

USING COLOR AS A NAVIGATION DEVICE IN ONLINE INFORMATION SPACES

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Abstract

Over the course of the last ten years, information production has increased dramatically as a result of the easy publishing enabled by the World Wide Web. As a result, information architects need to find ways to help users find the right answers to their questions as easily as possible and to retain relevant information as well as possible. One technique that has gone unexplored in prior literature is the use of color as a tool to help users in online information spaces orient themselves. Because color helps humans distinguish and categorize information, this study investigated the relationship of color and online navigation. Based on literature in color theory, cognitive psychology, and visual communication that predict color would have an effect on how a website is used, this study proposed the hypothesis that «users who view a website that uses color as part of a navigation system will perform faster on tasks, will recall more information that they see, and will subjectively rate a color website as more successful and pleasing than a black and white website with identical construction.» The results were not conclusive but they do suggest that using color as part of a website's navigation might improve the user's performance and subjective satisfaction of an online space. Participants of the experimentally constructed color website consistently performed better than participants who used an identical black and white experimental website. Based on these preliminary data, this study gives website designers some empirical support for using color as part of a navigation scheme since it appears that using such a scheme might aid in performance, recall, and in subjective ratings of a website's quality. The inconclusive, but promising, findings also suggest that more studies of this type need to be completed to confirm or refute the tentative success of this study.

Paraules clau

colour in interfaces, visual communication, visual perception, colour in information retrieval, usability, web

1 INTRODUCTION

As early as 1989, long before the «Internet Revolution,» those working with online information spaces identified the most vexing problem as one of orientation: users constantly seek to locate themselves in information spaces yet few online spaces successfully provide users with the cues necessary to do so (HORN 1989). Current work in website usability acknowledges the same problem, arguing that the three key questions

users ask of websites – Where am I? Where have I been? Where can I go? – continue to cause problems for designers of online information spaces (NIELSEN 2000). As Rosenfeld and Morville (1998) point out in their important book, *Information Architecture for the World Wide Web*, the need for information architects—those who organize information so that people can find the right answers to their questions—has never been greater because information is currently expanding at an incredible pace. To date, the primary approach to solving this problem has been to provide users with markers such as «greyed out» links or page headlines that reflect the underlying architecture of the website. These cues are often combined with extensive navigational choices on a given page in hopes that users will be able to reconstruct the information architecture of the website from the available choices, essentially building in their heads the equivalent of a topical outline of a site’s content.

To a degree, this approach of relying on users to reconstruct the logical or topical structure of a complex website has been successful at helping users locate themselves in information spaces. Usability testing as it is currently practiced focuses much of its attention, in fact, on determining the correspondence between users’ mental images of a site’s organization and the one intended by designers. This focus on a site’s logical structure, however, overlooks a key part of designing online spaces: «the aesthetic experience is as much a part of the creation of the message as it is part of the reception» (GREENZWEIG 2004). Specifically, current usability and web design processes overlook the very significant role that aesthetic and visual aspects play in helping users make sense of information they encounter. In fact, some of the most recent work in usability shows that «emotional design,» or actively implementing non-logical elements into a design, can increase a product’s perceived usability (NORMAN 2004). Color is one such non logical element that has the potential to demonstrate profound positive effects in a users’ ability to successfully locate themselves in large, online information spaces.

This realization comes as no surprise to students of visual communication, design, architecture, and even fashion. Color has always been used as an element to distinguish one type of information from another as in topographical maps, one room from another as in museum design, or one rank of individual from another as in the military. It also comes as no surprise to those who study visual cognition and the physiology of vision because humans are neurologically preprogrammed to perceive color, along with motion, prior to other visual aspects of our world such as shape and texture (BARRY 1997). In spite of the research in other media like architecture or print that studies interactions of color and navigation, research that specifically examines color’s role in helping users navigate virtual, online spaces remains scarce. The primary goal of the project reported here was, then, to answer this question:

Can color be used as a navigational device in online information spaces to answer for users the three key questions they ask of online spaces – Where am I? Where have I been? Where can I go?

In other words, as Jan White asks in a recent issue of *Technical Communication*, «Does color help to give order to information chaos (WHITE 2003)? To answer this question, this study investigated the interactions of color and the usability for two experimentally constructed websites that were identical with one exception: one used color as part of a navigation scheme, and the other was black and white.

2 BACKGROUND: WHY COLOR?

Noted color theorist, Johannes Itten, argued some time ago in *The Elements of Color* (1961) that as a system, color can be manipulated to achieve desired affects. Although Itten's book primarily concerns color for its use in painting and art, the principles outlined in the book ring true for anyone who wishes to use color to effectively elicit in viewers (or users in this case) a desired response. Itten reminds us that there are seven types of contrast: hue (or what we know as «color»); value (or what we call light and dark); cold – warm; complimentary (or colors that are opposite each other on a color wheel); simultaneous (or the eye filling in colors that are absent); saturation (or what we know as richness of color); and extension (or the size of color blocks relative to each other). Each of these contrasts, Itten shows, can work at three levels of experience: impression or vision itself; expression or the introduction of emotion into the interpretation of the perceptual act; and construction or the cognitive action that inflects the visual perception with symbolic quality. In Itten's view, every visual experience is characterized by a combination of these three levels and the effective use of color considers how a user will react on each level. The effective use of color, finally, also tries to synthetically reproduce combinations and patterns that occur in nature. Following Itten's logic, if we learn from, and subsequently implement in our designs, the patterns and forms that have already evolved, our works will more effectively reach viewers on the three levels of experience: impression, expression, and construction.

Itten's opinions become even more significant for information architecture when we consider the actual physiology of seeing. In short, humans see in millions of colors and not in black and white. Our evolution has privileged, probably for purposes of hunting, protection, and distinguishing among objects, a way of seeing that allows us to distinguish at a glance one thing from its neighbors. In short, color vision possibly evolved as an aid to cognition as a way of helping us understand our world better (HALL 1996). Further, in a study designed to test the interaction of color and memorability, Gilbert and Schleuder (1990) conclude that color, by increasing the complexity of an image, increases the image's memorability. Ironically, color images are also processed faster offsetting the increased complexity. Combined, these findings suggest that using color not only creates a situation in which users will remember more about the things they see, but it also speeds the time for comprehending the information perceived, quite possibly

because the color visual corresponds, as Itten suggests, to our natural experiences.

Jan White (1990) argues a very similar point in *Color for the Electronic Age*, applying the implications of color that Itten identified to document design. Congruent with Gilbert and Schleuder's findings, White identifies several ways that color can be used as a tool to aid the transfer and retention of information. Color can code elements; can increase the velocity of comprehension; can establish a unique identity for elements; can be used to guide a user's attention; can be used as a locator signal; and can enliven a product. These improvements suggested by color should not surprise us because color perception is fundamental to human experience and in fact pre-dates verbal ability in our cognitive development. Specifically, studies have shown that pre-verbal infants can distinguish color quite effectively (BARRY 1997).

Color, this brief review suggests, although a very subtle cue that is most often processed pre-attentively or unconsciously, carries enormous power as a visual design tool. It might be powerful exactly because it is so subtle, since as Mullet and Sano (1995) argue, color is simple and elegant. In their terms, color is approachable (rapidly understood); recognizable (distinguishable from other objects); immediate (requires no conscious processing effort); and usable (increases the memorability of a message). Color can also be part of an effective design because as Itten suggests, it is an *affective* tool that invests our emotions in the experience, literally «coloring» the experience in a positive way since a colored world reflects the natural world. Color, then, can accomplish what Rosenfeld and Morville (1998) suggest, creating a label system that communicates information efficiently, without taking up too much of a page's space or too much of a user's cognitive space.

Color has all the properties outlined here that characterize effective design and by considering them together lead, therefore, to the hypothesis tested in this study:

Users who view a website that uses color as part of a navigation system will perform faster on tasks, will recall more information that they see, and will subjectively rate a color website as more successful and pleasing than a black and white website with identical construction.

3 METHODS

In order to determine what impact color might have on users who navigate a large website, a usability study was constructed that would gauge how well users would perform on two experimentally constructed websites, how well users would recall the information they had seen, and how satisfied users were with the experiences on the two websites. The specifics of the test are outlined below, including who participated in the study, the nature of the two experimental websites, and what constituted the actual test protocol.

3.1 Participants

The participants in this study were drawn from a pool of students at a major university who were recruited through various listservs and word-of-mouth. The participants, therefore, represent a convenience sample with the sample comprised of 20 participants who qualified themselves for the study by successfully completing a pre-test questionnaire that gauged the participants' experience with the WWW and some limited demographic information. The study drew on 20 participants since 10 were needed to test the «control» website which was black and white, and the other 10 were needed to test the «treatment» website which used color in the navigation scheme (the specifics of the websites are detailed below). According to Lauer and Asher (1988), 10 participants are needed to test one experimental variable with a confidence factor of $p=.10$ and so this sample was sufficient for testing only one variable. Ten participants were randomly assigned to two groups: 10 for «B» or black and white and 10 for «C» or the color website.

Based on the pre-test questionnaire, the two groups are very comparable in their age, their sex, their experience with using the World Wide Web, and the amount they use the WWW each week. Table 1 above lists the characteristics of the participants, coded into categories. Table 1 shows that in the two test groups, the average age was 21-30, that both had a similar distribution of males to females (although females outnumbered males in this study), that the majority of the participants had between 7 and 8 years of experience with the WWW, and that on average the participants worked with the web 11-15 hours per week. The congruence of the two randomly assigned populations is important because it demonstrates that prior exposure to the WWW can probably be ruled out as a factor contributing to the results of the study. Further, it appears that the two test groups have no substantial differences that would automatically predispose one group more than the other to perform dramatically different on one website or the other. Certainly factors like reading comprehension speed and familiarity with the test website's content could have affected the performance of each group's members, but the homogeneity of the population otherwise (e.g. all students, mostly 21-30, spend the same amount of time on the WWW) suggest that these differences would be minimal.

3.2 The Two Experimental Websites

The website used in this study was chosen for its relative size, the ease of navigation present on the site, and because the visual elements were positioned in a way that would allow color-coding according to navigation to be relatively straightforward. A screen capture from each of the two test websites appears below in Figures 1 and 2. Notice the websites are identical except that the treatment website – the one with color – includes colored elements that correlate to a user's position in the site's hierarchy. In this case, the «People» section of the website, notice that the top graphic

TABLE 1. Pre-Test Demographic Data

Color	Age* 1-5	Sex m=0 / f=1	WWW Use y=1 / n=0	Years of Use** 1-5	Hours of Use*** 1-5
c1	2	1	1	5	4
c2	2	1	1	5	4
c3	2	0	1	4	3
c4	2	1	1	4	5
c5	2	1	1	5	3
c6	2	0	1	5	2
c7	3	0	1	5	5
c8	2	1	1	5	3
c9	2	1	1	4	2
c10	2	0	1	3	2
average	2.10	0.60	1.00	4.50	3.30
median	2.00	1.00	1.00	5.00	3.00
Black and White	Age* 1-5	Sex m=0 / f=1	WWW Use y=1 / n=0	Years of Use** 1-5	Hours of Use*** 1-5
b1	2	1	1	5	5
b2	3	1	1	5	5
b3	1	0	1	5	3
b4	2	1	1	3	3
b5	4	1	1	5	1
b6	2	1	1	5	2
b7	2	0	1	5	5
b8	2	0	1	5	5
b9	1	0	1	4	3
b10	3	0	1	5	3
average	2.20	0.50	1.00	4.70	3.50
median	2.00	0.50	1.00	5.00	3.00

*Age Grouping: 15-20=1; 21-30=2; 31-40=3; 41-50=4; 51 above=5

**Years of Use: 0-2=1; 3-4=2; 5-6=3; 7-8=4; 5 above=5

***Hours of Use: 0-5=1; 6-10=2; 11-15=3; 16-20=4; 20 or more=5

is orange as are the left side navigation and the right side word «observe.» When this site was restructured for the study, the same hue was chosen for each of the three elements although the opacity, or saturation, of the color varies slightly among the elements with the left side navigation being the most saturated and the right side word being the least saturated. Each section of the website correlated to a specific color, so for example, the «Graduate Studies» section had a yellow top image and right side word while the same elements in «Facilities» were red. The black

and white site, by comparison, did not use color to denote different sections of the website. Each of the main headings on the left side navigation bar are black while the subnavigation for each section is grey. The top image is mostly grey tending toward blue and the right side word is also grey tending toward blue with a reduced color saturation as in the color-coded websites.

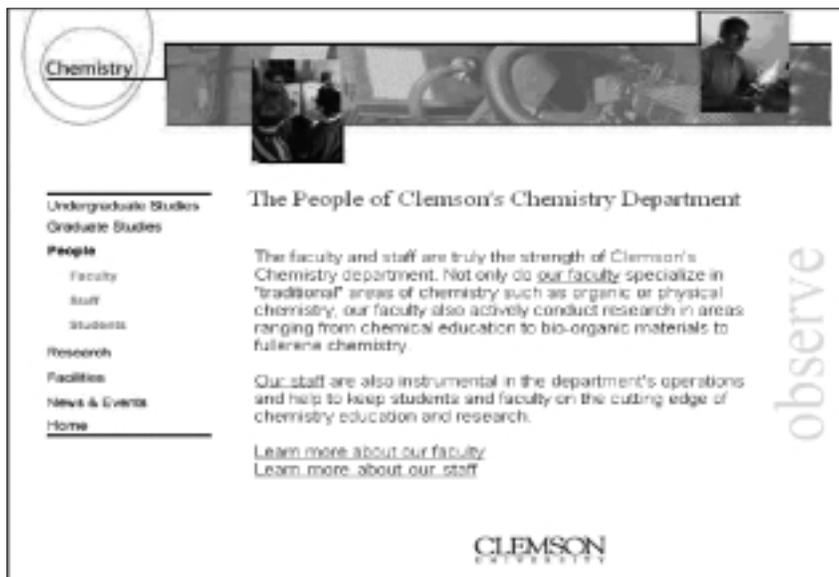


FIGURE 1. A page from the website

Except for the single factor of color that distinguishes the sites, the sites were identical. The same information appears on each page; the same images appear throughout the site; the navigation and organization are the same; and the placement of elements on specific pages remains identical. The site was relatively complex, containing approximately 100 different pages divided among six main topics and 35 second-level headings. The site actually used in the study was adapted from an existing website and all participants confirmed that they had not used the website prior to this study.

3.3 Test Protocol

In order to test the three separate aspects of the hypothesis – that users would perform better on the website with color, that they would demonstrate better recall from the color site, and that they would rate the color website better on subjective measures like how pleasing it was – a three part usability test was created. The tests were administered in Clemson University's Human-Technology Research Laboratory using accepted usability testing methodologies as outlined, for example in Barnum (2003), Dumas and Redish (1999) and Coe (1996). Each aspect of the test is described below.

3.3.1 Test 1: Performance

The participants in this study completed three tasks outlined in scenarios presented to them and were given a maximum of 6 minutes to complete each task since this time was discovered to be the breakpoint where users became frustrated in pilot tests of this study. Each of the three tasks completed by the users was measured separately for time to complete the task and for the total number of clicks it took for participants to locate the information that was required to successfully complete the task. The task time started with the participant's first click from the website's index page and ended when the participant clicked on the «Home» link on the website's navigation bar. Only clicks that resulted in a new page being displayed were counted.

Each of the three tasks required participants to view at least two separate major sections of the site and on all of the scenarios, the most direct route to the information necessary to successfully complete the task was available in 5 clicks. Each participant, after becoming confident that they had located the information required for the scenario, returned to the index page of the website and recorded their answers on the test script. Each scenario had 3 possible answers and the number of correct answers was recorded for each scenario to gauge the users' success in locating the information. For each scenario, the total time was recorded as were the total number of clicks, and together, the number of correct answers, the time required to complete the scenario, and the total number of clicks was used as a measure of the participants' performance on the website. Single-Factor ANOVA tests were conducted on each scenario to determine if the differences between the two groups was significant at $p=.05$.

3.3.2 Test 2: Recall

Once the participants had completed the three time/task scenarios, they were given 3 minutes to click through the website in whatever order they determined and after this time was up, each participant was asked 8 recall questions to determine how successfully they recalled the topical headings of the website and the location of specific pieces of information. This 3 minute «free period» evolved from the pilot studies of this test in which the pilot testers suggested that after they completed the three scenarios, they would like a little time to «just look around.» Since many web users often do navigate websites randomly at first just to familiarize themselves with a new site, this 3 minute period was used to simulate the random navigation often employed by users. Together, the free period and the structured navigation required for the scenarios enabled participants to view content in all of the major topical areas of the website with the structured scenarios, in fact, requiring that participants view information on 5 of the 6 major headings (graduate studies; people; research; facilities; news and events). Once the free period was over, the participants returned to the index page of the website, and answered the recall questions

without further reference to the website. The total number of correct answers was recorded for each participant. As with the performance tests, a single-factor ANOVA test was conducted on the results to determine if the difference between the two groups was significant at $p=.05$.

3.3.3 Test 3: Subjective Ranking

The final test of the study involved a subjective questionnaire that asked the participants to rank the website on a 4-point scale according to questions that gauged their perceptions of the site's success and pleasantness. Those questions were:

1. If you had to complete the tasks from this test a week from now, how easily could you remember the location of that information in this website?
2. How willing would you be to return to this website if you were interested in this type of information?
3. How well do you think the website helped you locate information?
4. How pleasant was this website to use?
5. How easy was it to learn how to use this website?
6. How efficient do you think you were at using the website?
7. How willing would you be to recommend this website to a friend interested in this topic?

Of the 7 questions asked, 4 specifically addressed participants' perceptions of the site's success (e.g. «How efficient do you think you were at using the site») and 3 specifically addressed pleasantness of use by asking 1 direct question («How pleasant was this site to use?») and 2 indirect questions (e.g. «How willing would you be to recommend this site to a friend?»). The numerical data was recorded for each participant and since this data was categorical and not measurable by performance, it was compared based upon average scores.

4 RESULTS

The results of this study indicate that color might play a role in a user's ability to effectively use a website, but the hypothesis that

Users who view a website that uses color as part of a navigation system will perform faster on tasks, will recall more information that they see, and will subjectively rate a color website as more successful and pleasing than a black and white website with identical construction

was not unequivocally proven by this study. Participants did perform better overall on the site that used color than on the site that was black and white, but not in a statistically significant way. Likewise, the C group, or color website participants, did recall more information than the B group,

or the black and white website participants, but again the results were not significant. Finally, the C group on average rated their experience more favorably than did the B group, but again, the results were not significant. The results of each of the tests are presented in more detail below.

4.1 Users Will Perform Better on Tasks

As outlined above, the method for determining how well participants performed on a website was gauged by the time it took the individual participants to complete tasks, how many clicks it took users to complete the tasks, and the number of questions users were able to answer correctly after completing each scenario. The complete data from each of these tests are shown below in tables 3, 4 and 5.

TABLE 3: Scenario 1 Task/Time Results

Color	time	dicks	coorrect
c1	104	5	3
c2	200	5	3
c3	182	15	3
c4	170	5	2
c5	150	6	3
c6	360	28	3
c7	240	20	3
c8	245	16	3
c9	247	19	3
c10	151	6	3
average	205	12.50	2.90
median	191	10.50	3.00
Black and White	time	dicks	coorrect
b1	120	7	3
b2	82	5	3
b3	184	14	3
b4	240	14	3
b5	94	7	3
b6	208	7	3
b7	312	8	3
b8	250	5	3
b9	151	8	2
b10	218	13	3
average	186	8.80	3.00
Median	196	7.50	3.00

As Table 3 shows, the B group participants performed nearly identically on scenario 1 as the C group participants. The median time for C group participants to complete scenario 1 was 191 seconds while the B group's median time was 196 seconds, nearly identical in performance. Although the C group performed just slightly better than the B group on median task time, the B group required far fewer clicks than the C group to complete scenario 1, with a median of 7.50 for the B group and a median of 10.50 for the C group. While the difference is not statistically significant, the C group did require nearly 40% more clicks than the B group to complete the scenario. Finally, the B and C groups performed nearly identically on the recall questions, with the median for both groups being 3 correct answers. It appears that scenario 1 neither completely supports or refutes the hypothesis since the C group performed better on one

TABLE 4. Scenario 2 Task/Time Results

Color	time	dicks	coorrect
c1	202	13	3
c2	247	13	3
c3	121	5	2
c4	350	15	2
c5	254	14	3
c6	207	19	3
c7	263	21	3
c8	167	11	3
c9	225	16	3
c10	337	20	3
average	237	14.70	2.80
median	236	14.50	3.00
Black and White	time	dicks	coorrect
b1	360	30	2
b2	130	13	3
b3	263	26	3
b4	360	22	2
b5	305	20	2
b6	244	16	3
b7	360	17	2
b8	172	10	2
b9	112	5	2
b10	191	12	3
average	250	17.10	2.30
median	254	16.50	2.00

measure, the B group performed better on a second measure and they performed the same on the third measure.

Table 4 below, however, shows that the C group did perform better on scenario 2 with the C group performing slightly better than the B group on all tasks although the results are not significant at $p=.05$. Table 4 shows that the C group required a median of 236 seconds to complete the scenario while the B group required a median of 254 seconds. While the results are not statistically significant, they do show a performance difference of about 8%. The difference in numbers of clicks for the C and B participants was not as dramatic as shown in scenario 1, but the C group still performed better with a median of 14.50 clicks and the B group requiring a median of 16.50 clicks, or about 13% more clicks. Finally, the C group demonstrated better recall on scenario 2 than the B group, answering a median of 3 questions correctly while the B group was only able to answer a median of 2 questions correctly. While none of the results from scenario 2 are statically significant, they do seem to at least support the first part of the hypothesis since the Color participants did actually perform better on this scenario.

Unlike scenarios 1 and 2, scenario 3 did demonstrate some significant results as shown below in Table 5. Unlike the prior two scenarios, the difference in the amount of time that participants took to complete the scenario was significant with $p=.01$. The median time for the color participants was 161 seconds while the median time for the B participants was 230 seconds, a difference of more than 42%. Likewise, the total number of clicks was highly significant with $p=.003$, where the C group required a median of 7.50 clicks to complete the scenario and the B group required 14, nearly twice that of the C group. Finally, the recall showed no difference with each group correctly recalling a median of 3 answers.

To summarize, of the nine tests completed to measure the participants' performance (three on each of three scenarios), six of them support the hypothesis with two of the supporting tests being statistically significant. Two of the tests, those on recall, are neutral because they show that both the C and B groups performed nearly the same, and one additional test from scenario 1 appears to counter the hypothesis. In all, it appears that the first part of the hypothesis has merit with 6 of 9 tests showing an affect predicted by the hypothesis although this aspect of the hypothesis was not unequivocally proven.

4.2 Users Will Recall More Information That They See

The second aspect of the hypothesis proposed that participants tested specifically for recall, separate from their task / time performance, would recall more information. This was tested with a series of post study recall questions where participants were asked to indicate where particular topics could be found in the website's structure. Unlike the recall portion of the performance tests, the stand alone recall questions demonstrated that the Color participants performed slightly better, although not in a

significant manner. Table 6 below shows the complete results from the recall test where 8 total correct answers were possible.

The median recall for the C participants was 7 of 8 questions, while the B participants answered a median of 5.50 questions correctly, greater than a 1 point spread. While the results were not significant, they do suggest that the Color website participants were able to recall more information than Black and White website participants which tentatively supports the second aspect of the hypothesis that users of a color website will demonstrate better recall than users of a black and white website.

TABLE 5. Scenario 3 Task/Time Results

Black and White	time	dicks	coorect
c1	107	6	2
c2	182	8	3
c3	203	11	2
c4	125	10	3
c5	173	7	3
c6	90	6	3
c7	153	7	3
c8	106	7	3
c9	173	8	3
c10	169	9	3
average	148	7.90	2.80
median	161	7.50	3.00
Black and White	time	dicks	coorect
b1	144	7	3
b2	142	13	2
b3	246	17	2
b4	238	16	3
b5	270	15	3
b6	283	22	3
b7	322	20	3
b8	192	7	3
b9	142	12	3
b10	102	8	3
average	216	13.70	2.70
median	230	14.00	3.00

TABLE 6. Recall Test Performance

Color	Correct	Color	Correct
c1	7	c6	7
c2	5	c7	5
c3	5	c8	7
c4	7	c9	8
c5	7	c10	7
average	6.50	median	7.00
Black and White	Correct	Color	Correct
b1	5	b6	6
b2	7	b7	7
b3	4	b8	6
b4	6	b9	5
b5	5	b10	4
average	5.60	median	5.50

4.3 Users Will Subjectively Rate a Color Website as More Successful and Pleasing Than a Black and White Website

The final aspect of the hypothesis proposed that users would enjoy using the color website more than a black and white one and that this enjoyment would lead to a higher subjective rating. The complete results are shown below in Table 7.

When the data are aggregated across the 7 questions to create a composite score for the subjective satisfaction of the two groups, the color website shows a slightly higher ranking than the black and white one, although not a difference that is remarkable.

Additionally, when the questions are divided according to the perceived «pleasantness» and «efficiency» indicators, Table 7 shows that 3 of the 4 perceived «efficiency» ratings were slightly higher for the C participants than for the B participants. Question 1 on recall, question 3 on ability to locate information, and question 5 on ease of learning the site all show higher average scores for color than for black and white. On the fourth efficiency question specifically about efficiency, users ranked the black and white website slightly better than the color website.

Finally of the three questions that gauged the perceived «pleasantness» of the two websites, all three showed higher rankings for the color website. Question 2 asked about willingness to return to the website and presented the most difference between of all the pleasantness questions with the C participants ranking the website on average as a 3.10 and the B participants ranking the site as 2.20, nearly a full point lower. Question 4 specifically about the pleasantness of the websites showed only a slightly higher ranking for the color website and the same was true of

TABLE 7. Subjective Ranking of the Color and Black and White Websites

Color	Q1 recall	Q2 willing	Q3 locate	Q4 pleasant	Q5 easy	Q6 efficient	Q7 recommend	AVG
c1	2	2	4	3	4	3	3	3.00
c2	3	4	3	4	4	3	4	3.57
c3	3	4	3	4	4	3	4	3.57
c4	3	3	3	3	4	2	4	3.14
c5	4	3	3	3	4	3	4	3.43
c6	4	3	3	2	3	2	4	3.00
c7	2	3	2	3	3	2	2	2.43
c8	3	4	3	4	3	3	4	3.43
c9	3	4	3	4	3	3	3	3.29
c10	3	1	3	3	4	3	3	2.86
average	3.00	3.10	3.00	3.30	3.70	2.70	3.50	3.19
median	3.00	3.00	3.00	3.00	4.00	3.00	4.00	3.29
Black and White	recall	willing	locate	pleasant	easy	efficient	recommend	
b1	1	1	3	3	3	2	3	2.29
b2	3	4	3	4	4	2	4	3.43
b3	3	2	2	2	3	2	1	2.14
b4	2	3	3	3	2	3	3	2.71
b5	2	3	2	2	4	4	4	3.00
b6	3	3	3	4	3	4	3	3.29
b7	3	2	3	3	4	3	3	3.00
b8	4	2	4	4	4	3	4	3.57
b9	3	1	3	4	4	3	4	3.14
b10	1	1	2	3	4	2	4	2.43
average	2.50	2.20	2.80	3.20	3.50	2.80	3.30	2.90
median	3.00	2.00	3.00	3.00	4.00	3.00	3.00	3.00

question 7 which asked about the participants' willingness to recommend the website to a friend.

While the differences are not dramatic, the average rankings were higher for the color website on 6 of the 7 measures and one was substantially higher. Combined, the subjective analysis seems to tentatively support the aspect of the hypothesis that predicts users will rate a color website higher than a black and white website when asked to give their perceptions of the website.

To summarize all of the results, when all the data are aggregated, it appears that the hypothesis, while not completely supported, is at least suggestive. On each of the three separate tests, the results showed a slight difference in favor of the color websites, suggesting that color

might have been a factor that positively influenced the participants' performance (Test 1); the participants' recall (Test 2) and the participants' subjective rating of the websites (Test 3).

5 DISCUSSION

These data, while not absolutely conclusive, do suggest that using color as part of a website's navigation might help elicit in viewers a desired response since all three of the tests – taken as a whole – show a positive impact of color. Work in color theory predicts that this might be the case and this study gives website designers some ground – albeit tentative – to stand on when choosing to use color as part of a navigation scheme. It appears that even though website users might not consciously recognize the interaction of colors and a navigation scheme, using such a scheme might aid in performance, recall, and in subjective ratings of a website's quality.

More specifically, the performance data suggest that using color does improve a user's ability to effectively and efficiently navigate a website, even if minimally. Of the nine tests performed, five resulted in demonstrable performance improvements for the users of the color website. Curiously, on one of the three tests in scenario 1, the B group outperformed the C group, but across the remaining two scenarios, the C group consistently, and in 2 cases significantly, outperformed the B group. Considering each scenario as 1 unique data point with the three tests comprising one scenario, then, the beginnings of a pattern emerge that suggest using color does help users navigate a website since each of the 3 scenarios when taken as a whole tentatively supported the hypothesis. Overall, then, Test 1 was positive – although not significantly so – for showing that color can help users locate themselves in an information space and thereby contributes to answering the questions «where am I?» «where can I go?» and «where have I been?».

The recall data also tentatively supported the hypothesis, since the Color group was able to recall more of their test website than the black and white group was able to. The data showed the C group performing quite a bit better, with their median correct answers showing 1 more question correct out of 8 than the B group. Given that there were only 8 total questions, this median score suggests the C group has at least 12% better recall than the B group. The differences are not statistically significant, but if taken as a whole, the recall test proves to be a second demonstration that color affects a user's ability to answer questions about «where they have been.»

Finally, the third test, the subjective measure of satisfaction, supported the findings of the prior tests, suggesting that participants perceived themselves to have performed better on the color website than on the black and white website. Of the seven questions asked, six showed higher rankings for the color website than for the black and white website, with question, «How willing would you be to return to this website?»

showing nearly one full point of separation on a 4-point scale. Given that 86% of the time the color website was rated subjectively as better than the black and white website, this test can be taken as a third point to mark a positive interaction of color on a website.

6 CONCLUSIONS

The purpose of this study was to determine whether or not color had an impact on users' ability to effectively use a website when color was implemented as part of a navigation scheme. Specifically, the larger research questions was

Can color be used as a navigational device in online information spaces to answer for users the three key questions they ask of online spaces – Where am I? Where have I been? Where can I go?

An additional goal was to determine not only if users of a color website would perform better because they were able to locate information easier and retain it better, but also whether or not they would have a more pleasant experience with a site that uses color than one that does not.

Taken as a whole, the study suggests that color does have an impact on users, even when a slight bit of color was used as was the case in this study. All of the three tests separately demonstrated that users performed better on the color website performed, both in absolute measures as in the case of time / task measurements and recall, and in the case of subjective ratings of performance. Given that the three tests all agreed, and that three data points suggest a trend, it seems fair to initially speculate that, yes, color can be used as a navigational device in online spaces since users performed better with a color-coded navigation scheme than a black and white one and users rated their experiences as subjectively more successful.

7 IMPLICATIONS AND DIRECTIONS FOR FUTURE INQUIRY

This project hopefully offers a starting point for future inquiry into the relationship of color and performance in online spaces, both as measured quantitatively and subjectively. It provides some primary empirical evidence that supports the intuitive sense of good information architects that information spaces have both a performance dimension as well as an aesthetic one and that the two interact. Recent work in «User Experience Design,» for example, claims, in fact, that we need to be designing along both planes, the aesthetic and task-based – for our systems to achieve optimum success (SHEDROFF 2001; GARRETT 2002). This study provides some preliminary data to ground these claims of user experience design. This study also furthers the claims of cognitive psychologists who assert the role of color in helping humans distinguish among classes of information.

At a root level, humans sort objects that are colored differently into different groups, both consciously and unconsciously, and drawing on this characteristic this study suggests that classifying different types of information under a color that separates the information into a categories might have consequences for improving the usability of navigation systems (BARRY 1997).

This study does not, however, provide absolutely conclusive findings about the interactions of color and performance and cannot rule out the possibility that just having well-crafted navigation systems and topical structures, regardless of how those systems are related to color, is the most important factor in aiding performance. Yet, given the tentative success of this study to prove the hypothesis that color will enhance users' performance, additional studies that work in the same vein as this one seem appropriate to substantiate or refute the findings presented here. Perhaps more subjects in a study would also reveal more significant results, especially when spread across a wider spectrum of studies that tested performance, recall, and subjective rankings.

In addition to duplicating and expanding this study, some additional studies could be designed, for example, to test different genres of websites and how color aids users in locating themselves in those spaces. This study tested an information-based website, but there are also commerce websites, entertainment websites, artistic websites, and argumentative or promotional websites (ALEXANDER 1999). Would each of these types of sites show differences in the way that color can be used or how it should be used as an aid in navigation? A second type of study might also examine types of colors and which colors are most effective for coding information. Is it better, for example, to use different hues (red, yellow, blue) to categorize information and if so which ones, complimentary colors? Or, rather than different hues, would it be more effective to employ the same hue in different saturation or luminosity to code how information is categorized? Another type of study might gauge how much color is necessary to help users locate themselves in online spaces. So for example, does using a color background for a type of information aid users more than colored headers and small visual elements as were used in this study? What would be the balance between too much color and just enough to differentiate parts of an information space so that a balance existed between aesthetic and subjective rankings and performance increases?

In all, this study is mostly suggestive and points out that we still have a lot to learn about the role that color can play in creating effective online spaces and navigation systems. However, given the ease of using color and the way that color works on us biologically, it seems that it can have some role, even if subtle, in helping users to locate themselves in online spaces. Although we need more studies to investigate the questions offered above and to either more conclusively confirm or refute the tentative findings presented in this study, hopefully this study opens a dialogue about the role that a very small, but very powerful, visual feature can play in helping us solve the three perennial questions about complex

information spaces: Where am I? Where have I been? Where can I go? After all, improving the performance—even slightly—of users in a large online space is an improvement worth trying for.

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