JUS
JOURNAL OF USABILITY STUDIES
Vol. 3, Issue 3, May 2008, pp. 103-117

An Empirical Investigation of Color Temperature and Gender Effects on Web Aesthetics

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Abstract

Limited research exists on the relevance of hedonic dimensions of human-computer interaction to usability, with only a small set of this research being empirical in nature. Furthermore, previous research has obtained mixed support for gender differences regarding perceptions of attractiveness and usability in Web site design. This empirical research addresses the above gap by studying the effects of color temperature and gender on perceptions of Web site aesthetics. A 2 x 2 between-subject research design manipulates the temperature of a Web site's primary and secondary colors. Each color pair consists of adjacent hues and is categorized as either *warm* or *cool*.

Findings include significantly more favorable perceptions regarding a Web site design's aesthetics when cool color combinations (blue-light blue), as opposed to warm color combinations (red-orange), are used; direct effects of classical aesthetic dimensions (e.g., cleanliness) on expressive aesthetics items (e.g., creativity); and no effects of gender on either set of aesthetics.

Keywords

Aesthetics, Attractiveness, Usability, Human Computer Interaction, Web site, Design, Color, Color Temperature, Gender, Hedonic

Introduction

As the World Wide Web continues to grow in popularity, currently estimated to exceed 1.2 billion users (Nielsen, 2005), Web sites have become core extensions of a business practice rather than a consideration of a new channel (Seethamraju, 2005). Companies seek new insights on how to create more effective Web sites and entice online customers. Extensive literature exists on the acceptance of a new technology, but the former has centered on utility-related dimensions that drive this acceptance. Although research has been conducted on the aesthetic dimensions of interfaces since the mid 1980s, limited research exists on the explicit relevance of hedonic dimensions of human-computer interaction (HCI) to usability. An even smaller set of this research is empirical in nature (Hoffman & Krauss, 2004; Schenkman & Jonsson, 2000; Zhang & Li, 2005). Current findings highlight the importance of aesthetics and specifically color in the scope of Web experience. For example, Tractinsky et al. (2000) empirically studied and showed that users perceive and evaluate aesthetics early in the human-computer interaction process, and that those evaluations are carried forward and may influence later perceptions of usability. Additionally, a few other studies have shown that the cool blue color schemes are associated with higher perceived credibility and trust levels (Fogg et. al, 2001; Lee & See, 2004; Zhang & Li, 2005). Furthermore, it appears that there are gender differences regarding perceptions of attractiveness, usability, and the consequent affective state of satisfaction in Web site design. Cyr and Bonnani (2005) studied the differences between genders' preferences in the context of e-commerce. According to their study, the two genders experience e-commerce differently especially in terms of design. Other factors such as trust and satisfaction seemed to be equally assessed. Furthermore, Simon (2001) explored the differences among genders and cultures. Simon's findings indicated that, in most cases, the perception of Web site attractiveness across genders was significantly different, especially in individualistic (e.g., North American) cultures. However, more research is needed to study the broad range of potential antecedents and their effects on Web site aesthetics. Such an understanding can contribute to further insight regarding Web site usability and in turn goodness (Hassenzahl, 2004). Thus, this research aims to address the above need by studying the effects of color temperature and gender on the perceptions of Web sites aesthetics.

Literature Review

The following sections present aesthetics and gender differences in hedonic effects.

Aesthetics

Aesthetics is a subset of value theory that studies values, sometimes called judgments of sentiment or taste. Aesthetics is interlinked with the philosophy of art. It is considered to be a particular theory of the conception of beauty; a particular approach to what is pleasing to the senses (Hoffman & Krauss, 2004; Kripintiris & Coursaris, 2007). People throughout the centuries have been highly interested in aesthetics. The appreciation of beauty is a classical quality that is applied to many aspects of life, such as senses, imagination, and understanding (Lavie & Tractinsky, 2004). Aesthetics have been a topic of study and research over the ages by many schools of thought. They have been approached from many different angles and points of view. Aesthetics possess multiple meanings (Lavie & Tractinsky, 2004). A commonality among aesthetics across the centuries is their dynamic nature. Beauty has been reformulated to address and reflect the propensities of the era to which it belongs. It has been observed and studied that aesthetic preferences of the present come to replace those of the past and so forth (Lavie & Tractinsky, 2004). Tarasewich (2001) cites Eysenck (1983) who addresses two conflicting points on aesthetics. The first considers aesthetics as an objective quality that can be understood and shown to people. The second point of view sees aesthetics as something completely subjective and that beauty is a quality unable to be shown. However, Eysenck supports the concept that there is objectivity in aesthetic considerations. Also, some of his experiments provide insight regarding simple stimuli like shapes and color that may influence aesthetic judgments (Tarasewich et al., 2001; Eysenck, 1983). Similarly, the aforementioned dyadic relationship parallels those described in the respective works of DeAngeli et al. (2006) and Lavie and Tractinsky. Lavie and Tractinsky describe this dyad as two distinct approaches of understanding aesthetics described as classical aesthetics and expressive aesthetics. Classical aesthetics are defined as aesthetic notions that "presided from antiquity until the 18th century"

and "emphasize orderly and clear design." Expressive aesthetics are defined as aesthetic notions that reflect a designer's creativity and originality (Lavie & Tractinsky, 2004). Nasar (1999) offers support for these two dimensions, but labels them visual clarity and visual richness respectively.

The relationship between classical and expressive aesthetics has received extremely limited attention. Lavie and Tractinsky (2004) point out that such a relationship is not predefined and that good design "should strive to balance their degrees given the design context." On the other hand, the Bayesian model presented by Papachristos et al. (2005) offers support for the following relationships between Web site design attributes: A "pleasant" design affects perceptions of a "fresh", "dynamic", and "modern" design, while an "attractive" design has a mediated effect on how "sophisticated" it is perceived to be. Several of these dimensions had been used in the operationalization of aesthetics by Lavie and Tractinsky, with "pleasant" falling under "classical" and "modern" measuring "expressive" aesthetics. Papachristos et al., based on a similar study from Kim et al. (2003), define their chromatic schemes after requesting actual users to characterize color combinations according to a set of emotional descriptors. Consequently, they gather the 12 most distinctive characterizations and they "formally" select (as they mention) a dominant and a secondary color scheme. Kim et al., following a similar pattern, first brainstorm with "design experts," and then survey Web users in order to identify 13 emotional dimensions. These attributes are found in the operationalization of the two aesthetics constructs by Lavie and Tractinsky, suggesting that classical aesthetics impact expressive aesthetics. Therefore, and with the caveat of extremely limited support, the following hypothesis is proposed:

H1. Higher levels of classical aesthetics will have a more positive effect on expressive aesthetics.

Aesthetics

Hedonic, derived from Greek where *hedonism* means pleasure, dimensions include factors such as color, graphics, animation, and other design elements that either implicitly or explicitly cause an affective state of pleasure. Zhang and Li (2005) argue that the more pleasing or attractive a Web site is, the easier it will be for the individual to learn how to use it and the more likely that this individual will continue to use it. Past studies have primarily looked at Web site design as the aggregate product of these hedonic dimensions and the users' consequent affect. However, a closer look at the impact of each hedonic dimension on affect is warranted.

Empirical studies on the impact of color on the perceived attractiveness and usability of Web sites are extremely limited. Kim et al. (2003) reference Liu (2001) in their claim that "prior studies did not identify any quantitative relations between the design factors emotional dimensions." Most studies focus on the role that aesthetics play in usability and treat color in an overly subjective and qualitative manner (Brady & Philips, 2003; Dittmar, 2001; Kim et. al, 2003; Papachristos et al., 2005). However, based on the limited number of empirical studies on the subject, it appears that color (and more specifically color combinations) has a significant effect on the perceived attractiveness and aesthetic appeal of a Web site. Brady and Philips (2003) suggest that users found a site with a triadic color scheme more usable and more aesthetically pleasing than a site with a non-standard color scheme (note: a review of the color scheme used by Brady and Philips suggests their design to be split-complementary instead of triadic; however, both are proximal techniques in combining colors). Their study was limited by its design in that it did not differentiate between color properties (e.g., hue, saturation, and temperature) and their respective effects on users' perceptions of usability and attractiveness. Papachristos et al. (2005) suggest that color combinations and schemes resonate with users in a particularly emotional manner. Their research shows that users tend to predictably attach specific emotional descriptors, such as fresh, modern, friendly, and aggressive, to specific color schemes and color combinations. Results of their research further suggest that the design attribute with the strongest effect on the Web site's perceived attractiveness is the *brightness* of the dominant color, followed by the *brightness* of the secondary color and its temperature (warm or cool), the *number of colors*, and the *contrast* between hues. As a rough point of reference to color theory, warm colors include those that fall in the spectrum between red and yellow (with orange as the secondary by-product), whereas cool colors encompass those that center around blue (with green and purple as the secondary by-products) (Ohta & Robertson, 2006).

Based on the limited past empirical research, it is plausible to suggest that color, color schemes, and color combinations are variables dependant on other areas of design such as balance and contrast. It is also possible to suggest, based on the work by Papachristos et al., where cooler colors were found to be preferred over warmer colors, that the perceived *temperature* of a color impacts a Web site's aesthetics. Thus, the following hypotheses are proposed for this study:

H2. Increasing the color temperature of a Web site design will negatively impact users' perceptions of its classical aesthetics.

H3. Increasing the color temperature of a Web site design will negatively impact users' perceptions of its expressive aesthetics.

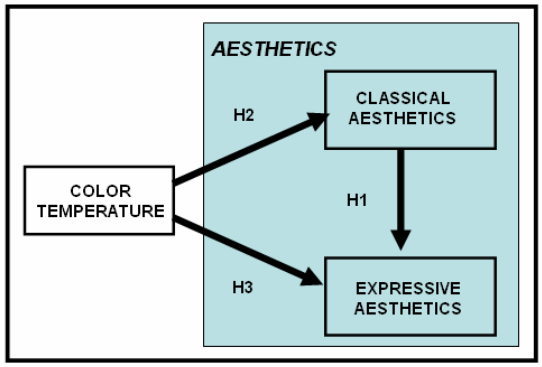

Figure 1. Proposed research model of color temperature effects on perceptions of Web aesthetics

Gender Differences in Hedonic Effects

Effects of Web design on affect have also been studied in the context of the users' gender. While several studies have explored the relationships between trust, satisfaction, and the consequent loyalty to a Web site (Anderson & Srinivasan, 2003; Cyr & Bonnani, 2005; Devaraj, Fan, & Kohli, 2002; Szymanski & Hise, 2000; Yoon, 2000), very few studies have focused on the relationship between gender and Web site design preferences (Cyr & Bonnani, 2005; Simon, 2001). In the realm of visual design, men had more favorable impressions of how product information was presented. Women were more attracted by the colors on the site, and men by animations and the interactive, "flashy" aspects of the site (Cyr & Bonanni, 2005). Simon (2001) found that women preferred sites that were less cluttered, having few graphics, as well as sites that avoid multiple levels of sub-pages to drill through. Men liked sites that used extensive graphics and animation. Additionally, in a study of gender and Web usage among college students, significant gender differences emerged with respect to evaluative criteria and use patterns, with men liking some of the "bells and whistles" and women using academic Web sites more (Mitra et. al, 2005).

It appears that there are gender differences regarding perceptions of aesthetics, usability, and the consequent affective state of satisfaction in Web site design, but more research is needed to understand the nature of such differences. As with past studies on hedonic dimensions and usability and acceptance, gender differences were explored in terms of Web site designs as an aggregate of multiple design elements instead of a more controlled design regarding these aesthetic factors. There is limited research that investigates the effects of gender on color preferences. Studies in various contexts have found that both men and women prefer the same color temperature (i.e., *cool* blue) (Dittmar, 2001; Guegen, 2003; Silver & Ferrante, 1995), but significant differences arose regarding their least preferred colors, where men "stated more often yellow and less often red as least preferred than women did" (Dittmar, 2001). Thus, the following hypothesis is proposed for this study:

H4. Increasing the color temperature of a Web site design will have a more negative impact on women's perceptions of its aesthetics than those of men.

Methods

The following sections present the experiment design and procedure, the subjects, and the instrument scales and validity.

Experiment Design and Procedure

This study employs a four-group between-subject research design, where color temperature is manipulated at four levels, each representing an increased level of overall color temperature for the Web site. To assist in operationalizing color temperature increases, a Web site's design elements (e.g., logo, navigation bar) were placed in two groups, herein referred to as primary and secondary. Primary layout elements refer to areas of the site which are specifically designed (by the site designer) to immediately attract the focus or attention of the user upon visiting the site or to contain primary information or content (such as body text relating to the site's intended purpose). These include, but are no means limited to, primary branding (i.e., logos, etc.), top level navigational elements (i.e., horizontal navigation bars), or primary content bearing columns or containers. Secondary layout elements refer to areas of the site which are not designed to convey vital information and include, but are no means limited to, hyperlinks, secondary or tertiary level text, form styling, and secondary navigational elements. Then, by assigning different colors to the primary (more dominant) elements, the secondary elements, or both, the Web site's overall color temperature would either increase or decrease. It is important to note that the terms *primary* and *secondary* do not refer to primary and secondary colors. Instead, the terms primary and secondary refer to design or layout elements of the site to which the specific color is applied.

Regarding color temperature levels, two sets of colors are selected from the color wheel, each being categorized as either *warm* or *cool*. A warm color refers to colors ranging between yellow to red-violet on the chromatic wheel. It is important to note that interaction between colors may cause a hue such as red-violet to appear warmer if it is placed next to a cold color, such as green, or colder if it is placed next to a warm color, such as orange. A cool or cold color refers to colors ranging between blue-violet and yellow-green on the chromatic circle. As with warm colors, interaction between colors may cause a hue such as yellow-green to appear colder if it is placed next to a warm color, such as red, or warmer if it is placed next to a cold color, such as blue.

A Web site was developed by the authors for the purpose of this study and represented the digital storefront of a fictional hotel. Four versions of the identical Web site design were produced with color (temperature) combination being the only varying design element (see Figure 2 for corresponding screenshots). All other design elements (e.g., text, images, background) were held constant across the four designs. Implementation of this design resulted in the following four split-complementary treatments or color combinations for the test Web site: (a) Warm Primary–Warm Secondary (i.e., #FF0000/#FF7F02 or 255.0.0/ 255.127.2 or Red/Orange), (b) Warm Primary–Cool Secondary (i.e., #FF0000/879ADC or 255.0.0/135.154.220 or Red/Light Blue), (c) Cool Primary–Warm Secondary (i.e., #3C4360/#FF7F02 or 60.67.96/255.127.2 or Blue/Orange), and (d) Cool Primary–Cool Secondary (i.e., #3C4360/#879ADC or 60.67.96/135.154.220 or Blue/Light Blue). For the purposes of the study, the logo and main navigation bar were designated as primary elements, while the form styling, secondary navigation (hyperlinks), and image borders were designated as secondary elements. All other design elements (e.g., text, images, background) were held constant across the four designs. This research design allowed for any differences found among the four groups of subjects to be attributed to the decreased levels of color warmth as a result of color choices for the primary and secondary colors of the Web site.

Tasks invoked participants to browse through a Web site developed for the purpose of this study in search of specific information. Participants were informed that the tasks were only meant to offer them an opportunity to explore the Web site and its design, instead of measuring their performance with it. Having evaluated the Web site design randomly assigned to them, participants were then asked to rank four different Web site designs in terms of their respectively perceived aesthetics.

A Structural Equations Modeling (SEM) technique, Partial Least Squares (PLS), is used in testing the validity of both the structural and measurement model. Data analysis will speak to the four aforementioned hypotheses.

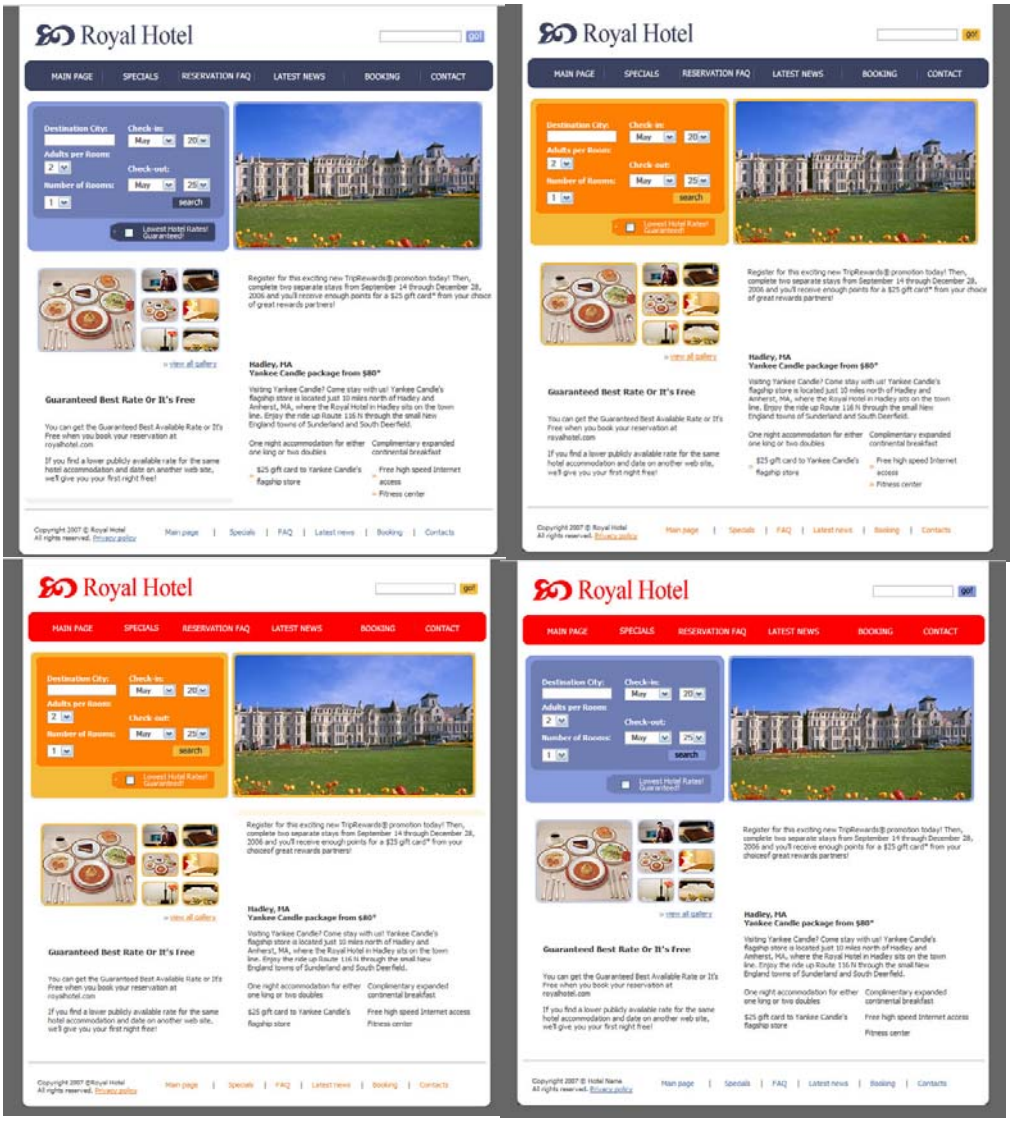

Figure 2. Screenshots of the Web site's designs from *coolest* to *warmest* (clockwise, from top left)

Subjects

A total of 356 subjects were recruited for this Web-based voluntary study via email announcements on various databases and electronic mailing lists. Of the 356 participants recruited, 328 usable data sets were collected, with a minimum of 72 subjects per group. All participants used the same Web site, but each treatment involved the use of a discriminant color design described above. The minimum sample size for the selected method, PLS, is 10 times the number of the most complex construct (Chin, 1998). In this study endogenous constructs consist of five items each, thus our sample size far exceeded the needed 50 cases. Each subject participated in only one treatment group, and assignment of subjects to groups was fully randomized to control for confounding effects due to differences in subject characteristics. The sample exhibited a relatively even split between males and females (170 males to 158 females). The average age was 34 (ranging from 18 to 70), and 83% described themselves as Caucasian/White (while another 7% as Asian/Pacific Islander and another 10% fell under remaining categories). The participants were almost entirely college-educated and

had an average experience of 17 years with computers and 10 years with the World Wide Web, respectively. ANOVA tests found no significant differences for subjects in the various treatment groups in terms of these control variables, thereby ensuring the successful randomization of assignment across groups.

Instrument Scales and Validity

The questionnaire used for data collection contains scales that measure the various constructs shown in the research model and are provided in Table 1. All scales were adapted from a prior study (Lavie & Tractinsky, 2004), which had established their reliability and validity, thereby satisfying content validity. These scales were used to measure the users' perceived attractiveness of Web sites through assessments of *classical aesthetics* and *expressive aesthetics*. These 7-point Likert scales (anchored "Strongly Disagree/Agree") measured responses to the shared question "My perception of this Web site is that it is…" for each of the following items: clean, clear, symmetric, aesthetic, pleasant for classical aesthetics, original, creative, fascinating, sophisticated, and uses special effects for expressive aesthetics.

When the questionnaire was conducted, items within the same construct group were randomized to prevent systemic response bias. Upon further testing it was shown that non-response, temporal, and common method biases were not present in our data set. The factor loadings for the total set of items used in this study are summarized in Table 1. Shimp and Sharma (1987), Carmines and Zeller (1979), and Hulland (1999) suggest that an item is significant if its factor loading is greater than 0.7 to ensure construct validity. Adherence to this criterion required the modification of only one scale (classical aesthetics) through the removal of two items: ClasAes1 (or clean) and ClasAes2 (or symmetrical). After the removal of the non-valid items, each item was re-validated by testing its item-to-total correlation measure, where all items had higher measures than the 0.35 threshold suggested by Saxe and Weitz (1982).

Table 1. Construct items and their factor loadings

Item	Question: Thinking about my impression with the Web site, it is …	Loading	Item-total correlations
ClasAes1*	Clean	0.661	0.593
ClasAes2	Clear	0.746	0.607
ClasAes3	Aesthetic	0.863	0.701
ClasAes4	Pleasant	0.895	0.547
ClasAes5*	Symmetrical	0.605	0.442
ExprAes1	Original	0.848	0.763
ExprAes2	Sophisticated	0.851	0.728
ExprAes3	Fascinating	0.895	0.825
ExprAes4	Creative	0.883	0.816
ExprAes5	Uses special effects	0.777	0.688

Note: * denotes items removed from the subsequent analysis; ClasAes–classical aesthetics; ExprAes–expressive aesthetics

Results of tests for convergent validity (Bagozzi, 1981), discriminant validity (Bagozzi, 1981; Fornell & Larcker, 1981), construct means, and Cronbach's alpha can be found in Table 2. All constructs had adequate reliability (Carmines & Zeller, 1979) and internal consistency well above the 0.7 threshold (Nunnally, 1978). Cronbach α-values were satisfactory for our constructs (0.771-0.906) and constructs' AVE exceeded the 0.5 benchmark for convergent validity (Fornell & Larcker,1981).

Table 2. Construct statistics

	ClasAes	ExprAes
Arithmetic means (all items)	5.457	3.294
Arithmetic means (used items)	5.342	3.294
Cronbach's α reliability	0.771	0.906
Internal consistency	0.875	0.930
Convergent validity (AVE)	0.701	0.726
Discriminant validity (sqr[AVE])	0.837	0.852

The square root of the variance shared between a construct and its items was greater than the correlations between the construct and any other construct in the model (see Table 3) suggesting discriminant validity (Fornell & Larker, 1981). Discriminant validity was confirmed by verifying that all items load highly on their corresponding factors and load less on other factors (see Table 4). Although the correlation between the two aesthetics constructs was quite high (i.e., 0.622), a phenomenon also observed in the work by Lavie and Tractinsky (2004), it is not exceedingly high according to Kline's (1998) suggestion that correlations between factors should not be greater than 0.85, thus further supporting the discriminant validity of the two aesthetic factors.

Table 3. Correlation matrix and discriminant validity assessment

ITEM	ClasAes	ExprAes
ClasAes	**0.985**[1]	
ExprAes	0.622	**0.832**[1]

[1] Fornell and Larcker (1981) measure of discriminant validity, which is the square root of the average variance extracted compared to the construct correlations. Bold values are supposed to be greater than those in corresponding rows and columns.

Table 4. Matrix of loadings and cross-loadings

ITEM	ClasAes	ExprAes
ClasAes2	**0.746**	0.455
ClasAes3	**0.863**	0.547
ClasAes4	**0.895**	0.554
ExprAes1	0.474	**0.847**
ExprAes2	0.638	**0.849**
ExprAes3	0.571	**0.896**
ExprAes4	0.524	**0.885**
ExprAes5	0.391	**0.779**

Results

Following from the earlier discussion on the instrument's validity, statistics regarding significant items and construct are reported in Table 5 (on subsequent page).

The proposed structural model shown earlier in Figure 1 was tested by Jackknifing in PLS. This resampling procedure assesses the significance of PLS parameter estimates (Chin, 1998). Jackknifing is just one of several PLS techniques that may be used in evaluating a research model. For example, Bootstrapping is another common PLS approach, but in general, estimations by either one approach should converge (Chin, 1998). All three of the original hypotheses were supported as shown in Figure 3, while Table 6 presents the validation of these hypotheses in more detail. Furthermore, the structural model tested using PLS demonstrated mixed explanatory power for perceived Web site aesthetics. With an R-square of 0.45, 45% of the variance in expressive aesthetics was explained by both the color temperature effects and

the classical aesthetics (more heavily so) in this study. Only 3.2% of the variance for classical aesthetics was explained by this manipulation, suggesting that there are other dimensions not captured by the scale (in part explained after the removal of two items), by the exogenous construct's effects, or both.

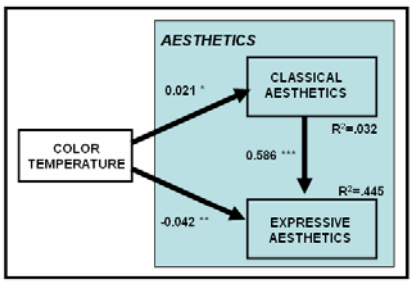

Figure 3. PLS model
(* significant at 0.05 level, ** significant at 0.01 level, *** significant at 0.001 level)

Table 5. Items and construct statistics

	Mean	Std. dev.	Loading	Error	Item-total correlation	Alpha	Alpha if item deleted
Classical aesthetics	5.342	1.632				0.771	0.783
Clear	5.317	1.433	0.746	0.018	0.495		0.835
Aesthetic	5.230	1.230	0.863	0.024	0.638		0.656
Pleasant	5.479	1.155	0.895	0.025	0.712		0.587
Expressive aesthetics						0.906	0.906
Original	3.412	1.558	0.847	0.319	0.763		0.885
Sophisticated	4.079	1.564	0.849	0.320	0.728		0.893
Fascinating	3.079	1.538	0.896	0.357	0.825		0.871
Creative	3.439	1.555	0.885	0.348	0.816		0.873
Uses special effects	2.460	1.381	0.779	0.270	0.688		0.900

Table 6. Validity test results

Hypotheses	From	To	Beta	t-Value	p-Value	Sig	Status
H1	ClassAes	ExprAes	0.586	13.317	< 0.001	***	Supported
H2	Design	ClassAes	0.021	2.110	< 0.05	*	Supported
H3	Design	ExprAes	-0.042	4.666	< 0.01	**	Supported

The next measurement pertains to the ranking of the different Web site designs. Rankings were significantly different (one-sample T-test) suggesting a preference for *blues* or the cool-cool color design (see Table 7).

Table 7. Web site rankings (of perceived aesthetics) and one-sample of comparison of means (mean reflects average of forced rank between 1 or *most aesthetic* and 4 or *least aesthetic*)

Color temperature (primary-secondary)	N	Mean	Std. deviation	Std. error mean	t	Df	Sig. (2-tailed)
Warm-warm	328	2.97	1.171	0.065	45.956	327	0.000
Warm-cool	328	2.62	0.914	0.050	51.959	327	0.000
Cool-warm	328	2.34	0.980	0.054	43.326	327	0.000
Cool-cool	328	2.00	1.135	0.063	31.971	327	0.000

The fourth hypothesis stated that "*increasing the color temperature of a Web site design will have a more negative impact on women's perceptions of its aesthetics than those of men.*" ANOVA test results suggested that there were no significant differences in the reporting of both classical and expressive aesthetics scale items (see Table 8), as well as in the ranking of the four Web site designs (see Table 9). Thus, gender does not appear to be related to users' perceptions of aesthetics as a result of color temperature combinations in the context of hotel Web sites. However, the hypothesized directionality becomes apparent when contrasting the p-values for the two *cool* Web site designs (i.e., third and fourth design with p-values above 0.88) with the two *warm* Web site designs (i.e., first and second design with p-values below 0.30). Thus, gender differences regarding color preferences at the warmer end of the spectrum may occur, although the findings of this study do not offer such support.

Table 8. ANOVA for relationships between gender and aesthetics (classical and expressive)

Item		Sum of squares	df	Mean square	F	Sig.
ClassAes2	Between groups	1.451	1	1.451	.707	.401
	Within groups	669.573	326	2.054		
	Total	671.024	327			
ClassAes3	Between groups	3.280	1	3.280	2.178	.141
	Within groups	491.110	326	1.506		
	Total	494.390	327			
ClassAes4	Between groups	.233	1	.233	.175	.676
	Within groups	435.617	326	1.336		
	Total	435.851	327			
ExprAes1	Between groups	.435	1	.435	.179	.673
	Within groups	793.001	326	2.433		
	Total	793.436	327			
ExprAes2	Between groups	4.632	1	4.632	1.899	.169
	Within groups	795.307	326	2.440		
	Total	799.939	327			
ExprAes3	Between groups	.027	1	.027	.011	.916
	Within groups	773.912	326	2.374		
	Total	773.939	327			
ExprAes4	Between groups	.085	1	.085	.035	.852
	Within groups	790.696	326	2.425		
	Total	790.780	327			

ExprAes5	Between groups	1.286	1	1.286	.674	.412
	Within groups	622.199	326	1.909		
	Total	623.485	327			

Table 9. ANOVA for relationships between gender and aesthetics rankings of four Web site designs (i.e., color temperature combinations)

Item		Sum of Squares	df	Mean Square	F	Sig.
Rank of site 1	Between groups	2.280	1	2.280	1.665	.198
	Within groups	446.473	326	1.370		
	Total	448.753	327			
Rank of site 2	Between groups	.931	1	.931	1.115	.292
	Within groups	272.191	326	.835		
	Total	273.122	327			
Rank of site 3	Between groups	.004	1	.004	.004	.949
	Within groups	314.066	326	.963		
	Total	314.070	327			
Rank of site 4	Between groups	.027	1	.027	.021	.886
	Within groups	420.970	326	1.291		
	Total	420.997	327			

Conclusion

The findings of the present study support and extend prior research regarding the effect of color combinations on aesthetics (Brady & Philips, 2003; Papachristos et al., 2005). First, color temperature variations on Web site designs appeared to impact both sets of aesthetic dimensions (i.e., classical and expressive). Second, the split-complementary color schemes that utilized a cool primary color (blue) for the top or global part of the page and then used either another cool color (medium blue) or a warm color (orange) for the secondary page components provided the color balance that users found most aesthetically pleasing. In contrast, the site that combined both a warm primary color (red) and a warm secondary color (orange) was the least aesthetically pleasing. The current results suggest that designers need to carefully consider color choice as the combinations will convey information about the quality of the site that may not be intended.

Furthermore, while there was limited literature regarding the hypothesis that *classical aesthetics* directly impact *expressive aesthetics*, this study offers strong support for this relationship. A significant implication to management arises: by ensuring Web site designs adhere to fundamental design principles and guidelines, thus satisfying more *objective* aesthetic dimensions, such favorable impressions will also influence perceptions of more *affective* aesthetic dimensions (e.g., originality, creativity). Consequently, this is a research area that warrants further investigation. Therefore, we can extend Tractinsky's et al. (2000) suggestion that "what is beautiful is usable" to argue that "what is orderly is beautiful and in turn usable" bearing in mind that *context of use* is the overriding factor that influences perceptions of order and beauty.

While other research has found gender effects in several computer-related contexts (Cyr & Bonanni, 2005; Simon, 2001), the current study did not indicate that gender impacted perceptions of Web site aesthetics. One plausible explanation for this observation is that women tend to employ more exhaustive information processing strategies than men do, which means that gender differences may have been masked by the lack of detailed content in the prototype Web site; the content was not as extensive as users expected from a travel Web site (Meyers-Levy & Maheswaran, 1991; Simon, 2001). We plan to expand and hone the Web site content to

create a more realistic level of detail on each page, as well as have more content pages, which would enable users to better assess perceived usability within the context of the multiple color schemes. Additionally, future research efforts will seek to broaden the focus to assess the influence of culture on perceptions of Web site aesthetics through a global multi-country study.

In closing, this study aimed at extending the limited body of research (DeAngeli et. al, 2006; Lavie & Tractinsky, 2004; Tarasewich, 2001) in the area of Web site aesthetics and our understanding of how the manipulation of design elements (here, color temperature and color scheme) may impact users' perceptions of a Web site's aesthetics.

Recommendations for Future Research and Conceptual Development

The next step on this research agenda is to study the effects of Web aesthetics on perceived usability. The authors will specifically seek to identify the relative importance of classical versus expressive aesthetics on the perceived efficiency and effectiveness of a Web site's design. The second step will be to engage in a multi-country, cross-cultural study that will attempt to gain support for the generalizability of these relationships beyond a U.S. audience.

At a higher level, this research stream will expand on currently limited insight on the relationship between aesthetics and usability, i.e., between hedonic and utilitarian effects consequent of Web site design choices.

Practitioner's Take away

The following list summarizes practical take-aways that practitioners can get from this article:

- Choose a Web site's colors wisely as they will impact visitors' impressions of its order and creativity.
- The *safest* split-complementary color schemes (in terms of influencing users' impressions of a Web site's aesthetic appeal) are those with a cool primary color (e.g., blue) for the top or global part of the page. Similarly, a cool secondary color is *safer* than a warm one. It should be noted that context is an overriding factor; in certain cases warm color combinations may result in higher aesthetic appeal.
- Using cool color schemes will create favorable impressions about the Web site's design, which in turn may translate in building credibility and trust.
- Web site designs that appear orderly are more likely to be also perceived as aesthetically pleasing and in turn more usable.
- No gender differences arose in terms of color preference in this context (i.e., hotel Web sites).
- When gauging the appeal of a Web site design, two discriminant dimensions should always be measured, i.e., *classical* and *expressive* aesthetics.
- The measurement of *classical aesthetics* centers on the Web site's orderly presentation. Designers and managers should gauge users' perceptions on the Web site's clarity, aesthetics, pleasantness (as shown in this study), cleanliness, and symmetry (validated in past studies).
- Even if designers are interested in producing creative, fascinating Web sites, they would be wise to consider orderly presentation given its very large effect on users' perceptions of *expressive aesthetics*.

Acknowledgements

The authors would like to thank the reviewers for their insightful feedback that was critical in producing the final version of this article.

References

Anderson, R.E., & Srinivasan, S.S. (2003). E-satisfaction and e-loyalty: a contingency framework. *Psychology and Marketing*, *20*(2), 123–138.

Bagozzi, R. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*, 1981.

Brady, L., & Phillips, C. (2003). Aesthetics and usability: A look at color and balance. *Usability News*, 5.1. Retrieved October 15, 2006, from http://psychology. wichita.edu/ surl/usabilitynews/51/aesthetics.htm

Carmines, E., & Zeller, R. (1979). Reliability and Validity Assessment. *Sage Paper Series on Quantitative Applications No. 07-017*, Beverly Hills, CA: Sage Publications Inc.

Chin, W.W. (1998). The Partial Least Squares Approach for Structural Equation Modeling. *Lawrence Erlbaum Associates*, 295-336.

Cyr, D., & Bonanni, C. (2005). Gender and website design in e-business. *International Journal of Electronic Business, (3:6)*, 565–582.

De Angeli, A., Sutcliffe, A., & Hartmann, J. (2006). Interaction, Usability and Aesthetics: What Influences Users' Preferences? *Proceedings of DIS*.

Devaraj, S., Fan, M., & Kohli, R. (2002). Antecedents of B2C channel satisfaction and preference: validating e-commerce metrics. *Information Systems Research*, *13(3)*, 316–333.

Dittmar, M. (2001). Changing Colour Preferences with Ageing: A Comparative Study on Younger and Older Native Germans Aged 19-90 Years. *Gerontology*, *47(4)*, 219-226.

Eysenck, H. J. (1983). Visual Aesthetic Sensitivity and its Measurement. In M. Russ (Ed.), *The Arts: A Way of Knowing* (pp. 105-125). Oxford: Pergamon Press.

Fogg, B. J., Marshall, J., Laraki, O., Osipovich, A., Varma, C., Fang, N., Paul, J., Rangnenkar, A., Shon, J., Swani, P., & Treinen, M. (2001). What makes web sties credible? A report on a large quantitative study. *SIGCHI'01*, *3(1)*, 61-68.

Fornell, C., & Larcker, D. (1981). Evaluating Structural Equation Models with Unobservable Variable and Measurement Error. *Journal of Marketing Research*, *18*, 39-50.

Guéguen, N. (2006). The Effect of Glass Colour on the Evaluation of a Beverage's Thirst-Quenching Quality. *Current Psychology Letters*, March 30. Retrieved April 30, 2007, from http://cpl.revues.org/document398.htm

Hassenzahl. M. (2004, Oct.–Nov.). Emotions can be quite ephemeral. We cannot design them. *Interactions*, 46-48.

Heijden, H.V.D. (2003). Factors influencing the usage of websites: The case of a generic portal in the Netherlands. *Information and Management*, *40(6)*, 541-549.

Hoffman, R., & Krauss, K. (2004). A critical evaluation of literature on visual aesthetics for the Web. *Proceedings of SAICSIT*, 205-209.

Hulland, J. (1999). Use of Partial Least Squares (PLS) in Strategic Management Research: A review of four recent studies. *Strategic Management Journal*, *20*, 195-204.

Kline, R.B. (1998). *Principles and Practice of Structural Equation Modeling*. New York: Guilford Press.

Kim, J., Lee, J., & Choi, D. (2003), Designing emotionally evocative homepages: an empirical study of the quantitative relations between design factors and emotional dimensions. *Int. J. Human-Computer Studies*, *59*, 899–940.

Kripintiris, K., & Coursaris C. (2007, March 23-24). Exploring the relationship between aesthetics and usability. In the proceedings of *International Telecommunication Education and Research Association Conference*, Louisville, KY, USA.

Lavie, T., & Tractinsky, N. (2004). Assessing Dimensions of Perceived Visual Aesthetics of Web Sites. *International Journal of Human-Computer Studies*, *60(3)*, 269-298.

Lee, J. D., & See, K. A. (2004). Trust in automation: Designing for appropriate reliance, *Human Factors*, *46*(1).

Liu, Y. (2001). Engineering aesthetics and aesthetic ergonomics: a dual-process methodology and its applications. Proceedings of the *International Conference on Affective Human Factors Design* (pp. 248–255). London. Asean Academic Press.

Meyers-Levy, J., & Maheswaran, D. (1991). Exploring gender differences in males' and females' processing strategy. *Journal of Consumer Research*, *18*, 63-70.

Mitra, A., Willyard, J., Platt, C., & Parsons, M. (2005). Exploring web usage and selection criteria among male and female students. *Journal of Computer-Mediated Communication*, *10*(3), 2005. Retrieved October 15, 2006, from http://jcmc.indiana.edu/vol10/issue3/mitra.html

Nasar, J. L. 1(999). *Design by Competition: Making Design Competition Work*. New York: Cambridge.

Nielsen, J. (2005). One billion Internet users. *Jakob Nielsen's Alertbox*, December 19, 2005. Retrieved October 15, 2006, from http://www.useit.com/ alertbox/internet_growth.html

Nunnally, J.C. (1978). *Psychometric Theory*, 2nd edition, New York: McGraw-Hill.

Ohta, N., & Robertson, A. (2006). *Colorimetry: Fundamentals and Applications*. Wiley–Halsted Pr.

Papachristos, E., Tselios, N., & Avouris, N. (2005). Inferring relations between color and emotional dimensions of a Web site using Bayesian Networks. *Proceedings of Interact 2005*.

Saxe, R., & Weitz, B. (1982). The SOCO Scale: A measure of the customer orientation of salespeople, *Journal of Marketing Research*, 19.

Schenkman, R. N., & Jonsson, U. (2000). Aesthetics and preferences of web pages. *Behaviour & Information Technology*, *19*(5), 367-377.

Seethamraju, R. (2005). Relative importance of Web quality dimensions. *Proceedings of AMCIS*.

Shimp, T., & Sharma, S. (1987). Consumer ethnocentrism construction and validation of the CETSCALE. *Journal of Marketing Research*, *24*.

Silver C., & Ferrante R. (1995). Sex differences in color preferences among an elderly sample. *Perceptual and Motor Skills*, *80*, 920-922.

Simon, S. (2001). The impact of culture and gender on Web sites: An empirical study. *The DATA BASE for Advances in Information Systems*, *32(1)*, 18-37.

Szymanski, D.A., & Hise, R.T. (2000). E-satisfaction: an initial examination. *Journal of Retailing*, *76*(3), 309–322.

Tarasewich, P., Daniel, H.Z., & Griffin, H.E. (2001). Aesthetics and Web Site Design. *Quarterly Journal of Electronic Commerce*, *2(1)*, 67-81.

Tractinksy, N., Katz, A.S., & Ikar, D. (2000). What is beautiful is usable. *Interacting with Computers. 13*, 127-145.

Yoon, S-J. (2002). The antecedents and consequences of trust in online-purchase decisions'. *Journal of Interactive Marketing*, *16(2)*, 47–63.

Zhang, P., & Li, N. (2005). The importance of affective quality. *Communications of the ACM*, *48(9)*, 105-108.

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