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EXPLORING AESTHETIC IMPRESSION OF WEB PAGES FROM ASPECTS OF VISUAL ORDER AND COMPLEXITY

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Abstract
Recent advances of the broadband Internet and multimedia environment let web users demand from web pages not only cognitive usability but also related feelings. Drawing on existing theories of cognitive psychology and human–computer interaction, a research model has been developed to explain the relationship between the visual factors and aesthetic impression of a web page according to users' emotional responses. In order to further understand users' feeling and preference, an investigation of web-based learning system were explored. The investigation has three phases: 1) 15 adjective pairs were classified into two major visual factors; order and complexity, through semantic difference survey and factor analysis. 2) Multi-dimensional scaling analysis was then used to define a perceptual map of four groups. 3) Finally, four groups were classified into: professional image type, graphics mainly type, main subject type, and informative mainly type, depending on each group's characteristics. The results of the study revealed how visual complexity and order influence users' initial emotional responses.

Keywords : Web-Based Learning System, Visual Complexity and Visual Order, Aesthetic Impression

Introduction

In recent years, more and more people are learning skill and obtaining information through learning websites or forum of share information on the Internet. However, web users are starting to demand from web pages are not only cognitive usability but also related feelings. The quality of studying environment has been overload by excessive information and chaotic visual design of web pages. As users are presented with many choices of different websites on the Internet, they can switch from one website to another effortlessly. Bucy (2000) argues that emotional responses may determine which interfaces people choose to use as they seek pleasure or enjoyment.

The affective aspects of user interface design have received increasing attention (Dillon, 2001; Norman, 2002). A human being's affective system is judgmental, assigning person's positive or negative dimension to the environment (Norman, 2002). Therefore, affect is closely linked to feeling, cognitions, and motivations. This new perspective emphasizes the user's subjective experience with the web page interface.

Visual Complexity and Visual Order

Thompson and Robitaille (1992) argued aesthetics fidelity is one of important factor to evoke user pleasure and preference. It was explained the degree of target impression the users feel as intended by designers who developed the web pages. When the aesthetic fidelity of a certain web page is higher, users feel aesthetic responses similar to those intended by the designers who developed the web page. Moreover, a few studies attested to the significant effects of visual complexity and order on web design and web qualities (Deng and Poole, 2010).

The visual complexity and visual order have been researched in the studies of visual preference for natural (Arnheim, 1966; Ngo and Byrne, 2001; Lavie, 2004). For example, in HCI research, Lavie and Tractinsky's (2004) study revealed that user' perceptions of website aesthetics consisted of two main dimensions: classic aesthetics and expressive aesthetics, which correspond to the properties of order and complexity. While web page visual complexity and order are not clearly defined in Information system research, the concepts of environmental complexity and order (Arnheim, 1966) can be extend to the website context. Therefore, adopting Deng and Poole (2010) definition of visual complexity: visual diversity, as measured by different types of elements (e.g., text, graphics, links) present in the web page; and visual richness, which refers to the detail of information present in a web page as measured by the amount of text, number of graphics, and links. Moreover, this definition suggests that visual order is related to the logical organization, clarity, and coherence of web page content and layout. Logical organization of a web page is associated with user's intuitiveness and understandability.

Recently research has been conducted on applying aesthetics to interface designs. It was also found that visual complexity and visual order were closely related to emotional responses and usability (Tsai and Chang, 2008). However, not enough empirical or theoretical studies have been performed in the area of visual complexity and visual order to web design and computer systems, not to mention web-based learning systems.

Measure of emotion

The emotion space can be constructed in terms of the major aesthetic dimensions, which can be measured by the semantic differential method (SD) (Osgood, 1957). The SD method has been used successfully as the basis for applying Kansei (Sensational) engineering, Kansei being a set of methods used for designing the aesthetic aspects of physical products, such as, automobiles , office chair design (Jindo etc, 1995; Lee and Nagamach, 1996) Using SD methods, each aesthetic dimension is defined by a set of pairs of polar adjectives, such as 'Beautiful–ugly, warm-cold' and is assumed to represent a straight-line function that passes through the origin of the emotion space (Tsai and Chang, 2008; Chuanga and Ma, 2001).

Recently, the multidimensional scaling method (MDS), a method to recovering the perceptual space of stimuli from the subjects' judgments of similarity among stimuli, has been applied to investigate users' perception and preference of product types (Green and Carmone, 1989). For example, Schenkman and Jönsson (2000) have implemented MDS to study the category scale of perception and preference on web pages of telecommunication and electronics companies. Hence, MDS makes researchers possible to understand underlying psychological structures of stimuli, and not only surface behavior, which is visible to an observer.

The aesthetic dimensions of web pages depend upon many interrelated factors. In order to identify major factors for the aesthetic of web pages, we need to investigate semantics of aesthetic dimensions (feelings) and web users, as well as each group's characteristics of visual design elements (objects). Therefore, the goal of this study is to identify the major factors of user's perception and preference on web-based learning systems in the first impression, and to investigate the relationship with aesthetic impression and visual complexity vs. visual order.

Method

In order to achieve our goal, we conducted three consecutive studies: An exploratory survey of semantic differences with web pages (stimuli), a study of emotional semantics (adjectives), and an experimental survey with stimuli and adjective pairs.

Survey on Stimuli

Investigate users' perception and preference which affect how to select the web pages of web-based learning system. 105 undergraduate students (50 males and 55 females) were asked to write down approximately 10 web-based learning systems for image editing software to which are they visited or used frequently. The participants were also encouraged to explain the reasons for their selections. All of the subjects were aged from 18 to 25, which corresponded to the main age groups that participated in web-based learning systems.

Then, according to summary of amounts of web-based learning systems, nine web-based learning systems were selected for the following studies. In this survey, stimuli subject was limited in image editing software, such as Adobe Photoshop, and capture main web pages (not including welcome page) for stimuli. Note that this experiment focuses on the first impressions and let user absorbed in layout of static visual stimuli on a web page, hence acoustic and animated stimuli are ignored. Therefore, the nine most visited frequently websites were decided from 44 primary websites summarized. All stimuli were web layout captured on 24th March and surveyed during 5th to 25th May 2010.

Survey on Semantic Adjectives

In second survey, those 105 students were asked to write down 10 emotional adjectives which define a good web-based learning system, such as beautiful, comfortable etc. Moreover, in order to have high reliability and natural response, some adjectives were adapted to Mehrabian and Russell's (1974) measures of pleasantness and arousal in this survey. Summing up all of the adjectives collected from students, the total number was 110 adjectives in preliminary phase. Then, five professional web designers were asked to screen for suitable 15 adjectives pairs for expressing the measurement of web-based learning systems.

15 opposite adjective pairs are as followed: exciting-unexciting, interesting-boring, creative-traditional, attractive-unattractive, satisfied-unsatisfied, refined-rough, various- uniform, varied- monotonous, aroused- un aroused, professional-amateur, clear-confused, easy to understand- not easy to understand, organized -chaotic, simple-complex, and regular-irregular. All variables have high reliability coefficients and Cronbach α was 0.87, which is larger than 0.7 within goodness of fit, derived from a reliability analysis.

Experimental Procedure

122 participants consisted of 69 female and 53 male undergraduate students (different from the previous two surveys). The participants' ages ranged from 18 to 25, with an average age of 21.3. All Participants were required to be familiar with basic computer functions and never used experimental stimuli before this experiment. They participated voluntarily in the study.

In order to clearly investigate user's perceptions, we develop a system for online survey. The nine web pages were used as stimuli in the survey. On each survey page, one of the nine web pages that were developed in this experiment was shown at the left side, and the 15 aesthetic adjectives in Figure 1 were shown at the right, with seven-point Likert scales. Therefore, all participants were asked to look at one of the nine web pages on computer screens. Users could view the web page and at the same time indicate how much they felt responses described by each of the 15 opposite adjective pairs. The system does not allow the users to go back to the previous pages and change their initial opinions. Each stimulus was randomly assigned to view only a single web page. Participants were asked to view each web page for same amount of time (30 seconds). Those stimuli were told not to click on the links on the web page.

Figure 1. Semantic Differential Method Was Surveyed on Each Web Page.

Analysis Method

Factor Analysis of the collected data was performed to separate several main factors for adjective pairs. In addition, MDS was conducted to convert the resulting similar data into a perceptual space representation (perceptual map) to further describe each group's features. The MDS procedure used in this study was SPSS ALSCAL. Perceptual map gives us a direct and obvious view about the relative position and intimate degree (the closer in distance, the more intimate in relationship) but it is not accurate enough to get the classification detail of web-based learning systems. We need cluster result to do classification and explanation. Therefore, five expert designers were invited to identify the number of links, number of graphics, and the amount of text as web page visual characteristics for further analysis.

Results and Discussion

Various analyses were conducted in the data collected from the above surveys to derive results for each survey in this study. These results will be described and discussed in the following sections, respectively.

Main Visual Factors

The data collecting from the SD survey were processed by factor analysis. The result, as shown in Table 1, reveals that the 15 opposite adjective pairs were used to configure the impression under web-based learning systems. They can be classified into two main factors with 60.386 of variance explained. A principal component analysis was used on classification. The analysis result showed two main factors with eigenvalues larger than 1.0, with explained variances being 43.74% and 16.65%, respectively. KMO is 0.916 within high acceptable limits. The factor loadings of the two factors for the variables are plotted against each other.

Table 1 The Factor Loading of 15 Adjective Pairs Were Cluster to Complexity And Order Factors.

tors	ective Pairs	Factor	Loading Value
nplexity	ting-unexciting	0.83	0.18
	resting-boring	0.81	0.08
	tive-traditional	0.78	-0.14
	active-unattractive	0.78	0.22
	sfied-unsatisfied	0.77	0.18
	ned-rough	0.77	0.04
	ous- uniform	0.75	-0.05
	ed- monotonous	0.74	-0.22
	used- un aroused	0.69	0.16
	essional-amateur	0.61	0.39
er	ar-confused	0.16	0.82
	y to understand- not easy to understand	0.08	0.79
	anized -chaotic	0.16	0.77
	ple-complex	-0.34	0.67
	ular-irregular	0.08	0.64
	envalue	10.65	4.05
	centage	43.74	16.65
	mulative Percentage	43.74	60.39

The first cluster, which accounts for 43.74% of the variance, includes the adjective pairs: exciting - unexciting, interesting - boring, creative - traditional, attractive - unattractive, satisfied - unsatisfied, refined - rough, various - uniform, varied - monotonous, aroused - un aroused, and professional - amateur. This factor may be concluded as the factor of visual complexity and richness. The second cluster, which accounts for 16.65% of the variance and includes the adjective pairs: clear - confused, easy to understand - not easy to understand, organized - chaotic, simple - complex, and regular - irregular, may be interpreted as the factor of order and logical organization. See the Figure 2.

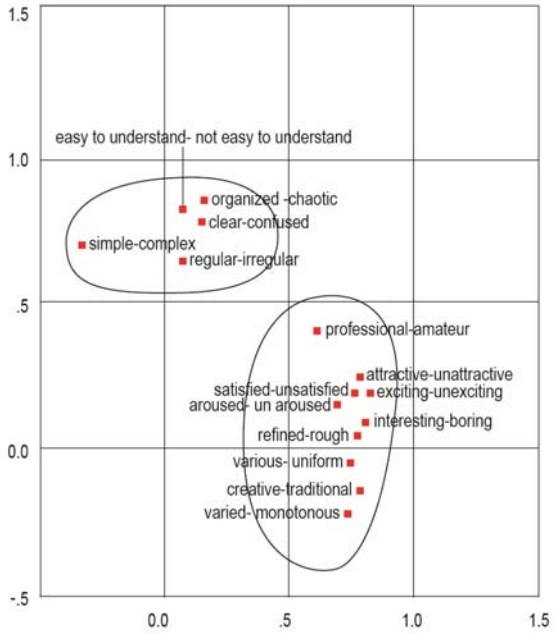

Figure 2. The Locations of 15 Adjective Pairs in The Space Derived From Factor Analysis.

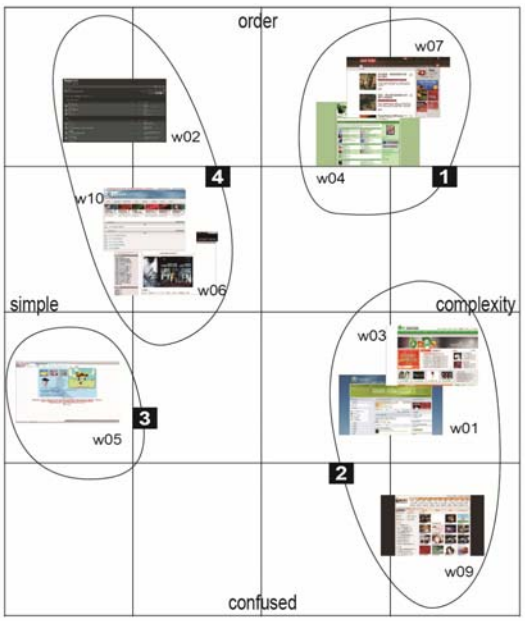

Figure 3. The main four groups were clustered in perceptual map.

3.2. Multidimensional Scaling

The result of MDS, RSQ and Stress were indexed to access the reliability and validity of the result map. To RSQ, the larger, the better with acceptance beyond 0.60; while to Stress, the smaller, the better with acceptance within 0.10. The results indicate two-dimensional solutions with RSQ value and the corresponding Stress measure being 0.977 and 0.065. It resulted in a fairly acceptable perceptual space of two dimensions through an appropriate rotation, as shown in Figure. 3. From this perceptual map, we find that the web page visual layout located on the upper side are more order/logical organization than those on the lower side; while the web page visual layout located on the right side are complex/richness than those on the left side.

This observation is further verified with the high correlation between X coordinate of perceptual map and corresponding complexity vs. simple scores; and between Y coordinate of perceptual map and corresponding order vs. confused scores in the previous SD survey.

According to the perceptual map (Figure 3), it classified the nine websites into four types. The first type consists of two web pages: w7 and w4. The second type includes three web pages: w1, w3, and w9. The third type is made up of only one web page: w5. The last type consists of three web pages: w2, w6, and w10. Moreover, five expert designers were invited to define each web page of fundamental characteristics and refer to statistical data (Table 2), until they unanimously reached the following for labeling four groups:

1) Professional images type: the main features consist of richness elements included: text, graphics, neuter-color tone, logical layout and appropriate spaces in web page.
2) Graphics mainly type: Multiple graphics, vivid color but minimum text. The layout arranged predominantly symmetrically and horizontally.
3) Main subject type: Main a large graphic positioned in the center of web page; mostly with less text.
4) Informative mainly type: Multiple text blocks and sections provide abundant information; but less graphics and mono-color tone.

The dimension of complexity means the degree of a web page containing graphics, text and links. For example, w3 and w9 web pages belong to high complexity. And the dimension of order means the degree of clear and easy to read the web page. For example, w7, w4 and w2 web page layouts belong to high order.

Table 2 Every Item's Statistical Data Were Showed in Nine Web Pages

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* PI: professional image type, GM: graphics mainly type, MS: main subject type, IM: informative mainly type.
Note: links, text, and pictures mean total amount in each web page.

Discussion

The aim of this study is to investigate what factors impact learner's aesthetic impressions when they visit a web-based learning system in the first expression. The results indicate aesthetic impression was closely related with web page visual complexity and visual order design features, due to the effects on the visual appeal of web page and users' initial emotional responses toward the web pages.

In the past, contrast to the ample amount of research focusing on the cognitive usability of interfaces/web page design (Cockton, 2002), only a few studies have focused on the aesthetic aspects of interfaces. Park et al. (Park, 2004) think aesthetic impressions are not necessarily uni-directional. Secondary emotions can be regarded as major types of aesthetic impressions tendency. Thus, for younger users, aesthetic impressions were include feeling qualities or secondary perception such as 'lovely,' 'hope,' 'cool,' or positive feeling which are not entirely related to only the dimension of beauty.

One interesting finding of aesthetic impressions is related to visual factors in determining the web users' emotional responses. In addition, the visual complexity and visual order to web users' pleasantness was largely dependent on the web users' initial impression. This finding is close related with Deng and Pool (2010), their results revealed how web page visual complexity interacted with order to influence the user's feeling of pleasantness. Arnheim (1966) has argued that order and complexity cannot exist without each other: Order is needed for individuals to deal with high complexity as "complexity without order produces confusion", and some degree of complexity is necessary to bring interest to high order "as order without complexity causes boredom".

Therefore, the result conclude that the impression of stimulus differentiation is based on users' perception on two factors: the degree of visual complexity and the degree of visual order. This finding supported the hypothesis of the preliminary study, which identified the relationship between visual factors effect emotional response. Visual complexity and visual order are one of important factors influence users' initial emotional responses and aesthetic impressions toward a new website.

Due to the limitation of resources, the impression investigated in this study were not of all kinds websites, instead, we focus on free web-based learning systems (no fees for join) from student favorites. This may have somewhat influenced the web page factor evaluations. The interactions among some usability and web page contents may generate special influences on user's perception and preference, however due to those complexity problems, they were not considered in this study.

Conclusion

Drawn from the above discussion, several findings from this study can be summarized as the following.

1. The effective semantic factors of aesthetic impression are clustered into two visual factors: visual complexity and visual order.
2. Individuals' perceptions in the differentiation of the layout types of web-based learning systems can be expressed as a perceptual map constituted by two dimensions of complexity vs. simple, and order vs. confused perceived.
3. Visual complexity and order factors should coexist on web-based learning systems, because opportune combination within visual complexity and visual order easily enhance professional or trusting feeling. Moreover, similar feelings are also depend on positive dimension, such as higher scales on positive adjectives resulted in higher satisfaction toward the web page.
4. Four types' main features of web-based learning system were defined by expert designers: professional image type, graphics mainly type, main subject type, and informative mainly type.

The findings not only revealed the relationship between visual complexity vs. visual order and aesthetics impression, but also provided different types of web layout examples to web page designer and system engineer.

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