

Cultural differences on attention and perceived usability: Investigating color combinations of animated graphics

Jantawan Noiwan^{a,*}, Anthony F. Norcio^b

^a*Faculty of Management Sciences, Prince of Songkla University, P.O. Box 5, Hat Yai, Songkhla 90112, Thailand*

^b*Department of Information Systems, University of Maryland Baltimore County, 1000 Hilltop Circle, Baltimore, MD 21250, USA*

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Abstract

This experimental study investigates the effects of animated graphic colors on attention and perceived usability of users from two cultural groups, American and Thai. The experiment employs a three-way split-plot design with one between-subjects factor and two repeated-measures factors. The between-subjects factor contains two cultural groups, American and Thai. The two repeated-measures variables are a banner background color factor with six levels and a banner font color factor with two levels. Participants search for target words from text on Web pages that contain three animated banner graphics. The findings lead to the conclusion that users across cultures tend to ignore animated banner graphics when they look for specific information on highly informative Web pages. This study also suggests influences of culture on overall performance, overall retention, and overall self-reports on usability, regardless of differences in banner color combinations. Moreover, cultural differences on the self-report of attention drawing are also revealed in each banner color usage, except yellow banners with white text. This study does not aim at exploring superiority of participants between cultures. Rather, it attempts to explore some possible cultural differences in interacting with a computer interface that could facilitate cognition and perception of users from different cultural groups.

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1. Introduction

Developing a successful computer interface requires careful consideration of language translation and the implications of culturally sensitive elements. A number of studies (e.g., Tractinsky, 1997; Dong and Salvendy, 1999) show that taking cultural diversity into account in a design process, particularly in interface design, is essential. Still, cultural studies in HCI are limited.

As cultural backgrounds could influence learned responses to color (Eiseman, 2000), color preferences might be considered culturally dependent. Interface designers need to understand color appreciation and color responses of people in different cultures and regions. Effective usage

of color can create several benefits, and these benefits must be given to all people throughout the world.

In terms of interface design, other than color, motion is also an important attribute of objects that can most distract visual attention (Constantine and Lockwood, 1999). Therefore, understanding how a user processes information on a Web interface that contains not only text but also animated graphics (e.g., banner advertisements) is particularly important to a Web usability engineer in designing usable Web pages. Moreover, Web users often perform more than one online activity simultaneously (e.g., information seeking, online chatting). Nevertheless, it is widely known that human beings have limited attention and limited short-term memory. As such, the effectiveness in human information processing is lessened when performing concurrent tasks.

This study explores the effects of combinations of text and background colors of Web animated graphics on

*Corresponding author. Tel.: +66 7428 7931; fax: +66 7421 2819.

E-mail addresses: jantawan.n@psu.ac.th (J. Noiwan), norcio@umbc.edu (A.F. Norcio).

attention and perceived usability in seeking information on Web pages containing animated banner graphics between American and Thai participants. This empirical study potentially contributes to a necessity of understanding cognitive processing of people across cultures when interacting with computer interfaces.

The study addresses the following questions:

1. Are there differences in performance, retention, and self-reports of usability when users perform target-word searching on different Web pages containing animated banner graphics with different combinations of text and background colors?
2. Does culture affect performance, retention, and self-reports of usability when users perform target-word searching on different Web pages containing animated banner graphics with different combinations of text and background colors?

2. Related work

Theoretical work of this study can be divided into two major sections, cultural issues in interface design and visual attention. Cultural issues in interface design are discussed in terms of the concept of culture, culture and color preferences, and culture and human information processing. Visual attention particularly points out the effects of animated graphics and colors on visual attention.

2.1. Cultural issues in interface design

Generally, culture differs not only in languages, symbols, images, colors, and formats of date and time, but also emotions, personalities, perception, cognition, and thinking styles. In other words, culture functions as the basis of people's behaviors, thoughts, and feelings (Komin, 1991). Therefore, general guidelines of cross-cultural interface design (Fernandes, 1995) and general models of cultural differences (e.g., the Onion model by Hofstede, 1991) exist and can be adapted for interface design purposes, thereby improving in user performance and satisfaction.

Currently, many HCI researchers are focusing on culture as a potentially important factor that can affect user performance and satisfaction toward an interface. However, cultural studies in HCI are insubstantial. In addition, recommendations of interface design for international users are mainly based on collective knowledge, personal experiences, and few case studies (Marcus, 1993; Russo and Boor, 1993; Belge, 1995; Fernandes, 1995; Kano, 1995; Nakakoji, 1996; Marcus et al., 1999; Schaffer and Sorflaten, 1999). Tractinsky (2000) states that theory building and testing is essential to facilitate researchers in cross-cultural HCI to explore their studies systematically. Hence, empirical investigations on the impacts of cultural factors on interface design are absolutely vital.

2.1.1. The concept of culture

Culture is an abstract, complex, and problematic term (Barber and Badre, 1998). It has been defined in various ways. Hofstede (1991) defines culture as “software of the mind,” i.e., “the collective programming of the mind which distinguishes the members of one group or category of people from another.” Segall et al. (1999) assert, “Any experience a person has is influenced by that person's previous experiences. To the extent that previous experiences are determined by the accident of birth at a particular time in a particular place, it becomes probable that the ‘same’ event will be different events, even in very fundamental ways, to members of different cultural groups.” Culture might include behavioral products, values, languages, ways of life of ancestors, art, music, shared preferences, rules, norms, attitudes, and beliefs (Segall et al., 1999). Cultural elements are transmitted, shaped, shared, and taught among people in each particular culture, thereby differentiating a culture from one another (Segall et al., 1999).

2.1.2. Culture and color preferences

Fernandes (1995) provides nine general principles in designing interfaces for international users. One guideline is to present information with culturally appropriate aesthetics such as colors. As cultural backgrounds can influence learned responses to colors (Eiseman, 2000), color preferences are probably considered culturally dependent. By rating separately or by comparing between each pair of colors on a subjective scale, several factors influencing human preferences of unique colors or color combinations have been investigated such as age, gender, emotion, personality, and nationality (Kreitler and Kreitler, 1972).

Kreitler and Kreitler (1972) emphasize that an investigation on color preferences of people from different cultural backgrounds is important to arts because aesthetic experience, which is culturally dependent, is greatly concerned in Arts. However, evidence of color preferences from culture to culture varies (e.g., Silver, 1988; Birren, 1992), therefore, more studies are needed to explore these variation preferences.

Several efforts in determining cultural factors in color preferences still continue. Particularly, a trend in studying color in interface design across cultures is crucial. For instance, Vanka, as cited in Kemnitzer and Dorsa (1999), develops “ColorTool” as a general guideline and a tool for assisting interface designers to choose appropriate colors for different cultures. Peterson and Cullen (2000) provide worldwide examples of color design in global graphics. In another study, Barber and Badre (1998) attempt to embed cultural factors into usability in the context of Web design.

2.1.3. Culture and human information processing

In cross-cultural psychology, Segall et al. (1999) state that the purpose of cross-cultural cognitive psychology is to understand human cognitive processes which are influenced by cultural factors. These processes include

visual perception, memorization, attention, reasoning, learning, categorization, and problem solving.

Differences in visual perception among people from different cultures exist because they perceive visual images in a way that they have experienced and learned (Segall et al., 1999). In other words, environment and culture shape humans' perceptual practices. Most empirical studies in cross-cultural interface design attempt to examine the question of whether cultural diversity affects visual perceptions (e.g., Kurosu and Kashimura, 1995; Tractinsky, 1997; Choong and Salvendy, 1998, 1999; Piamonte et al., 1999).

For instance, a comparative study between Chinese participants and American participants shows that object representation and categorization according to the experiences from internal and external environments of humans are mainly affected by cultural backgrounds and cannot be understood simply from a universal point of view (Liu, 1973). According to the study, e.g., the categories of money, cities, and states are more culturally specific, whereas the categories of social conventions (e.g., forks and spoons) are less culturally specific.

Moreover, several studies and real-world case studies often report icons as culturally dependent interface elements (e.g., Evers, 1998; Evers et al., 1999; Piamonte et al., 1999). For instance, a series of studies aiming at evaluating three sets of videophone icons and pictograms developed in Japan, the US, and England by Piamonte et al. (1999) show the effects of cultural differences in memory testing toward icon design. The studies indicate that symbols could be easily recognized and confused.

Additionally, Barber and Badre (1998) conduct a usability inspection on 168 Web sites originating in different countries and languages aiming at analysing cultural elements in Web design. The results indicate that there are differences in cultural preferences across cultures and genres of Web sites within each culture. In terms of metaphor design, Evers (1998) and Evers et al. (1999) attempt to explore cultural differences in perception toward metaphor design of virtual campuses. The studies conclude that users from different cultures perceive the meanings of metaphoric graphics differently.

Other than the studies of representations in perceptual processes, some cognitive studies in human perception have also been investigated. Poortinga and van de Vijver (1988) point out that relationships among cultural factors and cognitive functions are often recognized. For instance, cognitive differences between Chinese and American participants have been reported (Bond, 1986). Obviously, researchers and practitioners cannot deny that human cognitive processes vary across cultures. Segall et al. (1999) also mention that basic cognitive functions of humans are similar; however, by shaping with cultural experiences, humans differently apply their preferred skills and strategies to cognitive processes in each particular situation.

In terms of human attention in cross-cultural psychology, Das (1988) identifies that the social-cultural environ-

ment guides an individual's attention functions. Several variables that could influence human attention include sensory systems, information-processing capacities, learned behavior in specific situations, personality traits, amount of available information, social stress, and complexity of stimuli (Pankey, 2000).

Like these variables, colors of stimuli could affect human attention and the effect could differ from culture to culture. This present study expects that colors of animated banner graphics have an impact on attention. Color preferences are also foreseen to have relationships to performance. Color combinations of stimuli perceived as more annoying, less pleasant, less interesting, and less visually pleasing than other colors could lessen human attention span and thereby cause higher error rates and higher search time in the information-seeking task.

2.2. Visual attention

Attention generally refers to a selectivity of processing, concentration effort on a stimulus, or the limited resources available to the cognitive system (Eysenck and Keane, 1995; Ashcraft, 1998). Humans always encounter several information sources simultaneously, but they cannot easily attend to more than one source of information at a time because of the limitation on attention. When attempting to concentrate on one stimulus, a person ignores the surrounding stimuli or distractions. This process is called filtering or selecting (Ashcraft, 1998).

However, one study shows that objects in a visual peripheral system can capture human attention (Driver and Baylis, 1989). For example, as noted by Wickens and Hollands (2000), large, bright, colorful, changing items on a screen can distract attention. Constantine and Lockwood (1999) also mention that two attributes of objects that can most distract visual attention are motion and color, respectively.

2.2.1. Animated graphics and visual attention

Graphics are essential elements in computer interface design. Some benefits of graphics include conveying information, improving visual appeal, and drawing user attention. Nevertheless, in some cases, adding graphics such as animated banner advertisements can make a Web site's information more ambiguous as well as make it more difficult for a user to concentrate on the information.

Baecker and Small (1990) define an animated graphic as "a sequence of static images changing rapidly enough to create the illusion of a continuously changing picture." Studying graphic elements in relation to user performance has become a more interesting topic. Johnson and Nemetz (1998), for instance, attempt to develop multimedia design principles by empirically analysing Web pages in terms of text, diagrams, maps, photographs, hypermedia and animation. Their study shows that animations used in the Web pages distract user attention.

When more than one task is performed concurrently, they compete with one another for available limited mental resources. The competition results in decreasing task performance. The multiple resource theory shows that two tasks could interfere with each other when they have the same stimulus modality, use the same stages, and use the same working memory for information codes (Wickens, 1984).

Zhang (1999) reports significant differences in conditions of animated graphics in online information seeking. The study examines the impact of animated graphics in searching for target words on Web pages containing animated graphics with respect to task difficulty, animated graphic color, animated graphic content as well as instructions to ignore such animated graphics. The results show that the animated graphics worsen user performance in searching for the target words. For example, an animated graphic that is similar but irrelevant to a task distracts a user's attention more than does an animated graphic that is dissimilar to a task. Such results become more negative when users are instructed not to ignore the animated graphics. Nevertheless, in terms of banner advertisements, an animated one tends to be more effective than a static one in increasing a click-through rate.

2.2.2. Color and visual attention

Among a variety of graphic components on screen, color is one of the powerful components of design. Interface designers must be able to understand how to apply colors in design. As Tufte (1989) asserts, "skillful visual design of computer screens—with care given to color, typography, layout, icons, graphics and coherency—substantially contributes to quality and usability." Several studies show the effects of color in human information processing. Hoadley (1989), for example, states that color, one of the attributes of a visual stimulus, can attract human attention. Moreover, Marcus (1992) expresses that color is the most complicated visual component. Furthermore, extensive studies on color in visual attention, particularly in visual search, show that color is an object component that effectively distinguishes a stimulus from the surroundings (e.g., D'Zmura, 1991).

The effects of color on human performance have been evaluated in several task settings. These task settings are detecting colored targets among non-colored distractions, detecting colored targets among colored distractions whereby the color of targets is different from the color of distractions, and detecting targets containing the conjunctions of features (e.g., color and orientation). Treisman and Gelade (1980), for instance, report that the need of attention to join object features together causes a participant takes more time in detecting a green letter T on a screen that contains an equal number of brown T's and green X's. Another study shows that in searching for target words from a list of colored target words and colored non-target words, text-color differences signifi-

cantly influence search time, particularly when the target color is known (Nes et al., 1987).

Clearly, evidence shows that color has an impact on visual attention in various contexts (e.g., visual searching and reading). The above studies manipulate the color of targets and non-targets, and non-targets are defined as distractions. This present study, on the other hand, does not explore colors of target words and non-target words. Rather, colors of animated banner graphics (distractions) are investigated.

Zhang (1999) has investigated a similar problem. In that study, bright color is the vital attribute of animated banners, which can greatly distract user attention. The brightness attribute is explored in two levels, bright color and dull color. No hue color is reported, which leaves a difficulty for further investigations. However, the result shows that an animated graphic with a bright color distracts a user's attention more than an animated graphic with a dull color.

In terms of color usage in graphics, general guidelines are well discussed. Marcus (1992) recommends using appropriate colors for central and peripheral areas. Blue is appropriate for large areas such as screen backgrounds. Red and green are recommended for an area in the center of the visual field, whereas black, white, yellow and blue are better used in the periphery of the visual field.

Moreover, every combination of colors can probably create different effects. For instance, studies show that ineffective combinations of colors on graphic designs can reduce user performance and satisfaction (e.g., Latomia and Happ, 1987). Effective combinations of text and background colors of animated banner graphics are one of the influencing factors that could facilitate information processing and increase click-through rate, readability of banner message, brand awareness, appreciation of Web appearance, and usability of a Web page.

3. Methodology

This section details the research methodology of this study. Hypotheses, experimental design, independent variables, dependent variables, participants, incentives, apparatus, procedure, experimental materials, and methods of data analysis are explained.

3.1. Hypotheses

The review of literature on cultural differences and human information processing forms the basis for the following null hypotheses.

Hypothesis 1. There are no differences in performance, retention, and self-reports of usability when users perform target-word searching on different Web pages containing animated banner graphics with different combinations of text and background colors.

Hypothesis 2. Culture has no effects on performance, retention, and self-reports of usability when users perform target-word searching on different Web pages containing animated banner graphics with different combinations of text and background colors.

3.2. *Experimental design*

The experiment in this study employs a three-way $2 \times 6 \times 2$ split-plot design with one between-subjects factor and two repeated-measures factors. The between-subjects factor contains two cultural groups, American and Thai. The two repeated-measures variables are a banner background color factor with six levels and a banner font color factor with two levels.

Each participant performs all thirteen experimental tasks: one control task and 12 treatment tasks. The within-subjects design has an advantage of controlling for individual participant's differences between subjects by removing the between subjects variance. Hence, this approach increases the sensitivity of the experiment to treatment differences (Maxwell and Delaney, 1990). The study is designed to eliminate the possibility of practice effects in the within-subjects design. For this purpose, a practice session is provided to each participant, and an order of the experimental Web pages presented to each participant is designed by a Latin square plan to randomize the order of the conditions over the participants in each cultural group.

3.3. *Independent variables*

Regarding to the between-subjects design, a cultural group which has two levels, Thai and American, is used as an independent variable. In each cultural group, the two independent variables include a banner background color and a banner font color. Black and white, the two common text colors are used as levels of banner text colors. As a starting point, the six levels of background colors of animated banners are three primary colors and three secondary colors. The three primary colors, or colors that cannot be made by mixing colors, are red, yellow and blue. These three primary colors when combined in pair produce three secondary colors: orange, violet, and green. Extensive studies on color preferences for hues utilize these six basic colors (e.g., Eysenck, 1981; Saito, 1994).

3.4. *Dependent variables*

This study does not aim at exploring superiority of participants between cultures. Rather, it attempts to explore some aspects of cultural differences in interacting with a computer interface in order to design an interface that could facilitate cognition and perception of users from different cultural groups. Three major measures evaluated in this study are user performance, user retention, and perceived usability.

The dependent variables of user performance consist of correct search time in seconds, incorrect search time in seconds, and incorrect searches. Search time and search accuracy are recorded automatically. The recording begins when a Web page is displayed to a participant. It ends when a participant finishes the search task. User retention variables are frequency in looking at the banners, banner background color retention, banner font color retention, and banner word retention.

Five dependent variables of perceived usability of banner color usage consist of attention drawing, Web visual appeal enhancement, task enjoyment enhancement, task interest enhancement, and banner graphic readability. A participant can rate each factor in seven scales, namely, extremely disagree, quite disagree, slightly disagree, neither agree nor disagree, slightly agree, quite agree, and extremely agree.

3.5. *Participants*

Sixty American participants are recruited at the University of Maryland Baltimore County, USA. Sixty Thai participants are recruited at the Prince of Songkla University, Thailand. To reduce undesired variations among subjects other than cultural differences, factors such as age and gender are controlled. Nevertheless, due to time and research limitations, internet experience of the participants is loosely controlled, yet recorded for further analysis.

Each cultural group consists of 30 female and 30 male volunteers range in age between 18 and 19 years old, not color-blind, and not majoring in computer-related fields of study. All participants fluently speak their native language as their primary language. The participants in each cultural group live their entire lives in their own country where their parents were also born.

3.6. *Incentives*

Providing monetary rewards is a way to motivate participants in a experiment and to perform experimental tasks as fast and as accurately as possible. The first reward is \$100.00 and the second one is \$50.00. Both rewards are randomly given to two participants from each cultural group. The equivalence of the magnitude of the rewards between the Thai and American participants is maintained.

3.7. *Apparatus*

Three laptop computers are utilized in this experiment: two IBM-based HP Pavilion and one IBM ThinkPad. All have a 14 in, 1024×768 TFT color display. An external mouse is used for the experiment. Each experimental Web page is written by using Microsoft Active Server Pages (ASP), VBScript, and JavaScript. Microsoft Personal Web Server runs as a desktop Web server throughout the experiment. Information of each participant is recorded into Microsoft Access databases. Microsoft Internet

Explorer browser is used to access the experimental Web pages.

3.8. Procedure

Subjects participate individually at their convenience. Each subject is seated in front of the laptop computer and is given brief instructions by the experimenter. A subject signs the consent form after being informed about his or her rights and fills out the pre-experiment questionnaire page about demographics, internet usage information, and color preferences. Each participant is presented with 13 different Web pages containing different animated graphics. Examples of experimental Web pages in English and in Thai are shown in Figs. 1 and 2, respectively.

When target-word searching task is conducted, a participant searches for target words from a mixed set of non-target words and target words on a Web page that also contains three animated banner graphics. The task of identifying target strings from other strings is one of the typical information-seeking tasks in Web environment (Marchionini, 1995; Zhang, 1999). In addition, this task is widely used in visual attention in reading. For instance, in a target-word searching study by Nes et al. (1987), participants are presented with a list of non-target and target words on a screen.

In this present study, a participant is first presented with a pre-task page which contains a target word to search for. The subject is then required to search for 16 target words in

a task Web page. When a target word is found, the subject must click on it once. Time and error in each search task is automatically recorded. When all target words are selected, the participant is automatically taken to a post-task page to test for retention toward banners and rate usability of the corresponding experimental Web page and select the word that is not appeared on three animated banners. Then, the participants must take a break for 5 s by closing their eyes for relaxation. Afterwards, each participant has to click a button on a screen to continue the experiment.

3.9. Experimental materials

3.9.1. Target words and non-target words

All words used in this study have five letters, which can be read with a single eye fixation (Kreuz, 1987). This experiment is controlled for word familiarity by taken from a corpus of English words which are used frequently in daily life (Sinclair et al., 1995). The experiment with Thai participants uses five-letter words taken from a corpus of Thai words controlling for word familiarity (Promchan, 2001). To control for similarity of word formats used between Thai and American participants, this study eliminates Thai words containing tonal marks located on the top of the letters or vowel marks located at the bottom of the letters.

In each experimental Web page, 200 words, including 184 non-target words and 16 target words are randomly listed by not attempting to make sentences. A target word

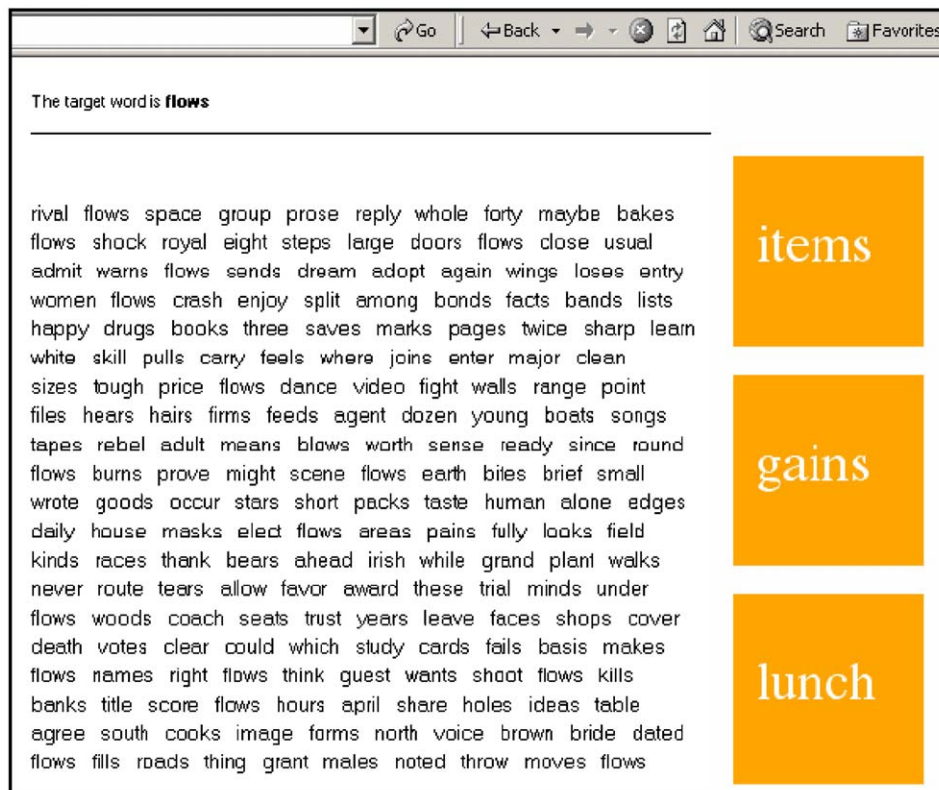


Fig. 1. An experimental Web page in English.

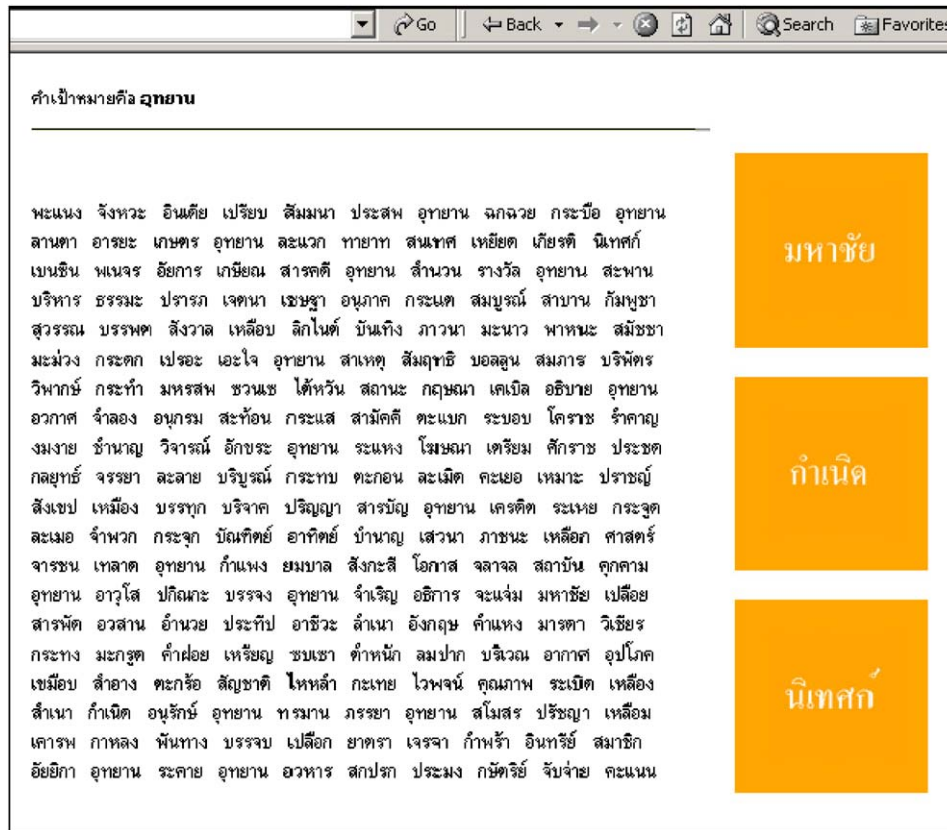


Fig. 2. An experimental Web page in Thai.

is varied in each experimental Web page. In other words, 13 different target words are used with 13 experimental Web pages. Like the order of Web pages, the order of each target word is designated by a Latin square plan. Locations of non-target and target words are randomized by a computer program. However, target words are not placed next to each other. Words shown in each Web page are selectable. When a participant clicks on a word, which is originally black, it changes to gray and then information of the word is recorded into a database. All words are listed to fit within one Web page that is wholly visible on a 14.1 in screen with 1024×768 resolution. A style of font for both Thai and American-English words is the Web common Microsoft Sans Serif font, with 12-point size, black text on a white background.

3.9.2. Animated banner graphics

An animated banner graphic contains a five-letter word. It could be considered as a task-similar graphic. Three animated graphics are located at the right side of the textual information across text lines. The common size of 125×125 pixel banners on the right side of the screen is used. Words on banners are drawn from the non-target word database used for the search task. The background colors are red, orange, yellow, green, blue, and violet. The text colors are white and black. All colors are commonly used in Web banner graphics. Moreover, such colors have also been used to investigate color preferences and color

meanings across cultural groups. A moderate level of color brightness and saturation are particularly used to minimize overly distracting effects. Two Perl scripts are written for creating the 10912 animated banner graphics for this study.

3.9.3. Experimental web pages

In this study, 13 experimental Web pages are developed. Twelve pages meet the experimental conditions of cross-products from the two levels of banner text color and the six levels of banner background color, and one page is a base-line page with no banner graphic. With the objective of eliminating the potential role of practice effects in the interpretation of the results, the study utilizes a Latin square design variation to distribute the order of page presentation events over participants.

3.9.4. Post-task survey

In each task, after all target words are selected, a participant is automatically taken to a post-task page. Its purpose is to evaluate user retention and perceived usability. User retention evaluation consists of these following measures: frequency in looking at banners, banner background color retention, banner font color retention, and banner word retention. The scale used for evaluating the frequency in looking at the banners is also used by Zhang (1999).

In this post-task survey, a participant is asked to approximate how many times he or she looks at banners while searching for target words. Afterwards, the subject recalls banner elements: background color, font color, and word. Then, a participant rates the usability of banner color usage in the corresponding experimental Web page in terms of attention drawing, banner readability, Web appeal enhancement, Web search interest enhancement, and Web search enjoyment enhancement.

3.10. Methods of data analysis

Methods of data analyses are presented in two sections: the analyses of demographic data and the analyses of user performance, user retention, and self-reports. SAS (version 8.0) statistical software is utilized throughout the analysis. All statistical tests are analysed at alpha level .05.

3.10.1. The analyses of demographic data

Demographic data are age, area of study, gender, color preference, internet experiences, and internet usage. Except age, the demographic data are analysed in comparison between the two cultural groups by χ^2 tests. A χ^2 test of independence is used to analyse the relationships between two nominal variables whereby the variables are explained through frequencies rather than means (Polit, 1996). In this study, the two nominal variables are a cultural group and each category of demographic data, except age.

3.10.2. The analyses of user performance, user retention, and self-reports

The repeated measure analysis of variance (ANOVA) using the traditional MANOVA approach is utilized for the analysis of user performance, user retention, and self-reports since this approach does not require the sphericity assumption. Information about this traditional approach is primarily taken from Maxwell and Delaney (1990). Tukey's honestly significant difference (Tukey's HSD) post-hoc tests are performed when the analysis reveals significant effects of between-subjects factors that involve within-subjects factors. The pairwise post-hoc Student's *t* statistic tests are used for the matched pair between levels of within-subjects factors (Cody and Smith, 1997).

4. Results

This section presents the statistical analyses of the experiment divided into five major sections as follows: the summary of significant differences, the demographic data, the hypothesis testing on user performance, the hypothesis testing on user retention, and the hypothesis testing on perceived usability.

4.1. Summary of significant differences

Table 1 presents the summary of the significant differences of user performance. In all three analyses of

Table 1
Summary of significant differences of user performance

Source	Correct search time	Incorrect search time	Incorrect searches
Between-subjects			
NT ^a	Yes	Yes	Yes
Within-subjects			
BG ^b	No	No	No
BG × NT	No	No	No
FT ^c	No	No	No
FT × NT	No	No	No
BG × FT	No	No	No
BG × FT × NT	No	No	No

“Yes” indicates a significant difference whereas “No” indicates no significant difference.

^aNationality.

^bBanner background color.

^cBanner font color.

Table 2
Summary of significant differences of frequency in looking at banners

Source	Frequency in looking at banners
Between-subjects	
NT ^a	No
Within-subjects	
BG ^b	No
BG × NT	No
FT ^c	No
FT × NT	No
BG × FT	Yes
BG × FT × NT	No

“Yes” indicates a significant difference whereas “No” indicates no significant difference.

^aNationality.

^bBanner background color.

^cBanner font color.

user performance, namely, correct search time, incorrect search time, and incorrect searches, only the nationality main effects are found.

Tables 2–4 present the summaries of the analyses of user retention. As shown in Table 2, only the two-way interaction between banner background color and banner font color on the mean of frequency in looking at banners is revealed.

Table 3 summarizes the significant differences between the American and Thai groups on means of total numbers of retention answers. Five significant differences are revealed, which are (1) the total numbers of right answers in guessing banner background color, (2) the total numbers of unaware answers in guessing banner background color, (3) the total numbers of right answers in guessing banner font color, (4) the total numbers of unaware answers in guessing banner font color, and (5) the total numbers of wrong answers in guessing banner words.

Table 3
Summary of significant differences between the American and Thai groups on means of total numbers of retention answers

User retention	Types of answers	Significant differences
Banner background color retention	Right	Yes
	Wrong	No
	Unaware	Yes
Banner font color retention	Right	Yes
	Wrong	No
	Unaware	Yes
Banner word retention	Right	No
	Wrong	Yes
	Unaware	No

“Yes” indicates a significant difference whereas “No” indicates no significant difference.

Table 4
Summary of significant differences on means of accumulated numbers of retention answers regardless of nationality

User retention	Types of answers	Treatment effects		
		BG ^a	FT ^b	BG × FT
Background color retention	Right	Yes	No	No
	Wrong	Yes	No	No
	Unaware	No	No	No
Banner font color retention	Right	No	No	No
	Wrong	Yes	Yes	Yes
	Unaware	No	No	No
Banner word retention	Right	No	No	No
	Wrong	No	No	No
	Unaware	Yes	No	Yes

“Yes” indicates a significant difference whereas “No” indicates no significant difference.

^aBanner background color.

^bBanner font color.

Table 4 summarizes the treatment effects on means of accumulated numbers of retention answers regardless of nationality. Two statistically significant treatment effects are revealed in terms of banner background color retention. These are the main effects of background color on means of accumulated numbers of right answers and wrong answers. In terms of banner font color retention, three statistically significant treatment effects are found. These include the two main effects and the interaction effect on means of accumulated numbers of wrong answers. In terms of banner word retention, two statistically significant treatment effects are revealed. These consist of the main effect of background color and the interaction effect on means of accumulated numbers of unaware answers.

Table 5 presents the summary of the significant differences of usability self-reports. There exist the nationality main effects. Moreover, the analysis reveals

the banner background color main effects at four types of self-reports, except banner attention drawing measure. The interaction effects between nationality and banner background color are found when measuring Web appeal enhancement, Web enjoyment enhancement, and Web interest enhancement. In addition, the analysis reveals the main effects of banner font color at four measures of self-reports, except Web appeal enhancement. However, the interaction effects between banner font color and nationality are found only at Web interest enhancement measure. Additionally, the interaction effects between banner background color and banner font color are found at all measures of the self-reports. However, the three-way interaction effect among banner background color, banner font color, and nationality is found only on the self-report of attention drawing.

4.2. Demographic data

4.2.1. Color preferences

Color preferences are investigated based on these following colors: red, blue, orange, yellow, violet, and green. The preferences are ranked from the most favorite color (the first favorite color among the six colors) to the least favorite color (the sixth favorite color among the six colors). As shown in Tables 6 and 7, participants from both cultural groups rate blue as their most favorite color. Red is the second favorite color of American group, whereas Thai participants rate yellow as their second favorite color. To both cultural groups, the least favorite color is violet.

4.2.2. Internet experience

As shown in Table 8, the χ^2 test reveals a statistically significant relationship between internet usage and nationality ($\chi^2 = 50.70, p < .001$). American participants report more internet experience than do Thai participants. The majority of American participants (61.67%) have internet experience of more than 3 years. The years of internet experience of Thai participants vary equally (25.86%) of less than 6 months, 1–2 years, and 2–3 years.

4.2.3. Web navigation frequency

As shown in Table 9, participants from both cultural groups significantly differ in frequency in navigating Web sites ($\chi^2 = 62.89, p < .001$). American participants navigate Web sites more often than do Thai participants. The plurality of American participants (38.33%) spends 1–4 times per day, and 25.00% spends 5–8 times per day on Web sites. In contrast, the plurality of Thai participants (41.07%) navigates Web sites a few times per week, and 32.14% navigate less than once a week.

4.3. Hypothesis testing on user performance within and between cultural groups

Followings are the statistical analyses of user performance outcomes which include correct search time in

Table 5
Summary of significant differences on perceived usability

	Distraction	Appeal	Enjoyment	Interest	Readability
Between-subjects					
NT ^a	Yes	Yes	Yes	Yes	Yes
Within-subjects					
BG ^b	No	Yes	Yes	Yes	Yes
BG × NT	No	Yes	Yes	Yes	No
FT ^c	Yes	No	Yes	Yes	Yes
FT × NT	No	No	No	Yes	No
BG × FT	Yes	Yes	Yes	Yes	Yes
BG × FT × NT	Yes	No	No	No	No

“Yes” indicates a significant difference whereas “No” indicates no significant difference.

^aNationality.

^bBanner background color.

^cBanner font color.

Table 6
Percentages of color preferences of the American group

Color	1st	2nd	3rd	4th	5th	6th
Red	11.67	31.67	20.00	21.67	6.67	8.33
Blue	58.33	26.67	10.00	5.00	0.00	0.00
Orange	3.33	3.33	10.00	30.00	35.00	18.33
Yellow	3.33	1.67	15.00	15.00	33.33	31.67
Violet	8.33	16.67	13.33	15.00	13.33	33.33
Green	15.00	20.00	31.67	13.33	11.67	8.33

Table 7
Percentages of color preferences of the Thai group

Color	1st	2nd	3rd	4th	5th	6th
Red	10.00	15.00	15.00	23.33	20.00	16.67
Blue	68.33	16.67	8.33	1.67	5.00	0.00
Orange	3.33	5.00	10.00	30.00	31.67	20.00
Yellow	1.67	28.33	23.33	18.33	15.00	13.33
Violet	8.33	15.00	18.33	18.33	15.00	25.00
Green	8.33	20.00	25.00	8.33	18.33	20.00

seconds, incorrect search time in seconds, and incorrect searches. Nine of the null hypotheses for testing within each cultural group and other nine of the null hypotheses for testing between the two cultural groups pertain to the effects of the treatment variables on performance. None of the null hypotheses can be rejected.

4.3.1. Correct search time

Nationality has an effect on a mean of total correct search time [$F(1,118) = 32.34, p < 0.001$]. No banner background color main effects, banner font color main effects, and interaction effects are revealed within cultural groups and between cultural groups. As shown in Fig. 3, American participants experience lower search time than do Thai participants in every treatment condition. On a page with green banners with white text, the American group has the

Table 8
Percentages of internet experience

Internet experience	American	Thai	Total
Less than 6 months	0.00	25.86	12.71
6 months to 1 year	5.00	17.24	11.02
1–2 years	11.67	25.86	18.64
2–3 years	21.67	25.86	23.73
More than 3 years	61.67	5.17	33.90

Table 9
Percentages of Web navigation frequency

Web navigation frequency	American	Thai	Total
Less than once a week	3.33	32.14	17.24
Once a week	1.67	21.43	11.21
A few times a week	20.00	41.07	30.17
1–4 times/day	38.33	5.36	22.41
5–8 times/day	25.00	0.00	12.93
More than 8 times/day	11.67	0.00	6.03

fastest mean of search time (Mean = 75.37, s.d. = 23.08). On the contrary, the fastest mean of search time of the Thai group (Mean = 95.37, s.d. = 29.59) is found at the condition of orange banners with white text. Moreover, on a page with violet banners with white text, the American group has the slowest mean of search time (Mean = 90.97, s.d. = 39.91). In contrast, the slowest mean of search time of the Thai group (Mean = 104.42, s.d. = 36.19) is found at the condition of blue banners with white text.

4.3.2. Incorrect search time

The processing time when participants search for target words but end up clicking on non-target words is recorded as incorrect search time. In other words, it is the time between when a participant clicks a correct word until when he or she clicks an incorrect word.

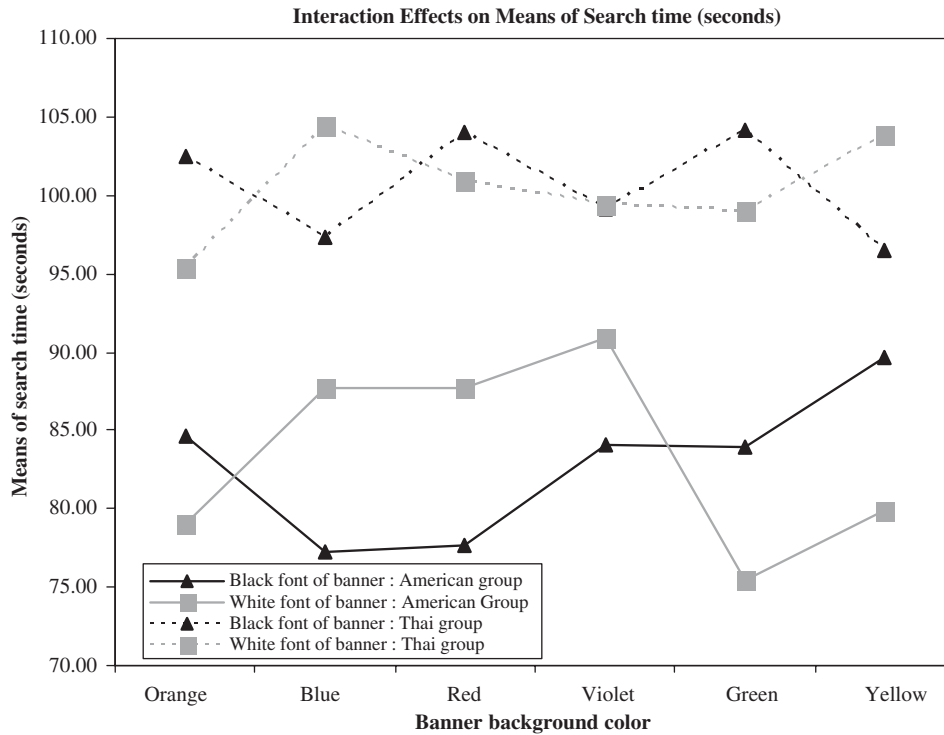


Fig. 3. Means of correct search time.

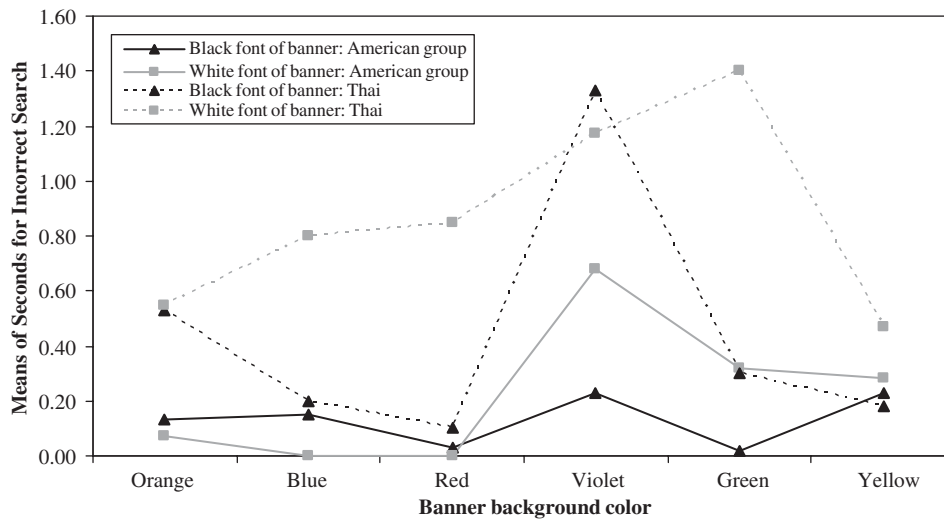


Fig. 4. Means of incorrect search time.

A significant difference exists between the Thai and American groups on their total incorrect search time [$F(1,118) = 5.38, p < 0.05$]. No banner background color main effects, banner font color main effects, and interaction effects are found within cultural groups and between cultural groups. As shown in Fig. 4, American participants experience lower incorrect search time than do Thai participants in several treatment conditions, except on a page with yellow banners with black text. The highest mean of incorrect search time is found at the Thai group under the condition of white text on green banners (Mean = 1.40, S.D. = 10.45).

4.3.3. Incorrect searches

As discussed earlier, when searching for target words, the participants sometimes unintentionally click on non-target words. The numbers of such words are recorded as incorrect searches. Each subject group has very low incorrect searches. The analysis shows only a significant difference between the Thai and American groups on the total number of incorrect searches [$F(1,118) = 8.60, p < 0.05$], regardless of banner background colors and banner font colors.

Fig. 5 presents average incorrect searches. All are less than one. American participants make lower incorrect

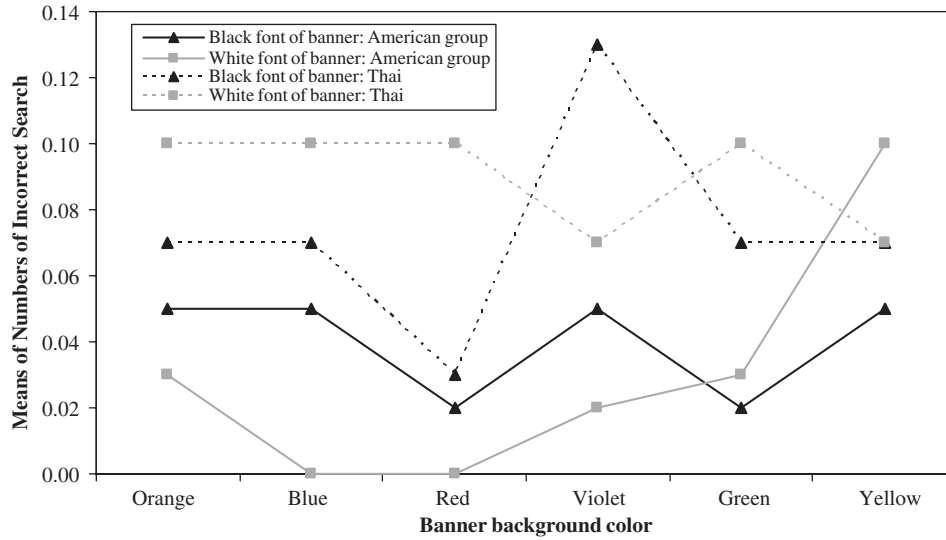


Fig. 5. Means of incorrect searches.

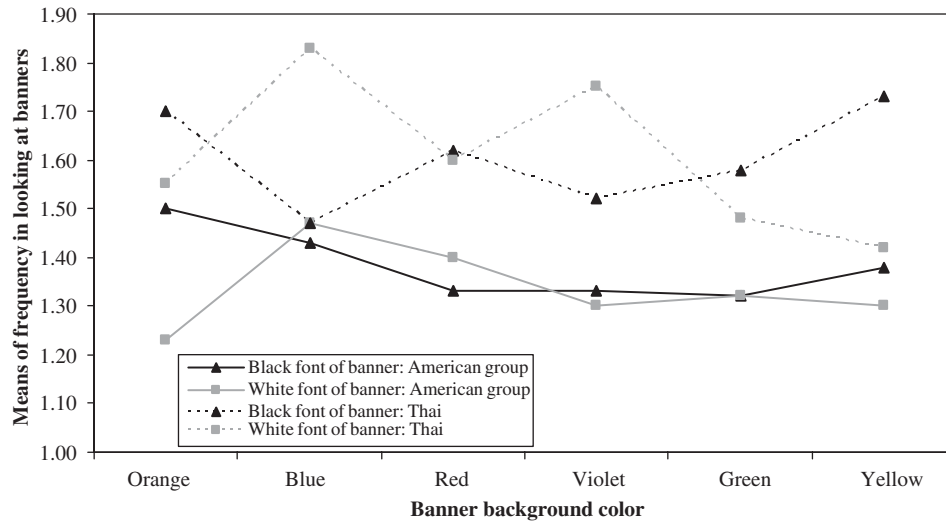


Fig. 6. Means of frequency in looking at banners.

searches than do Thai participants in several treatment conditions, except on a page with yellow banners with white text. In the American group, no incorrect search is found at the banner conditions of white text on blue background and white text on red background. The highest average incorrect searches is found in the Thai group at the condition of violet banner with black text (Mean = 0.13, s.d. = 0.57).

4.4. Hypothesis testing on user retention within and between cultural groups

The user retention measure consists of four dependent variables; frequency in looking at banners, banner background color retention, banner font color retention, and banner word retention. Followings are the analyses of such measures. Six hypotheses belong to the measure of frequency in looking at banners. The empirical analysis

permits rejection of only one hypothesis. Thirty-six hypotheses belong to the other measures of user retention. Twelve hypotheses can be rejected.

4.4.1. Frequency in looking at banners

The analysis confirms that regardless of nationality, combinations of banner background color and banner font color differently affect frequency in looking at banners while users search for target words [$F(5,590) = 3.29, p < 0.01$]. Even though the analysis yields no evidence of cultural differences in this frequency, Thai participants report higher frequencies in several banner conditions than do American participants, as shown in Fig. 6.

In each color condition, participants report either looking at the banners one time (score = 1) or 2–4 times (score = 2). This subjective finding supports search performance outcomes that when users perform a search task on Web pages containing animated banner graphics, users

Table 10
Percentages of retention answers of the American group

		Background color retention			Font color retention			Word retention		
		R ^a	W ^b	U ^c	R	W	U	R	W	U
Black	Orange	75.00	20.00	5.00	88.33	3.33	8.33	36.67	6.67	56.67
	Blue	98.33	0.00	1.67	90.00	3.33	6.67	28.33	6.67	65.00
	Red	90.00	6.67	3.33	88.33	1.67	10.00	35.00	10.00	55.00
	Violet	96.67	1.67	1.67	86.67	3.33	10.00	31.67	13.33	55.00
	Green	96.67	0.00	3.33	83.33	11.67	5.00	36.67	6.67	56.67
	Yellow	90.00	1.67	8.33	76.67	6.67	16.67	23.33	13.33	63.33
White	Orange	75.00	18.33	6.67	85.00	3.33	11.67	31.67	5.00	63.33
	Blue	95.00	3.33	1.67	76.67	13.33	10.00	38.33	13.33	48.33
	Red	96.67	3.33	0.00	75.00	18.33	6.67	38.33	10.00	51.67
	Violet	90.00	5.00	5.00	68.33	13.33	18.33	33.33	8.33	58.33
	Green	98.33	0.00	1.67	78.33	10.00	11.67	35.00	8.33	56.67
	Yellow	93.33	3.33	3.33	90.00	1.67	8.33	25.00	8.33	66.67

^aRight.
^bWrong.
^cUnaware.

simply ignore such banners to focus their attention on the search task.

Additionally, this study also shows that banners with the same background colors but the different text colors dissimilarly affect the self-report of frequency in looking at such banners. The detailed findings indicate that banners with white text on blue background have a significantly higher rate of the respective frequency than do the ones with black text on blue background. The yellow banners with black text also have a significantly higher rate of the frequency than the ones with white text.

Moreover, among banners with the same text colors, different banner background colors also show dissimilar effects on the self-report of frequency in looking at such banners. However, the detailed findings only indicate the significant differences among the banners with white text. When comparing the white-text banner background colors, blue is reported as the most distracting color; whereas the least distracting color is yellow. The higher degree of readability which is caused by higher color contrast, the higher the degree of distraction tends to be.

4.4.2. Banner background color retention, banner font color retention, and banner word retention

Other than measuring frequency in looking at banners, the participants are asked to guess banner font colors, banner background colors, and banner words. An answer can be right, wrong, or unaware. This study shows a number of statistically significant differences between the American and Thai groups on means of total numbers of retention answers. The significances are right answers in guessing banner background color [$F(1,22) = 4.94, p < .05$], unaware answers in guessing banner background color [$F(1,22) = 21.26, p < .001$], right answers in guessing banner font color [$F(1,22) = 19.94, p < .001$], unaware answers in guessing banner font color [$F(1,22) = 43.14, p < .001$], and

wrong answers in guessing banner word [$F(1,22) = 13.28, p < .001$]. In general, American participants tend to retain banner colors better than do Thai participants.

Additionally, each answer type regardless of nationality is accumulated to find its mean difference among treatment conditions. The study shows these following significant differences: the main effect of banner background color on the mean of right answers in guessing banner background color [$F(5,12) = 5.38, p < .01$], the main effect of banner background color on the mean of wrong answers in guessing banner background color [$F(5,12) = 20.58, p < .001$], the main effect of banner background color [$F(5,12) = 4.53, p < .01$], the main effect of banner font color [$F(1,12) = 16.29, p < .01$], and the interaction effect on the means of wrong answers in guessing banner font color [$F(5,12) = 6.57, p < .01$], the main effect of banner background color unaware answers in guessing banner words [$F(5,12) = 3.29, p < .05$], and the interaction effect on unaware answers in guessing banner word [$F(5,12) = 4.63, p < .01$].

Further analysis of each treatment condition yields no evidence of cultural differences in banner background color retention. However, as shown in Tables 10 and 11, the number of correct answers is higher in the American group than in the Thai group in every banner color condition. Regardless of banner color combinations, the average number of correct answers in guessing a banner background color is significantly higher in the American group than in the Thai group. The more the participants pay attention to the search task, the less they retain banner elements. In addition, the Thai group has more unaware answers of background color retention than does the American group. Nevertheless, the percentages in both groups are quite low.

Guessing banner font colors seems more difficult than guessing banner background colors. Even though there are

Table 11
Percentages of retention answers of the Thai group

		Background color retention			Font color retention			Word retention		
		R ^a	W ^b	U ^c	R	W	U	R	W	U
Black	Orange	70.00	23.33	6.67	76.67	6.67	16.67	35.00	11.67	53.33
	Blue	91.67	1.67	6.67	80.00	3.33	16.67	35.00	1.67	63.33
	Red	86.67	5.00	8.33	73.33	6.67	20.00	40.00	6.67	53.33
	Violet	70.00	13.33	16.67	65.00	6.67	28.33	45.00	1.67	53.33
	Green	86.67	5.00	8.33	63.33	8.33	28.33	40.00	6.67	53.33
	Yellow	86.67	3.33	10.00	71.67	8.33	20.00	40.00	8.33	51.67
White	Orange	61.67	28.33	10.00	68.33	3.33	28.33	33.33	3.33	63.33
	Blue	93.33	3.33	3.33	65.00	15.00	20.00	40.00	5.00	55.00
	Red	86.67	3.33	10.00	61.67	10.00	28.33	36.67	3.33	60.00
	Violet	83.33	8.33	8.33	50.00	15.00	35.00	43.33	3.33	53.33
	Green	86.67	1.67	11.67	60.00	15.00	25.00	45.00	1.67	53.33
	Yellow	91.67	1.67	6.67	78.33	3.33	18.33	20.00	3.33	76.67

^aRight.

^bWrong.

^cUnaware.

only two colors of banner text in this study, right answers in guessing banner font colors are lower but unaware answers are higher than those answers in guessing banner background colors. The results show no cultural differences in correctly guessing font colors. However, the average of the total number of right answers is significantly higher in the American group than in the Thai group. Moreover, regardless of nationality, the analysis yields no significant effects on banner font color retention.

In terms of banner word retention, in each color condition, both cultural groups have less than 50% of right answers in guessing banner words. The percentage is evidently less than the percentages of right answers of other retention measures. The analysis reveals that over 50% of participants in both groups are unaware of banner words while searching for target words. Based on the observation, the participants report that they can recall only one or two words in each page and sometimes they cannot recall any words at all. As a consequence, they choose the unaware answer choice rather than diffidently guess the banner words. Similar to other retention measures, the study shows no cultural differences in banner word retention. Also, the average answers of this retention measure in both cultural groups are not significantly different. Additionally, the analyses show the interaction effect of banner font colors and banner background colors on unawareness toward banner words.

As shown in Table 10, by analysing all information together, in the American group, for the black-text banner category, on pages with blue banners with black text, the highest percentage of the participants who can correctly guess banner background color (98.33%) and the highest percentage of the participants who can correctly guess banner font color (90.00%) are revealed. However, this treatment condition is also the one in which the highest percentage of the participants who are unaware of banner

words (65.00%) is found. For the white-text banner category, on pages with green banners with white text, the highest percentage of the participants who can correctly guess banner background color (98.33%) is disclosed. The highest percentage of participants who can correctly guess banner font color (90.00%) is found on pages with yellow banners with white text. This treatment condition is also the one that the highest percentage of participants who are unaware of banner words (66.67%) is revealed.

As shown in Table 11, in the Thai group, for the black-text banner category, on pages with blue banners with black text, the highest percentage of the participants who can correctly guess banner background color (91.67%), the highest percentage of the participants who can correctly guess banner font color (80.00%), and the highest percentage of the participants who are unaware of banner words (63.33%) are revealed. For the white-text banner category, on pages with blue banners with white text, the highest percentage of the participants who can correctly guess banner background color (93.33%) is disclosed. The highest percentage of participants who can correctly guess banner font color (78.33%) is found on pages with yellow banners with white text. This treatment condition is also the one that the highest percentage of participants who are unaware of banner words (76.67%) is revealed.

4.5. Hypothesis testing on perceived usability within and between cultural groups

After finishing each search task, the participants rate the usability of banner color usage in the corresponding experimental Web page in terms of attention drawing, Web visual appeal enhancement, task enjoyment enhancement, task interest enhancement, and banner graphic readability. Fifteen of the null hypotheses for testing within each cultural group and other nine of the null

hypotheses for testing between the two cultural groups pertain to the effects of the treatment variables on self-reports. The analysis permits the rejection of 13 of the 15 null hypotheses for each cultural group and five of the 15 null hypotheses between the two cultural groups.

This study indicates that regardless of the diversity of banner color combinations, nationality has an effect on the means of the color usage self-report on attention distraction [$F(1,118) = 25.96, p < 0.001$], of the self-report on Web visual appeal enhancement [$F(1,118) = 47.80, p < 0.001$], of the self-report of task enjoyment enhancement [$F(1,118) = 39.82, p < 0.001$], of the self-report of task interest enhancement [$F(1,118) = 57.16, p < 0.001$], and of the self-report on banner readability [$F(1,118) = 11.79, p < 0.01$].

Thai participants rate each self-report of each color combination higher than do American participants. In general, the American group rates the self-reports as “neither agree nor disagree” (score = 4) or “slightly agree” (score = 5), whereas the Thai group rates the self-reports as “slightly agree” (score = 5) or “quite agree” (score = 6). The comparison of all self-reports of all banner color combinations between the two cultural groups are presented in Tables 12 and 13.

Analysing the self-report on attention drawing, the study reveals three significant differences: the banner font color main effect [$F(1,118) = 4.14, p < .05$], the two-way interaction effect between banner background color and banner font color [$F(5,590) = 3.52, p < .01$], and the three-way interaction effect of nationality, banner background color, and banner font color [$F(5,590) = 3.04, p < .01$]. Since the between-subjects main effect and the three-way interaction effects are found, Tukey’s HSD post-hoc analyses are performed. The post-hoc analyses for the interaction between the cultural groups reveal that the means of self-report of attention drawing in the American group are significantly lower than in the Thai group in every color condition, except in the condition of yellow banners with white text.

Table 12
Means of perceived usability of the American group

		Distraction	Appeal	Enjoyment	Interest	Readability
Black	Orange	4.55	4.38	4.13	4.35	4.40
	Blue	4.50	4.87	4.50	4.50	4.15
	Red	4.43	4.53	4.28	4.37	4.42
	Violet	4.32	4.40	4.17	4.25	4.25
	Green	4.48	4.45	4.20	4.33	4.10
	Yellow	4.42	4.00	3.98	3.98	4.10
White	Orange	4.23	3.97	4.05	4.02	3.70
	Blue	4.38	5.18	4.80	4.90	4.53
	Red	4.43	4.63	4.28	4.42	4.32
	Violet	4.25	4.58	4.25	4.37	4.10
	Green	4.42	4.67	4.37	4.45	3.95
	Yellow	4.28	3.52	3.47	3.48	2.73

Table 13
Means of perceived usability of the Thai group

		Distraction	Appeal	Enjoyment	Interest	Readability
Black	Orange	5.27	5.73	5.60	5.85	4.83
	Blue	5.37	5.67	5.47	5.77	4.87
	Red	5.62	5.80	5.53	5.82	4.85
	Violet	5.40	5.78	5.72	5.90	4.95
	Green	5.13	5.60	5.47	5.58	4.80
	Yellow	5.60	5.93	5.83	5.88	5.13
White	Orange	5.03	5.32	5.35	5.45	4.43
	Blue	5.77	6.05	5.73	5.95	5.07
	Red	5.35	5.67	5.47	5.83	4.70
	Violet	5.55	5.75	5.55	5.70	4.75
	Green	5.33	5.55	5.52	5.68	4.68
	Yellow	4.55	5.18	4.98	4.97	3.78

In terms of the self-report of Web visual appeal enhancement, the study reveals three significant differences: the banner background color main effect [$F(5,590) = 14.94, p < .001$], the two-way interaction effect between banner background color and nationality [$F(5,590) = 5.63, p < .001$], and the two-way interaction effect between banner background color and banner font color [$F(5,590) = 9.82, p < .001$]. The Tukey’s HSD pairwise post-hoc analyses reveal that the Thai group significantly rates this self-report higher than does the American group in every background color condition. In addition, within the American group, the pairwise post-hoc Student’s *t* statistic tests reveal the significant differences in means of the self-report in all pairs of banner background color, except the pairs of orange and violet, red and violet, red and green, and violet and green. The pairwise post-hoc analyses also reveal that the significant differences in pairs of banner background color in the Thai group are fewer than in the American group. These differences are found only in the pairs of orange and blue, orange and violet, blue and green, and blue and yellow.

In terms of the self-report on task enjoyment enhancement, the study reveals four significant differences: the banner background color main effect [$F(5,590) = 8.98, p < .001$], the banner font color main effect [$F(1,118) = 4.19, p < .05$], the two-way interaction effect between banner background color and banner font color [$F(5,590) = 9.69, p < .001$], and the two-way interaction effect between banner background color and nationality [$F(5,590) = 4.11, p < .01$]. The Tukey’s HSD pairwise post-hoc analyses reveal that the Thai group significantly rates this self-report higher than does the American group in every background color condition. In addition, within the American group, the pairwise post-hoc Student’s *t* statistic tests reveal the significant differences in means of the self-report in all pairs of banner background color, except the pairs among these three colors: orange, red, violet. Within the Thai group, the pairwise post-hoc analyses reveal no significant differences.

In terms of the self-report on task interest enhancement, the study reveals five significant differences: the banner background color main effect [$F(5,590) = 14.38, p < .001$], the banner font color main effect [$F(1,118) = 6.32, p < .05$], the two-way interaction effect between banner background color and banner font color [$F(5,590) = 12.56, p < .05$], and the two two-way interaction effects between banner background color and nationality [$F(5,590) = 2.36, p < .05$], and between banner font color and nationality [$F(1,118) = 6.32, p < .05$]. The Tukey's HSD pairwise post-hoc analyses reveal that the Thai group significantly rates this self-report higher than does the American group in every background color condition. In addition, within the American group, the pairwise post-hoc analyses reveal the significant differences in means of the self-report in all pairs of banner background color, except the pairs among these three colors: orange, red, violet. Within the Thai group, the pairwise post-hoc analyses reveal five significantly different pairs. These are blue and green, blue and yellow, red and green, red and yellow, and violet and yellow.

Analysing the self-report on banner readability, the study reveals the banner background color main effect [$F(5,590) = 12.39, p < .001$], the banner font color main effect [$F(1,118) = 24.25, p < .001$], and the two-way interaction effect between banner background color and banner font color [$F(5,590) = 17.43, p < .001$]. Within the white font color treatment conditions, the pairwise post-hoc analyses reveal significant differences in means of the self-report in all pairs of banner background color, except the pairs of orange and green, red and violet, red and violet, and violet and green. When examining the simple main effects of banner background color across the two banner font colors, the pairwise post-hoc analyses yield the significant differences in means of the self-report in the comparisons between the black-text and white-text conditions of orange, blue and yellow.

In further details, even though all three-way interaction effects are not robust enough to yield statistically significant differences, they can provide more understanding of how people from different cultures perceive usability of banner color usage. For the black-text banner category, in the American group, the majority of the highest means are found on pages with blue banners. In contrast, in the Thai group, the majority of the highest means are revealed on pages with yellow banners. However, pages with yellow banners are where the lowest means of self-reports of the American group are mainly found. In contrast, most of the lowest means in the Thai group are found on pages with green banners. For the white-text banner category, in both cultural groups, all lowest means of self-reports are found on pages with yellow banners. Moreover, all of highest means of self-reports of the Thai group and the majority of highest means of self-reports of the American group are revealed on pages with blue banners.

Generally, regardless of nationality of the participants, banner color combinations perceived as distracted are also perceived as promoting banner readability, aesthetic

appeal, enjoyment, and interests. Additionally, blue is positively perceived in terms of banner usability measures by participants from both cultural groups. Moreover, blue is not likely to be perceived as a distracting banner color by American participants. However, the results of user performance and attention in the Thai group indicate that blue is perceived as a distracting banner color.

5. Discussions

5.1. Banner graphic color impacts on attention of the two cultural groups

On average, regardless of banner color conditions, Thai participants take more time for correct searches and incorrect searches and have higher numbers of incorrect searches than do American participants. Additionally, American participants tend to retain banner colors better but retain banner words no better than do Thai participants. The differences between the two cultural groups in the means of these total performance and retention measures as mentioned above may be the result of the differences in internet experiences, natures of languages, and cultural values.

First, internet experience may play a significant role in searching for words. The majority of Thai participants are novice internet users, while the majority of American participants are moderate to expert ones. As such, Thai users tend to be distracted more easily by the animated banners than do American participants. Second, although before beginning the experiment, both cultural groups are informed about the experimental procedures in similar fashions (e.g., "there is no right or wrong in doing this experiment"), the nature of Thai culture may create more anxiety in Thai participants. According to Hofstede (1980), America is a low power-distance country whereas Thailand is a high power-distance one. Thai society is hierarchical on seniority, status, authority and power (Moore, 1974; Klausner, 1984; Komin, 1991). This makes social differences between Thai students and teachers inevitable.

Based on the observation, the Thai students who participate in this study were anxious that they might perform the experiment incorrectly and harm the experimenter's study. Moreover, the students might feel uncomfortable when the experimenter observes of the subjects, and spend longer search time in scanning through each word on each line to prevent an incorrect search. Hofstede (1991) mentions that users in collectivistic cultures tend to believe that they cannot control the situation they face (e.g., computer operation) and tend to be fearful of doing things wrong.

Third, Thai language has a complex writing system (Apple Computer, 1992). For example, one Thai word can be composed from 44 characters, 32 vowels, 4 tone marks and 5 special symbols (Koanantakool et al., 1997). In this current study, the Thai words used in the experiment are five-letter words that are frequently used in daily life. To

control for the similarity of word formats used between Thai and American experimental settings, this study attempts to eliminate Thai words containing tonal marks located on the top of words or vowel marks located at the bottom of words as much as possible. However, among the five-letter words used in this study, it is completely impossible to eliminate all the words with tonal marks and vowel marks. As a consequence, it may be the formats of the Thai words themselves that make search performance in the Thai group lower than the American group's.

In terms of banner graphic color, considering the performance and retention analyses together, blue is suggested to be the most effective color for animated banner graphics compared with five other colors; red, yellow, violet, orange, and green. Blue tends to allow the users to retain the banner elements such as banner words, banner background colors, and banner font colors. However, it also tends to be the most distracting color when performing the word search task.

The study suggests that because blue is easily seen in the peripheral area of human eye [Marcus \(1992\)](#) and because blue is proven to be the universally favorite color ([Birren, 1950](#); [Chattopadhyay et al., 1999](#); [Pastoureau, 2001](#)), blue is empirically proven to be the most influential banner background color in this study. However, in terms of the graphic color contrasts, the results are not inclusive in themselves whether the blue banner with white text or the one with black text is likely to be the most suggested color combination among all experimental color pairing treatments.

Considering other color combinations, color contrast also seems to play an important role in retention on banner elements. As is evident, both cultural groups unsuccessfully retain the banner words on yellow banners with white text. Even though yellow is likely to be the second most favorite color for the Thai users, the retention cannot be succeeded. However, it is possible that color preferences change over time since the color preference outcome in this present study contradicts the study cited in [Hoft \(1995\)](#) which identified red as the favorite color in Thailand. This suggests that interface designers must periodically reinvestigate color preferences in to predict trends for future designs.

5.2. *Banner graphic color impacts on perceived usability of the two cultural groups*

The result of this study also leads to the conclusion that cultural differences exist in overall means of self-reports on banner color usage. Moreover, cultural differences on the self-report of attention drawing are also revealed in each banner color usage, except yellow banners with white text. Generally, Thai participants rate the self-reports significantly higher than do American participants. The American group rates the self-reports as “neither agree nor disagree” or “slightly agree,” whereas the Thai group rates the self-reports as “slightly agree” or “quite agree.”

Plausible explanations for these differences in perceived usability between the two cultural groups are as follows. First, internet experience may play a significant role in reflecting how people perceive degrees of usability. Thai participants who are mainly considered novice users on the internet rate all self-reports higher than American participants who are mainly moderate to expert users on the internet. American participants may use their past experiences on the internet as part of the reasons to rate the self-reports. Banner advertising may be negatively perceived as annoying as of ineffective practices of internet advertisers to draw consumers' attention to click on banners.

Second, due to different thinking styles, attitudes, feelings and behaviors of users influenced by their cultures, users from different cultures might possess different degrees of perceived usability on the same Web page elements. [Segall et al. \(1999\)](#) state that dissimilarities in visual perception among people from different cultures evidently exist because people perceive things in the way that they experienced and learned them. Hence, culture might shape how the participants evaluate self-reports.

Third, [Komin \(1991\)](#) also states that Thai culture places value on forms and superficial appearance. As such, preferred visual appearance for Web sites might be more colorful, bright, and vivid for Thai participants than for American participants, which cause them rate in high degrees of usability measures. Lastly, as of the collectivistic culture of Thailand, Thai participants may rate self-reports higher to pay respect to the experimenter who is older and posses higher social status than they, although they are informed about the experimental procedures in the same way as are American participants.. Thus, some of Thai participants on a random basis are asked whether they rate self-reports sincerely. They confirm that they show their sincerities in the ratings.

[Yeo \(2000\)](#) suggests about participant qualifications that, to improve the quality of usability evaluation in Malaysia, participants who are familiar with the experimenter and have higher social status may be recruited. Even though Thailand shares some cultural characteristics with Malaysia such as collectivism and high-power distance ([Hofstede, 1980](#)), Yeo's suggestions can only be applied with care to the Thai case. For example, in a worst case scenario, if Thai participants are acquainted with a Thai experimenter, they might simply violate experimental procedures, particularly if the experiment is complicated or time-consuming. This might happen because one of the most important values found in Thailand is “Ar-Lum-Ar-Luay” or being flexible by not taking anything seriously depending on situations and opportunities ([Komin, 1991](#)). As a consequence, a previous relationship between an experimenter and participants might lessen quality of research results. Thus, an experimenter must be well-disciplined and well-trained. Both parties must harmoniously agree and understand research importance. On the other hand, Thai society also values interpersonal relationships, thus, in the best case scenario, perhaps by having an

optimum degree of acquaintance, “*Nam Jai*” which means sincerity, kindness, and considerateness (Komin, 1991), between an experimenter and participants would help in obtaining valid research results.

6. Conclusions

The success of E-commerce businesses may depend on effectiveness in supporting cultural differences of users from different parts of the world. With the rapid growth of business competition on the internet, companies need effective advertising media to attract potential customers. In principle, this study attempts to inspect the cross-cultural differences in the usability of designing effective E-commerce Web sites. In particular, the study investigates the effects of animated banner graphic colors on attention and perceived usability of users from two cultural groups.

The results of this study support three general conclusions. First, users across cultures tend to ignore banners when they look for specific information on highly informative Web pages that include banner graphics. Second, in general, the study suggests influence of cultures on overall performance, overall retention, and overall self-reports on usability, regardless of differences in banner color combination. Third, cultural differences on the self-report of attention drawing are also revealed in each banner color usage, except yellow banners with white text.

Considering the results of attention and perceived usability of banner color together, the study recommends that blue may be the color of an animated banner graphic that is beneficial for all internet stakeholders: Web designers, Web advertisers, and internet users. Comparing all banner color combinations inspected in this study, a blue banner with white text is the best color combination because it gains user attention while users positively perceive its usability. On the contrary, less favorite colors and low-contrast favorite colors may not be the most effective color choices for animated banner graphics for any internet stakeholders. For Thai users and American users, violet may be the most ineffective choices of banner graphic colors. Yellow may also be ineffective for American users but not for Thai users. However, if yellow is used in low-contrast, it also may be considered as an ineffective color choice.

Moreover, since banner colors are also proven to have positive impacts on perceived usability and negative impacts on attention drawing for internet users, reducing the impact of the movement feature of banners is recommended. For instance, banner advertising may be designed to be static while using influential banner messages. Designing banners that have one quick loop of banner movement to gain attention when a Web page is first visited might also reduce rate at which the banner is ignored. Moreover, the study recommends that Web designers should be concerned about the purposes of Web sites in considering using animated graphics. For instance, using animated graphics on commercial Web sites

might be more appropriate than using them on informative Web sites.

The results of this study provide a foundation of future studies into other cultural groups. Additionally, because of the time and resource limitations, the current study loosely controls internet experience of the participants. Given more strict control in the experimental settings, it would be important to investigate the relationship between internet experience of users across cultures and user attention on the effects of banner graphic colors.

More experimental studies on settings which are closer to real-world environments might be explored, such as prototyping a whole Web site with emphasis on investigating online advertising as experimental stimuli. Additional studies might also emphasize task variety (e.g., aimless Web navigation) as a variable in order to investigate the effects of banner graphic colors on performance and preferences of users across cultures. Further investigations on other variations of banner text and background combinations that were not examined in this present study are useful to provide more of an understanding of color effects.

In addition, other banner graphic features and presentation styles in concert with cultural differences in interface elements such as locations of graphics and reading directions might be worthwhile to studies on cross-cultural interface development. Moreover, detailed research by using eye-tracking devices is certainly beneficial to understand how users interact with interface elements. Other techniques for online advertising which promises to promote effectiveness of advertising while minimizing the usability problems of online banners should be empirically investigated. Furthermore, by receiving a number of lessons learned from conducting an experiment across cultures, in-depth investigations on usability evaluation across cultures are particularly fruitful.

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