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The Effects of Animation on Information Seeking Performance on the World Wide Web: Securing Attention or Interfering with Primary Tasks?

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Abstract

Although animation is commonly used in the web environment, scant scientific evidence can be found either on the effects of animation on viewer information seeking performance or on the implications for online advertising. This paper reports a limited study that provides such scientific evidence. Using research results from visual attention and perception literature to guide the discovery, the study confirms four hypotheses.

(1) Animation as a secondary stimulus deteriorates viewer information seeking performance.

(2) As the difficulty of the task increases, viewer performance is less affected by animation.
(3) Animation that is similar but irrelevant to a task has more negative impact on viewer performance than animation that is dissimilar to the task.
(4) Animation that is brightly colored has a stronger negative effect on viewer performance than does dull colored animation.

The study sheds light on the applicability of research results in visual attention to the web environment. It also provides practical guidance for content providers and online advertisers as they design and place online ads in web pages.

Keywords: animation, information seeking, visual attention, visual interference, world wide web

I. INTRODUCTION

The rapid advancement of software tools such as JAVA, VRML, and specialized graphic and animation packages has made animation very easy to produce and use. When surfing the Internet with a Web browser, one encounters many pages with vivid animation jumping about on the screen. Often a user is reading the primary information on a page when animation appears in the peripheral visual field. To some viewers, animation is annoying, flashing graphics that divert attention from the content of a page. To the Web site designers, animation is a practical tool that can make less seem like more. On the limited display area of a computer screen, animation can be used to make something more distinctive, to promote a special section within a site or to allow illustration of editorial content more effectively (McGalliard 1998). To online advertisers, animation is a great way of increasing click-throughs. In fact, online advertising accounts for the majority of animation on the Web nowadays.

Advertising on the Web is growing at a fast pace. Online advertising revenue reached $906.5 million in 1997 (Internet Advertising Bureau 1998), topped $1.2 billion for the third quarter of 1999 (Internet Advertising Bureau 2000), and is projected to soar to $7.7 billion in 2002 (Davidson 1998). During the same period, total ad revenue for all other media—including print, TV, and radio—is projected to grow just 7% annually (Davidson 1998). Research shows that static banners (a posting on the computer screen akin to a print ad) do boost product awareness (Wang 1997). However, it is believed that using animation rather than static banners is a more effective way of online advertising, resulting in a 25% increase in click-through rates (Hein 1997; McGalliard 1998). Despite the very fast growth of animation for advertising, companies have learned valuable lessons along the way. For example, AT&T, one of the four largest marketers, learned not to "pester" consumers with intrusive Internet ads (*USA Today* 1998).

Being interrupted or having one's attention involuntarily shifted by animation on a Web page is a typical experience for many Web users. “Many find AOL’s full-screen 'pop-up' ads maddening” (Davidson 1998). Animation, when used to carry information that is not essential to one's information seeking tasks, may create visual interference that affects one’s information-seeking performance. Extraneous animation that is present continuously or appears suddenly can act as a distraction, making it difficult to concentrate on pertinent information. Thus, it disturbs and then often annoys people as they search for useful information on the Web, lengthening the time needed to obtain information correctly.

It is certainly not the content providers' intention to disturb or annoy their viewers. Web-owners or content providers want to make money from advertising, but they also care about the potential side effects of animation on their viewers’ information-seeking performance and attitude toward their Web sites. Given a choice, content providers would prefer advertisements that minimally disturb viewers' performance as they seek primary information on the Web pages. Advertisers or marketers, on the other hand, want to draw viewer attention, so they may want to design advertisements that have different characteristics than those the content providers would choose. The ads that advertisers favor may require more of the viewer’s attentional resources and thus have a higher chance of being processed semantically. To achieve their goals, both content providers and advertisers must understand the effects of animation in the Web environment. Unfortunately, there is a paucity of Information Systems literature on the effects of animation in the Web environment.

Research results from studies in visual attention and perception can provide a plausible explanation for the disturbance phenomenon. Studies show that in general, objects in our peripheral vision can capture our attention (Driver and Baylis 1989; Warden and Brown 1944). The meaning of a non-attended stimulus is processed to a certain extent (Allport 1989; Duncan 1984; Treisman 1991). Because attention has limited capacity, the available resource for attention on the pertinent information is reduced, thus information processing performance, including time and accuracy, deteriorates (Miller 1991; Treisman 1991).

It is, however, questionable whether we can apply visual-attention theories or research results directly to information-seeking tasks in a computing environment such as the Web. A primary reason for this is that the exposure time of stimuli in traditional visual attention studies is much shorter (milliseconds) than that on the Web (seconds or minutes), and one's visual attention behavior may change during this relatively long exposure time. The second reason is that the experimental environment or setting in visual attention studies is different from that in a computing environment, such as the Web. In visual attention studies, special types of equipment are used to display stimuli and capture responses. To date, few empirical studies report the effects of animation in a Web environment. The applicability of visual attention studies needs to be tested by conducting experiments in the Web environment.

This paper reports on a study investigating the effect of animation in the Web environment. Animation refers to motion of any kind. In this study, animation is limited to the kind that does not provide extra information for the user's information-seeking tasks. This type of animation is a non-primary stimulus, because it carries non-primary information. A controlled experiment is used to evaluate the effect of animation under different conditions. Data on subjects' perceived distraction and attitude toward the use of animation in information-seeking tasks are collected.

The value of this study is twofold. First, it sheds light on the applicability of visual attention and perception research results to the Web environment. Visual attention theories have not been extensively applied to IS research and practice in general and the Web environment in particular. Although the Web environment is different from the context within which visual attention theories were developed, it presents a unique opportunity to study the generalizability of research results in human visual attention. This has implications for extensively applying those theories to IS research and practice. Second, the study has practical value in providing Web page designers with data that can replace speculation on the effects of animation, as a non-primary information carrier, on user performance. As many more people search for information on the Web, conduct business over the Internet, and encounter animation more frequently as advertisers invest heavily in online advertising, research that investigates the real effects of animation becomes increasingly important.

The rest of the paper is organized as follows. In section II, some research results on visual perception and attention are reviewed and the research hypotheses are laid out. Section III describes the experimental design and section IV, the results. In section V, limitations of the current study are discussed along with the implications of the findings on Web user interface design from both content provider and online advertiser perspectives. Section VI points out contributions of the current study and poses future research questions.

II. LITERATURE REVIEW AND RESEARCH HYPOTHESES

Our ability to attend to stimuli is limited, and the direction of attention determines how well we perceive, remember, and act on information. Objects or information that do not receive attention usually fall outside our awareness and, hence, have little influence on performance (Proctor and van Zandt 1994, p. 187). Perceptual attention is usually studied with two primary themes: selectivity (conscious perception is always selective) and capacity limitations (our limited ability to carry out various mental operations at the same time), although a variety of other notions are also studied (Pashler 1998). Specifically, attention has been studied from two perspectives in order to understand different aspects of attention: selective and divided.

Selective attention is also known as "focused attention." It is studied by presenting people with two or more stimuli at the same time and instructing them to process and respond to only one (Eysenck and Keane 1995, p. 96). Usually the criterion of selection is a simple physical attribute such as location or color (Pashler 1998). Selective attention concerns our ability to focus on certain sources of information and ignore others (Proctor and van Zandt 1994, p.187). Work on selective attention can tell us how effectively people can select certain inputs rather than others, and it enables us to investigate the nature of the selection process and the fate of unattended stimuli (Eysenck and Keane 1995, p. 96). Divided attention is also studied by presenting at least two stimulus inputs at the same time, but with instructions that attention and a response must be given to all stimulus inputs (Eysenck and Keane 1995, p. 96). In divided attention, the question asked of the subject depends on the categorical identity of more than one of the stimuli (Pashler 1998, p. 29). Studies on divided attention provide useful information about our processing limitations (ability to divide attention among multiple tasks), and tell us something about attentional mechanisms and their capacity (Eysenck and Keane 1995, p. 96; Proctor and van Zandt 1994, p.187).

Pashler summarizes the discoveries in the visual attention literature. Following is a list of conclusions that are relevant to this study.

(1) The to-be-ignored stimuli are analyzed to a semantic level, although "the totality of the evidence does not favor the view that complete analysis takes place on every occasion."

(2) Capacity limits are evident when the task requires discriminating targets defined by complex discriminations (e.g., reading a word).

(3) More specifically, the capacity limits in perceptual processing of complex discriminations depend on the attended stimulus load and hardly at all on the ignored stimuli.

In summary,

> people can usually exercise control over what stimuli undergo extensive perceptual analysis, including, on occasion, selecting multiple stimuli for analysis. When this takes place, the stimuli that are selected compete for limited capacity. If the total load of stimulus processing does not exceed a certain threshold, parallel processing occurs without any detectable reduction in efficiency. Above this threshold, efficiency is reduced by the load of attended stimuli, and processing may sometimes operate sequentially, perhaps as a strategy to minimize loss of accuracy. (Pashler 1998, p. 226)

In this study, the subject's primary task is to search for some information (a phrase, word, or term) from a document on a Web page and animation provides no information for the primary task. This is not a clear-cut selective- or divided-attention task, but rather like a hybrid divided- and selective-attention task (Pashler 1998). In a real world situation, animation can have different properties such as size, speed, location, and content design and color (for examples of animation size, location, and possible cost to the advertisers, visit http://www.ecommercetimes.com/ad_info/). All these factors can affect the impact of animation. The effect of the same animation could also depend on the types of user tasks and different individuals. To make this study feasible, we consider some factors as constants; namely size, speed, and location. We treat three factors as independent variables; these are task difficulty (simple and difficult), animation color (bright color such as red, green, light blue, and orange, and dull colors such as gray, white, and black), and animation content (task-similar and task-dissimilar). Individual differences are eliminated by experimental design. We use research results from the literature to predict animation effects, while keeping in mind the question of the applicability of these results.

For information seeking tasks in the Web environment, both target stimulus (information to be searched) and non-target stimuli are defined by "complex discriminations" and must be identified by the subject before a decision (whether a stimulus is a target) can be made. In this situation, capacity limits should be evident, as summarized by Pashler. The amount of resources for processing the target stimulus may be affected by the amount of resources used to "attend" to non-target stimuli, either other words in the document or animation. Given that the number of non-target words in a document is a constant, adding animation to the document may add demand for resources and thus decrease the available amount of resources for processing the target stimulus. Therefore, the subject's information-seeking performance may be affected. It should be noted that we draw hypotheses from visual attention studies of the characteristics of our human visual attention mechanisms. However, the experimental settings for the Web environment are different from those in the visual attention studies.

Hypothesis #1. Animation as a secondary stimulus deteriorates subjects' information-seeking performance.

As indicated in the summary of attention research results, increasing the difficulty of processing the attended items eliminates effects of unattended stimuli (Pashler 1998, p. 98). Lavie and Tsal, for example, discovered that a distracter has less impact on a more difficult task (that is, a task with high perceptual load) than on a simple or low load task (Lavie 1995; Lavie and Tsal 1994). In Lavie's study, after being exposed to a string of one to six letters for 50 ms, participants were asked whether a target letter appeared in the string. The one- or two-letter condition was called a simple task, the six-letter condition a difficult task. The argument is that a difficult task required more cognitive effort by participants, thus their capacity was utilized, leaving less room for processing irrelevant information (that is, the distracter). We apply the findings to the Web-based tasks. In order to test this, we divide tasks into simple and difficult ones. The corresponding hypothesis is:

Hypothesis #2. As the level of task difficulty increases, subjects' performance will be less affected by animation.

The visual attention literature also indicates that the degree of interference has to do with the physical or/and the semantic relation between the distraction and the target (e.g., Mayor and Gonzalea-Marques 1994; Miller and Bauer 1981; Treisman 1991). The more similar their physical features or semantic meanings, the greater the interference. The basic argument is that visual items that are perceptually grouped (because they are very similar) will tend to be selected together and thus lengthen the time to detect the target or attended stimuli. In our case, we compare animation that has physical features and/or content similar to a user's tasks to another type of animation that has no similar physical features/content to the tasks. The corresponding hypothesis is:

> **Hypothesis #3.** Animation that is similar but irrelevant to a task has more negative effect on performance than animation that is dissimilar to the task.

Personal experience and anecdotal evidence indicate, however, that bright color is an important attribute of annoying animation. We anticipate that bright colored animation is more noticeable and thus more distracting than animation with dull color.

> **Hypothesis #4.** Animation that is brightly colored has a stronger negative effect on subjects' performance than does dull colored animation.

III. EXPERIMENTAL DESIGN

The experiment used a within-subject full factorial design in order to reduce error variability and increase statistical test power. Besides the three independent variables (task difficulty, animation color, and animation content), baseline conditions, where no animation was used, were also considered for tasks with two different difficulty levels. The experiment consisted of 10 imposed settings, as depicted in Table 1. Each subject did a total of 20 tasks, two for each setting. The sequence of the 20 tasks was randomized for each subject in order to reduce the potential order effect.

Table 1. Structure of the Study: Task Settings

	Baseline (no animation)	Task-similar animation		Task-dissimilar animation	
		Dull Color	Bright Color	Dull Color	Bright Color
Simple task	1	2	3	4	5
Difficult task	6	7	8	9	10

Subjects worked with a table of strings where some of the strings were target strings and were to be identified and counted. The table, which was designed as ten rows by eight columns, was displayable on one page and big enough to eliminate the one-glance-grabs-all effect (otherwise time spent on the task would not be measurable). The task of identifying target strings (which could be words, abbreviations, or phrases) from other strings is one of the typical information-seeking tasks in the Web environment. It is frequently conducted when viewers use either browsing or analytical information seeking strategies in the Web environment (Marchionini 1995). In this study, we defined a string as a random combination of one to four letters in order to eliminate any automatic processing of familiar target strings. Automatic processing is considered nonselective processing or requiring no attention (Pashler 1998). A target string appeared from one to five times in a table. After some trials, we found that one letter strings were too easy to count, and any string with more than four letters was extremely difficult to work with. We decided that in this study, a target string with two letters was a simple task, and a target string with four letters was a difficult one.

Each of the 20 tasks was associated with a pre-page and a task-page. A pre-page showed the target string that subjects needed to look for. A click on the link of the pre-page loaded the task-page. A task-page had a no-border table of strings in the middle, a clickable answer section at the bottom, and possibly some animation. The subject could select an answer and click the “Submit” button, which led the subject to the next pre-page in the task sequence.

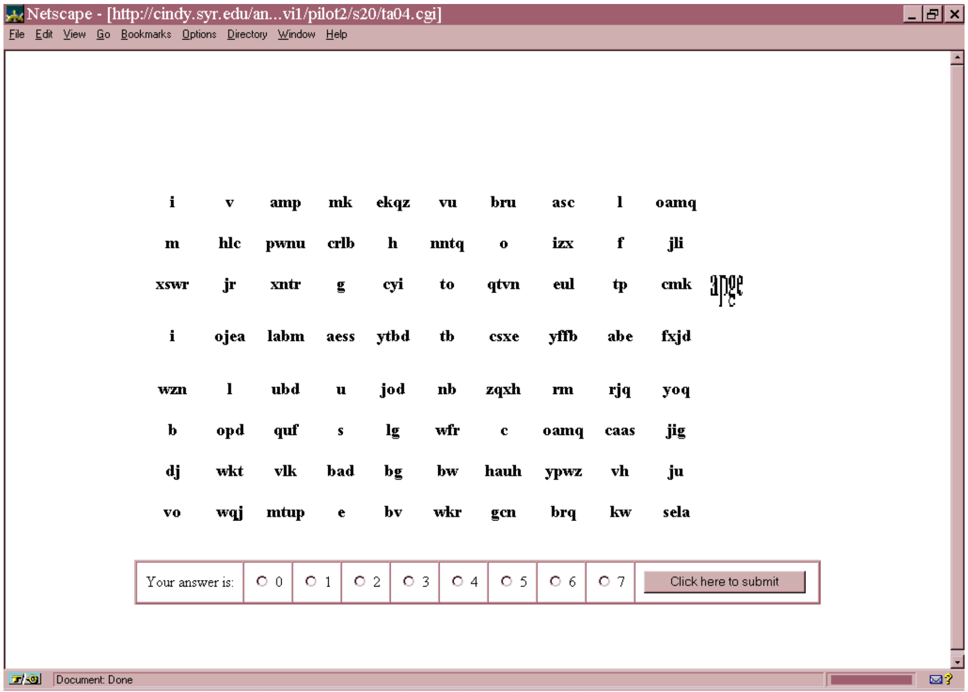

Figure 1. A Task-page with String Animation: Snapshot 1

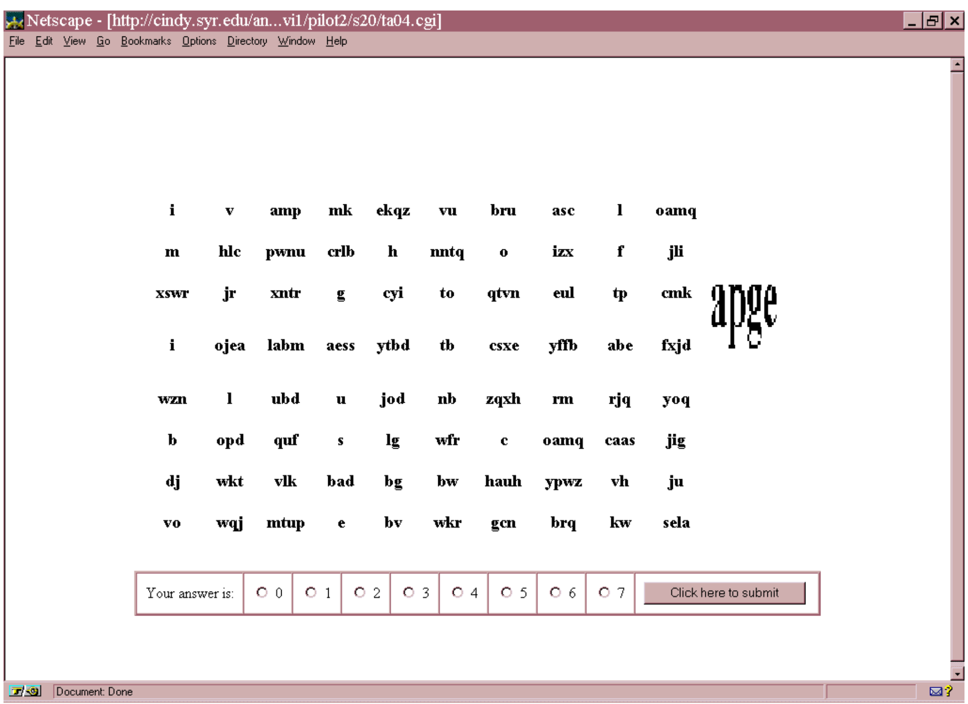

Figure 2. A Task-page with String Animation: Snapshot 2

Animation could appear in a random location right outside the table (top, bottom, and side). The content of animation included moving strings (similar to that in the tasks) and moving images such as animals, objects, and people. Both types of animation can be found frequently in real Web pages. String animation seemed to fly into a subject's face from deep in the screen then receded; this cycle continued for as long as the page was displayed. Figures 1 and 2 display two snapshots of a task-page at different stages of string animation. The size for all animations remained the same: 110 x 110 pixels. This arbitrary size is used in this study because there is no fixed size of animation in real Web pages. Animation appeared when a task began and stayed on until the end of the task. This task setting, where subjects need to focus on target strings with animation appearing in the peripheral fields, is very close to if not exactly what occurs in the real Web environment.

Both pre-pages and task-pages disappeared from the screen within a certain period; a pre-page stayed 10 seconds and a task-page 20 seconds. These pages also allowed subjects to process faster if they wanted by providing a link to the next page in the sequence. Interested readers or researchers may go to the study's URL (http://cindy.syr.edu/animation/public) to experience and expand the study themselves.

The Web browser was Netscape Navigator Gold 3.01. The background color of all Web pages was the default color. The foreground color was black; font size for strings in the tables was HTML “h3” in non-capital case. The PCs in the computer lab used for the experiment were the same model with same size and resolution monitors.

The subjects were not randomly selected. They were 24 undergraduate students majoring in Information Management and Technology. All had experience using the Web and the browser. Owing to the limited number of computers available, subjects were divided into two sessions. Each subject received a bonus for a course s/he was taking (either substituting an assignment or receiving extra credit). To encourage subjects to do their best during the experiment, we offered prizes for best performance at three levels ($30, $10, and $5).

Subjects were instructed to count as accurately and as quickly as possible how many times a target string appeared in the table. Once finished counting, they were to click the corresponding answer and then click the Submit button. They were reminded that "your performance is determined by the correctness of the answers and the time you spend on the task-pages, and you have only a limited time to finish each table." They were also warned that "going back to a previous page will mess up your log and waste your time. Your new answers will not be recorded, and the total amount of time you spend will be increased automatically by 1,000 times." At the beginning of the experiment, subjects practiced with four randomly selected tasks (with targets strings different from those used in the competition) to familiarize themselves with the experiment. Following the practice, subjects performed 20 tasks. After finishing the tasks, subjects filled out a questionnaire of biographic data, perceived interference, attitude toward animation used, search strategies, and animation features noticed. When everyone was done, performance scores were calculated, awards were given to subjects with best performance scores, and the subjects were dismissed. The entire experimental session lasted less than 45 minutes. The average length per task was 15 seconds.

All tasks for all the subjects were located on a computer server and were accessed through Netscape Navigator browsers through a campus local area network. The computer server captured the time spent on and subjects' answers to the tasks.

IV. EXPERIMENT RESULTS

The accuracy of task execution and the amount of time spent on the task determine the performance on the task. Because each task-page had a different number of target strings, we used count accuracy to represent errors in a task instead of number of miscounts. The accuracy score should consider that a subject could over-count or under-count the number of targets on a task-page. It should also have the property that the higher the score, the higher the accuracy. The following formula, where accuracy is dependent on the difference between reported count and correct count, is used to calculate the accuracy score: CA = (1 - absolute(CorrectCount - ReportedCount)/CorrectCount).

Time (number of seconds) spent on a task starts when the task-page is loaded and ends when the subject submits the answer to the task. The subjects were told that they would be evaluated by a combination of time and accuracy, which means that they might sacrifice one in order to achieve the other. In order to have a unified performance score (p) for comparison, we used accuracy per unit time as the performance score of a task. That is: p = accuracy/time*1000, while the constant 1,000 is to eliminate the decimal places of the p scores.

The three factors in Table 1, presented earlier, are analyzed at two levels. Level 1 considers a full 2 x 2 factorial repeated measure analysis of animation conditions (baseline and animation) and task difficulty conditions (simple and difficult). This helps us to test the first hypothesis, whether animation deteriorates one's performance, and the second hypothesis, animation's effect on tasks at different difficulty levels. Table 2 summarizes the ANOVA results.

Table 2. ANOVA Results for Animation by Task Difficulty

	Performance $F_{1,23}$
Animation	55.17 ****
Task difficulty	.00
Animation by Task Difficulty	10.74 **

* $p < .05$ ** $p < .01$ *** $p < .001$ **** $p < .0001$

Table 3. ANOVA Results for Task Difficulty by Animation Content by Color

	Performance $F_{1,23}$
Task difficulty	4.47 *
Content	0.64
Color	13.41 ***
Task by content	10.52 **
Task by color	0.48
Content by color	6.05*
Task by content by color	23.68 ****

* $p < .05$ ** $p < .01$ *** $p < .001$ **** $p < .0001$

Level 2 analysis is within animation conditions. That is, given that all the tasks are done with animation present, we consider a 2 x 2 x 2 full factorial repeated measure analysis on animation content (string and image), task difficulty (simple and difficult), and animation color (dull and bright). This second level analysis helps us to confirm hypotheses 3 and 4. Table 3 exhibits the ANOVA results of this level 2 analysis. The two tasks in each of the 10 experimental settings are averaged for the analysis.

Next, we examine each of the four hypotheses in light of the experimental results on performance.

Hypothesis #1. Animation as a secondary stimulus deteriorates subjects' information-seeking performance.

This hypothesis is well supported by the data. As shown in Table 2, animation has a main effect, severely decreasing performance from the baseline condition. This is true no matter what the difficulty level of the task. Support for this hypothesis is depicted by Figure 3, which displays the group mean performance scores. Baseline tasks (no animation) have higher performance scores than tasks with animation presence.

Hypothesis #2. As the level of task difficulty increases, subjects' performance will be less affected by animation.

The level 1 ANOVA concerns the relationship between animation conditions and task difficulty levels and can be used directly to test this hypothesis. Both Table 2 and Figure 3 show a significant interaction effect ($p < 0.01$) between animation and task difficulty level. That is, the degree of the animation's effect is related to the task difficulty levels. Specifically, animation affects simple tasks more than it does difficult tasks. Thus, as the level of task difficulty increases, performance is less affected by animation. This supports the hypothesis.

Hypothesis #3. Animation that is similar but irrelevant to a task has more negative effect on performance than animation that is dissimilar to the task.

ANOVA results in Table 3 indicate that this hypothesis is true under certain conditions. Table 3 shows a significant three-way interaction effect ($p < 0.0001$). This three-way interaction effect can be better depicted by Figures 4 and 5.

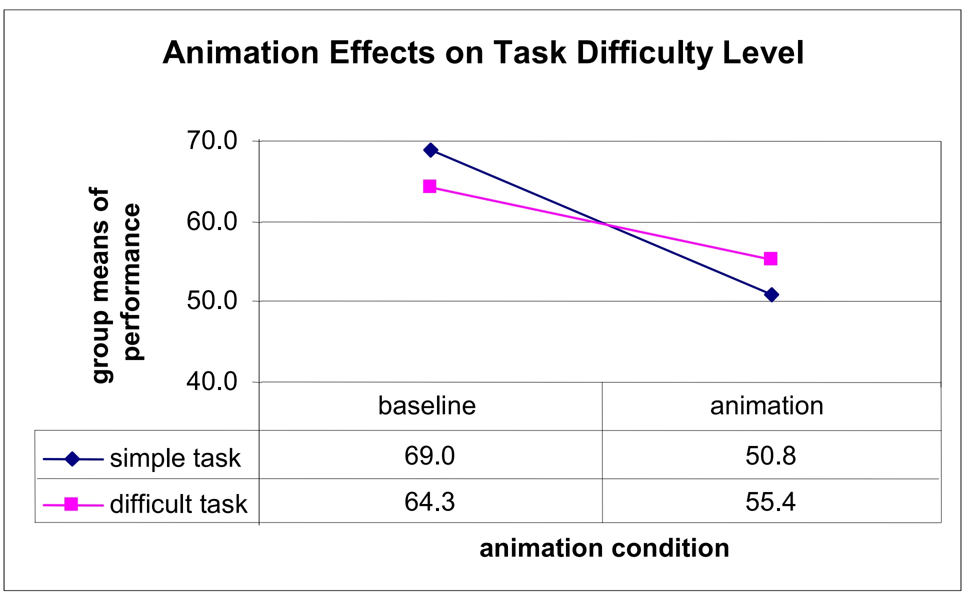

Figure 3. Group Means of Animation Effects on Simple and Difficult Tasks

For simple tasks as in Figure 4, dull color string animation has more negative effect than dull color image animation does; and bright color image animation has more negative effect than bright color string animation. That is, the effect of string animation that is similar but irrelevant to the tasks is associated with the color of the animation for simple tasks.

For difficult tasks, as shown in Figure 5, string animation has more negative effect than image animation. Color of the animation does not seem to matter.

> **Hypothesis #4.** Animation that is brightly colored has a stronger negative effect on subjects' performance than does dull colored animation.

Table 3 shows the significant main effect of color. The group mean for dull color tasks is 57.2 (the average of 43.1, 65.4, 67.5, and 53, obtained from the data tables in Figures 4 and 5), compared to the group mean of bright color of 48.9. This shows that dull color animation affects tasks less than bright color animation. The three-way interaction effect shown in Table 3 and Figures 4 and 5, however, indicates that one needs to look at other conditions. For simple tasks as depicted by Figure 4, dull color can be worse than bright color when animation is string, seemingly refuting the hypothesis. For image animation, or for difficult tasks, the hypothesis is supported.

Next, we discuss questionnaire responses and compare them to the analyzed data that support the hypotheses. Table 4 summarizes the responses from the subjects on (1) perceived effects of animation and animation features (columns 2 through 6) and (2) the answers to "How strongly would you agree that you would rather have no animation while performing this type of tasks" (the last column).

When they were asked to describe the most distracting animation, six out of 24 subjects explicitly mentioned that animation was "not at all" or "not very" distracting. For other subjects, colored animation was explicitly mentioned 14 times, changing sized animation nine times, word or string animation 10 times, and image animation twice. One subject indicated several animation features, stating "bright

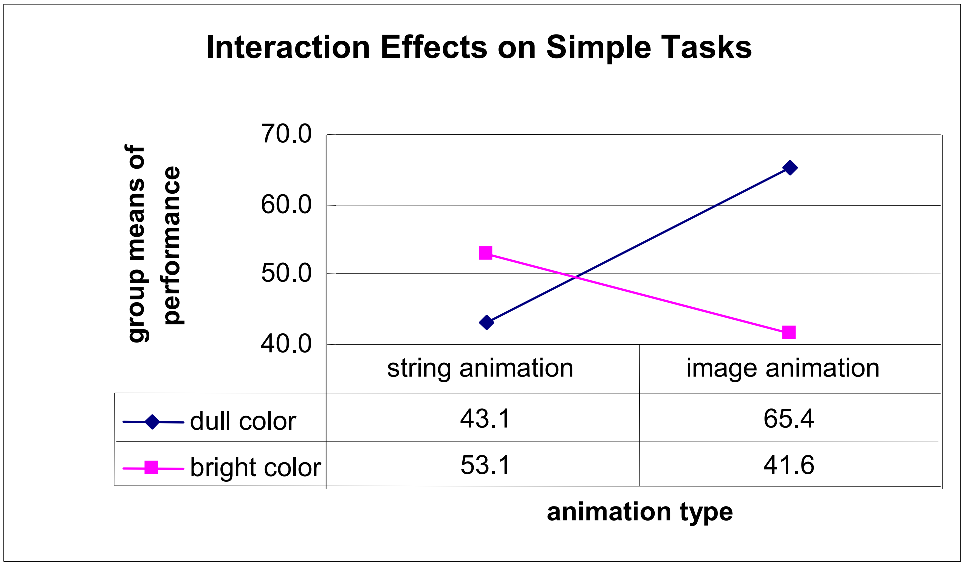

Figure 4. Color by Relevance Interaction Effects on Simple Tasks

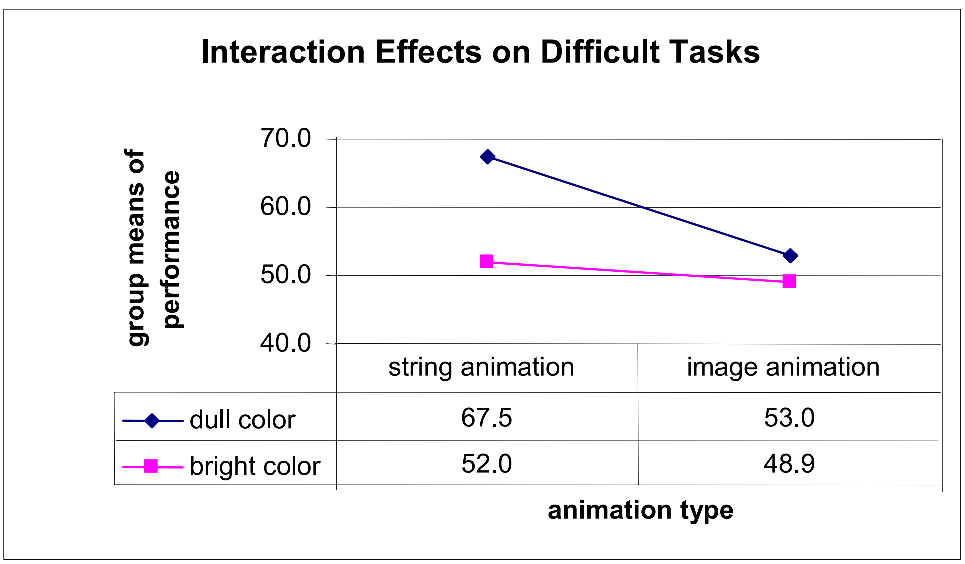

Figure 5. Color by Relevance Interaction Effects on Difficult Tasks

Table 4. Perceived Animation Effects and Attitude

Sid	Animation not at all or not very distracting	Tasks were distracted by animation				Preference for absence of animation
		Colored	Changing size	String	Image	
s01	x					1
s02		x	x			7
s03	x					4
s04		x		x		5
s05		x		x		7
s06		x	x		x	6
s07		x				7
s08						7
s09				x		6
s10		x	x	x		7
s14	x					5
s15	x					6
s17		x	x	x		7
s18		x				7
s19		x	x	x		7
s25				x		6
s26			x			7
s27	x					4
s28						7
s31		x		x		7
s32		x		x		7
s35	x	x				5
s43		x	x	x		5
s44		x			x	5
Total #	6	14	7	10	2	
%	25%	50%	29%	42%	8%	

colored letters that change sizes," which includes color, string, and changing size. Two subjects (s08 and s28) did not make any explicit claim on the effects of features but did state that animation distracted them from performing the tasks. It could be that some subjects only mentioned the most "impressive" annoying feature, even though other features were also distracting.

The perceived color effect, exhibited in Table 4, is consistent with the performance data. String animation that is similar to tasks is another confirmed distracting feature, with more people reporting it than image animation. It is, however, difficult to pin down what the changing-size feature actually implies. Among all the animations used in the study, only string animations change size (the way string animation moves makes it look as if it changes its size; see Figures 1 and 2). That is, some subjects may use this phrase to describe the string animation (as indicated by Table 4, some subjects reported either changing size or string, but not both), or the true feature of animation that changes its size. This feature needs to be studied in future research.

The attitude toward use of animation accompanying information-seeking tasks is shown in column 7 of Table 4. When asked how strongly they agreed that they would rather have no animation while performing this type of tasks, 50% of the subjects answered “completely agree” (scale 7), 38% answered “strongly or somewhat agree” (scales 6 and 5), 8% answered “neutral” (scale 4), and one subject (4%) answered “completely disagree” (scale 1 by s01). Subject s01 further explained that “if a person is looking at a page with a specific goal in mind, such as the task I was given, then any distractions can be easily ignored.”

To test whether perceived effects are consistent with the performance data, the data of the six subjects who said animation was not at all or not very distracting were analyzed descriptively. Table 5 shows the results. Except s01 and s27, whose performance was not changed much by animation, the performance data of the other four subjects decreased substantially (more than 20% and up to 41%). Two observations can be drawn from this analysis. First, it seems that perceived effects may not necessarily be the true effects, as indicted by the four subjects whose performance dropped when animation was introduced. Second, it could be that animation has little or no effect on some people, such as s01 and s27. This raised a question concerning the conditions under which animation does not interfere with information-seeking tasks.

Table 5. Change in Performance of Those Who Perceived No or Little Animation Effects

	Baseline	Animation	Decrease %
s01	57	55.3	-3%
s03	66.3	50.8	-23%
s14	61.6	43.6	-29%
s15	66.7	39.5	-41%
s27	73.4	71.6	-2%
s35	61.6	40	-35%
mean	**64.4**	**50.1**	**-22%**

V. DISCUSSION

The primary goals of this study were to test the applicability of some visual attention and perception research results to the question of whether animation is a source of visual interference in the Web environment and to determine under what conditions and to what extent animation affects information-seeking performance. In order to achieve these goals, a controlled lab experiment was conducted and many factors were eliminated from the study. For example, the speed of animation, many potential locations of animation (for instance, animation inside the content section, which is currently a strategy of some online advertisers), and the size of animation are not considered in this study. Another unexamined factor is multiple animation images on one page, which is typical in the real Web environment. These animation features and other commonly used features can be studied in future research investigations.

Cook and Campbell (1979) consider three factors concerning the external validity of a study: people or samples, settings, and times. In this study, the intended population was people who may use the Web. These include almost the entire population on Earth with various racial, social, geographical, age, sex, education, and personality groups. The subjects in this study were undergraduate students majoring in Information Technology in a northeast U.S. university. This non-random sample may not be a representative of the population. On the other hand, the study was designed to eliminate individual differences by using within-subject measures. From this perspective, the particular sample should not affect the findings. Another benefit of using within-subject measures is the increase in statistical power because of the reduced variability due to individual differences.

The setting of the study was a controlled campus lab with performance incentives. This may not be a typical setting for Web users. Most often, however, viewers need to find the correct information from a Web page, either in a computer lab or at the convenience of a home computer, within a reasonable, if not the shortest, time period. The performance incentives were intended to create pressure similar to that of a Web user. In terms of the time factor of external validity, the findings should not be biased by the particular day the study was conducted. During the fast development of the Web, animation may be used differently on Web pages over time. The effects of animation under the studied conditions, however, should not change owing to a rather slow process of human evolution. Nevertheless, the findings could be made more robust by further studies.

The implications of this study for Web user interface design and online advertising are significant. A poll of 1,000 households conducted by Baruch College and Harris Poll (*Business Week* 1997) indicates that the most common activity on the Net is research (82% of users), followed by education (75%), news (68%), and entertainment (61%). Another study (Chatterjee and Sambammurthy 1999) shows that U.S. companies are using the Web to facilitate the entire range of primary business activities—from product/service design and production to marketing, sales, delivery, and after-sales customer service. From the perspective of either the user information seeking or companies using the Web to realize both operational and strategic benefits, content providers must understand the potential effects of animation on users.

Specifically, in order to have minimum impact on viewers' information seeking performance and attitude toward a page, content providers should consider the following factors as suggested by this study: the target audience's typical task load, use of animation in combination with task load, and color and semantic meaning of animation. Specific strategies are: (1) raise the perceptual load, making information-seeking tasks more challenging by involving viewers in the content of a Web page; (2) use very little animation if tasks should not impose a high load; (3) avoid bright colored animation; and (4) avoid animation that is semantically similar to the primary tasks.

On the other hand, online advertising is very attractive to marketers, as proven by the fast pace of revenue increase. There are many issues to study, both theoretically and empirically, before one can advise online advertisers comprehensively. For example, some suggest that advertisers should be "negotiating for top of the page for online ads" (Hein 1997), while others discovered that ads should be placed at a place on the page that viewers will reach after they have gained a certain amount of the primary information (Scanlon 1998). One thing seems certain at the moment: the decrease of a viewer's performance in the presence of animation is due to the viewer's attention (perhaps even involuntary attention) to the animation. In order to have viewers pay (more) attention to online ads composed of animation, advertisers need to analyze the same factors that content providers must analyze: task load, animation color, and animation content. Thus, the strategies for advertisers are almost the opposite of those for content providers: (1) target pages where audiences tend to have simple tasks, (2) use bright color when possible, and (3) design animation that is semantically similar to the tasks.

VI. CONCLUSION

With the rapid evolution of the Internet and the World Wide Web, and as more people use the Web for gathering information, conducting business, and entertainment, studies on the effect of certain Web features such as animation become timely and important. For a relatively new medium such as the Web, empirical studies are as important as theoretical predictions and implications. Research on applicability of existing theories or research results has theoretical as well as practical value. This study tested the applicability of some visual-attention and perception research results to the Web environment. The interference effect of animation was predicted by these visual attention and perception studies. Thus, the findings of this study are plausible. This implies that, despite some different experimental conditions (such as short exposure time), the traditional visual perception and attention studies might be applicable to the Web environment. After all, human evolution changes our characteristics much more slowly than the environment changes. Certain study results on human characteristics can be applied over a relatively long period. This particular study suggests that designers of any type of user interface should consider possible visual interference sources that may affect an individual's information seeking performance.

This research provides a base for future investigations. One interesting observation from the current study is the fact that some subjects can block the distraction caused by animation (refer to Table 5 and comments from s01). Others have also noticed this fact. For example, as Jakob Nielsen observed, “Users are completely ignoring banner ads. Click rates are falling through the floor” (Machlis 1998). It is worth studying the conditions under which Web viewers can intentionally block animation or static banners they identify as non-primary information. Furthermore, even if viewers can indeed intentionally ignore animation and banners, visual perception theories suggest that animation/banners are semantically processed to some extent (Pashler 1998). It would be interesting to know the extent to which viewers semantically process non-primary animation or banners. In other words, perhaps viewers' intentionally ignoring animation/banners does not mean they are not aware of the semantic content of the ignored features. If this notion were confirmed, it would be good news to online advertisers who, among other goals, want to raise brand awareness.

Another possibility is to study user satisfaction with a website that has online advertising. The current experiment is meant to test information-seeking performance. Although the study also touched on some of the user attitude issues, such as perceived animation distraction and opinions on use of animation on Web pages, it did not test user satisfaction with using a website that has online advertising. The satisfaction question should be addressed in a less controlled field setting. This is beyond the scope of the current study. Satisfaction is an important indicator of user attitude toward using and continued use of a website. Rafaeli (1991) did a pilot experiment on combining advertising messages with a software package perceived to be useful by the subjects. His study shows that (1) user satisfaction with the software seems unaffected by use of advertising messages; (2) recall of advertising messages seems high; and (3) it seems well worth further investigating the effect of software's communication bandwidth on advertising effectiveness. If his conclusions can be applied to the Web environment, and if the usefulness of the website is highly regarded by the user, advertising carried by the website might not reduce user satisfaction levels, regardless of reduced performance. This would be useful to advertisers as well as content providers. It thus calls for future investigation.

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[1]Editor's Note: The following reference list contains hyperlinks to World Wide Web pages. Readers with the ability to access the Web directly or are reading the paper on the Web can gain direct access to these linked references. Readers are warned, however, that

1. these links existed as of the date of publication but are not guaranteed to be working thereafter.
2. the contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.
3. the author(s) of the Web pages, not AIS, is (are) responsible for the accuracy of their content.
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