made to increase the ease and efficiency of the user's experience on each site. As previous research [15, 16] has indicated, the layout of a page can increase or decrease usability, based on the user's native language and culture. Studies [10, 11] have also suggested that language skills affect an individual's visual scanning approach and patterns. If the user's native language can alter the usability of a page layout, and these linguistic skills also change visual search tendencies, then there must also be a connection between visual scanning and the usability of particular

interface designs. Therefore, if a user's native language changes (from a right-to-left reading pattern to left-to-right, or vice-versa), their visual search approach also changes, and the page layout must change to maintain usability.

This study aims to further establish this connection between culture, specifically language, and the usability of various web designs, based on associated visual search tendencies. The results of the experiment and subsequent data analysis will look to explain scanning trends on localized website designs, and how these trends affect the usability of each site. In order to test these claims, the experiment tracks and records a user's eye movement and latency when completing a usability task. American users, and native English speakers, are presented with American and Japanese websites (both displayed in English) and asked to find a specific item on each page. Using localization techniques similar to the Saudi Arabian IKEA website, the American and Japanese pages have been specifically chosen for how close matching pairs of pages (within a particular genre) mirror each other. While none of the pages are strict mirror images, the major difference among the pages is that the American sites are left-justified, while the Japanese sites are right-justified – with the exception of one particular pair of sites. The eye-tracking application used in the experiment asks each user to find an item that has been located at a mirrored orientation on each pair of websites. The software records the user's visual path as he or she scans each page, as well as the amount of time that it takes the user to locate both the navigation menu that contains the requested item, as well as the item itself.

Based on previous research and the nature of this experiment, I would expect that the American users will tend to begin their visual search path with a movement to the left that corresponds with the left-to-right scanning pattern for English language readers. In addition, I would also expect that this initial tendency to begin the search on the left side of the layout will decrease the latency for locating the item on American pages with left-justified navigation, with a corresponding increase in latency for finding items on Japanese pages with right-justified menus. Because the American sites have been designed with American users in mind, it stands to reason that it will be easier for American users to locate the item on these pages. However, this does not mean that the Japanese pages should be less usable – as measured by latency to complete a task – unless there are inherent usability problems for American users on right-justified websites. And, if this is true, one could reason that Japanese users would do well with right-justified Japanese pages, but have similar usability issues with left-justified websites. This would mean that for optimal usability, websites should be left-justified for American users and right-justified for Japanese users, which is, essentially, the strongest argument for localization. If there are cultural or linguistic differences among peoples that affect the usability of particular interface layouts, then web and software developers should respect these differences and create sites that incorporate the unique interface design needs of each culture.

## Chapter IV – Methodology

### Participants

The participants were 15 undergraduate students (9 female, 6 male) from Boston College, representing a broad range of majors. Every participant was a native English speaker from North America (14 US, 1 Canada), who used the Internet at least several times per day (as self-reported on an exit survey). Three participants reported fluency in another language – either French or Spanish – but no participant was familiar with Japanese or other right-to-left reading languages. Six participants reported that they view web pages from countries outside of the United States at least one a week, with one participant as frequent as once per day. Three participants reported that they use the Internet to view websites in languages other than English at least once a week, with two of the participants noting that they visit French websites for class assignments. Twelve participants claimed to use Google as their primary search engine, while the other three participants use Yahoo! for online searches. One participant wore prescription eyeglasses during calibration and the experiment, with no noticeable tracking problems. Participants were not compensated for their assistance. All participants were provided with written consent forms in accordance with the Boston College Institutional Review Board regulations [protocol #05.087.01], and the experiment was conducted in accordance with Boston College IRB ethical regulations.

### Equipment

The experiment was performed using an ASL R6 commercial eye-tracker,

which uses a pan/tilt camera mounted under the computer screen. The ASL system also includes an optional magnetic head tracker that was not used in this study. The camera uses reflections from the pupil and cornea to measure eye position [20]. For increased accuracy, the system uses a bright pupil image, which reduces error resulting from eyelashes, eyeglasses, contacts, and distance from the camera [21]. Using these points, the ASL software calculates a gaze trail at each eye fixation point, with the spatial error between the software calculation and true eye position designed to be less than 1 degree [22]. The software also records timing information, including the length of fixations and the total time spent on a page. This information is passed to GazeTracker, eye-movement analysis software that operates independently from the tracking system. GazeTracker defines a fixation as a series of three or more samples within a 40 pixel radius for at least 200 ms, and records, in sequence, the coordinates of each fixation, and the duration. The GazeTracker application also allows for the creation of lookzones, which specify particular areas of interest on each displayed image. GazeTracker records information about those fixations that fall within the borders of one or more lookzones, including: number of times observed; number of fixations before first arrival; and, most importantly for this experiment, the duration before first fixation arrival (seconds). The participant's computer contained the stimuli images and the GazeTracker application, while the operator's computer ran the ASL software. All images were displayed on a 17-inch flat panel monitor at a resolution of 1024x768 and 32-bit color quality. The graphics card was an ATI Radeon X800 XT.

**Stimuli**

A selection of ten websites (presented in Appendix B) were chosen as examples of five different genres of online content, including education, tourism, food service, hotels, and search engines. Each genre was represented by an American webpage and a Japanese webpage (in English) from a sample of real-world websites discovered through a combination of intuition and meticulous search. The education and hotels websites represent traditional American and Japanese localization techniques, with the navigation menu on the left and right, respectively. Each pair of websites was selected based on matching complexity levels, with the education sites relatively simple and the hotels sites quite complex. Complexity was judged based on the amount of content – including text and graphics – on the page as compared to the amount of white space. The US tourism page includes a navigation menu at the top, while the Japanese tourism navigation menu remains on the right side of the layout. This was specifically done to compare the traditional Japanese layout with the alternate standard US layout.

The food service and search engine pages were intended to compare localization and globalization techniques. Food service was represented by the Starbucks company website, which, much like the Saudi Arabian IKEA site, localizes their pages by mirroring around a central axis. Although the Starbucks pages are not entirely identical in content between the US and Japanese sites, the

layout is virtually the same in terms of position and complexity. Google, well-known for their straightforward search engine layout, was chosen to represent strict globalization. The Google website for the US and Japan are exactly the same, except that the text of each is translated into their respective native languages. Fortunately, the target item on each page – "I'm Feeling Lucky" – remains in English, so the participants were not required to recognize any Japanese text to complete the task. In fact, the Japanese pages for each genre are almost entirely in English, which I found rare while searching for sample pages. With localization guidelines becoming more common in multicultural web design, most English pages based out of Japan had left-hand navigation. While this demonstrated the increased spread of localization, it made it more difficult to find appropriate websites for the study.

The websites were presented as screenshots taken within Internet Explorer, with the address bar and browser navigation buttons removed, allowing for greater area to be displayed, with fewer distractions to the participants. The decision to use screenshots instead of live websites was made in order to reduce the number of actions that the participant needed to take during the experiment. This indirectly resulted from the difficulties that accompany identifying the visual trail on a scrolling website. While the GazeTracker application has the ability to handle live websites, it was determined that such interaction was unnecessary for the purposes of this study. As a result, each participant saw the same websites in the same manner (but not the same order), and allowed for a more precise

analysis. I felt that ten websites provided enough information for the data to be useful, without the added participant stress – both mentally and physically – that might accompany viewing twenty or thirty successive websites. In addition, I wanted to avoid the participants developing practice techniques or an understanding of the specific goals of the study while the experiment was being conducted. It was possible that after more than ten sites displayed, the participants may have begun to expect either an American or Japanese webpage with the corresponding navigation.

**Procedure**

The screenshots of the ten selected websites were arranged within the GazeTracker application to fall in four pseudo-random sequences (listed in Appendix C). The sequences were created such that, for any particular genre, the US version was presented prior to the Japanese version in two of the four sequences, and the Japanese version was presented prior to the US version in the other two. In addition, no sequence contained a series of more than two US or Japanese pages in a row. Each website version was also placed in different positions within the four sequences; for example, the US hotels page fell in the $9^{th}$, $6^{th}$, $4^{th}$, and $1^{st}$ positions. Finally, no two sites of the same genre (such as the US and Japanese Starbucks pages) were presented within three positions of each other. An instruction page (Figure 4.1) was placed immediately before each of the ten websites, with the message: “Please locate the item labeled: [X] // When you have found the item, stare at it for one second and press the spacebar key” where

Please locate the item labeled:
our stores

When you have found the item, stare at it for one second and press the spacebar key

Figure 4.1 – Instructions for US Starbucks Website Item Search Task

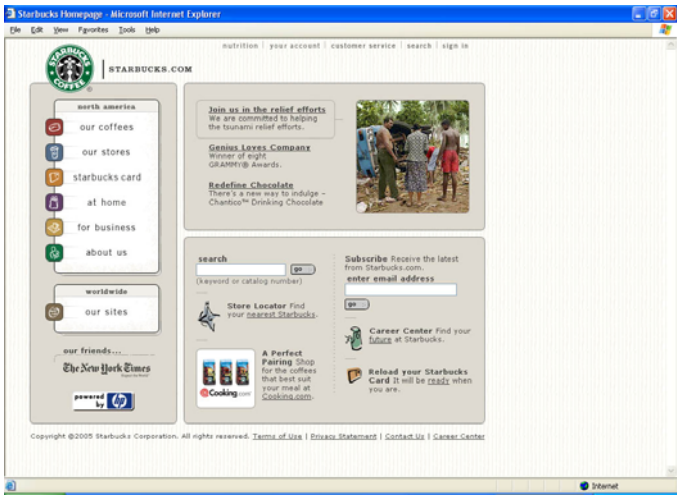


Figure 4.2 – US Starbucks Website

[X] is the search task item for each site.

A target item was identified on each page through the creation of lookzones – visible to the operator before and after the study, but invisible for the participant during the experiment. Each item was chosen based on its location relative to the corresponding cultural version. For example, the menu item "our stores" is located approximately 30% from the top of the US Starbucks page (Figure 4.2), and the item "company information" falls about 30% from the top of the Japanese Starbucks page (Figure 4.3). Each item chosen (one per page) was part of a large, prominent navigation menu, and selected with the intention of providing no clues as to whether the site was American or Japanese. The items "our stores" and "company information" do not denote any cultural information that could influence the visual search path. The only exception to this rule may have been the hotels pages, where the Japanese site item chosen was "Hotel Ginza." This was intentionally balanced with the selection of "Casa Del Mar" as the American hotel search task item. Using the GazeTracker software, a lookzone


Figure 4.3 – Japanese Starbucks Website

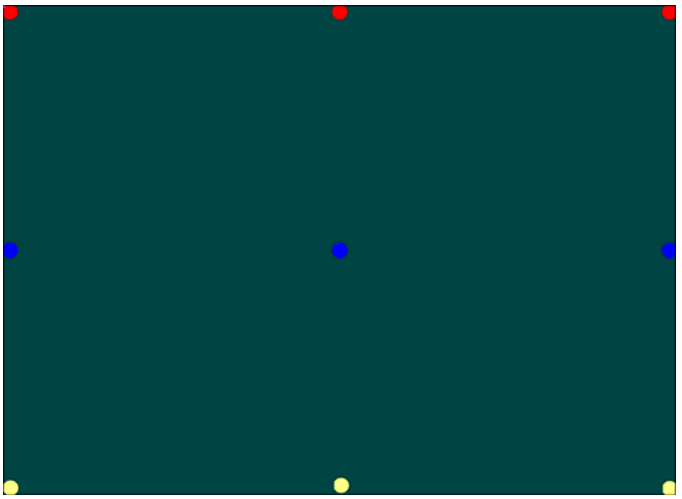

Figure 4.4 – Calibration Grid

was created around the selected task item for each website presented. An additional lookzone was created around the navigational menu that contained each task item. Overall, each website included two lookzones, for a total of twenty different lookzones for the entire experiment.

When participants entered the eye-tracking lab (Boston College, Fulton Hall 156), they signed a written consent form (Appendix D). Participants then sat in a standard office chair, positioned in front of a table, approximately 25-inches from where the user monitor and pan/tilt camera were situated. The image displayed on the screen was a nine-point grid (Figure 4.4), which was used to calibrate the participant's standard eye position. After the operator used a remote control to focus on the user's eye in a window on the operator's computer, the participant was asked to look at each grid point in order – left-to-right and top-to-bottom. Each pupil position was recorded using the ASL software to calibrate the system to the participant's unique eye angle. Calibration was then verified by asking the participant to look at one of the nine points at random, while the

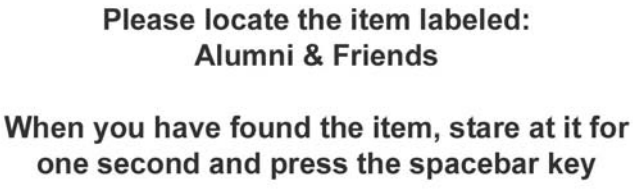


Figure 4.5 – Instructions for Experimental Demo Item Search Task

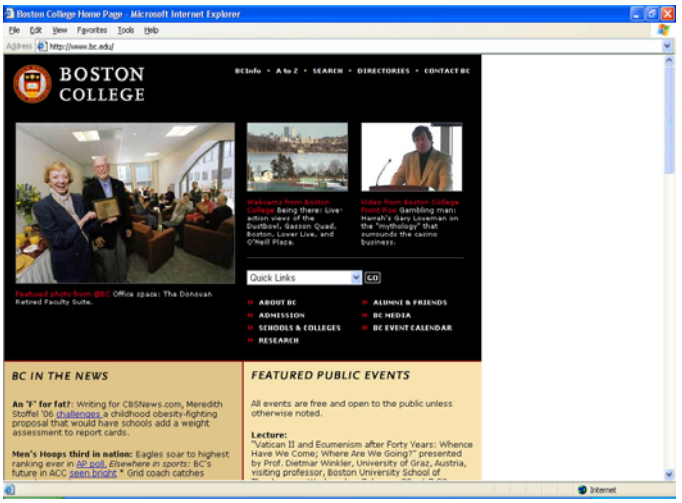


Figure 4.6 – Experimental Demo Website

operator checked the tracking position in the ASL software. Several participants were not successfully calibrated on the first attempt, and the calibration procedure was completed a second time. After successful calibration, the participant was asked to keep their head as still as possible for the remainder of the trial. The magnetic head tracker would have allowed for a freer range of movement, but also required further calibration and that the participant wore an additional apparatus. I felt that these added participant requirements did not outweigh the benefit of free head motion during the relatively short trial.

Once the participants were calibrated, they were given a demonstration of the search task. An instruction page (Figure 4.5) was shown on-screen, asking the participants to locate the item "Alumni & Friends." When participants finished reading the instructions, they pressed the spacebar key and a screenshot of the Boston College homepage (Figure 4.6) was displayed. Keeping their heads still, participants visually searched for the words "Alumni & Friends," and, upon locating the item, focused their attention for about one second before pressing the

spacebar key to continue. At this point, the operator asked the participants if they had any questions about the experimental task, and then loaded up one of the four random sequences of the ten websites in the GazeTracker application. A blank white screen marked the start of the experimental trial, and the participants were asked to press the spacebar key when they were ready to begin. The first set of instructions was displayed, following the same pattern as the demonstration version of the instruction / website combination. During the trial, the operator monitored the system to make sure that the participant was still calibrated; however, no trial was interrupted to re-calibrate the system. After the sequence of ten websites was displayed and each task item had been located, the GazeTracker application recorded appropriate latency information, along with the participant's ID number (001-015). Participants were given an exit survey (Appendix D), and debriefed as to the nature of the study. In several situations, multiple participants were in the laboratory simultaneously, and users were not debriefed until the last participant had completed the trial. Any additional participants were seated away from the screen during the first trial, and did not see the instructions, task item, or website sequence. For each participant, the total time from signing the consent form to final debriefing was approximately ten minutes, while the experimental trial lasted about two minutes in duration.

**Data Collection**

All data was recorded on the participant's computer using the GazeTracker software. The data was collected in order to perform two separate

analyses – one quantitative, and one qualitative – on the participant's visual search path. The first was performed using the tracking information for each lookzone – task item and navigation menu – of each of the ten websites, as recorded by GazeTracker. The software also recorded the visual path while the participant read each of the instruction pages; however, that information was not used due to limited relevance in this study. GazeTracker allows for the ability to export lookzone latency information for each participant into a separate text file. The text file included additional pupil diameter information that was not relevant to the data analysis in this experiment.

The second collection of data was also gathered through the GazeTracker application, without the use of lookzones. GazeTracker records the participant's visual search trail on each website, in addition to the fixation points, which are labeled in order and in duration. On each image, the visual search path can be replayed in real-time, allowing for an observer to note specifically where the participant was looking during the experimental trial. In this study, I observed whether the initial movement for each participant on each slide was toward the left or toward the right. Because of the positioning of the instructions in the center of the screen, almost all participants began their visual search in the center and made their first movement toward the left or right of the website displayed. For some participants on certain websites, I was unable to detect whether the visual trail began with a movement to the left or to the right. In these situations, the visual trail either started with a vertical movement, or occurred off-screen. In

addition, the position of the Google navigation menu and task item – for both the US and Japanese versions – made it nearly impossible to identify the initial movement on these pages. As a result, only data for the tourism, hotels, education, and Starbucks pages was collected for this part of the analysis.

## Chapter V – Experimental Results

The study was conducted as a matched pairs experiment, comparing latency in finding a specific item on an American website and corresponding Japanese website. The analysis was conducted to determine the first fixation latency for the navigation menu and the task item on each page. A total of 15 participants were tested on 10 different websites (5 American and 5 Japanese), with fixations recorded for the menu and task item on each page, for a total of 300 data points. There were several situations where the GazeTracker application did not record at least one fixation point for a participant's visual search of a specific website. These instances were not included in the recorded data, resulting in 28 data points removed from the analysis. Note that the columns in the following tables do not reflect the display sequence of the websites (which was randomized, as described earlier).

Table 5.1. Mean Latency Values for First Menu Fixation (in Seconds)

| Country | Tourism | Hotels | Education | Starbucks | Google |
|---|---|---|---|---|---|
| US | 2.812 | 1.583 | 0.963 | 1.080 | 1.145 |
| Japan | 3.814 | 4.367 | 1.262 | 1.082 | 0.878 |

Table 5.2. Mean Latency Values for First Item Fixation (in Seconds)

| Country | Tourism | Hotels | Education | Starbucks | Google |
|---|---|---|---|---|---|
| US | 5.151 | 5.437 | 1.587 | 1.442 | 1.225 |
| Japan | 5.170 | 5.168 | 1.612 | 1.605 | 1.129 |

Table 5.3. Significance (p value) of Two-Tailed T-Test (US and Japanese Menus)

| Tourism | Hotels | Education | Starbucks | Google |
|---|---|---|---|---|
| 0.31 | 0.01 | 0.38 | 0.46 | 0.71 |

Table 5.4. Significance (p value) of Two-Tailed T-Test (US and Japanese Items)

| Tourism | Hotels | Education | Starbucks | Google |
|---|---|---|---|---|
| 0.99 | 0.84 | 0.98 | 0.24 | 0.91 |

Looking at the raw data, there are several extreme latency values that greatly skew the means for the menu and item data for both US and Japanese websites. Removing values that fell outside of twice the standard deviation for each mean provides for a stronger analysis. There were an additional 15 data points subtracted for this step.

Table 5.5. Standard Deviation of Latency Values for First Menu Fixation (in Seconds)

| Country | Tourism | Hotels | Education | Starbucks | Google |
|---|---|---|---|---|---|
| US | 2.290 | 1.710 | 1.016 | 0.948 | 1.527 |
| Japan | 1.582 | 3.126 | 0.459 | 0.596 | 0.999 |

Table 5.6. Standard Deviation of Latency Values for First Item Fixation (in Seconds)

| Country | Tourism | Hotels | Education | Starbucks | Google |
|---|---|---|---|---|---|
| US | 4.956 | 9.344 | 1.064 | 1.027 | 1.483 |
| Japan | 3.198 | 3.307 | 0.485 | 0.719 | 0.965 |

Table 5.7. Adjusted Mean Latency Values for First Menu Fixation (in Seconds)

| Country | Tourism | Hotels | Education | Starbucks | Google |
|---|---|---|---|---|---|
| US | 2.402 | 1.189 | 0.713 | 0.893 | 0.764 |
| Japan | 3.814 | 3.683 | 1.262 | 1.082 | 0.667 |

Table 5.8. Adjusted Mean Latency Values for First Item Fixation (in Seconds)

| Country | Tourism | Hotels | Education | Starbucks | Google |
|---|---|---|---|---|---|
| US | 3.911 | 3.078 | 1.385 | 1.257 | 0.851 |
| Japan | 4.479 | 4.446 | 1.686 | 1.605 | 1.129 |

Table 5.9. Adjusted Significance (p value) of Two-Tailed T-Test (US and Japanese Menus)

| Tourism | Hotels | Education | Starbucks | Google |
|---|---|---|---|---|
| 0.05 | 0.00 | 0.00 | 0.45 | 0.73 |

Table 5.10. Adjusted Significance (p value) of Two-Tailed T-Test (US and Japanese Items)

| Tourism | Hotels | Education | Starbucks | Google |
|---|---|---|---|---|
| 0.50 | 0.09 | 0.23 | 0.25 | 0.37 |

Observation of the visual search path indicated the participant's initial eye movement when each website was displayed. These movements were described as "Left," "Right," or "Unknown." The collective results of this visual observation were recorded and are presented in the following tables. Due to the limited size of the search trail, results for the Google website – both American and Japanese – are not included.

Table 5.11. Aggregate Number of Initial Eye Movements (US)

| Movement | Tourism | Hotels | Education | Starbucks |
|---|---|---|---|---|
| Left | 13 | 12 | 12 | 13 |
| Right | 0 | 0 | 1 | 0 |
| Unknown | 2 | 3 | 2 | 2 |

Table 5.12. Aggregate Number of Initial Eye Movements (Japan)

| Movement | Tourism | Hotels | Education | Starbucks |
|---|---|---|---|---|
| Left | 14 | 14 | 11 | 8 |
| Right | 0 | 0 | 1 | 5 |
| Unknown | 1 | 1 | 3 | 2 |

Table 5.13. Total Number of Initial Eye Movements per Country

| Movement | US | Japan |
|---|---|---|
| Left | 50 | 47 |
| Right | 1 | 6 |
| Unknown | 9 | 7 |

On the exit survey, participants were asked how difficult they found the task of locating the item on the American and Japanese websites, using a Likert Scale from 1 (Less Difficult) to 10 (More Difficult). 11 participants reported that the items were more difficult to find on the American pages, while 4 participants said that the Japanese items were more difficult to locate. There were not enough participants in each group for a significant T-test; however, the mean values for each group are presented in the tables below. Latency values have not been adjusted by standard deviation as extreme values often swayed the participant difficulty ratings.

Table 5.14. Mean Task Item Location Difficulty (Self-Reported by Participants)

| Country | US | Japan |
|---|---|---|
| Difficulty | 3.87 | 5.73 |

Table 5.15. Mean Latency Values for First Item Fixation – US Pages Difficult (in Seconds)

| Country | Tourism | Hotels | Education | Starbucks | Google |
|---|---|---|---|---|---|
| US | 3.229 | 11.121 | 2.500 | 2.407 | 0.396 |
| Japan | 4.609 | 5.286 | 1.714 | 1.438 | 1.773 |

Table 5.16. Mean Latency Values for First Item Fixation – Japanese Pages Difficult (in Seconds)

| Country | Tourism | Hotels | Education | Starbucks | Google |
|---|---|---|---|---|---|
| US | 5.728 | 3.371 | 1.338 | 1.179 | 1.452 |
| Japan | 5.322 | 5.136 | 1.584 | 1.635 | 0.986 |

## Chapter VI – Discussion

Examining the unadjusted latency values (Tables 5.1 – 5.4) leads to some interesting results, despite the lack of statistical significance. Each of the localized websites had a smaller mean latency to locate the navigation menu on the American pages as compared to the Japanese pages, although some of these differences were quite small. The comparison between the American and Japanese Starbucks pages, for example, appears to be quite coincidental. While I expected the comparison of latency values for the Google search pages to differ from the localized websites, I did not anticipate that the Japanese menu would be faster to find than the American menu. Conceptually, I expected that globalization would lead to a similar situation to the Starbucks pages, where there was virtually no latency difference between the US and Japanese sites. One of the goals of globalization is that the generalities of the layout allow for users to be familiar enough with one version of a website, that a cultural modification (for example, translation) would not cause major usability problems. A mean difference of 0.267 seconds would probably not be a major usability problem, but, theoretically, the difference should not exist in the first place.

Nevertheless, the lack of statistical significance, especially with latency values for first item fixation had p values that ranged from 0.84 – 0.99 for 80% of the websites tested, certainly questions the validity of the results. Looking at the raw data, I noticed that there were several latency values that stood out among the rest. One participant needed only 0.343 seconds to find the menu on the US

tourism page, yet took an additional 19.688 seconds before the first item fixation. Another participant needed more than 30 seconds to locate the US hotels item, beyond the time that it took to fixate on the navigation menu. Considering that no participant for any website took more than 21 seconds to find the item, the extreme latency value was clearly throwing off the results. In fact, removing one data point for the US hotels item fixation reduced the mean latency value from 5.437 to 3.078, a decrease of more than 40%. Each of the ten US latency values tested had one extreme data point (from various participants), while five of the Japanese values included one data point outside of a reasonable range. It was for this reason that I decided to perform a separate analysis on those values that fell within two standard deviations from the mean latency value for each website's latency values tested.

In looking at the reasons behind the extreme latency values, I noticed several possible explanations. Of those values which fell above the range, half occurred on either the American or Japanese versions of the tourism and hotels websites. Unsurprisingly, these pages were also considered the most visually complicated of those tested, and had the highest latency values – for both menu and item fixations – among the five groups. On the hotels pages, the items were located on the bottom corners, among lists of relatively similar hotel names. Participants with extreme latency values appeared to miss the item on their first scan, moving to seemingly random search patterns on subsequent passes (an example of Hornof's noisy systematic search, perhaps). A well-designed visual

search routine would likely have led to faster results, yet one needs to pause at this point to consider the role of the web user and web designer. Frankly, it is an unreasonable request by the designer to require that the user develop a particularly well-designed search routine in order to find information on a website. It suffices to say that poor web design transcends cultural boundaries, and if native users cannot adequately navigate a website, an additional usability burden is placed upon the international community. Incidentally, I also noticed that one participant fixated for several seconds in one location on the US tourism page, before continuing their search. Curious, I looked at the upper-right section of the tourism page and found the sentence "Shop and stay this season …" It seems that the participant noticed the word "Shop" while looking for "Shopping," resulting in the delay. It was an oversight on my part not to recognize the possible conflict before the experimental trials, though the similarity did not appear to affect any of the other participants.

After removing the extreme values, the mean latency values (Tables 5.7 – 5.10) become more reasonable and valid. The navigation menu for the tourism, hotels, and education pages are all statistically significant ($p <= .05$). For each of the localized pages, the American navigation menus and task items had smaller first fixation latency values than corresponding Japanese pages. While the significance of the difference between the American and Japanese item latencies exceeded the accepted range, p values were greatly reduced as compared to the unadjusted item means. This trend has led me to believe that additional studies on

similar websites may lead to statistically significant results with a larger participant pool. Still, it is particularly interesting to note that the American latency values are smaller than the Japanese, especially in regard to the Starbucks pages. The first fixation for both menus and items had smaller latency values on the US page, which is essentially a mirror image of the Japanese page. The idea that American users can navigate an American Starbucks page easier than a Japanese Starbucks page is, in itself, strikingly significant, because it validates consideration of the culture of the audience when designing websites. Here are two pages where the content is virtually identical, and a design that is simply flipped along its axis, and yet the latency value clearly favors the natural reading layout. The tourism, hotels, and education pages all feature similar situations, although their first menu fixations do reach statistical significance. The Google pages are interesting on their own accord, not for their significance, but rather the lack thereof. Google had the least significant difference in menu latency, and second least significance in item latency. Essentially, compared to the localized versions, the similarities between the US and Japanese Google page layout, leads to especially similar usability between the two pages. This is, of course, one of the goals of globalization: greater culture usability on (virtually) the same page.

The initial movements of the visual search path (Tables 5.11 – 5.13) indicate a strong left-hand favoritism from the participants. It was only one of the American pages that a participant made an initial movement toward the right side of the screen. Because American layout favors left-side navigation, this innate

tendency to look in that direction surely leads to the decrease search latency and subsequent usability increase. With the exception of the Starbucks pages, participants also favored the left side on Japanese pages, with initial movements toward the left for all but one trial. The Starbucks page was a comparative anomaly, as five users initially looked toward the right side of the websites. I considered that because the Starbucks pages had a mirrored layout, if users had already seen the American page, they may have recognized a pattern and known to look to the right. However, I don't believe that this is a valid explanation. For one thing, it would be virtually impossible for the user to be able to recognize a page as a Starbucks page without scanning the page first, which would already have required that initial search movement. Thus, the user could not identify the page, and then go back and modify their initial movement. In addition, the participants were not informed that there would be multiple pages from one genre, let alone one company, and therefore had no reason to expect a second Starbucks page in the first place. It turns out, actually, that of the five participants who looked to the right on the Japanese Starbucks pages, four saw the Japanese Starbucks page before the American version. At this point, I am unable to explain the situation as anything but a random coincidence. Most importantly, though, is the overwhelming trend of initial movements toward the left for both American and Japanese websites.

Due to the consistency of initial movement directions, several patterns emerged among participant visual search paths. A sample search path on the


Figure 5.1 – Sample Search Path for US Education Website

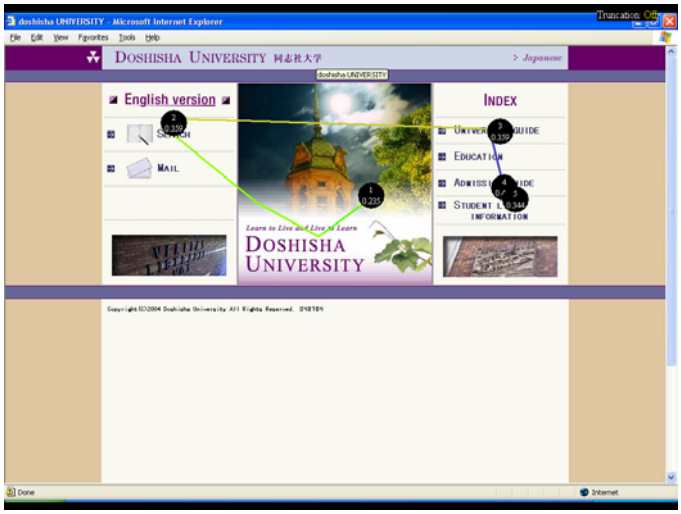


Figure 5.2 – Sample Search Path for Japanese Education Website

American education website (Figure 5.1) reveals that the user looked to the left side of the screen to find the navigation menu, and then scanned down the menu to locate the search item. On the Japanese education website (Figure 5.2), the user also initially looked for the navigation menu on the left. However, the user then scanned back across the entire page to locate the navigation on the right. At this point, the user then scanned down the menu. This view helps to visually demonstrate why the participants had higher latency values in locating items on the Japanese pages as compared to the American pages. There appeared to be more consistent search patterns with pages that were less complex, such as the education and Starbucks websites. In searching the US Starbucks page (Figure 5.3), the user had a similar gaze trail to the US education page, looking for the navigation menu on the left, and then scanning the menu to find the item. The Japanese Starbucks page (Figure 5.4) also parallels the Japanese education website, with an initial movement toward the left, followed by a large sweep across the page to locate and scan down the right-hand navigation menu. Although not all participants shared the exact same search techniques, there were


Figure 5.3 – Sample Search Path for US Starbucks Website


Figure 5.4 – Sample Search Path for Japanese Starbucks Website

vast similarities across the localized pages. Again, these patterns demonstrate the specific trends that lead to increased usability on US pages for American users as compared to Japanese designs, with the navigation on the right.

Finally, as part of the survey, participants were asked to rate the difficulty (Tables 5.14 – 5.16) of each group – American and Japanese – of websites. Not surprisingly, users found the Japanese task item searches to be more difficult than the American versions. Only four of the participants believed that the American search was more difficult. Of those four, three had specific problems navigating one or more of the American pages (as evidenced by their corresponding latency data). I asked the remaining participant why they felt that the American pages were more difficult, and they replied that they knew they did not have to search the areas of the Japanese websites that contained Japanese characters. In knowing to search for American words on pages with both American and Japanese text, it reduced the relative size of the search field. I found this to be a remarkable strategy for a participant that only saw ten websites and had no prior knowledge

of the experimental goals prior to the trial. The example provides one look into how users may circumvent problems in websites designed with another culture in mind. I was also interested how well individuals were able to correctly identify the sites that they had navigation difficulty with. On the localized pages, individuals who claimed more difficulty with American pages did, in fact, have higher latency values with 3 of the 4 websites. Those participants who said that the Japanese pages were more difficult to search were also accurate with 3 of 4 genres. The combination of this data with the previous example leads me to believe that not only are users able to identify websites with troublesome navigation, they are also able to find strategies to resolve those issues. The main issue then becomes whether that responsibility should lie with the web developers or the users themselves.

## Chapter VII – Conclusions

In this study, I set out to evaluate the impact of culture on interface usability by comparing American users on US and Japanese websites. I examined latency values for item search tasks on traditional layout examples from each culture and found significant differences, especially in locating navigation menus. The experimental results have both answered many of my original questions, and raised additional questions on the use of localization and globalization in multicultural interface design. Overall, I would consider the study to be a successful examination of current approaches to designing for international audiences. While the study is by no means intended as an exhaustive reference for all questions on cultural web design, I feel that the results have led to significant answers.

In comparing websites that had been translated into English (with the exception of several Japanese characters), the study was able to factor out the impact of the displayed text itself on cultural usability. Certainly whether or not a user can read and understand the content of a website has a major impact on usability; however, this study looked to demonstrate that there are important factors beyond translation that affect cultural usability. While many different possibilities were discussed, including graphics, color, and organization, the main feature analyzed was the placement of the navigation menu in localized pages. I found that in virtually all situations, arranging the navigation menu on the left side of the page allowed for a smaller latency in the item search task. Observation of

the visual search trail provided further explanation as to why this was the case, as American users with no prior knowledge of the website origin instinctively looked toward the left side first. When the navigation was on the right side of the Japanese pages, users had to sweep back across the width of the page to locate the item. This showed that native language skills influence usability beyond text translation, through the intermediate impact on visual search path.

The difference between localization and globalization also merits consideration, although this study does not intend to claim one primary design strategy as superior to the other. In fact, there are situations where each would be more appropriate when developing international websites. The Google search engine pages were the sole representatives of globalization, and were also the only examples where the mean latency values were higher for the US version than the Japanese version. This difference, however, was also the least significant, which is the desired goal of globalization in the first place. The general nature of each Google site did not create a major task latency advantage for one version over the other. If the main version of a site is balanced for the needs of multiple audiences, then globalization alone appears to be a viable solution for a developer with a certain approach in mind. For both US and Japanese websites, the complexity of the layout and content also influenced the usability of the site, as demonstrated by several extreme latency values for the tourism and hotels pages. The Starbucks pages, as well as the IKEA pages, which were discussed but not tested, took what I would consider to be the most reasonable and usable approach

toward multicultural interface design. Each site had a similar style, with similar content, yet made a drastic change between cultural versions by changing the location of the navigation bar. At least with the Starbucks pages, this resulted in stronger usability for American users on a layout that was designed with their cultural needs in mind.

I feel that it is this final point – appreciation for the user's needs – that provides the strongest message resulting from this study. If the ultimate goal of good web design is to provide usable content access, then it becomes all the more important to study user needs on a cross-cultural level. This study has shown that there are innate cultural differences that cause certain aspects of web design to be more or less appropriate for specific peoples. Whether these issues are met with localization, globalization, or a combination of both, is less material to the overall picture than the simple fact that each user's cultural needs cannot be ignored by international web and software developers seeking maximum usability for their products. With global users becoming an increasingly active online audience, multicultural interface design is now more important than ever. While the difference between searching a localized and non-localized website may be less than a few seconds, it only takes a few seconds to make a lasting impression online. Visual layout may well be the difference between a sale in an online store and a more culturally-conscious competitor's advantage. Users are aware when a developer has considered their needs in designing a website, and users respond accordingly. The simple strategy of focusing American pages on the left side, and

Japanese pages on the right side, is a strong step down the path of solid multicultural interface design, though real-world developers will likely want to consider additional characteristics of online layouts. Although the Internet and other forms of computer-mediated communication have helped to make the world smaller, the Internet itself is becoming larger and increasingly more difficult to navigate. International interface designers need to develop products with a global perspective, guiding users down cultural roads, and remembering their responsibility to appreciate the human characteristics of human-computer interaction.

## Chapter VIII – Future Work

Due to the size and scope of the issues that accompany multicultural interface design, there are many opportunities for future studies related to the experiments that have been discussed in this paper. One of the most interesting would involve repeating the same experiment with native Japanese users and comparing their results to the American participants. I considered recruiting Japanese volunteers for this experiment, but realized that it would be almost impossible to differentiate the amount of exposure to American culture for Japanese individuals living in the United States. The ideal solution, I suppose, would be to run the experiment in Japan, though such work extended beyond the reach and resources of this project. Additional work can be done on the specific usability differences to compare localization and globalization approaches to global web design. Although this study touched upon such differences, additional experiments could be designed to more strongly compare and contrast the two methodologies. The ASL eye-tracker also allows for eye-tracking of explicit interaction with an online interface. While this study only required the user to press the spacebar, further interaction using the keyboard, mouse, and scrolling pages would allow for a more in-depth study of the navigation issues with cultural interface design.

It would also be interesting to examine the results of training a user on different cultural approaches toward interface design. For example, if one were to alter the instruction page used in this study to explicitly tell the user that the

upcoming website was American or Japanese, their initial visual search movements may change accordingly. In most online interaction, the user is at least broadly aware of the culture of the pages that they are viewing. As patterns develop, users may be able to adapt to localization techniques that differ from those of their native culture. One possible experiment could display ten similarly designed Japanese pages in a row, and determine how much learning and adaptation occurs from the first page to the last. If users are able to quickly adapt in situations where they know to expect certain characteristics of web design, it may result in less specific localization requirements in real-world situations where there are less likely to be drastic changes among one particular assortment of cultural websites from. Still, it would be wrong to assume this capability from all users, and the overlying responsibility for strong cultural usability remains with the human developers that oversee the creation, evaluation, and implementation of multicultural interface designs.

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## Appendix A – Experimental Data

Table A.1. Latency Values for First Menu Fixation – US (in Seconds)

| Participant | Tourism | Hotels | Education | Starbucks | Google |
|---|---|---|---|---|---|
| 1 | 1.547 | 0.719 | 0.469 | 0.828 | 0.984 |
| 2 | 2.719 | 3.328 | 0.328 | 0.671 | 0.359 |
| 3 | 0.735 | 0.750 | 0.547 | 2.500 | 0.109 |
| 4 | 1.937 | 1.297 | 1.000 | 0.453 | 1.906 |
| 5 | 2.875 | 0.516 | 0.610 | 0.906 | 0.266 |
| 6 | 1.438 | 0.734 | 0.578 | 0.719 | 0.469 |
| 7 | 5.656 | 0.735 | 0.953 | 0.531 | 0.719 |
| 8 | 5.766 | 0.687 | 4.218 | 0.438 | 0.453 |
| 9 | - | 0.656 | 0.609 | 0.438 | 0.859 |
| 10 | 0.343 | 0.797 | 0.281 | 0.937 | 0.375 |
| 11 | - | 1.531 | - | - | - |
| 12 | 1.109 | 2.390 | 1.047 | 2.109 | 6.094 |
| 13 | 7.734 | 1.015 | 0.500 | 0.813 | 1.593 |
| 14 | 3.750 | 1.484 | 1.813 | 0.266 | 1.500 |
| 15 | 0.953 | 7.109 | 0.531 | 3.516 | 0.344 |

Table A.2. Latency Values for First Menu Fixation – Japan (in Seconds)

| Participant | Tourism | Hotels | Education | Starbucks | Google |
|---|---|---|---|---|---|
| 1 | 3.547 | 5.656 | 1.422 | 1.032 | 0.297 |
| 2 | 2.688 | 2.562 | 1.578 | 1.516 | 1.015 |
| 3 | 2.672 | 2.875 | - | 0.375 | - |
| 4 | 1.390 | 2.937 | 2.047 | 0.375 | - |
| 5 | 6.125 | 2.969 | 1.968 | 1.125 | 0.407 |
| 6 | 3.000 | 3.250 | 0.813 | 0.547 | 0.344 |
| 7 | 4.812 | 4.079 | 1.171 | 1.531 | 0.313 |
| 8 | 2.953 | 3.672 | 1.203 | 1.859 | 0.328 |
| 9 | 5.437 | 2.360 | 0.828 | 0.640 | 0.391 |
| 10 | 3.875 | 2.281 | 1.265 | 0.500 | 2.718 |
| 11 | - | - | 0.843 | - | - |
| 12 | 3.625 | 1.219 | 1.047 | 2.203 | 0.281 |
| 13 | 1.750 | 13.266 | 0.641 | 0.891 | - |
| 14 | 4.812 | 8.156 | 0.953 | 1.469 | 0.578 |
| 15 | 6.703 | 5.859 | 1.891 | - | 2.984 |

Table A.3. Latency Values for First Item Fixation – US (in Seconds)

| Participant | Tourism | Hotels | Education | Starbucks | Google |
|---|---|---|---|---|---|
| 1 | 6.297 | 6.391 | 0.469 | 1.281 | 0.984 |
| 2 | 2.719 | 4.312 | 2.062 | 1.687 | 0.578 |
| 3 | 1.250 | 2.000 | 0.985 | 2.938 | 0.390 |
| 4 | 2.906 | 7.266 | 1.000 | 0.453 | 1.906 |
| 5 | 3.594 | 0.938 | 1.422 | 2.031 | 0.641 |
| 6 | 2.203 | 1.656 | 1.031 | 0.719 | 0.469 |
| 7 | 6.937 | 2.641 | 1.563 | 0.766 | 0.719 |
| 8 | 5.766 | 2.484 | 4.218 | 0.438 | 0.453 |
| 9 | - | 1.672 | 0.609 | 0.813 | 0.859 |
| 10 | 20.031 | 1.156 | 1.156 | 1.625 | 0.625 |
| 11 | - | 1.531 | - | - | - |
| 12 | 1.109 | 4.640 | 1.766 | 2.109 | 6.094 |
| 13 | 7.734 | 4.687 | 0.500 | 1.219 | 1.593 |
| 14 | 3.750 | 1.719 | 3.141 | 0.266 | 1.500 |
| 15 | 2.671 | 38.469 | 2.297 | 3.844 | 0.344 |

Table A.4. Latency Values for First Item Fixation – Japan (in Seconds)

| Participant | Tourism | Hotels | Education | Starbucks | Google |
|---|---|---|---|---|---|
| 1 | 14.141 | 5.656 | 1.969 | 1.641 | 0.922 |
| 2 | 3.188 | 2.562 | 2.125 | 2.047 | 1.343 |
| 3 | 2.672 | 4.484 | - | 0.672 | - |
| 4 | 1.390 | 3.593 | 2.047 | 0.906 | - |
| 5 | 7.875 | 4.265 | 1.968 | 2.469 | 0.407 |
| 6 | 4.125 | 3.250 | 1.188 | 0.547 | 1.063 |
| 7 | 4.812 | 4.313 | 1.687 | 2.047 | 0.938 |
| 8 | 3.468 | 5.078 | 1.203 | 2.203 | 0.562 |
| 9 | 5.687 | 4.797 | 1.406 | 1.203 | 0.391 |
| 10 | 4.938 | 2.281 | 1.500 | 0.938 | 2.953 |
| 11 | - | - | 1.422 | - | - |
| 12 | 3.906 | 1.828 | 1.656 | 2.875 | 0.281 |
| 13 | 2.422 | 14.563 | 0.641 | 1.594 | - |
| 14 | 6.062 | 9.390 | 1.234 | 1.719 | 0.578 |
| 15 | 7.688 | 6.297 | 2.516 | - | 2.984 |

## Appendix B – Websites Used

US - Tourism


http://www.chicago.il.org/default.html (February 21, 2005)

Japan - Tourism


http://www.tourism.metro.tokyo.jp/english/ (February 21, 2005)

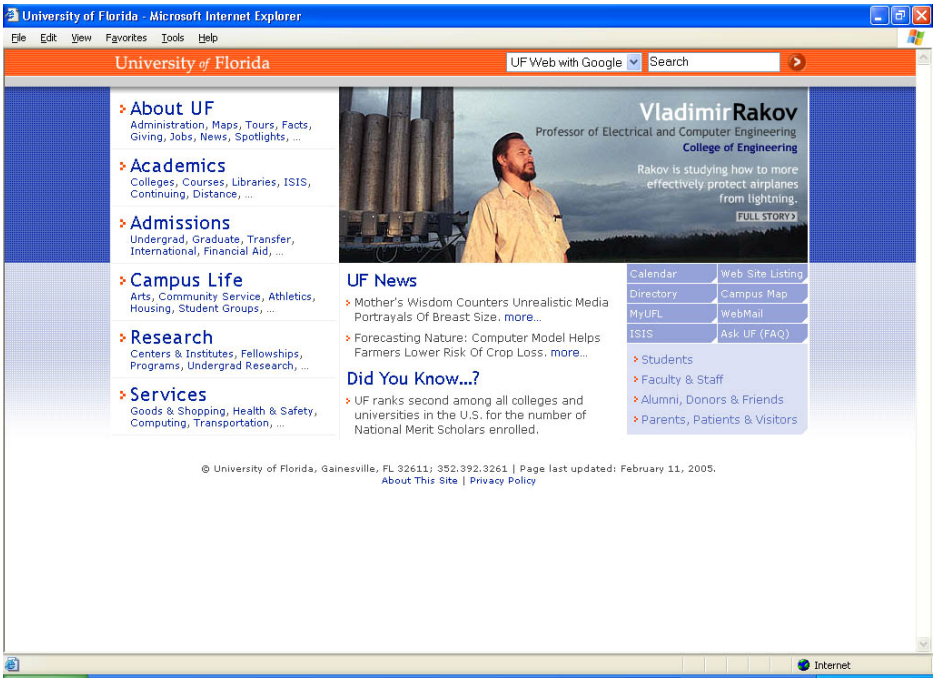
US - Hotels


http://www.houston-guide.com/guide/hotels/framehotels.html (February 21, 2005)

Japan – Hotels

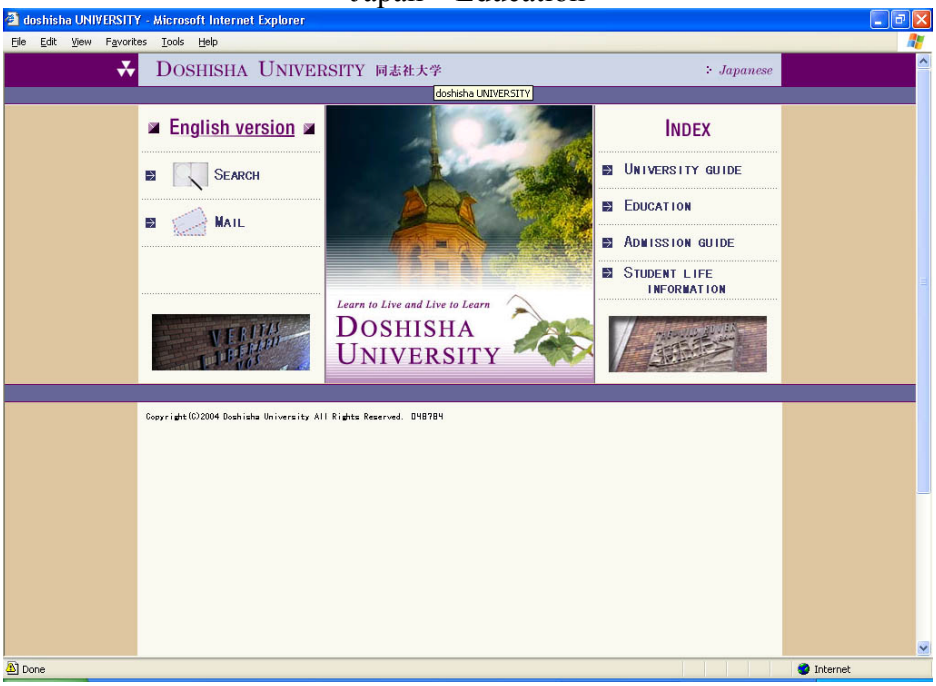

http://www.asiavoyage24.com//japan-hotels/index.html (February 21, 2005)

US – Education



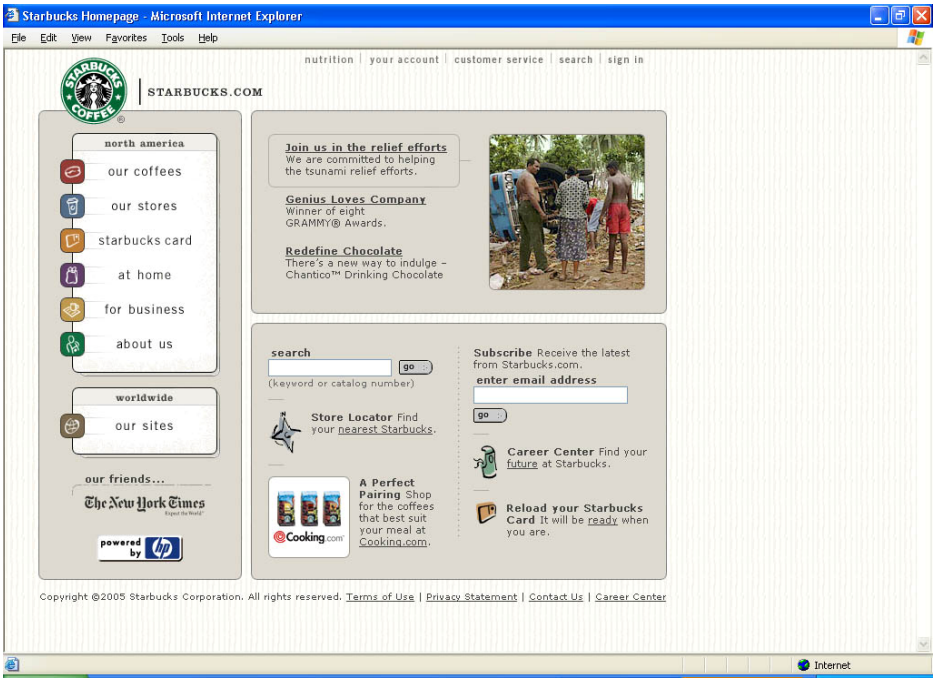

http://www.ufl.edu/ (February 21, 2005)

Japan – Education



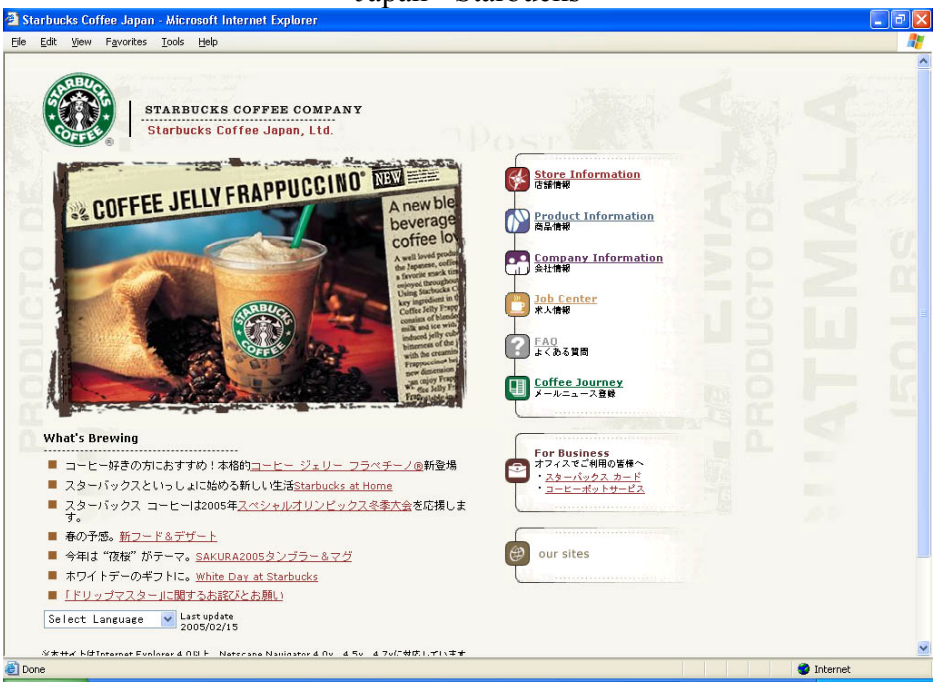

http://www.doshisha.ac.jp/english/ (February 21, 2005)

US – Starbucks



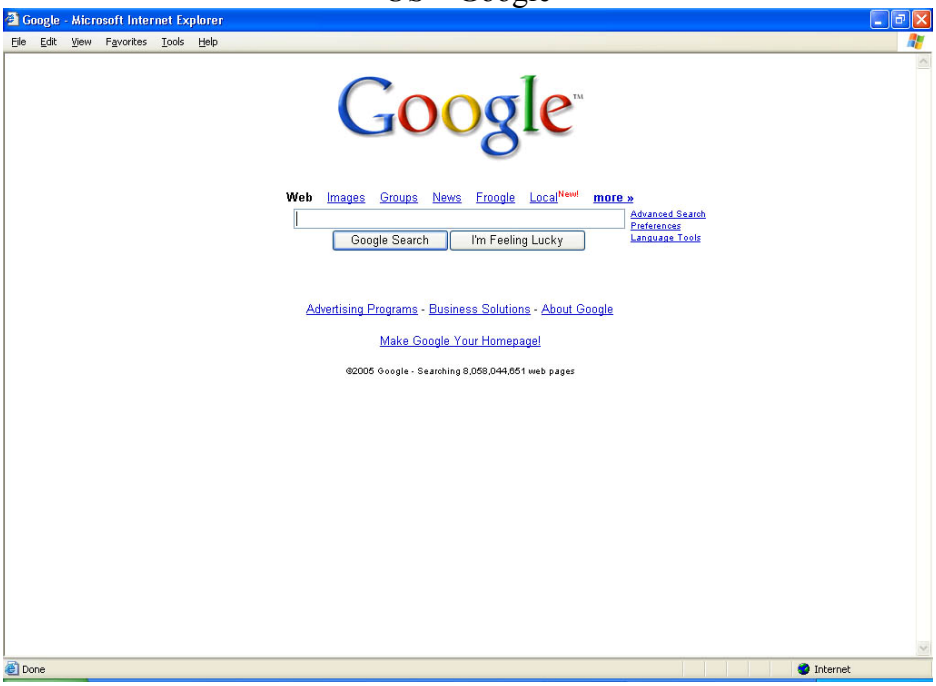

http://www.starbucks.com/ (February 21, 2005)

Japan - Starbucks




http://www.starbucks.co.jp/ja/home.htm (February 21, 2005)

US – Google




http://www.google.com (February 21, 2005)

Japan - Google


http://www.google.co.jp/ (February 21, 2005)

## Appendix C – Randomization Order

**Random Order 1**
1. US Education
2. Japan Starbucks
3. Japan Hotels
4. US Tourism
5. US Google
6. Japan Tourism
7. US Starbucks
8. Japan Google
9. US Hotels
10. Japan Education

**Random Order 2**
1. US Starbucks
2. Japan Google
3. US Education
4. Japan Hotels
5. Japan Tourism
6. US Hotels
7. Japan Education
8. US Google
9. US Tourism
10. Japan Starbucks

**Random Order 3**
1. US Tourism
2. Japan Education
3. Japan Google
4. US Hotels
5. US Starbucks
6. Japan Tourism
7. US Education
8. US Google
9. Japan Hotels
10. Japan Starbucks

**Random Order 4**
1. US Hotels
2. Japan Starbucks
3. US Google
4. Japan Tourism
5. Japan Education
6. US Starbucks
7. US Tourism
8. Japan Hotels
9. Japan Google
10. US Education

## Appendix D – Participant Forms

Participant Consent Form


# BOSTON COLLEGE

### Consent to Participate in a Research Study

**Introduction:**
You are being invited to participate in a research project about the affects of cultural web designs on usability. The study is being undertaken through the Computer Science department at Boston College. Your participation is completely voluntary. This study is being conducted by Dan Shaw, A&S '05, under the advisement of James Gips, a Professor of Computer Science at Boston College.

**Purpose:**
The study intends to explore the relationship between culturally-influenced web page designs and user efficiency. We are examining the correlation between the design of multicultural interfaces and corresponding ease of use, as measured by the amount of time it takes to navigate each page.

**Procedures:**
If you decide to participate you will be asked to sit in front of a computer monitor and navigate through a collection of screen shots of real web pages. A small camera will track the position of your eye as you visually navigate each web page. As each subsequent web page is displayed, you will be asked to find a specific item on the page. After each page is displayed, you will be given a brief rest period and a new set of instructions. In order to standardize the camera software, you will first be asked to look at specific points on the screen during a short calibration process. The entire process should take about 30 minutes in total. At the conclusion of the procedure, you will be asked to complete a short exit survey on your experiences with the various interfaces.

**Risks:**
To the best of our knowledge, the procedures used in this study have no more risk of harm to you than what you experience in everyday life.

**Benefits:**
We hope this research demonstrates the efficiency and increased usability of culturally-specific interface designs, and will encourage greater research and development in this area. There are no direct benefits to you for participating in this study.

**Withdrawal from the study:**
If you choose to participate in this project, please understand that your participation is voluntary and you have the right to withdraw your consent or discontinue participation at any time. You are also welcome to ask questions at any time during the session.

**Confidentiality:**
No personally identifiable information will be collected during the study, and no identifiers will be used that could potentially link you to the data collected. This data will be in the form of X and Y coordinates that track eye position over the recorded time. In addition, your responses on the exit survey will not contain personal identifiers. All of the data collected will be stored in a locked file cabinet in James Gips' office at Boston College, which is also locked at all times. All data and documents relating to this study will be kept for five years beyond the termination of the study and then destroyed. Only the principal investigator (Dan Shaw) and research advisor (James Gips) will have access to this data set.

**Questions:**
You are encouraged to ask questions now, and at anytime during the study. You can reach Dan Shaw at 617-655-5614 or Professor James Gips at 617-552-3981. If you have any questions about your rights as a participant in research, please contact the Boston College Office for Human Research Participant Protection at 617-552-4778.

I have read and I believe I understand this Informed Consent document. I believe I understand the purpose of this research project and what I will be asked to do. I have been given the opportunity to ask questions and they have been answered satisfactorily.

I understand that I may stop my participation in this research study at any time and that I can refuse to answer any question(s).

I have received a signed copy of this Informed Consent document for my personal reference.

I hereby give my informed and free consent to be a participant in this study.

**Signatures:**

_____ _____

**Date** **Consent Signature of Participant**

_____

**Print Name of Participant**

_____

Person providing information and witness to consent

Participant Exit Survey

Age: 18-24 25-34 35+ ID #: _____

Gender: Male Female Random #: _____

Country of Birth: _____

1. How often do you use the Internet to view web pages?
   a) Once a month (or less)
   b) Once a week
   c) Once a day
   d) Several times per day (or more)

2. How often do you use the Internet to view web pages from countries other than the United States?
   a) Once a month (or less)
   b) Once a week
   c) Once a day
   d) Several times per day (or more)

3. How often do you use the Internet to view web pages in languages other than English?
   a) Once a month (or less)
   b) Once a week
   c) Once a day
   d) Several times per day (or more)

4. Is English your native language?
   a) Yes
   b) No

5. Are you fluent in languages other than English?
   a) Yes
   b) No

5a) If you answered "yes" to question 5, please list the languages below:

6) Which Internet search engine do you use most often?
   a) Yahoo!
   b) Google
   c) MSN
   d) Other (please specify): _____

7) Overall, how difficult did you find it to locate the item on Japanese web sites?

| Less | | | | | | | | | More |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

8) Overall, how difficult did you find it to locate the item on English web sites?

| Less | | | | | | | | | More |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |