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The authors investigate the link between the color of a Web page's background screen while the page is downloading and the perceived quickness of the download. They draw on research that supports links between color and feelings of relaxation and between feelings of relaxation and time perception. The authors predict that the background screen color influences how quickly a page is perceived to download and that feelings of relaxation mediate this influence. In a series of experiments, they manipulate the hue, value, and chroma dimensions of the color to induce more or less relaxed feeling states. The findings suggest that for each dimension, colors that induce more relaxed feeling states lead to greater perceived quickness. The authors provide triangulating evidence with an alternative manipulation: the number of times subjects wait for a download. As does color, this also leads to variation in levels of relaxation and perceived quickness. A final experiment reveals that color not only affects perceived download quickness but also has consequences for users' evaluations of the Web site and their likelihood of recommending it to others.

Waiting for the Web: How Screen Color Affects Time Perception

A significant criticism that consumers raise about using the Internet is that it often takes a long time to download Web pages, a problem that is only becoming worse (Dennis 2001). Zona Research maintains that pages on many consumer Web sites take up to 20% longer to download now than they did a year ago, mainly because of the introduction of heavy graphics and multimedia elements on the Web sites (Dennis 2001). A Jupiter Media Metrix consumer survey found that 40% of online surfers would visit a content site more often if its pages downloaded more quickly, but only 20% would be motivated by the addition of a richer media experience (Pastore 2001). Limited bandwidth plagues the industry, and as rich media–based content offerings proliferate, download time is becoming an increasingly pressing issue for online commerce.

Broadband is a widely embraced solution to Web congestion and slow download times. However, its penetration is and will continue to be costly (Virtel 2001). Broadband also does not fully solve the problem, because it encourages the use of rich media content, which in turn affects download speeds (Dennis 2001). Furthermore, broadband as a solution is fundamentally driven by an engineering view and its focus on the objective time needed to download a page. Although the objective speed of a download is important to users' perception of its speed, other subjective factors may be at work as well. We suggest that such a factor is the background screen color that typically first appears when a download is in progress, a feature that is ubiquitous in the Web environment. We draw on research that links each of the three dimensions of color (hue, value, and chroma) to feelings of relaxation.[1] We integrate this work with research on time perception that suggests that being relaxed during a wait influences whether the wait is perceived as long or short. Associating the two, we propose hypotheses about how the color of the download screen and the feelings of relaxation that it elicits influence the perceived quickness of

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[1]Hue is the pigment of the color (e.g., red, blue), chroma is the saturation (amount of pigmentation) in the color, and value is the whiteness or blackness of the color.

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a download. We present four experiments that test our hypotheses.

Our research makes both conceptual and practical contributions. More broadly, we contribute to an emerging area of research whose focus is on understanding consumer responses in computer-mediated environments (Alba et al. 1997; Dholakia and Bagozzi 2001; Hoffman and Novak 1996; Johnson 2001). We add to this literature by examining how the screen color, an important visual element of the computer-mediated environment, influences the perceived quickness of a download. In proposing that feelings of relaxation act as a mediator of this influence, we contribute to an understanding of the underlying mechanism. This should be important in terms of both theoretical knowledge about the effects of color and how exposure characteristics in general influence perceived quickness through the same process. We provide convergent evidence for the role of feelings of relaxation by also examining repeated exposure to a slow downloading screen, another aspect of the exposure context that affects feelings of relaxation. We also show how color's effect on relaxation and its effect on perceived quickness have downstream effects on consumer judgments of a Web site and willingness to recommend it to others.

Apart from theoretical considerations, we demonstrate that management of perceived quickness complements engineering solutions to the problem, which are the dominant approaches today. Our findings should help guide managerial decisions on the design of Web interfaces, because they suggest that a manager consider each of the dimensions of color and select screen colors that relax people during a wait, thus influencing perceived quickness and overall evaluations.

CONCEPTUAL FRAMEWORK

In developing our conceptualization, we review the literature on time perception to establish the link between feelings of relaxation and judgments of elapsed time. We then review the literature on color and link each of the three dimensions of color (hue, chroma, and value) to feelings of relaxation. We then suggest how the color of the background screen during a download from the Web influences the perceived quickness of the download.

Time Perception

Research on time perception suggests that particular feeling states, variously described in the literature as "stressed" or "tense," lengthen the estimate of how much time has elapsed.[2] Watts and Sharrock (1984) find that subjects who had a phobia of spiders gave longer estimates of a short interval spent observing a spider than did nonphobic controls. Thayer and Schiff (1975) find that the time estimates of participants who were asked to make eye contact with a person with a negative facial expression (a scowling, angry expression) were longer than for those asked to make eye contact with a person with a positive facial expression (a smiling, friendly expression). Thayer and Schiff (1975) describe the experience of respondents making eye contact with a person with a negative facial expression as more stressful.

Why does this occur? Two contributing factors may be at play. First, stress or anxiety may accelerate a person's "internal clock" (more time passes on that clock than may actually be the case), which results in a perception of time passing slowly (Lockhart 1967; Schiff and Thayer 1968; Triesman 1963). Second, people typically want an unpleasant situation to end as soon as possible, and the anticipation of this desired goal makes it seem that time is dragging. Thayer and Schiff (1975) use the notion of time seeming to drag to explain the longer time estimates of subjects who made eye contact with people with negative facial expressions. Similarly, the spider-phobic subjects in the work of Watts and Sharrock (1984) likely believed that the time dragged until the spider that was placed on a table in front of them during the experimental session was removed. Taken together, these studies suggest that time should seem to pass slowly when a person is in a state of tension or, in other words, when a person is at the tension end of the relaxation–tension continuum.

The Three Dimensions of Color and Feelings of Relaxation

Color is a variable that has been shown to elicit feelings of relaxation and is ubiquitous on Web sites. Each of the three dimensions associated with a color has been shown to affect feelings of relaxation.[3] We first examine the hue dimension, which is the dimension that has been the focus of both academic and industry research (e.g., Bellizzi and Hite 1992; Gorn et al. 1997; Jacobs et al. 1991; Madden, Hewett, and Roth 2000).

Hue. Hues (e.g., blue, yellow, red) are experienced as discrete psychological categories. Differences across hues are perceived as qualitative instead of as varying along a quantitative continuum (Abramov 1997).[4] Although the existing research on color does not provide a theoretical rationale for exactly how a hue might affect feelings of relaxation, sufficient evidence exists to indicate that certain hues are more relaxing than others. In particular, an extensive body of research supports the premise that blue hues elicit relaxed feeling states (see Gerard 1958; Gorn et al. 1997; Jacobs and Hustmyer 1974; Jacobs and Suess 1975; Valdez and Mehrabian 1994). In contrast, yellow has been found to elicit less relaxed feeling states (see Adams and Osgood 1973; Jacobs and Suess 1975). For example, using measures of galvanic skin response, Jacobs and Hustmyer (1974) show that blue is a more relaxing color than yellow or red. Batra, Urvashi, and Muhar (1998) report similar results. Using rating-scale measures of feelings, Gorn and colleagues (1997) show that red elicits more excitement and that blue elicits more relaxation.

Chroma. In contrast with hue, which is perceived in categories, chroma is a continuous dimension. It ranges from high to low pigmentation (saturation). By virtue of having more pigmentation, higher chroma colors are more vivid and stand out more than lower chroma colors. On the basis of this characteristic, Valdez and Mehrabian (1994) pre-

[2]Tension and relaxation are related and considered opposite sides of the same spectrum (Apter 1982; Smith and Apter 1975).

[3]We formulate main-effect hypotheses for each dimension. In the limited research that has examined the effect of all three dimensions on feelings, interaction effects were not found (Gorn et al. 1997; Valdez and Mehrabian 1994).

[4]The underlying dimension of hue is the wavelength of light, which is continuous. However, because of the way the retinal cones respond to different light frequencies, hues are experienced as discrete psychological categories (see Abramov 1997).

dicted and found that higher chroma colors in print were more arousing.[5] We expect that this should be even more the case with computers, because colors on a computer screen appear to be more intense than colors in print because of the additional light source coming from the monitor. Golding and White (1997) suggest that because of this light, contrasts on the Web are far more intense than contrasts in noncomputer contexts. They further state (p. 90) that the "intense projected light is constantly tiring the cones." As a result, higher-chroma colors, which already stand out more than lower-chroma colors, should appear to be even more intense on a computer screen. Thus, they should elicit less relaxed feeling states than lower-chroma colors.

Value. As is chroma, value is a continuous dimension. Lower-value colors have a blackish quality about them, as if the color black were mixed into the pigment; higher-value colors have a whitish or pastel quality about them, as if the color white were mixed into them. Research suggests that higher-value colors elicit greater feelings of relaxation than do lower-value colors. James and Domingos's (1953) psychophysiological work suggests that white has a calming effect, because white light seems to produce the least amount of tension in the form of hand tremor. Ott (1976) reports that students in classrooms lit with full-spectrum white light are calmer and less fidgety than students in classrooms with other lighting conditions. Profusek and Rainey (1987) investigate the effects of rooms painted in red or Baker-Miller pink, a higher-value color, on a person's feelings of anxiety. As they hypothesized, the rooms painted in Baker-Miller pink induced calmness. Gorn and colleagues (1997) show that higher-value background colors in advertisements enhance feelings of relaxation. Valdez and Mehrabian (1994) report similar results.

We subsequently describe the experiments that we conducted. Experiment 1 investigates the effects of hue, the dimension of color that has attracted the most academic research and has been the focus of managers as well. Experiment 2 replicates our effects with a different manipulation of hue. It provides triangulating evidence for the notion that feelings of relaxation mediate perceived quickness by showing how a different exposure characteristic (number of exposures) influences perceived quickness through the same relaxation mechanism. Experiment 3 explores the value and chroma dimensions. Experiment 4 follows up on the first three experiments by investigating whether the effects of color on perceived download quickness extend to managerially relevant, evaluation-related dependent variables, such as consumers' attitudes toward a Web site and their willingness to recommend the site to others. We held the actual download time constant across all experiments.

EXPERIMENT 1

As we discussed previously, some hues have been found to induce more relaxed feeling states than other hues (see Batra, Urvashi, and Muhar 1998). Of particular relevance to reactions to colors on a screen is the research of Jacobs and Suess (1975). They projected colored slides onto a screen and obtained higher anxiety scores for yellow than for blue. In Experiment 1, we compare blue with yellow. Given the tendency for blue on a screen to elicit a more relaxed feeling state than yellow, and because of the suggestion in the time-perception literature that time passes more quickly when a person is relaxed rather than tense, we expect that blue results in greater perceived download quickness than yellow. This leads to the following hypotheses:

H_1: (a) Perceived quickness of the download is greater with blue than yellow, and (b) this effect is mediated by the greater feelings of relaxation that blue induces than yellow.

Method

Subjects and design. In exchange for course credit, 49 undergraduate students from introductory marketing classes participated in Experiment 1. We used a between-subjects design with two experimental conditions: blue hue and yellow hue. Subjects were randomly assigned to experimental conditions.

Procedure. We used the same procedure, with only minor variations, in all experiments. We describe the basic procedure in full here and then mention only points of difference for subsequent experiments. Subjects were introduced to the ostensible purpose of the study as follows: They were told that they would be exposed to a new Web-based real estate program and would be asked some questions that pertained to both the executional elements and the content of the program. The first two screens helped subjects become familiar with the computer they were on and illustrated the question format. The Web program followed. It consisted of a series of screens that contained pictures of rooms or houses/apartments, and each picture was followed by a screen that contained a question about the picture. The test screen was a Web page with a full screen of the assigned color and the word "Downloading…" in the lower-right-hand corner in a gray box. Gray is a neutral color (Valdez and Mehrabian 1994) and thus the best choice if an undesirable contrast effect is to be avoided.

The color selected for each of the experimental conditions (blue or yellow) remained on the screen for 17.5 seconds. We chose 17.5 seconds as a result of discussions with Internet experts who suggested using a download time between 15 and 20 seconds and because of the information that the average page-response time for a business-to-consumer site is 17 seconds (Dennis 2001). Too short a time would not have allowed for a test of the effects of the download color, nor would too long of a time, because no matter what color was on the screen, subjects would become tense if they needed to wait long for a screen to download. To control the download speed of the program, all files associated with the Web site were copied to a local Web server, which had a high-speed direct link to the computer laboratory and ensured that the actual times were accurate (17.5 seconds). We then collected the dependent measures. After completing the dependent measures and the background measures, subjects were debriefed and dismissed.

Stimuli. We chose the blue and yellow tested in this experiment using the hue, saturation, and brightness (HSB) model, the color model most widely used by Web designers. The HSB model measures hue on a color wheel that ranges from 0 to 360 degrees. Chroma is represented as the amount of gray in proportion to the hue, measured as a percentage from 0% (gray) to 100% (fully saturated). Value, the rela-

[5]Relaxation is a low-arousal positive state (Apter 1982); thus, by definition, high arousal means low relaxation.

tive lightness or darkness of the color, is measured as a percentage from 0% (black) to 100% (white).

A convenience sample of professional designers from a respected Web design group on the Internet (Babble) helped us choose blue and yellow hues that were perceptually maximally distinct in Experiment 1; the designers also helped with the later experiments. Using the HSB model, we chose the hues blue 240 and yellow 60 because they are full blues and yellows, respectively. We set the chroma and value levels at 100%, because at that level, the hues are most distinct. We also used these value and chroma levels in Experiments 1 and 2.

Dependent variables. Because our focus was consumers' perceptions of the speed of downloading Web pages, we used an evaluative measure of perceived download speed. We asked subjects whether the download was quick or not quick. We measured perceived quickness on three nine-point scales: 1 = "slow" and 9 = "fast," 1 = "not speedy" and 9 = "speedy," and 1 = "not quick" and 9 = "quick." The coefficient alpha computed for this measure ($\alpha = .94$) indicates a high degree of internal consistency. The mean of the three items served as the measure of perceived quickness, a measure that is consistent with what are called "verbal estimates" in the time-perception literature (for a discussion of the various approaches, see Doob 1971; for the use of similar measures, see Banks and Cappon 1962; Goldstone and Goldfarb 1964).

We chose perceived quickness rather than a quantitative estimate of the number of seconds subjects believed the download took because perceived quickness is an evaluative construct, not just a time estimate. As such, it not only is better linked to the relaxation measure, which is a valenced construct, but also has managerially relevant consequences, such as attitudes and intentions about the Web site. In Experiment 4, we also incorporate a seconds estimation and show how perceived quickness has more substantive implications than does the seconds estimate.

For the feelings-of-relaxation measure that followed, the color was reinstated at the top of the screen, and subjects were asked how they felt at the time they were watching the color and waiting for the page to download. Subjects rated the following items on nine-point scales that ranged from 1 = "not at all" to 9 = "very much so": relaxed, calm, peaceful, uneasy, tense, and anxious. We reverse-scored the latter three to construct the dependent measure. The coefficient alpha for this measure ($\alpha = .81$) represents a sufficiently high level of internal consistency, such that the mean of the scale items served as the measure of feelings of relaxation. We structured the order of the measures (perceived quickness followed by relaxation) to allow for a stronger test of feelings of relaxation as the proposed mediator. At the end of the experimental session, subjects answered questions that pertained to their age, sex, native language, and Internet experience. We do not discuss these measures herein because they do not affect responses to the dependent measures. We also measured color blindness, so that we could remove color-blind subjects from the analyses.

Results and Discussion

The main effect of hue on perceived quickness was significant ($F(1, 47) = 3.95$, $p < .05$; $MS_{Hue} = 43.05$). Consistent with H_{1a}, participants in the blue-hue condition perceived the download as quicker (mean = 3.67) than did participants in the yellow-hue condition (mean = 3.04; for means and confidence intervals, see Table 1). The relaxation measure followed a similar pattern. There was a significant effect of hue on relaxation ($F(1, 47) = 9.12$, $p = .01$; $MS_{Hue} = 473.23$). Participants exposed to the blue background screen reported feeling more relaxed (mean = 5.13) than did participants exposed to the yellow background screen (mean = 4.10).

We then ran an analysis of covariance (ANCOVA) with hue as the independent factor, perceived quickness as the dependent variable, and relaxation as the covariate, to examine the proposed mediating effect of relaxation on perceived quickness. Findings revealed that the previously significant effect of hue disappeared with the inclusion of relaxation as a covariate ($F(1, 46) = 1.08$, $p > .10$; $MS_{Hue} = 10.94$); furthermore, the covariate was statistically significant ($F(1, 46) = 4.40$, $p < .05$). As an index of the magnitude of the mediation, we computed the percentage of reduction in the mean square (MS) of the effect produced by the covariate (Pham and Muthukrishnan 2002). Felt relaxation mediated 75% of the MS effect for hue on perceived quickness. These results support H_{1b}, the mediation hypothesis.[6]

EXPERIMENT 2

Experiment 2 extends the findings of Experiment 1 by providing convergent evidence in two ways. First, it extends the generalizability of the hue effect obtained in Experiment 1 by comparing blue with a different hue: red. As with yellow, Jacobs and Suess (1975; see also Lewinski 1938) found that when red was projected onto a screen, it induced less relaxed feeling states than when blue was projected. Thus, we expect greater perceived quickness with blue than red, as was the case for blue versus yellow in Experiment 1. Again, feelings of relaxation should mediate this effect. This leads to the following hypotheses:

H_2: (a) Perceived quickness of the download is greater with blue than red, and (b) this effect is mediated by the greater feelings of relaxation that blue induces than red.

Second, to provide triangulating evidence for the effect of relaxation on perceived quickness of a download, we examine a different element of the exposure context that should be important in a Web-surfing experience. Specifically, we investigate subjects' reactions to a repeated (rather than a single) slow download experience. Research shows that a negative situation becomes increasingly negative the

[6]We obtained similar results for percentage eta square reduction. The two also produced similar results in the later experiments as well. Thus, we report only MS percentage reduction throughout the article.

Table 1

EXPERIMENT 1: CELL MEANS AND CONFIDENCE INTERVALS FOR PERCEIVED QUICKNESS AND RELAXATION

	Blue (N = 25)	*Yellow (N = 24)*
Perceived quickness	3.67	3.04
	(3.22–4.11)	(2.59–3.49)
Relaxation	5.13	4.10
	(4.67–5.62)	(3.61–4.59)

Notes: The 95% confidence interval is in parentheses.

longer a person is in that situation (e.g., Osuna 1985; Palm 1953; Wolff and Wolf 1959). The longer a person is forced to wait for a service, the more negative is the reaction (Carmon, Shanthikumar, and Carmon 1995). Thus, if the waiting experience occurs more than once during a service occasion, we expect that people become more tense and find it more difficult to relax. This leads to the following hypotheses:

H_3: (a) Perceived quickness of the download is greater with one exposure to the download screen than with two consecutive exposures, and (b) this effect is mediated by the greater feelings of relaxation induced by one exposure to a wait for a download than two exposures.

Method

Subjects and design. In exchange for course credit, 64 undergraduate students participated in Experiment 2. We used a 2 × 2 mixed design, with one between-subjects factor (hue: blue versus red) and one within-subjects factor (exposures to the slow downloading screen: one versus two). Subjects were randomly assigned to experimental conditions. We eliminated data from three color-blind subjects, for a total of 61 usable questionnaires.

Procedure. The procedure was the same as in Experiment 1, except for the following: (1) between the first and second exposures, subjects were exposed to 17 filler screens that primarily contained pictures of apartments/houses and then questions about them, and (2) the dependent measures were administered after each exposure to the download screen. The download time was 17.5 seconds on each occasion.

Stimuli. The specific blue we tested was blue 240, as in Experiment 1. The red was red 340, a full red. We set the chroma and value levels at their maximum (i.e., 100%).

Dependent variables. In Experiment 2, we used the same dependent variables as in Experiment 1: measures of relaxation and perceived quickness. We computed coefficient alphas for perceived quickness and felt relaxation, which resulted in values of .93 and .79, respectively. The mean scores of the items making up each scale served as the operational measure.

Results and Discussion

We ran two two-way analyses of variance (ANOVAs) to analyze the effects of hue and number of exposures to the wait. In the first, repeated exposure served as a within-subjects factor, hue as a between-subjects factor, and perceived quickness as the dependent variable. The hue effect was significant (hue: $F(1, 59) = 5.21$, $p < .05$; $MS_{Hue} = 189.35$; for the cell means and confidence intervals, see Table 2). Participants who were exposed to the blue background screen perceived the download as quicker (mean = 5.92) than did participants exposed to the red background screen (mean = 5.09). The repeated-exposure effect was also significant ($F(1, 59) = 6.95$, $p < .01$; $MS_{Exposure} = 38.91$). The download was perceived as quicker after the first delayed download (mean = 5.69) than after the second delayed download (mean = 5.31). The hue × exposure interaction for perceived quickness was not significant ($p > .25$).

Felt relaxation was the dependent variable in the second ANOVA, which resulted in a significant effect of hue on relaxation ($F(1, 59) = 31.45$, $p < .01$; $MS_{Hue} = 1007.57$). Consistent with H_{2a}, participants reported being more relaxed with the blue screen (mean = 5.78) than the red screen (mean = 4.83). Consistent with H_{3a}, the repeated-exposure factor also exerted a significant effect on relaxation ($F(1, 59) = 56.76$, $p < .01$; $MS_{Exposure} = 193.87$). As we expected, participants reported being more relaxed after the first delayed download (mean = 5.51) than after the second (mean = 5.09). In addition, the hue × exposure interaction was significant ($F(1, 59) = 5.88$, $p < .05$; $MS_{Hue \times Exposure} = 20.10$). An examination of the means in Table 2 reveals that the difference in feelings of relaxation between blue and red is somewhat smaller after the second exposure (5.51 and 4.68 for blue and red, respectively) than after the first exposure (6.06 and 4.97, respectively), though it is still significant at the .05 alpha level. The results imply that consumers' repeated exposure to a slow download can decrease feelings of relaxation, even for a favorable (i.e., intrinsically relaxing) background screen color.

To examine whether relaxation mediated the impact of the independent variables on perceived quickness, we ran an ANCOVA with hue and repeated exposure as the independent variables, perceived quickness as the dependent variable, and the difference in the score on the relaxation measure taken after the first and the second delayed download as the covariate. The ANCOVA revealed that the previously significant effects of hue on perceived quickness disappeared ($F(1, 58) = 2.72$, $p > .10$; $MS_{Hue} = 94.70$), and the effect of repeated exposure was attenuated ($F(1, 58) = 3.61$, $p < .06$; $MS_{Exposure} = 20.56$). The covariate approached statistical significance ($F(1, 58) = 3.65$, $p < .06$). Feelings of relaxation accounted for 50% of the MS effects for hue and 47% of the MS effects for repeated exposure. In general, these results support H_{2b} and H_{3b}. They add further evidence to the results we obtained in Experiment 1 for the proposed mediating role of feelings of relaxation on perceived quickness. The findings imply that the results for hue in Experiment 1 generalize to Experiment 2. They also provide convergent evidence for the mediating role of relaxation by showing that another factor (number of exposures) affected feelings of relaxation and influenced perceived quickness in the manner predicted.

EXPERIMENT 3

Experiment 3 investigated the other two dimensions of color: chroma and value. As we discussed previously, lower-chroma colors should be perceived as less intense than higher-chroma colors, particularly on a computer screen (Golding and White 1997; Khouw 2001). Thus, we

Table 2

EXPERIMENT 2: CELL MEANS AND CONFIDENCE INTERVALS FOR PERCEIVED QUICKNESS AND RELAXATION

		Blue (N = 30)	*Red (N = 31)*
Time 1	Perceived quickness	6.09 (5.57–6.61)	5.29 (4.70–5.88)
	Relaxation	6.06 (5.83–6.29)	4.97 (4.67–5.25)
Time 2	Perceived quickness	5.74 (5.28–6.20)	4.88 (4.38–5.39)
	Relaxation	5.51 (5.28–6.07)	4.68 (4.46–4.90)

Notes: The 95% confidence interval is in parentheses.

expect that lower-chroma colors produce greater feelings of relaxation and greater perceived quickness.[7] This leads to the following hypotheses:

H_4: (a) Perceived quickness of the download is greater with a lower-chroma color than with a higher-chroma color, and (b) this effect is mediated by the greater feelings of relaxation that a lower-chroma color induces than a higher-chroma color.

As we mentioned previously, it has been found that higher-value colors induce greater feelings of relaxation than do lower-value colors (e.g., Batra, Urvashi, and Muhar 1998), which leads to the following hypotheses:

H_5: (a) Perceived quickness of the download is greater with a higher-value color than with a lower-value color, and (b) this effect is mediated by the greater feelings of relaxation that a higher-value color induces than a lower-value color.

Method

Subjects and design. In exchange for course credit, 120 undergraduate marketing students participated in Experiment 3. We used a 2 × 2 between-subjects factorial design with two levels of value and chroma. Subjects were randomly assigned to experimental conditions. We eliminated data from three color-blind subjects, for 117 usable questionnaires.

Procedure. The procedure we used in Experiment 3 was the same as in Experiment 1, which also had a single exposure to the download screen. As in the previous experiments, the download time was 17.5 seconds.

Stimuli. As we have indicated, we consulted with a group of Web designers to choose the colors we tested in this research. For chroma and value, the designers suggested that chroma levels of 42% and 100% and value levels of 58% and 100% were suitable, because these levels are perceptually distinct. Although there were virtually an infinite number of combinations of chroma and value levels that we could have tested, our goal in selecting colors to use in the experiments was to ensure that the levels that we chose would be adequate to manipulate feelings of relaxation. Note also that the specific levels of value and chroma chosen are symmetrical, in that the 42% level for chroma is 58 degrees away from maximum saturation (100% chroma), and the 58% for value is also 58 degrees away from maximum blackness (0%). The hue was blue 240.

Dependent variables. The dependent variables were the same as in the previous experiments: measures of perceived quickness and feelings of relaxation. Coefficient alphas for the measures of perceived quickness and feelings of relaxation were .97 and .88, respectively. The mean of the items comprising each scale served as the operational measure.

Results and Discussion

As we expected, there was a main effect of value on perceived quickness ($F(1, 113) = 137.90$, $p < .01$; $MS_{Value} = 2455.93$). Perceived quickness of the download for subjects in the higher-value condition was considerably greater (mean = 6.53) than for those in the lower-value condition (mean = 3.47; for cell means and confidence intervals, see Table 3). The chroma effect was also significant ($F(1, 113) = 7.32$, $p < .01$; $MS_{Chroma} = 130.46$). People in the lower-chroma condition perceived the download as faster (mean = 5.35) than did people in the higher-chroma condition (mean = 4.64). The interaction between value and chroma was not significant ($p > .25$). These results support H_{4a} and H_{5a}.

The results for relaxation paralleled the results for perceived quickness. There was a significant effect in the predicted direction for value ($F(1, 113) = 116.11$, $p < .01$; $MS_{Value} = 3678.21$). Subjects in the higher-value condition (mean = 6.88) were more relaxed than subjects in the lower-value condition (mean = 5.00). There was also a significant effect for chroma ($F(1, 113) = 51.20$, $p < .01$; $MS_{Chroma} = 1622.04$); people in the lower-chroma condition were more relaxed (mean = 6.56) than people in the higher-chroma condition (mean = 5.32).

The interaction between value and chroma for feelings of relaxation was significant ($F(1, 113) = 5.58$, $p < .05$; $MS_{Value \times Chroma} = 176.80$). The interaction was driven by the effect of chroma being larger when value was higher (means: lower chroma = 7.70 and higher chroma = 6.05) than when it was lower (means: lower chroma = 5.42 and higher chroma = 4.59). We were not surprised by this because lower-value colors are darker, which means that changes in chroma are more difficult to distinguish at lower-value levels than at higher-value levels. In any event, the variance explained by the interaction was small compared with that explained by the main effects. The MS effect of the interaction was 176.80, compared with 3678.21 and 1622.04 for the value and chroma MS effects, respectively. An analysis of the simple effect of chroma for each level of value showed that chroma significantly affected relaxation in the expected direction at each value level (lower value: $F(1, 113) = 11.38$, $p < .01$; higher value: $F(1, 113) = 45.74$, $p < .01$).

To examine whether relaxation mediated the effect of the independent variables on perceived quickness, we ran an ANCOVA with value and chroma as the independent variables, perceived quickness as the dependent variable, and feelings of relaxation as the covariate. The analysis showed that the previously significant effect of chroma on perceived quickness disappeared ($F(1, 112) = 1.10$, $p > .05$;

Table 3

EXPERIMENT 3: CELL MEANS AND CONFIDENCE INTERVALS FOR PERCEIVED QUICKNESS AND RELAXATION

		Low Chroma (N = 59)	*High Chroma (N = 58)*
Low value (N = 58)	Perceived quickness	3.70 (3.20–4.20)	3.23 (2.70–3.77)
	Relaxation	5.42 (5.09–5.75)	4.59 (4.23–4.94)
High value (N = 59)	Perceived quickness	7.00 (6.47–7.53)	6.05 (5.55–6.55)
	Relaxation	7.70 (7.35–8.05)	6.05 (5.72–6.38)

Notes: The 95% confidence interval is in parentheses.

[7]The greater intensity of higher- versus lower-chroma colors was confirmed in a focus group. Even after only a brief period of exposure to a full computer screen of a higher-chroma color, participants believed that the color strained their eyes and was too intense. This was not the case when they looked at higher-chroma colors on a printed page. In support of this, Khouw (2001) finds that a high-chroma background screen color is considered overpowering.

MS_{Chroma} = 18.92). The covariate was significant ($F(1, 112) = 4.89$, $p < .05$). Feelings of relaxation mediated 83% of the MS effect of chroma on perceived quickness. The MS effect of value on perceived quickness was attenuated with feelings of relaxation included as a covariate ($F(1, 112) = 46.42$, $p < .01$; $MS_{Value} = 799.15$). Feelings of relaxation mediated 68% of the MS effect of value on perceived quickness. Overall, these results provide support for the mediation hypotheses (H_{4b} and H_{5b}).

In summary, consistent with H_4 and H_5, the results of Experiment 3 provide evidence that both the value and the chroma level of a screen color influence perceived quickness and that, as in Experiments 1 and 2, feelings of relaxation mediate these effects. Experiment 4 builds on these results by examining whether the download screen color and concomitant feelings of relaxation extend to measures of Web site evaluation.

EXPERIMENT 4

Taken together, Experiments 1–3 provide support for the premise that the feelings of relaxation elicited by the download screen color influence perceived quickness. The question then arises as to whether this effect carries over to affect people's reactions to a Web site. Previous marketing research in Web site contexts supports the notion that more waiting does have implications for the evaluation of a Web site (Dellaert and Kahn 1999). In Experiment 4, we tested the hypothesis that screen colors influence evaluations of the Web site and that the perceived quickness of a download mediates this effect.

Method

Subjects and design. In exchange for course credit, 73 undergraduate marketing students participated in the study. Experiment 4 was a between-subjects single-factor design, with two colors as a between-subjects factor. Subjects were randomly assigned to experimental conditions in which the color would create more or less relaxed feeling states, as in the previous experiments. The two experimental conditions were (1) blue hue, high value, low chroma and (2) yellow hue, low value, high chroma. The procedure was the same as that used in Experiments 1 and 3.

Stimuli. Our goal in selecting colors for the two experimental groups was to create a maximal difference in the feelings of relaxation they elicited, because evaluations are more distal from feelings of relaxation than perceived quickness and thus more difficult to influence. On the basis of the results of Experiments 1–3, we selected the following two colors: (1) positive color: blue 240, value 100, chroma 42, and (2) negative color: yellow 60, value 58, chroma 100.

Dependent measures. The measures were the same as in the previous experiments, with some additions, including a time-estimate measure that required subjects to report in seconds how long they believed that it took the page to download (the scale ranged from 1 to 46 seconds). This measure enabled us to investigate whether we would obtain the effects we had observed for perceived quickness for time estimation as well. After subjects completed the perceived-quickness measure, the seconds estimate, and the measures that pertained to feelings of relaxation ($\alpha = .91$; for perceived quickness, $\alpha = .97$), we presented them with two additional measures to tap their evaluative reactions. The first was an attitudinal measure; the second was a behaviorally oriented measure. In the evaluative measure, subjects assessed the Web site on two nine-point scale items (9 = "good" and 1 = "bad" and 9 = "like" and 1 = "dislike"). We used the mean of these items as our attitude measure ($\alpha = .89$). In the behaviorally oriented measure, subjects indicated whether they would recommend the company's Web site to a friend looking for real estate (9 = "definitely yes" and 1 = "definitely no"). Last, we investigated another possible explanation. We examined whether the effects of color on perceived quickness were simply due to differences in mood states rather than feelings of relaxation. Subjects were asked to rate their mood on two scales: 1 = "bad" to 9 = "good" and 1 = "sad" to 9 = "happy." We used the mean of these two scales as a measure of mood valence ($\alpha = .82$).

Results and Discussion

The results suggested that, as we expected, there was a significant effect of color on perceived quickness ($F(1, 72) = 4.77$, $p < .05$; $MS_{Color} = 75.98$). As in the previous experiments, participants in the positive color condition perceived the page as downloading faster (mean = 3.56) than did participants in the negative color condition (mean = 2.88; see Table 4). The results for feelings of relaxation paralleled the results for perceived quickness. There was a significant effect in the predicted direction for color ($F(1, 72) = 4.23$, $p < .05$; $MS_{Color} = 116.63$). Participants who viewed the positive color had greater feelings of relaxation (mean = 4.26) than did participants who viewed the negative color (mean = 3.41).

The mediation analysis showed that the previously significant effect of color on perceived quickness disappeared when we introduced feelings of relaxation as a covariate ($F(1, 72) = 1.65$, $p > .05$; $MS_{Color} = 19.91$; covariate $F(1, 72) = 23.62$, $p < .05$). The MS effect was reduced by 75%. The results parallel those we obtained in Experiments 1–3.

It is important to note that attitudes toward the Web site were also higher for subjects in the positive color condition (mean = 5.78) than for subjects in the negative color condition (mean = 5.09; $F(1, 72) = 10.59$, $p < .002$; $MS_{Color} = 34.98$). Perceived quickness partially mediated this effect ($F(1, 71) = 7.32$, $p < .009$; $MS_{Color} = 23.23$; covariate $F(1, 71) = 4.22$, $p < .05$). The degree of mediation of the color effect produced by the covariate was moderate; the MS effect was reduced by 34%.

Table 4
EXPERIMENT 4: CELL MEANS FOR DEPENDENT VARIABLES

	Positive Color (N = 39)	*Negative Color (N = 34)*
Perceived quickness	3.56 (3.14–3.99)	2.88 (2.43–3.34)
Perceived time	15.18 (12.55–17.81)	14.76 (11.95–17.58)
Relaxation	4.26 (3.70–4.82)	3.41 (2.81–4.01)
Site attitude	5.78 (5.49–6.07)	5.09 (4.78–5.40)
Recommend to a friend	6.10 (5.66–6.55)	5.00 (4.52–5.48)

Notes: The 95% confidence interval is in parentheses.

Given that much of the variance in site attitudes remained to be explained, we examined whether feelings of relaxation directly mediated the effect of the color on site attitudes, beyond the effect mediated by perceived quickness. To assess this, we introduced feelings of relaxation as a second covariate in an ANCOVA, with color as the independent variable and perceived quickness as a covariate. The results show that feelings of relaxation appear to have a direct effect on site attitudes, beyond the perceived-quickness effect. The covariate feelings of relaxation is significant ($F(1, 70) = 13.83$, $p < .01$), and the effect of color is further attenuated ($F(1, 70) = 5.99$, $p < .05$; $MS_{Color} = 16.50$). Taken together, the indirect effect of relaxation through perceived quickness and its direct effect account for 53% of the effect of color on site attitudes (i.e., the direct effect of feelings of relaxation accounts for an additional 19% of the effect).

For the behaviorally oriented measure, the positive color led to a greater likelihood that subjects would recommend the Web site to a friend (mean = 6.10) than the negative color (mean = 5.00; $F(1, 72) = 11.39$, $p < .001$; $MS_{Color} = 22.08$). Again, perceived quickness partially mediated this effect ($F(1, 72) = 5.19$, $p < .05$; $MS_{Color} = 9.15$; covariate $F(1, 72) = 8.07$, $p < .01$). The MS effect was reduced by 59% when we introduced the mediator as a covariate. The results also show that feelings of relaxation did not have a direct effect on recommending the Web site, beyond the perceived-quickness effect ($F(1, 71) < 1$, $p > .05$).

There was no effect of color on the estimated number of seconds that subjects perceived had elapsed ($F < 1$; more relaxing color mean = 15.18, less relaxing color mean = 14.76). We were not surprised by the different results for perceived quickness and time estimates. The time-perception literature has documented that the results for different methods of time estimation are often inconsistent (Doob 1971). In this particular case, the two estimates may differ because people have different baselines for what is fast or slow, such that two people might estimate the same amount of time having elapsed, but one person would consider the amount of time fast and the other would consider it slow.

We mentioned previously that we preferred the perceived-quickness measure (to the seconds estimate) because, given its evaluative nature, it is more likely to be linked to important consequences, such as attitudes toward the Web site. To check this reasoning, we compared our two measures of elapsed time in terms of how well they predicted the two major evaluative outcomes of Web site attitudes and willingness to recommend the site to a friend. There was a significant correlation between the perceived-quickness measure and both of the evaluative outcomes (attitude toward the Web site: $r = .31$, $p < .001$; recommendation to a friend: $r = .37$, $p < .001$). However, the seconds estimate did not have a significant effect on either evaluative outcome ($r = .06$ and $-.21$, respectively, $p > .05$ in both cases). Thus, as we expected, it is the evaluation-laden measure of perceived quickness, a measure that taps into how consumers *perceive* the download (i.e., was it fast or slow), not the evaluation-barren seconds estimation measure, that has an effect on managerially important outcomes such as Web site judgments. The notion that it is the evaluation of a wait that matters rather than the simple estimate of the length of the wait is also consistent with arguments found in the services literature. As Katz, Larson, and Larson (1991, p. 44) note, "if customers think that their wait was short enough, then it was short enough, regardless of how long it was." Indeed, perceptions of a wait have been found to be more predictive of the service evaluation than the perceived duration of the wait (Hui and Tse 1996).

In summary, consistent with the hypotheses, the results of Experiment 4 provide evidence that color affects perceived quickness and that feelings of relaxation mediate this effect. In addition, the results provide initial evidence that the perceived quickness of a download can affect downstream variables, such as consumers' evaluations of the Web site and their willingness to recommend it to others.

Finally, there was no evidence that the feelings of relaxation elicited during the wait affected mood. The effect of mood valence was not significant (mood valence: $F(1, 72) < 1$; positive color mean = 4.84, negative color mean = 4.79). Thus, the results do not support the explanation that perceived quickness is driven by mood valence rather than feelings of relaxation. This provides discriminant validity for the importance of feelings of relaxation on perceived quickness. The results also do not support a common-methods-bias explanation. We measured feelings of relaxation, perceived quickness, attitude toward the Web site, and recommendations of the site on nine-point scales. If the similarity of the scales accounted for the results we obtained, the nine-point mood-valence scale would have been affected as well.

GENERAL DISCUSSION

In this article, we have investigated the effect of screen color on perceived quickness of a download. We hypothesized that a critical element in explaining this effect was the feelings of relaxation that the color elicited. We obtained support for our conceptualization from a series of experiments that manipulated the value, chroma, and hue of colors. A different manipulation of relaxation provided convergent evidence for the importance of feelings of relaxation, namely, the number of times the person waited. We also found that the effects of color on perceived quickness have downstream effects. Perceived quickness affected both Web site evaluation and willingness to recommend it to others.

These findings possess intrinsic theoretical value because they tap into the theoretical mechanism underlying the effects of executional factors such as screen color on the perceived download speed of a Web page. By implication, therefore, they offer insight into how affective responses to other exposure characteristics, beyond visual elements such as color, might affect perceptions of download speed. Anything that increases feelings of relaxation during a wait should make the time during a wait seem to pass more quickly; conversely, feelings of anxiety or tension should lead to lowered perceptions of speed. For example, consider the use of interstitials, advertisements or "intro screens" that pop up on the screen during a download. Although interstitials successfully attract attention, data from Jupiter Media Metrix (2001) suggest that users find interstitials to be annoying. Consider the use of animation or audio content in Web interfaces. Both have been criticized on various counts because of the nonstandard demands they impose on

a Web site's user and the often forced nature of the exposure (see Nielsen 2000). In all these cases, interstitials or soundtracks or animations, the results of our research suggest that intrusive or annoying components of the computer-mediated environment have the potential downside of increasing tension and thus causing, among other effects, a drop in perceived quickness of downloads.

Questions might arise about how representative the exposure characteristics used in our research are of the actual interaction experience on the Web, where a download experience ordinarily consists of not one stock color but a medley of the background color as well as text, images, and other dynamic content. It is noteworthy that with the growing popularity of Macromedia Flash–based interfaces (i.e., animated movies), full-color waiting screens are quite common; the browser window is typically covered in a single lead color with a "Loading, please wait…" meter that progressively displays the percentage of the overall movie that has been downloaded to a user's computer. When this percentage reaches 100%, the actual movie (the Web site) loads, and the interface is revealed to users. Such movies are known as "preloaders" and closely resemble the waiting screens we used in our research.

Of the three color dimensions, value had the greatest effect on both feelings of relaxation and perceived quickness. Although calibration differences for the hue, chroma, and value dimensions make comparison of their effects difficult, the findings we obtained are consistent with those of Gorn and colleagues' (1997) advertising study. They also found that the value dimension had the greatest effect on feelings of relaxation and that value affected attitudes toward both the ad and the brand, whereas chroma affected only attitudes toward the ad and hue affected neither (Gorn et al. 1997). These findings have implications for both academics and managers. They imply that attention needs to be focused on value and chroma, not just on hue, which, as we mentioned previously, has been the primary focus of attention of both the academic and the trade literature (e.g., Bellizzi and Hite 1992; Dunn 1992). They also imply that when managers design Web pages, they should choose value and chroma levels that promote feelings of relaxation.

In terms of the specific levels to choose, our research provides some grounds to believe that higher levels of value and lower levels of chroma are, in general, associated with greater feelings of relaxation and should thus produce quicker perceived downloads. Although we offer this general advice, we realize that we tested only limited samples of chroma and value here. More specific guidance would require the testing of more samples of low and high chromas and values as well as the testing of midrange samples. A more comprehensive test would help determine the shape of the relationship between chroma and value on the one hand and feelings of relaxation and perceived quickness on the other hand. In terms of hue, which is the more discrete dimension, consistent with prior research on both consumers and managers (Chattopadhyay, Gorn, and Darke 2001; Gorn et al. 1997; Valdez and Mehrabian 1994), the results point to the potential effectiveness of a blue (rather than red or yellow) background screen color in inducing feelings of relaxation and reducing the perceived download time. As has blue, green has been found to elicit feelings of relaxation and thus might be considered as well (Jacobs and Suess 1975). Further research should test green and other hues that might potentially induce relaxation when presented on a screen.

Although our research focused on perceived quickness of a download as the primary dependent variable, the results of Experiment 4 provide initial evidence that perceived quickness influences important evaluation-related consequences, such as consumers' attitudes toward a Web site and their willingness to recommend it to others. In addition, they provide evidence that color-induced relaxation has a direct effect on attitude, in addition to its indirect effect through perceived quickness. This suggests that site-design characteristics such as color have effects beyond their influence on perceived quickness. Overall, the results are consistent with research that shows that people use feelings to judge stimuli (Pham 1998; Schwarz and Clore 1996), including services (e.g., Hui and Tse 1996). The results also indicate the practical importance of the study and management of perceived download speed. This variable has the potential to influence evaluative consequences that might eventually affect the transactions conducted on the site. In this regard, Experiment 4's findings underscore industry knowledge that download time is becoming an increasingly pressing issue in online commerce. For example, Charny (2000) cites an estimate that businesses lose more than $4 billion annually because visitors do not wait for time-consuming pages to download. Our results merely suggest that transactions potentially could be affected. Further research should more directly study the effects of contextual variables on feelings of relaxation and the resultant impact on the likelihood of online consumers abandoning transactions.

There were no significant effects on the seconds measure in Experiment 4. A possible reason that relaxation influenced perceived quickness but not seconds is that perceived quickness is an evaluative measure, as is relaxation. Because there is a common evaluative base to the relaxation measure and the perceived-quickness measure, perceived quickness should be more sensitive to differences in feelings of relaxation than the nonevaluative seconds estimate, which is a more descriptive than evaluative measure (subjects simply wrote down the number of seconds they believed had elapsed). In support of this, judgments expressed on objective scales have been found to be less sensitive to contextual influences than judgments expressed on more evaluative scales (see Manis, Biernat, and Nelson 1991). Still, more marketing research that uses time estimates is called for, because time estimates have been used successfully in previous research in marketing (Hornik 1984; Kellaris and Kent 1992).

Our manipulation of feelings of relaxation was likely weaker than in previous research. We induced relaxation in our experiments simply through the background screen color; compare this with other studies in which relaxation was lowered (or tension raised), for example, by exposing subjects to the object of their fear (Watts and Sharrock 1984) or by forcing subjects to make eye contact with people with negative facial expressions (Thayer and Schiff 1975). Thus, because perceived quickness is more sensitive to changes in relaxation than is the seconds measure, our manipulation was likely sufficient to yield changes in perceived quickness but not seconds.

Although feelings of relaxation had a consistent effect on perceived quickness, because the variance explained in perceived quickness was sometimes moderate, further research might explore factors other than feelings of relaxation that

might influence perceived quickness. We found no effects of mood valence, but we measured it slightly later in the questionnaire than feelings of relaxation. Further research on mood valence, on feelings more broadly, and on factors other than feelings might reveal other influences on perceived quickness.

Another notable avenue for further research is the establishment of relevant boundary conditions for the effects obtained herein. A relevant boundary condition pertains to the time period of exposure, which was 17.5 seconds in our research. Further research might test other time intervals. It would be expected that if a wait is short, feelings of tension are likely to be minimal, whereas if the wait is long, tension is likely to be substantial. In both cases, executional factors such as screen color may have less of an influence. Another boundary condition to examine might be the cultural universality of the color effects observed in this research. The literature is mixed in this regard. Anecdotal evidence and some research suggest that color effects vary across cultures (e.g., Jacobs et al. 1991; Madden, Hewett, and Roth 2000). However, the framework presented by Gorn and colleagues (1997) suggests that some color effects are basic effects and thus are likely to generalize across cultures. Further research can add to the understanding of this by exploring conditions in which color effects generalize across cultures and conditions in which they are likely to be culture specific.

Another boundary condition might be the effects of relevance or involvement with the Web site. In our research, subjects were unlikely to have been in the market for real estate when we conducted the experiment. However, what would happen when the consumer is interested in the site itself and eager to obtain its information? Would that exaggerate the annoyance of a slow-downloading page and result in more tension across conditions? Would people consider the temporary interruption of a slow-downloading page unimportant if their overall involvement with, or interest in, the site was high?

We found that a second exposure to a wait resulted in lower feelings of relaxation (increased tension) and lower perceived quickness than a single exposure. These findings suggest another possible boundary condition: If there are many fast-downloading screens and few slow ones, the link between perceived quickness and site evaluation is likely to be modest. However, if the reverse is true, the effect should be substantial.

Most of the research on waiting for services has been conducted in offline contexts in which people present themselves in person for a service. Typically, the waits are in minutes or hours rather than seconds. The time-perception literature suggests that the expectation of a wait's length affects its perceived length (Doob 1971). If so, it would be expected that feelings of tension are elicited as a function of how long a person expects to wait (a 20-second wait for a page to download in an online environment may be similar to a 20-minute wait for a service in person). However, the contexts associated with in-person and online services are sufficiently unique to make such predictions difficult. This suggests that variables such as feelings of relaxation should be compared across contexts.

In closing, we recognize that our results may not apply to all downloading contexts. With this in mind, the contributions of our findings lie not so much in providing comprehensive managerial advice but in providing evidence that executional factors such as color affect perceived download speeds and in testing theory about how feelings of relaxation explain this effect.

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