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Effects of Aesthetics and Playfulness on Web Usability – An empirical investigation

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ABSTRACT

Limited empirical research exists on the explicit relevance of hedonic dimensions (aesthetics and playfulness) of human-computer interaction design to usability. This research aims to determine the effects of color temperature on the perceptions of websites aesthetics, playfulness, and in turn usability. A Partial Least Squares (PLS) analysis of data collected from 328 participants in a four-group between-subject research design involving the use of a mock hotel website offered support for all nine hypotheses proposed. 'Cooler' colors (e.g. blue) were found to favorably impact perceptions of classical aesthetics, which in turn influenced perceptions of efficiency positively, while also correlating with perceptions of expressive aesthetics. The latter, on the other hand, were affected favorably by warmer colors (e.g. red), and had a positive effect on perceptions of playfulness. In line with prior usability studies, positive relationships between efficiency and effectiveness respectively and satisfaction with the Website were supported, and by considering the shown positive relationship between playfulness and satisfaction 60% of the variance in satisfaction was explained. Implications for theory and practice are also discussed.

Keywords

Aesthetics, hedonics, usability, utility, color temperature, playfulness, efficiency, effectiveness, satisfaction, PLS.

INTRODUCTION

Having an effective Web presence is critical in today's marketplace. Organizations are interested in evaluating Websites to ensure that they are effectively reaching and retaining customers, and recent research has shown that aesthetics have become increasingly important to users (Tractinsky, 2006). Fairly limited empirical research exists on the explicit relevance of hedonic dimensions (aesthetics and playfulness) of human-computer interaction design to usability (Diefenbach & Hassenzahl, 2008). In a study of the role of aesthetics on Website usability, Brady & Phillips (2003) noted that most people cite color as a factor in their assessment of both aesthetics and perceived ease-of-use for Websites. In addition to the aesthetics of the website, the second hedonic dimension, playfulness, seems to be an important element in the process (Lee, Cheung, & Chen, 2005). While it has been argued that achieving a pleasurable, "beautiful" experience is crucial, the empirical support for what constitutes a beautiful experience is less clear, especially in determining color's role in the effective interaction with a system. Given the limited research on the role of color in the formation of affect in these contexts, and the importance of playfulness in usability, this research aims to determine the effects of color temperature on the perceptions of websites aesthetics, playfulness, and, in turn, usability.

THEORETICAL BACKGROUND

Hedonics

Hedonics, derived from the Greek word for pleasure, includes two main dimensions, aesthetics and playfulness, as well as a number of orthogonal factors including color, graphics, animation and any other design elements that induce an affective state of pleasure (Lin, Wu, & Tsai, 2005). The emphasis on hedonics in emerging research is important for the design community because there is evidence that the more pleasing or attractive a website 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 (Gray, 2009). Past studies have primarily looked at website design as the aggregate product of hedonic dimensions and the users' consequent affect. However, a closer look at the impact of individual hedonic dimensions and factors on affect is warranted.

Color

Empirical studies on the impact of color on the perceived attractiveness and usability of websites are extremely limited. Brady and Philips (2003) suggested that users found a site with a triadic color scheme to be more usable and more aesthetically pleasing than a site with a non-standard color scheme (it has been suggested that their color scheme was actually split-complementary, but both techniques are proximal in combining colors). Their study was limited by its design in that it did not differentiate between color properties (e.g., hue, saturation, temperature) and their respective effects on users' perceptions of usability and attractiveness. Papachristos et al. (2005) suggested that color combinations and schemes resonate with users in a particularly emotional manner. It was also suggested that the design attribute with the strongest effect on the website'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. Hence, the following hypotheses are proposed:

H1. Increasing the color temperature of a website design will positively impact users' perceptions of its classical aesthetics.
H2. Increasing the color temperature of a website design will negatively impact users' perceptions of its expressive aesthetics.

Aesthetics

Aesthetics is defined as what is pleasing to the senses (Kripintiris & Coursaris, 2007), although Tarasewich, Daniel, and Griffin (2001) cite Eysenck (1983), who addresses two conflicting points of view on aesthetics. The first considers aesthetics as an objective quality, which can be understood and shown to people. The second sees aesthetics as subjective, with beauty as a quality unable to be shown. This dyadic perspective parallels that described in the work by De Angeli, Sutcliffe, and Hartmann (2006) and Lavie and Tractinsky (2004). The latter describe two distinct approaches of understanding aesthetics, which they term classical and expressive aesthetics. Classical aesthetics, so named because they are conceived to have "presided from antiquity until the 18th century," stress clear, orderly design, while expressive aesthetics reflect a designer's creativity and originality (Lavie & Tractinsky, 2004).

Papachristos et al. (2005) argue that a "pleasant" design affects perceptions of a "fresh", "dynamic", and "modern" Website, 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 (2004), with "pleasant" falling under "classical" and "modern" measuring "expressive" aesthetics. More recent research has been establishing a connection between classical and expressive aesthetics and attractiveness, but results have been mixed (Tractinsky, Cokhavi, Kirschenbaum, & Sharfi, 2006). Hence, the following hypothesis is proposed:

H3. Higher levels of Classical Aesthetics will have a more positive effect on Expressive Aesthetics.

Playfulness

Playfulness is the interactive component of hedonics, and has been described as a situational characteristic of a Website (Lin et al., 2005). Moon and Kim (2001) developed a measure they termed "perceived playfulness" and defined it as "the strength of one's belief that interacting with a WWW will fulfill his or her intrinsic motives." Similarly, Lavie and Tractinsky (2004) defined playfulness as "a state characterized by perceptions of pleasure and involvement," and developed a scale based on the work of Webster and Martocchio (1992), who had found a link between playfulness and satisfaction. In the context of software product design, Hassenzahl, Platz, Burmester, and Lehner (2000) found that the ergonomic and hedonic qualities contributed almost equally to judgments of perceived fun of working with their website prototypes. Lin et al. (2005) evaluated models of Website usage and found that playfulness was related to satisfaction, and that intent to use a Website was affected by playfulness and perceived usefulness. In addition to being tied to satisfaction, playfulness has also been linked with aesthetics (Chung and Tan, 2003), as was expressive aesthetics (Huang, 2003). Hence, we propose the following:

H4. Higher levels of Expressive Aesthetics will positively impact Playfulness.
H5. Higher levels of Playfulness will positively impact Satisfaction.

Usability

Usability refers to the "extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (International Organization for Standardization, 1998). Frokjaer, Hertzum, and Hornbæk (2000) recommended including all three components of usability (efficiency, effectiveness and satisfaction) independently when studying usability. Efficiency and effectiveness are frequently grouped together under the

terms "utility" and "performance" by researchers; e.g. Coursaris, Hassanein, Head, and Bontis (2007) did so in a study of the impact of distractions on the usability of PDAs, where they found that both efficiency and effectiveness affect satisfaction.

The relationship between usability (including performance and satisfaction) and hedonics (including aesthetics and playfulness) has received much less attention than the relationships between the individual elements of usability (Tractinsky & Hassenzahl, 2005). Tractinsky, Katz, and Ikar (2000) found that the aesthetics of ATM layouts affected the post-use perceptions on both aesthetics and usability. Diefenbach and Hassenzahl (2008) found that both hedonics and utility impact product choice, but that usability is more closely tied to it. In a study of audio player usability, Thuring and Mahlke (2007) also found that user satisfaction (overall appraisal) was affected by usability and aesthetics (instrumental and non-instrumental qualities), but that usability had a larger influence.

Van der Heijden (2003) found effects of perceptions of attractiveness on usefulness and ease of use, as well as on enjoyment. The study also found that efficiency had a significant impact on enjoyment. Mahlke (2002) found that effectiveness, efficiency, and aesthetics all affected users' intentions to use a Website, but that perceived effectiveness had a larger role than the other factors. However, Kurosu & Kashimura (1995) found that attractiveness had a greater impact on apparent usability than inherent usability did. Tractinsky (1997) replicated and extended the findings of Kurosu and Kashimura (1995), again linking aesthetics to perceived efficiency. In both studies, it was found that ATM users experienced less difficulties using a more attractive interface than a less attractive one. This suggests a path leading from aesthetics through efficiency to effectiveness. We do not include any paths from usability constructs to hedonics constructs, as Thuring and Mahlke (2007) found no effect of usability on aesthetics. Taken together we propose the following hypotheses:

H6. Higher levels of Classical Aesthetics will positively impact Efficiency.

H7. Higher levels of Efficiency will positively impact Effectiveness.

H8. Higher levels of Efficiency will positively impact Satisfaction.

H9. Higher levels of Effectiveness will positively impact Satisfaction.

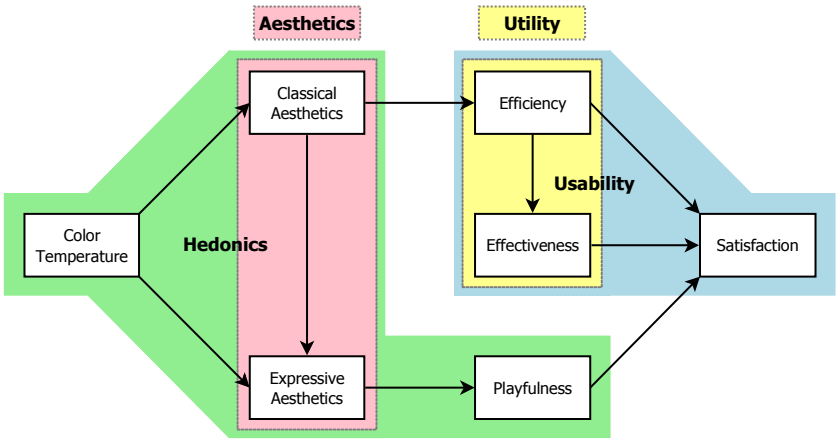

Figure 1. Proposed research model.

METHOD

Experiment Design and Procedure

This study employs a four-group between-subject research design, where color temperature is manipulated at two levels for both primary and secondary layout elements, resulting in four levels of overall color temperature for the website. Primary layout elements include 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 include areas not designed to convey vital information, such as hyperlinks, secondary or tertiary level text, form styling, and secondary navigational elements. 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. A cool or cold color refers to colors ranging between blue-violet and yellow-green on the chromatic circle.

A website 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 website design were produced with color (temperature) combination being the only varying design element (see Figure 2). All other design elements (e.g. text, images, background) were held constant across the four designs, resulting in the following four split-complementary treatments or color combinations for the test website: 1) Warm Primary – Warm Secondary (Red/Orange); 2) Warm Primary – Cool Secondary (Red/Light Blue); 3) Cool Primary – Warm Secondary (Blue/Orange); and 4) Cool Primary – Cool Secondary (Blue/Light Blue). This research design allowed for any differences found among the four groups to be attributed to the decreased levels of color warmth as a result of color choices for the primary and secondary colors of the website.

Participants browsed through a website developed for this study in search of specific information. Having evaluated the website design randomly assigned to them, participants were then asked to rank all four designs in terms of their respectively perceived aesthetics.

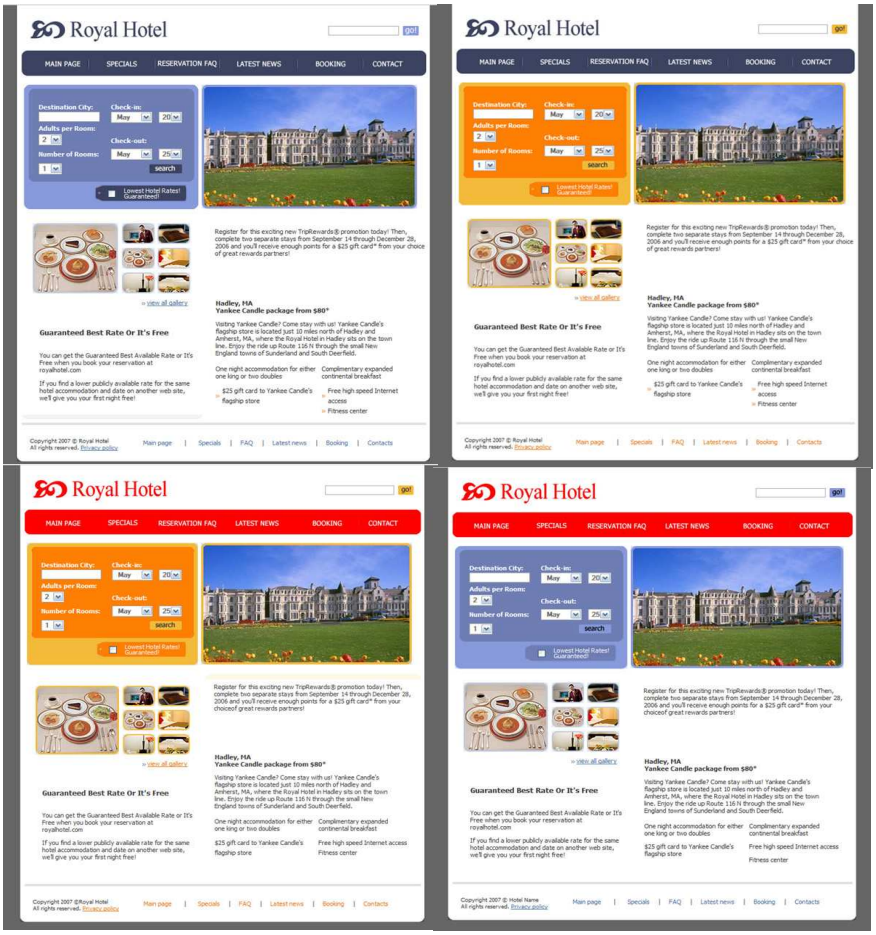

Figure 2. Screenshots of the website's designs from "coolest" to "warmest" (clockwise, from top left).

Subjects

Subjects were recruited for this Web-based voluntary study via email announcements on various databases and electronic mailing lists, resulting in 328 usable data sets with a minimum of 72 subjects per group. All participants used the same Website, but each treatment involved the use of a discriminant color design described above. This sample size far exceeded the minimum sample size of 60, per Chin's (1998) guidelines for Partial Least Squares analysis of our proposed research model. 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 was fairly gender balanced (170 males to 158 females). The average age was 34 (range: 18 to 70), participants were almost entirely college-educated and had an average experience of 17 years with computers and 10 years with the Web, respectively. ANOVA tests found no significant differences for subjects in the various treatment groups in terms of these control variables (gender, age, and education).

Instrument Scales and Validity

The questionnaire used for data collection contains scales that measure the various constructs shown in the research model and were adapted from Lavie & Tractinsky (2004) (Classical Aesthetics & Expressive Aesthetics); Webster & Martocchio (1992) (Playfulness); and Coursaris et al. (2007) (Efficiency, Effectiveness, and Satisfaction). The item "Easy to Navigate" was added to the Efficiency construct. Efficiency, Effectiveness, and Satisfaction combined represent usability. For all items other than those measuring satisfaction (which was measured through four semantic differential items), participants were asked to indicate agreement along a seven-point Likert scale ranging from "strongly disagree" "strongly agree." Participants responded to the questionnaire after being prompted to think about their impressions or experience with the website.

Tests for non-response, temporal, and common method bias were satisfied, as were those to ensure construct validity and the threshold for item-to-total correlation. Results of tests for convergent validity, discriminant validity, construct means, and Cronbach's alpha can be found in Table 1. All constructs had adequate reliability and internal consistency well above the 0.7 threshold. Cronbach α-values were satisfactory for our constructs (0.7921-0.9416) and constructs' AVE exceeded the 0.5 benchmark for convergent validity. As the Effectiveness construct consisted of only one item ("Completed All Tasks"), item analyses were not conducted.

Construct	Mean (All Items)	Mean (Used Items)	Cronbach Alpha	Composite Reliability (Internal Consistency)	Convergent Validity (AVE)	Discriminant Validity (√AVE)
Classical	5.4573	5.4573	0.7921	0.8567	0.5481	0.7403
Expressive	3.2939	3.2939	0.9058	0.9300	0.7270	0.8526
Playfulness	3.4304	3.1902	0.9280	0.9458	0.7781	0.8821
Efficiency	5.3994	5.3994	0.9416	0.9561	0.8136	0.9020
Effectiveness	5.1372	5.1372	N/A	N/A	N/A	N/A
Satisfaction	4.6128	4.6814	0.9030	0.9350	0.7828	0.8847

Table 1. Construct statistics.

Color

The four designs created were produced by manipulating color temperature and considering the intrinsic brightness of the primary colors first, followed by the intrinsic brightness of the secondary colors. Hence, the two designs with a blue navigation menu (example of primary color use) would denote the two cooler designs, and among them, the one with blue as text subheadings (example of secondary color use) ends up being the coolest temperature scheme among all four designs, and was coded in PLS as 0 and 1. Similarly, the two designs with the red navigation menu represent the two warmer designs, and among them the one with the red secondary elements would reflect the warmest color temperature design among all four (effectively a 2 & 3 coding in PLS). Hence, color temperature was coded in discreet, linear form in PLS representing the four levels of color temperature tested in this study. Rankings of Website designs were significantly different (tested via one-sample T-test) suggesting a preference for blues or the cool-cool color design (see Table 2).

Color temperature (primary-secondary)	N	Mean	S. Dev.	SE Mean	t-Value	df	Sig. (2-tail)
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

Table 2. Website rankings (of perceived aesthetics) and one-sample of comparison of means (mean reflects average of forced rank between 1 (most aesthetic) and 4 (least aesthetic).

Model Evaluation

Following from the earlier discussion on the instrument's validity, statistics regarding significant items and constructs are reported in Table 3. The proposed structural model shown earlier in Figure 1 was tested by Jackknifing in PLS. All nine hypotheses were supported, as shown in Figure 3, while Table 4 presents the validation of these hypotheses in more detail.

Hedonics

The paths from color temperature to both classical (β = .037, p < .001) and expressive aesthetics (β = -.046, p < .001) were significant, confirming Hypotheses 1 and 2. The effect of classical aesthetics on expressive aesthetics was significant (β = .566, p < .001), supporting Hypothesis 3. While color temperature accounted for only 4% of classical aesthetics (R2 = .041), color temperature and classical aesthetics together accounted for nearly 40% of the variance in expressive aesthetics (R2 = .394). The relatively small amount of variance explained in classical aesthetics suggests that there are other dimensions not captured by the scale, by the exogenous construct's effects, or both. Finally, Hypothesis 4 was supported, as the effect of expressive aesthetics on playfulness was significant (β = .783, p < .001). Nearly 67% of the variance in playfulness was accounted for by color temperature and aesthetics (R2 = .667).

Hedonic Effects on Usability

Supporting Hypothesis 5, playfulness significantly predicted satisfaction (β = .202, p < .001). In line with Hypothesis 6, classical aesthetics had a significant effect on efficiency (β = .574, p < .001).

Usability

Approximately one-third of the variance in efficiency and effectiveness was explained by the model (R2 = .367 and R2 = .303, respectively). Efficiency was a strong predictor of effectiveness (β = .580 , p < .001), confirming Hypothesis 7. While both the paths from efficiency to satisfaction (β = .554, p < .001) and effectiveness to satisfaction (β = .203, p < .001) were significant, efficiency was twice as strong a predictor. While the magnitude differences were not predicted, Hypotheses 8 and 9 were confirmed. In all, the model accounted for a very large amount of the variance in satisfaction (R2 = .649).

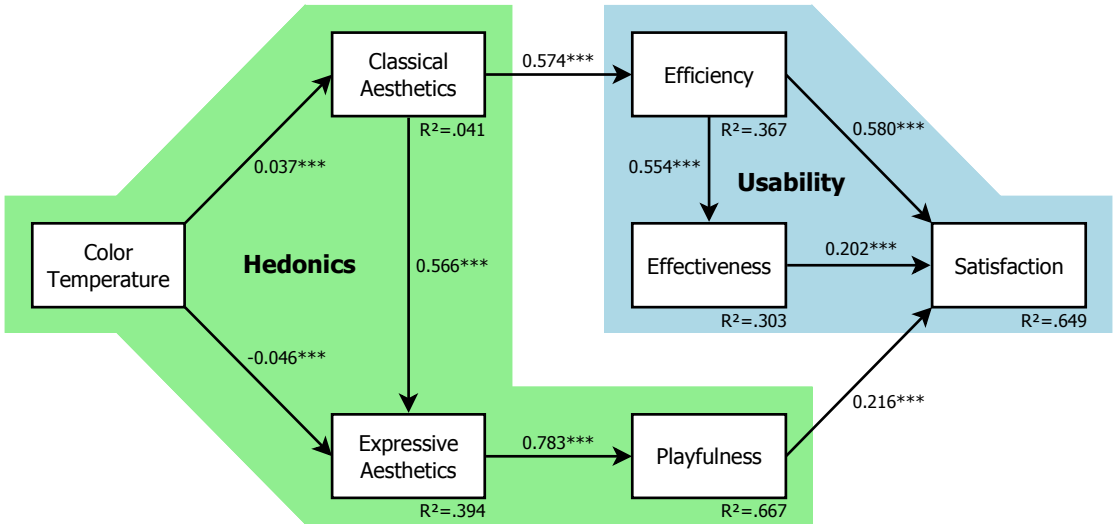

Figure 3. Research model with PLS results (* significant at 0.05 level, ** significant at 0.01 level, * significant at 0.001 level).**

Construct	Indicator	Mean	S. Dev.	Loading
Classical	Clean	5.9421	1.0549	0.6700
	Clear	5.3171	1.4325	0.7841
	Aesthetic	5.2317	1.2296	0.7831
	Pleasant	5.4787	1.1545	0.8415
	Symmetric	5.3171	1.2815	0.5962
Expressive	Original	3.4116	1.5577	0.8521
	Sophisticated	4.0793	1.5641	0.8308
	Fascinating	3.0793	1.5384	0.8958
	Creative	3.4390	1.5551	0.8910

	Uses special effects	2.4604	1.3808	0.7890
Playfulness	Spontaneous	3.1189	1.3550	0.7546
	Imaginative	3.2012	1.3644	0.9236
	Creative	3.3323	1.4365	0.9167
	Original	3.1707	1.4698	0.9018
	Innovative	3.1280	1.5029	0.9025
Efficiency	Easy to Learn	5.4909	1.4077	0.9188
	Easy to Use	5.4360	1.4449	0.9501
	User Friendly	5.2165	1.5813	0.9289
	Fast to Use	5.4512	1.4727	0.8107
	Easy to Navigate	5.4024	1.4950	0.8950
Effectiveness	Completed All Tasks	5.1372	1.9542	
Satisfaction	Terrible (1) Delighted (7)	4.7774	1.3932	0.9277
	Frustrated (1) Contented (7)	4.6890	1.3160	0.9208
	Unhappy (1) Gratified (7)	4.5030	0.9642	0.8100
	Sad (1) Joyful (7)	4.7561	1.4319	0.8757

Table 3. Items and construct statistics

Hypothesis	From	To	Path Coefficient	t-Value	p-Value	Status
1	Color Temp	Classical	0.037	26.2011	<.001***	Supported
2	Color Temp	Expressive	-0.046	-19.0226	<.001***	Supported
3	Classical	Expressive	0.566	81.3989	<.001***	Supported
4	Expressive	Playfulness	0.783	25.5049	<.001***	Supported
5	Playfulness	Satisfaction	0.216	6.4983	<.001***	Supported
6	Classical	Efficiency	0.574	-30.7984	<.001***	Supported
7	Efficiency	Effectiveness	0.554	8.6869	<.001***	Supported
8	Efficiency	Satisfaction	0.580	14.9864	<.001***	Supported
9	Effectiveness	Satisfaction	0.202	3.6387	<.001***	Supported

Table 4. Validity test results (* significant at 0.05 level, ** significant at 0.01 level, * significant at 0.001 level).**

CONCLUSION

All nine hypotheses were supported and the model accounted for more than 30% of the variance of all constructs with the exception of classical aesthetics, and more than 60% of the variance of playfulness and satisfaction. The path weights between color temperature and both classical and expressive aesthetics were found to be relatively small, while those between expressive aesthetics and playfulness, classical aesthetics and efficiency, and efficiency and satisfaction were extremely high.

While Hassenzahl et al. (2000) argued that users can independently perceive usability and hedonic qualities which contribute to overall product appraisals, our results show that the two are in fact closely connected. While differences in context (software prototypes in Hassenzahl et al. and Website designs in the present study) does not allow for a direct comparison, further research is needed to evaluate our model's applicability outside of Web design. Similarly, Diefenbach and Hassenzahl (2008) conceptualized aesthetics and utility competing with each other in affecting product choice. Our model suggests that while the two may compete at times, the relationship between hedonics and usability makes independent manipulation of aesthetics impossible. Despite linkages between aesthetics and usability, De Angeli et al. (2006) and Hartmann, Sutcliffe, and De Angeli (2008) found that websites considered to have better expressive aesthetics actually tended to have worse perceived usability. While we did not find any negative effects between aesthetics and usability, we did not include a direct path between expressive aesthetics and usability. We have, however, confirmed a path from aesthetics through efficiency to effectiveness, as suggested by Tractinsky (1997) and Kurosu and Kashimura (1995) in their studies of ATM usability. Evidence of a path from aesthetics through utility and playfulness to satisfaction is consistent with Tractinsky et al. (2000).

Consistent with Lavie and Tractinsky (2004), our results support the impact of playfulness on satisfaction, couched within the larger scope of hedonics and usability. The presence of direct connections between utility and satisfaction (instead of indirect connections between aesthetics and satisfaction) is in agreement with Thuring and Mahlke (2007), who found that user satisfaction is more affected by usability than aesthetics. Unlike Mahlke (2002), who found that effectiveness had a larger role than efficiency in influencing the products of satisfaction, we found that the relationship between efficiency and satisfaction was more than double the magnitude of effectiveness.

Our results partially support Frokjaer et al. (2000) in that the individual constructs of efficiency, effectiveness, and satisfaction were found to be distinct, but unlike Frokjaer et al. we did find strong relationships between them. Work by Coursaris et al. (2007) is in agreement with the strong link between efficiency and effectiveness seen in our model.

The findings of the present study also extend prior research regarding the direct effects of color combinations on aesthetics (Papachristos et al., 2005). 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 may convey information about the quality of the site that may not have been intended.

Implications for Practitioners

There are several important lessons to be gleaned from this research. First, Website design should attempt to use colors that will positively impact users' perceptions, and thereby increase their overall satisfaction. The colors present on a Web page directly impact visitors' impressions of its order and creativity, and indirectly impact perceptions of efficiency, effectiveness, playfulness, and satisfaction. The "safest" split-complementary color schemes (in terms of influencing users' impressions of a website'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. In general, using cool color schemes will create favorable impressions about the website's design, which in turn may translate in building credibility and trust. It should be noted that context is an overriding factor; in certain cases warm color combinations may result in higher aesthetic appeal.

Second, clean, orderly, and creative Website designs are more likely to be perceived as aesthetically pleasing, and in turn more usable. Third, efficiency and effectiveness are closely related to satisfaction, and must be considered, but with the understanding that they do not stand on their own, but rather are affected by the aesthetics of a Website. Finally, making Websites aesthetically pleasing, efficient, and effective is not sufficient to maximize user satisfaction. Playfulness must be considered; sites must be engaging and creative.

Future Directions

Through their work in developing a new user-assessment instrument, Zeng, Salvendy, & Zhang (2009) created a "creativity checklist for Website design." The major categories in the checklist are Aesthetically Appealing, Interactive, Novel and Flexible, Affective, Important, Common and Simple, and Personalized design. While the present paper focused on the largest of those categories (more than a third of all items fell into "aesthetically appealing design"), it is clear that there are other areas that may be included to create a more comprehensive model of Website usability and the antecedents of satisfaction. Other conceptualizations and constructs in the hedonics and usability literatures that should be considered include credibility (Robin & Holmes, 2008), enjoyment (Lee et al., 2005), visual complexity (Michailidou, Harper, & Bechhofer, 2008),

accessibility (Mbipom, 2009), curiosity (Huang, 2003), goodness (Van Schaik & Ling, 2008), and emotions (Thuring & Mahlke, 2007).

Attractiveness, another hedonic concept that should be considered for addition into the model, and has been linked to both aesthetics and to usability in the literature. Van Schaik and Ling (2009) examined the effects of context on aesthetics, and found that classical aesthetics was more tightly associated with attractiveness than expressive aesthetics for informational Web pages. Van der Heijden (2003) found that attractiveness had a strong impact on efficiency. Taken together, this suggests that attractiveness may provide a third link between hedonics and usability, with paths leading to it from both classical and expressive aesthetics, and leading out to efficiency.

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