

THE EFFECT OF ANIMATED BANNER ADVERTISEMENTS
ON A VISUAL SEARCH TASK

by

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The growth of the Internet as a commercial medium has led advertisers to exploit humans' inherent sensitivity to movement in the form of animated banner ads. An experiment was designed to compare the exogenous, or involuntary, attention capture of four types of banners: animated commercial banners, static commercial banners, flashing text banners, and blank banners. Participants performed a simple visual search task in the presence of the different banner types, and software recorded search times and errors. Subjective workload ratings were also collected using NASA's Task Load Index system. No significant difference in search time was found between the four conditions; however, participants rated the search task with the animated banner distractors as much more work-intensive.

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INTRODUCTION

Increase in Computer Use and Growth of the Internet

From punch cards to GUIs,¹ advancements in the computer interface have made machines more accessible to a nontechnical audience. Computer.com even features grandmas and children in its commercials ("Nephew," n.d.). Home computer ubiquity coupled with the Internet boom has led more and more people to use computers to perform everyday tasks. Consequently, as computers become *de rigueur* for research, communication, even entertainment, advertisers exploit the technology to reach netizens of various demographic groups in a dynamic, hip medium.

However, unlike the sequential and captivating nature of television, radio, and paper media, the Internet's hypertext² encourages spasmodic exploration. Thus, advertisers and webpage hosts vie to entice visitors who are a click away from a competitor's site. Designers must use the most appropriate technology and techniques to create layouts that steer the viewer's eyes in a predetermined course. The prevalence of animated banner ads over the past five years indicates that advertisers have relied on animation as an ostensibly surefire attention-getter.

¹ Graphical User Interface (GUI) - The graphic layer through which people interact with a computer; Windows and MacOS are two examples. Non-GUI systems use command prompts, and include DOS and UNIX.

Animation as an Aid and Attention-Getter

A primitive context explains why movement, especially in the peripheral vision, attracts attention: hunters roaming the plains needed to sense the prowling tiger to survive. Graphic designers have manipulated this rudimentary instinct in the form of blinking icons, swirling logos, and scrolling banner advertisements, all intended to liminally lure the casual web surfer.

Furthermore, high resolution monitors and fast processors have enabled animation to become an integral part of popular software, especially to assist the user in performing a task. For example, Microsoft Office products include an animated office assistant, "Clippit," to aid novice users with



Figure 1: Clippit, the MS Office assistant.

the program (see Figure 1). Clippit periodically offers tips and suggestions, and users can click on the icon for additional help. When not in active use, Clippit occasionally blinks and dances. Giving the traditional help system an animated, lively demeanor could make the program more attractive to users. However, empirical evidence suggests that both the persona and even the mere presence of an animated assistant play a large role in effectiveness and user anxiety (Rickenberg & Reeves, 2000). If the animated agent is too intrusive, users may avoid or even resent it.

Yet animation can provide meaningful clues in an interface, especially one with a traditionally steep learning curve, such as a sophisticated painting program. For example, the selection tool (see Figure 2) is a common digital painting instrument used to delineate a specific area in an image. What is the best way to represent the selection tool in a

² hypertext - A nonlinear cross-referencing system fundamental to the structure of the Web. Users click on hyperlinked text to jump to another part of the current document or to another document.

toolbar, where each icon must fit in a small area? Photoshop and other popular painting programs use marquee and lasso metaphors, but these might not be immediately recognizable to a beginner. Several studies show that animating an icon clarifies its purpose and invites a user to try it (Baecker, Small, & Mander, 1991; Dormann, 1994; Rist, André, & Müller, 1997), though others warn that animation should be halttable by expert users (Alpert, 1991). While animation could assist a novice, gratuitous movement might annoy expert users.



Figure 2: Part of Photoshop's toolbar, with the marquee (upper left) and lasso (lower left) selection tools.

The problems of digital animation carry over to the analog world, as well. In 1980 the Federal Highway Administration released a report investigating the safety and aesthetic effects of "commercial electronic variable-message signage," indicating that certain aspects of animated road signs were hazardous. In particular, the "animation and message flow," brightness and contrast, and cycle length all have a high impact on traffic safety. In fact, the danger comes from human's limited attention capacity: instead of favoring official signs and filtering out billboards, when people are hungry or in need of gas they look for signs advertising those things, lowering the attentional priority of driving and leading to accidents.

Animation in Banner Advertisements

The most prevalent form of advertisement on the Web today is the banner: a 468 x 60 pixel³ image, often at the top of a webpage. Advertisers value banners for their customizability and automatic log of clickthrough⁴ statistics. The Internet Advertising

³ pixel - Short for "picture element," a pixel is the smallest discrete unit of an image on a computer screen, often a single-colored dot.

⁴ clickthrough - When a consumer clicks on a banner advertisement and is taken to the advertiser's website.

Bureau (IAB), founded in 1996, recommends standard sizes adopted by most businesses to maintain a professional appearance. The IAB lauds the effectiveness of banner ads (PricewaterhouseCoopers, 1999), although a few years after their inception in the mid-nineties, banner clickthrough rates had fallen, and Benway and Lane (1998) announced the "banner blindness" phenomenon, in which people missed information prominently displayed in colorful, banner-shaped images.

Thus, advertisers turned to more drastic methods to attract consumers, and found animation to be a successful option. ZDNet (1996) found that animations increased clickthrough rates by at least 15%, and as much as 40% ("Research," 1998). With the new prevalence of high bandwidth⁵ Internet connections, more advanced animations created with Flash,⁶ DHTML,⁷ and other rich media⁸ allow advertisements to interact with users. People can now purchase a book through a Barnes and Noble advertisement, typing their credit card number into a form field embedded in the ad, all without leaving the current site they are exploring. However, like animated software assistants, animated banner ads also risk irritating people. Online discussion groups like Plastic.com post daily complaints about web advertising, including "nothing [is] more annoying than banner ads," and "banner ads and other advertising atrocities on the web . . . don't really

⁵ bandwidth - The rate of data transmission across a network. A high-bandwidth T1 line operates at roughly 1.5 Megabits per second, and low-bandwidth modem connection is roughly 14.4 Kilobits per second.

⁶ Flash - An interactive, multimedia file format created with a Macromedia software package. Flash file sizes are extremely small, allowing even users with a low bandwidth connection to interact in real time.

⁷ Dynamic Hypertext Markup Language (DHTML) - An extension of the basic WWW coding language, HTML, which allows a web page to change dynamically without an extra (time-consuming) call to the server.

⁸ rich media - The latest forms of interactive, multimedia technology used on the Web, often for entertainment or marketing. Rich media include Flash, DHTML, and many 3D modeling applications.

work" ("Shoshkeles," 2001). If people dislike animated ads they might intentionally ignore them. Can people do this successfully?

Animation in Attention-Capture Research

Traditional attention-capture studies tend to fall into two positions regarding animation: automatic attentional capture vs. potential capture contingent on other factors. The first group asserts that humans involuntarily orient their attention toward moving objects regardless of importance (Hillstrom & Yantis, 1994; Jonides, 1981), while the second maintains that animation only attracts a user when the animation is relevant to the user's task (Folk, Remington, & Johnston, 1992; Pashler, under review). Both groups refer to exogenous attention orientation, or "shifts of spatial attention that are elicited by salient external events and that occur involuntarily (i.e., without conscious intent)" (Folk et al., 1992, p. 1030). Neither group investigates endogenous attention, visual attraction caused by the semantic content of an animated distractor, such as the presumed appeal of a banner with the word "FREE."

Hence, the first group would favor the theory that animated banners automatically capture a user's attention, making any concurrent visual task more difficult, assuming limited attentional capacity. Several researchers have investigated the attentional capture of animated icons in a simple visual search task. Yantis and Johnson (1990) showed that when searching for a letter icon, participants found their target more quickly when the target appeared abruptly (flashed on) in a previously empty area, than when the target appeared due to simple changes to the shape of a similar object already sitting there. Furthermore, Jonides and Yantis (1988) found that abrupt visual onset was unique in its ability to capture attention; differences in luminance and hue did not produce a similar

effect. Dynamic discontinuities, such as a flash, catch attention; static discontinuities, such as feature changes, do not.

Folk, Remington, and Johnston (1992) purport a strong restriction to animation's supposed power: they claim that animation is only distracting when the motion is relevant to a person's primary task. The "Contingent Involuntary Orienting" hypothesis states that "involuntary orienting of attention will occur if the event shared the critical property and will not occur if it does not" (p. 1032). Pashler (under review) bolsters this theory in a visual search experiment, in which participants actually performed faster in the presence of irrelevant, animated (shimmying) distractors.

Based on the two conflicting sets of studies, from a traditional research standpoint the effect of animated banner advertisements is unclear. Are people involuntarily drawn to the motion, or does exogenous capture occur only if the banner has relevant material on it? And, though Benway and Lane only looked at static graphics in their banner blindness study, perhaps a similar effect now holds for animated banners, as consumers become inured to the banners' effects.

RESEARCH QUESTION

Do animated advertisements attract people's attention involuntarily? One indicator of this exogenous attention capture would be slower task performance. Thus, can computer users perform a simple visual search task in the presence of an animated banner as quickly and accurately as in the presence of a similar static graphic, or no graphic? Furthermore, based on the colloquial reports of animation as annoying, does the presence of animation affect the way the user feels about the task or its difficulty?

EXPERIMENT 1

Introduction

Given the conflicting body of animation research and yet the prevalence of animated advertisements, a study was designed to test how animation affected a simple Web task. The study investigated response times in a visual search task, and how the participants felt about the task's difficulty afterward, using a well-known rating system, NASA Task Load Index (TLX).

Participants were asked to find a particular word on a screen with many other distractor words. Meanwhile, banners (described below) appeared on the screen, some of which were animated. This scenario is common on the Web; people look through lists of links while advertisements blink at the top of the page.

Since links are sometimes arranged in columns and sometimes scattered on a webpage, and banners themselves may appear in many different locations, the study investigated layout (columnar vs. scattered), banner location predictability, and banner type. To keep running time under 1 1/2 hours, the study was divided into two portions (noted Experiment 1 and 2).

Experiment 1 looked at the combination of layout and banner type, when banners were centered at the top and bottom of the screen during the task. After the analysis of the results of Experiment 1, Experiment 2 was designed with slightly different focus: a

more difficult search task and variable banner placement. Participants were given four words to search for, only one of which would appear on the screen, much like a real-world Web task, in which multiple words could fit someone's search criteria. Experiment 2 looked at banners that appeared in various locations throughout the search area. Only the columnar layout was used.

Materials And Methods

Subjects

Four adults (2 female) aged 19 to 24 with a mean age of 22 participated in the experiment for \$10 to \$15. All participants were comfortable using GUIs and had normal or corrected-to-normal vision.

Equipment

Software

Experiment software was run using Macromedia Director, a multimedia authoring tool commonly used to make interactive CD-ROMs and Shockwave movies for the Web. The software was written in Lingo, Director's scripting language. Director was chosen for its adeptness with both animated and static graphics, and for its relation to Macromedia Flash, with which many modern banner advertisements are made.

Hardware

The experiment was presented on a Sun 18" LCD monitor with 0.28 mm pitch, controlled by a 350 MHz PII processor running Windows 98. The participants responded using a new Microsoft Wheel Mouse optical mouse.

Design

Basic Task

For each experimental trial, the participant was instructed to find a particular target and click on it with the mouse. Each trial had two parts: the precue stage and the search stage. In the precue stage, a copy of the target object, called the precue, appeared on the screen. When ready, the participant would click on a button beneath the precue, making it disappear, and initiating the search stage. Just below the precue's previous position, a two-dimensional layout of objects would appear. One of the objects would match the precue; the others were distractors, including other words and banners, designed to make the search harder. The participant would search for the target item and click on it.

Target and Distractors

Each experimental trial contained one target object for the participant to find and click on with the mouse, and 23 distractor objects. Targets and distractors were four-letter words written in 18-point Helvetica type enclosed in a 2.4 x 0.7 cm rectangle. Six hundred seventy-two four-letter words were used, gathered from an automated, exhaustive search of the first two levels of text on Wired.com. Words were filtered for appropriateness and limited to one or two syllables to facilitate vocal repetition during the search process.

Layout

Experiment 1 used two layouts: columnar and scattered. In the columnar layout (see Figure 3), items were arrayed in three columns of eight rows, with 1.25 cm between rows and 8.48 cm between columns. Two banners (described below) were centered above and below the target/distractor objects.

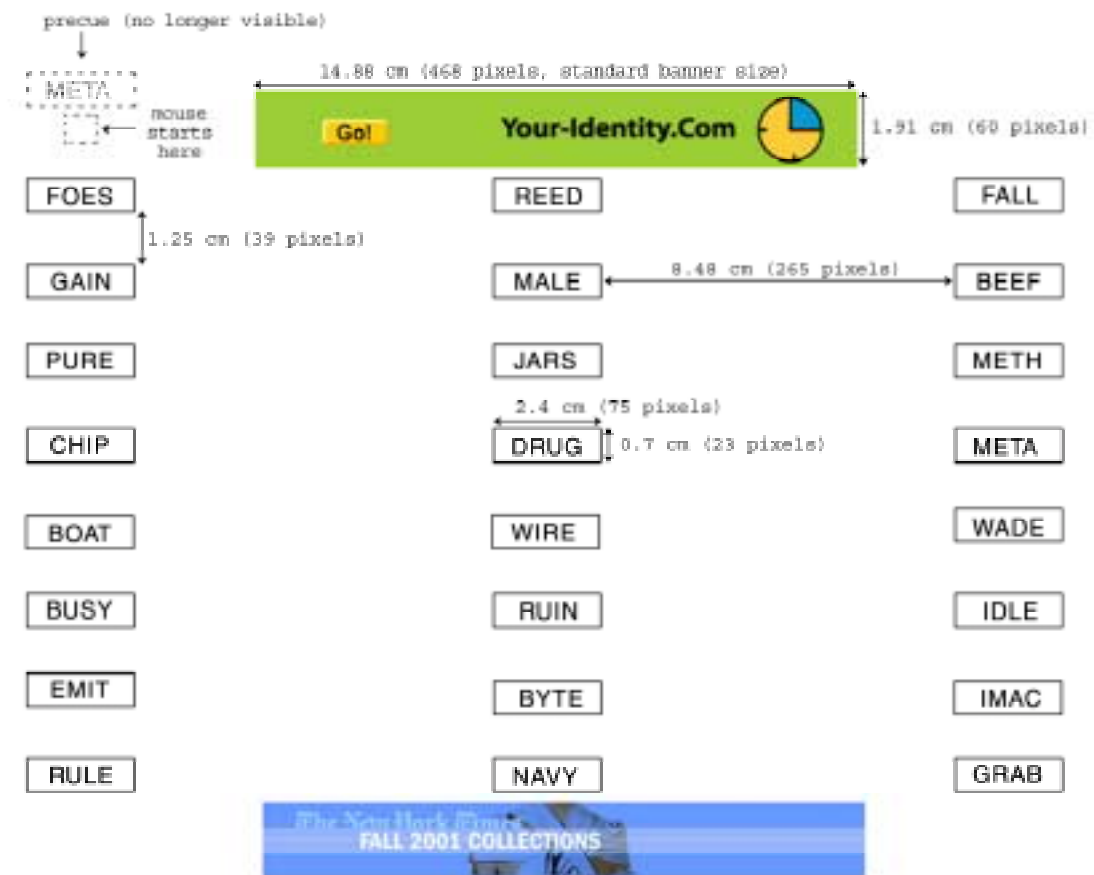


Figure 3: Columnar layout used in Experiment 1, drawn to scale. The precue location is also shown.

In the scattered layout (see Figure 4), items were also arrayed in rows, but each column was divided into a triplet of possible positions, with the target and distractors placed in one of the three positions chosen at random for each triplet, giving the layout an

unpredictable appearance. The vertical distance between screen objects remained 1.25 cm, but the horizontal spacing varied from .32 to 11.2 cm, depending on which position in each triplet was used.

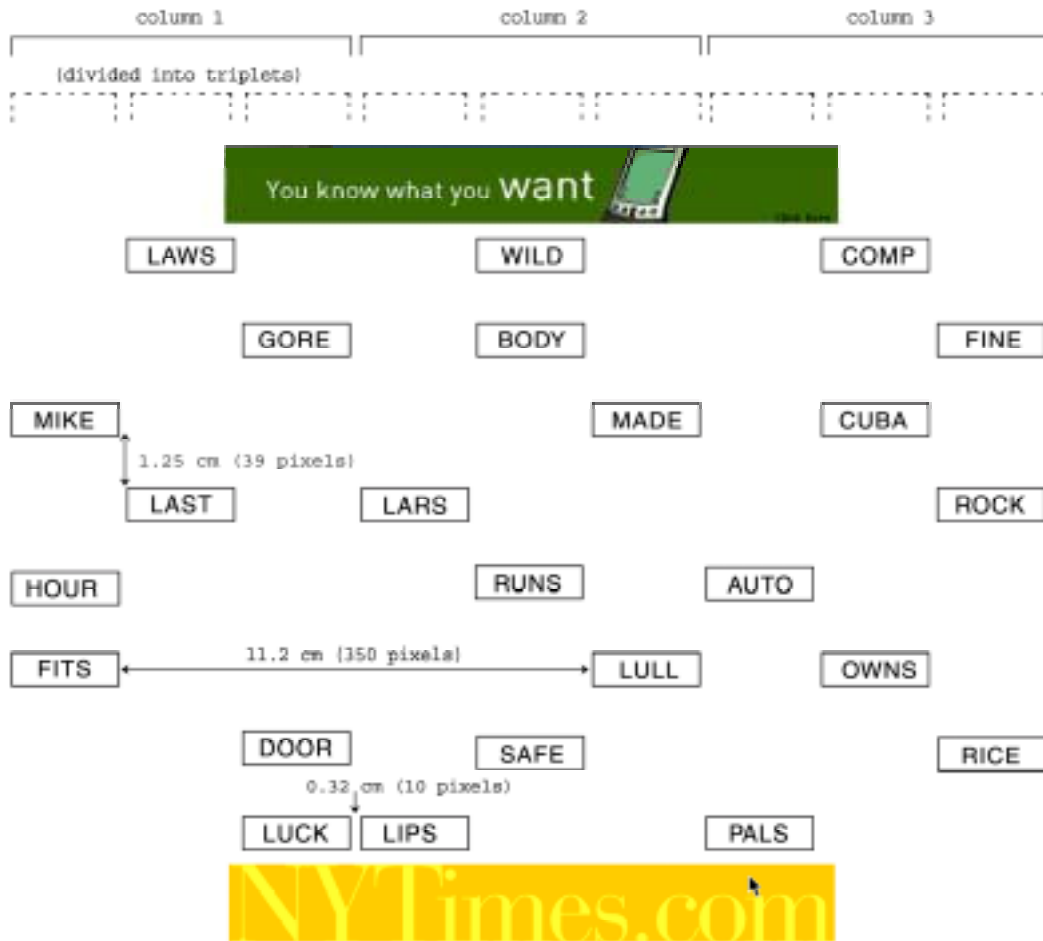


Figure 4: Scattered layout used in Experiment 1, drawn to scale.

Banners

Figure 5 shows the four banner types used in the experiment: (a) blank banners, (b) animated commercial banners, (c) static commercial banners, and (d) flashing text banners.

Blank banner:

Static commercial banner:



Flashing text banner
(two frames with sample words):



Animated commercial banner
(sample frames):



Figure 5: Samples of the four banner types used in the experiment. Sample frames for the animated banners are shown.

One hundred ten animated commercial banners from popular news websites, search engines, and portals,⁹ including the New York Times website, AltaVista, Yahoo!, AOL, and CNN.com were chosen. Static commercial banners consisted of a representative frame from each animated commercial. Finally, as an extreme example of animation, flashing text banners were created: each had a bright cyan background with large black text that alternated flashing on the left and right halves of the banner every 150 msec. The cycles for the two banners were offset by 80 msec, making them change asynchronously. Text for these banners rotated through the target and distractor words for any given trial.

⁹ portal - A website with many categorized links and (usually) a search engine, giving people an easy place to start browsing the Web. Popular portals include AOL, MSN, and Yahoo!.

Point Completion Deadline

To isolate search time and selection time, the point completion deadline (PCD) designed by Hornof (in press) was used in this experiment. Briefly, participants were instructed to hold the mouse stationary until they found the target. Once they moved the mouse more than five pixels in any direction, they had a small amount of time to click on the target. If participants took longer than should have been necessary for a single mouse point,¹⁰ a buzzer sounded and the trial was recorded as an error. Participants were given as long as they liked to practice with the PCD before the experiment so that they could grow accustomed to not moving the mouse until they found the target, and thus error rates were minimized during the real trials.

Incentives and Penalties

Every participant was paid a minimum of \$10, but each had the opportunity to earn an additional bonus of up to \$5 based on speed and accuracy in the trials. Each trial had a potential bonus of four cents, with one cent deducted for every second that passed on the clock. When participants hit the target, they would hear a 150 msec "ding" and earn the trial bonus. If participants clicked on anything other than the target, or if the PCD expired, a 350 msec buzzer sounded and a five-cent penalty was deducted from their earnings. A longer penalty sound was used to slow the onset of the next trial, delaying participants and subtly encouraging them to avoid making mistakes. In the case

¹⁰ This time was determined by Fitts' Law, which describes the time necessary to move the mouse to a target, based on the distance to the target its width along the axis of travel from the initial location. Welford's version is used here:

Movement time = $a + b \log_2(d/w + 0.5)$ msec, with a and b both set to 300 to accommodate for slower participants, as in Hornof (in press).

of a PCD expiration, an alert box would also appear reminding participants not to move the mouse until they had seen the target. The software displayed cumulative earnings at the end of each block of trials. Overall, incentives and penalties were weighed to encourage fast but mostly accurate responses.

Blocking

Trials were grouped into two blocks with one layout per block. Every participant experienced both blocks to eliminate between-groups error. Each of the four banner types was used with each of the 24 potential target locations. Thus, each block had $4 \times 24 = 96$ trials. Trials were randomized in each block, and blocks were counterbalanced with a randomized Latin square.¹¹

Whenever a participant made an error, an additional trial with the same banner type and target position combination was added to the end of the block, and the remaining trials for that block were reshuffled. This way participants completed a correct trial for every combination. Subtleties in the experimental software led to 98% of all combinations being presented to every participant.

To reveal search time in an unimpeded environment, an additional target-only block was added. In this block, only the target appeared in the search portion of the trial, with no other distractors on the screen. Each of the 24 target positions appeared three times to give a mean search and selection time for each position. Participants began

¹¹ Latin square - An experimental design used to remove an effect due to the order of the blocks. Specifically, a square matrix of the numbers 1 through n such that no number occurs more than once in any row or column. Each column represents a block; each row a participant. For the experiment, a Latin rectangle was actually used, where enough Latin squares were stacked vertically to accommodate the number of participants.

target-only trials with two cents, rather than seven cents, since the task was much easier and there were three times as many trials as in other blocks. The target-only block was presented in between the other two blocks for all participants.

Procedure

Basic Experiment

Participants began the experiment by filling out a preliminary questionnaire, detailing their usage of computers and the Web.¹² Next, they read detailed instructions about the precue, target, point completion deadline, bonuses, and block structure. The lights were then dimmed and participants were positioned 56 cm from the screen with the precue at eye level. This eye-to-screen distance was remeasured before each block. Approximately half of the participants chose to use an optional mousepad, although the optical mouse did not require one.

Before the timed portion of the experiment, participants were given unlimited practice trials from the first block to get used to the point completion deadline. When they were ready, the software was restarted and data collection began. At the start of each block, participants were given five additional practice trials to get used to the block conditions. During these trials, the words "Practice trial" appeared above the precue.

For each trial, the precue would appear alone on the screen. Participants took as long as they needed to memorize it. When ready, participants clicked the box beneath the precue. The precue would disappear, and the target and distractors would appear. When the participant clicked on a target or distractor, the item's colors would invert briefly for feedback, and either a ding or buzzer sounded, as previously described. At the

end of each block, a summary screen showed how much money the participant had earned so far.

NASA Task Load Index (TLX) ratings

After the timed experiment, participants were asked to subjectively evaluate their experience with the different conditions. The Task Load Index (TLX) system developed by NASA (Hart & Staveland, 1988) was used to allow comparison of subjective ratings across participants. TLX measures "workload," defined by the following factors: mental demand, physical demand, temporal demand, impression of performance, effort, and frustration.¹³ Participants rated each factor on a visual scale and then performed a pairwise weighting comparison, indicating for each pair which factor contributed more to the sense of workload. Though either of these measures separately would vary significantly between participants, combining the two to reveal the relative importance of each factor provides a reasonable metric with which many participants' responses can be compared.

Combination of the ratings and weights is calculated as follows:

1. The number of times each factor was chosen in the pairwise comparisons is divided by six, giving an average weight.
2. The average weight is multiplied by the magnitude rating, giving a workload score.

The scores for each factor can now be compared, both between factors and between participants. Overall workload is the sum of the factor scores. Thus, the factors

¹² This and all subsequently mentioned experiment documents can be found in Appendix A.

¹³ See Appendix A for detailed factor definitions and evaluation forms.

considered more important to workload are weighted more heavily in the overall workload score. This process can be repeated to gain comparable overall workload scores for several experimental conditions or tasks.

Participants were shown each banner type and layout again before being asked to record their subjective ratings for that banner type. Again, these blocks of banners and layouts were administered with a randomized Latin square to reduce an order effect. All eight layout/banner combinations were not used because of time constraints. Instead, the following five representative conditions were chosen:

columnar layout with blank banner

scattered layout with static commercial banner

scattered layout with animated commercial banner

scattered layout with flashing text banner

target only condition

Participants ran a few trials in a given block to refresh their memory, and then gave TLX ratings and weights for the condition in that block. The experimenter then jumped the software to the next block and asked participants to evaluate the next condition.

In addition to the TLX evaluations, participants also gave an exit interview, conducted verbally with the experimenter. Participants described the level of difficulty of different parts of the experiment, ranked the different banner types for distraction, and described any strategies they used to perform well.

Results

Search Time and Error Rates

Table 1 shows the mean search time for each banner type and layout combination, along with the target-only condition for comparison.¹⁴ Error and practice trials are excluded from analyses unless specifically noted.

Table 1. Search times for each banner type and layout combination in Experiment 1, averaged across target position and participant. Error and practice trials are excluded.

Banner Type	Layout	Mean Search Time (in msec)	Standard Deviation (in msec)
Blank	Columnar	2529	1417
	Scattered	2421	1459
Animated Commercial	Columnar	2615	1564
	Scattered	2601	1431
Static Commercial	Columnar	2748	1688
	Scattered	2850	1912
Flashing Text	Columnar	3068	2507
	Scattered	2914	2105
Target-only		281	93

A 2 x 4 factorial repeated-measure ANOVA failed to show a significant main effect for either layout or banner type, nor did it reveal a significant interaction between the two at the 0.05 level.

Error rates were also not significantly different between conditions (see Table 2). Participants experienced two kinds of errors: misses, in which they clicked on something other than the target, and timeouts, in which the point completion deadline expired. No significant difference was found between either misses or timeouts across the different banner types; total errors were also approximately the same.

Table 2: Number of errors for each banner type and layout combination, averaged across target position and participant. Errors are divided into two groups: misses and timeouts.

Banner Type	Layout	Misses	Timeouts
Blank	Columnar	1.25	0.25
	Scattered	0.25	0.75
Animated Commercial	Columnar	0.25	0.5
	Scattered	0.5	0.75
Static Commercial	Columnar	0.5	0.5
	Scattered	0.75	0.5
Flashing Text	Columnar	0.25	0.75
	Scattered	0.25	1.25
Target-only		0.5	1

A serial position effect is evident; participants found targets in the upper-left positions much more quickly than those to the lower-right. This effect appears strongly in the columnar layout, $F(23,361) = 6.74$, $p < .0001$, and almost as strongly in the scattered layout, $F(23,361) = 4.61$, $p < .0001$ (see Figure 6).

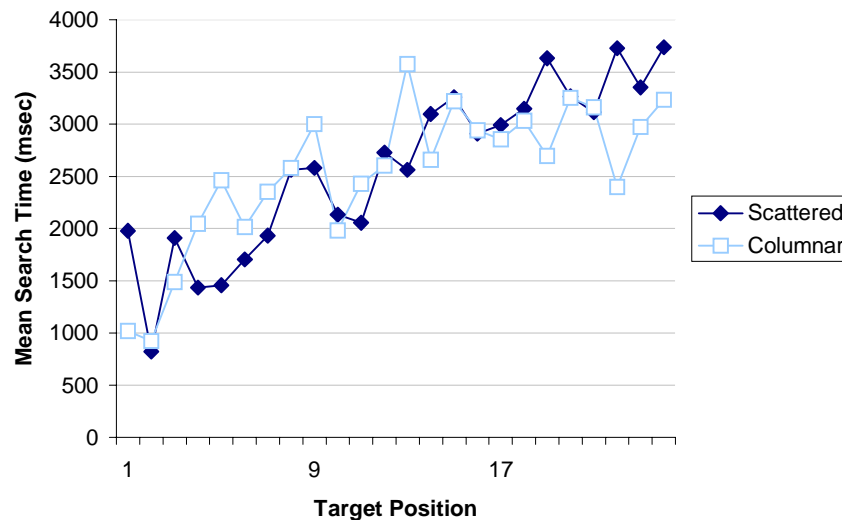


Figure 6. Mean search times split by target position show a strong serial position effect for both the columnar and scattered layouts. Target positions are numbered 1 to 24, starting at the upper left and counting down each column. X-axis labels show the topmost item in each column.

¹⁴ Mean search times split by target position are listed in Appendix B.

TLX Workload Scores

Though actual search times were not significantly different for the various banner types, the TLX scores show that participants reported having to work the hardest in the presence of the flashing text banners. Figure 7 shows the overall workload scores for the five conditions tested. Participants also gave a high workload score to the animated commercial banners, and a lower score to the static commercial banners. Notice that when flashing text banners were on the screen, participants reported more than double the workload of the target-only condition.

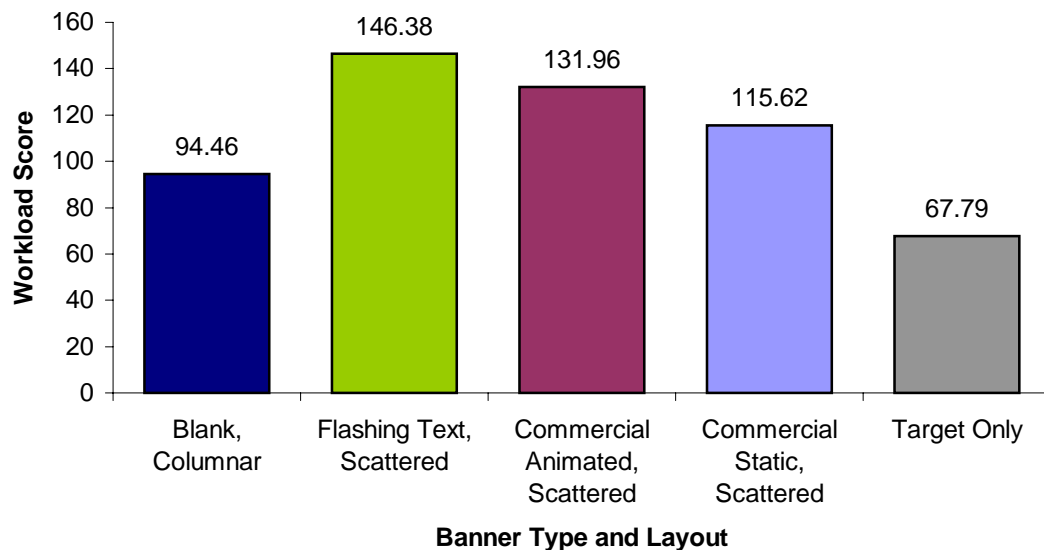


Figure 7. Overall TLX workload scores for the five measured conditions participants rated in Experiment 1.

Figure 8 shows how much each of the six TLX factors contributed to the overall workload score for the four banner types. Of the six factors, mental and temporal demand, along with effort, contributed the most to the overall task workload for all banners. Participants reported that physical demand, performance, and frustration added little to the overall workload.

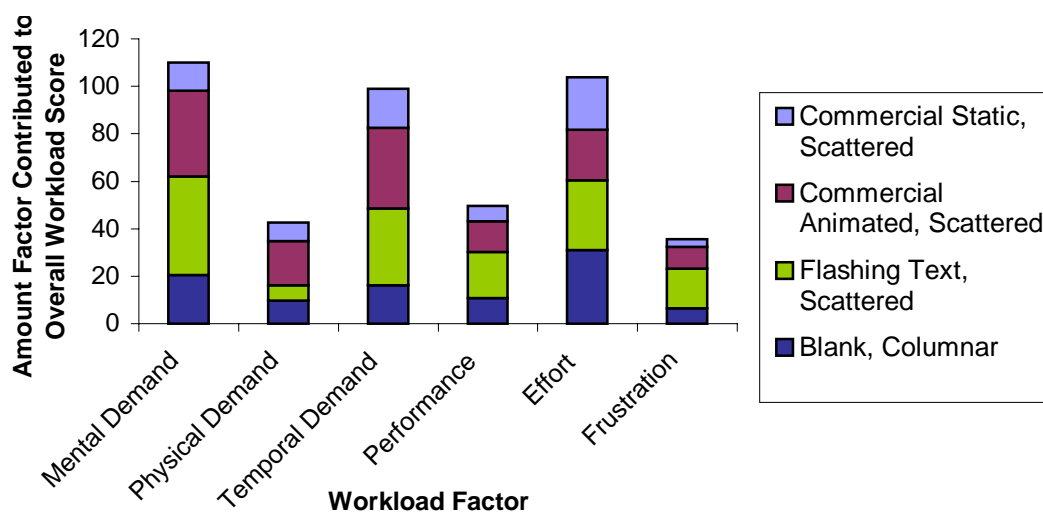


Figure 8. Amount each of the six TLX factors contributed to the overall workload for each banner type. Mental demand, temporal demand, and effort were the greatest contributors to task workload.

Discussion

The lack of a significant difference in search times and errors across the different banner types suggests that animation does not slow people down. However, participants rated the tasks with animated banners as more workload-intensive than the others, indicating that the animation did have some kind of effect. The incongruity between search time results and TLX scores was interesting enough to merit further investigation in the area, and so a second experiment was designed.

Thus, in Experiment 2, the task difficulty was increased and the banners were placed randomly throughout the search area. In this setting, the animated banners might have a greater effect, as people given a more difficult task spend more time searching for the target, and would thus have more exposure to the banners. As statistical power was low in Experiment 1, more participants were used in Experiment 2. General trends across both experiments are discussed at the end of Experiment 2.

EXPERIMENT 2

Materials and Methods

Subjects

Twelve adults (6 female) aged 19 to 51 with a mean age of 27 participated in the experiment for \$10 to \$15. All participants were comfortable using GUIs and had normal or corrected-to-normal vision.

Equipment

Experiment 2 used the same software and hardware as Experiment 1.

Design

Experimental design was identical to Experiment 1, with the following exceptions (as shown in Figure 9):

1. Four precues were used instead of one. Precues were arranged in a column above the search area. Only one of the precue words matched the target word.
2. Banners now appeared in rows in the search area, rather than being centered above and below. Each of the two banners covered the area previously used by two distractor words. Thus, in any given trial there were 20 words on the screen (one target word and 19 distractors), rather than 24 (one target and 23 distractors). However, all 24 target positions were investigated. In the case of blank banners, distractor words that would be covered by the banners were

simply removed. Banners appeared in random rows; banner location was not balanced across participants.

3. Only the columnar layout was used.

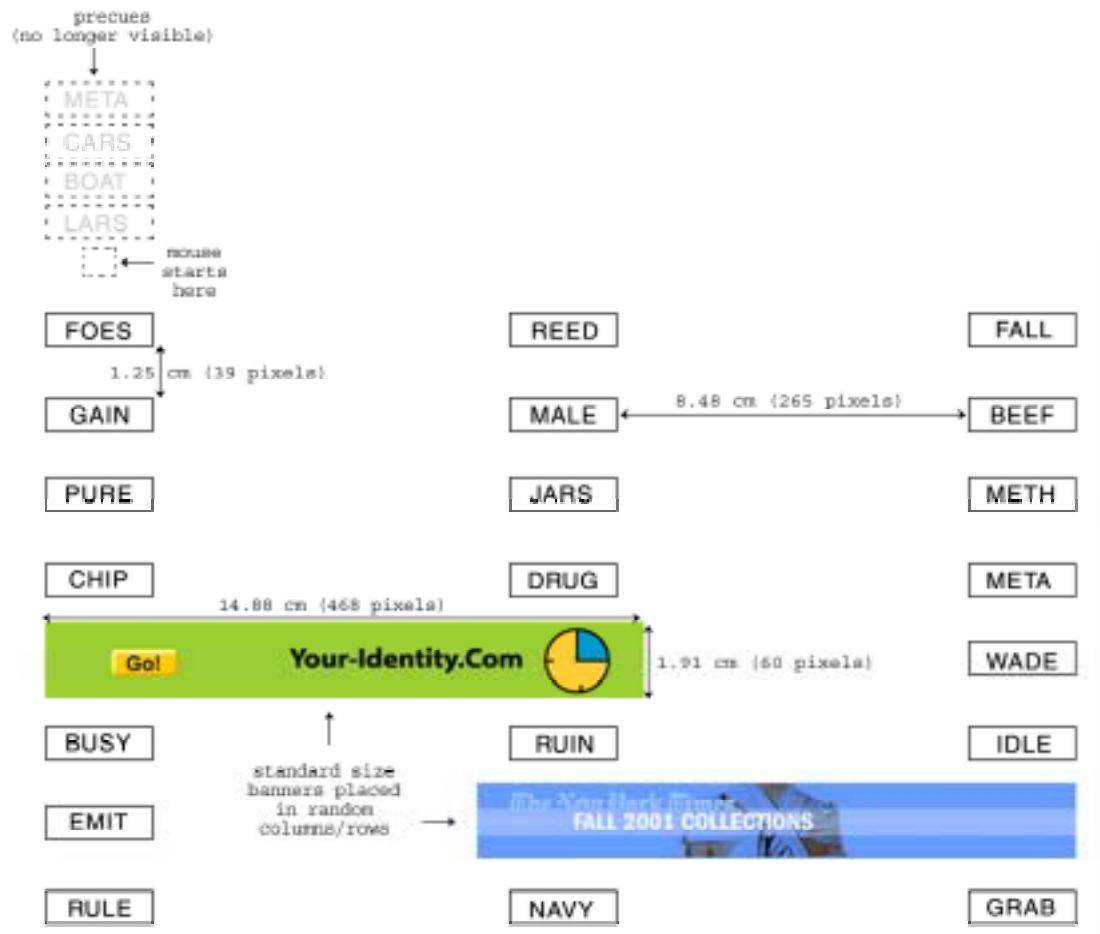


Figure 9: Columnar layout used in Experiment 2, drawn to scale. The four precues are also shown.

4. Each trial had a potential bonus of seven cents, rather than four, to account for the difficulty of the task.
5. Since only one layout was used, the only factor that could be used to divide trials into blocks was banner type. However, blocking by banner type would eliminate the unpredictability of the next banner. Instead, the list of all banner

type and target positions (a total of $4 \times 24 = 96$) combinations was shuffled and divided into four pseudo-blocks, to give participants the chance to rest between blocks.

6. To allow for comparison of blocks between participants, the initial shuffling was performed the same way for each participant, using a given random number seed.¹⁵ This way, each block would have the same set of combinations. The trials in each pseudo-block were then shuffled (differently) for each participant to eliminate an order effect. As in Experiment 1, an additional target only block was added.

Procedure

Experiment 2 used the same general procedure as Experiment 1. In this case, all experimental conditions were evaluated with NASA TLX: blank banners, animated commercial banners, static commercial banners, flashing text banners, and the target only condition.

Results

Search Time and Error Rates

Table 3 shows the mean search times for each banner type, along with the target-only condition for comparison.¹⁶ Results from a repeated measures ANOVA again fail to show a significant difference in search time caused by banner type.

¹⁵ Random number seed - The initial number put into a random number generator. Random number generators are not truly random; instead they perform a complicated algorithm on a seed number to get a seemingly-random list of numbers. If a generator is fed the same seed twice, it will generate the same "random" sequence.

Table 3. Search times for each banner, averaged across target position and participant.

Banner Type	Mean Search Time (in msec)	Standard Deviation (in msec)
Blank	5829	5430
Animated Commercial	4809	3778
Static Commercial	5329	5179
Flashing Text	5757	6372
Target-only	248	135

As in Experiment 1, no significant difference was found in error rates between banner types. Participants did have more PCD timeouts in the target only condition, but there were three times as many trials in the target only condition, and so the error rate is still not significantly different from other conditions. Table 4 shows the number of errors, divided into misses and timeouts, from each condition, averaged across participant and target position.

Table 4: Number of errors for each banner type and layout combination, averaged across target position and participant. Errors are divided into two groups: misses and timeouts.

Banner Type	Misses	Timeouts
Blank	1.4	1.25
Animated Commercial	1.6	2.3
Static Commercial	1.3	2.1
Flashing Text	1.5	2.4
Target-only	1.6	5.1

¹⁶ Mean search times split by target position are listed in Appendix B.

One noteworthy effect occurs when a target is sandwiched between two flashing text banners. In this case, the target takes an average of 4.3 seconds longer to find than if the flashing text banners were placed elsewhere, $F(1, 298)=7.0, p<.01$. This effect is not seen with the other banner types, nor does it hold if the target is merely adjacent to one of the banners.

TLX Workload Scores

As in Experiment 1, participants expressed a much greater sense of workload with the flashing banners than with any other condition, even though search times varied little (see Figure 11). Again, the animated commercial banners ranked highly in terms of workload, but this time, static commercial banners ranked approximately the same as the blank banner condition.

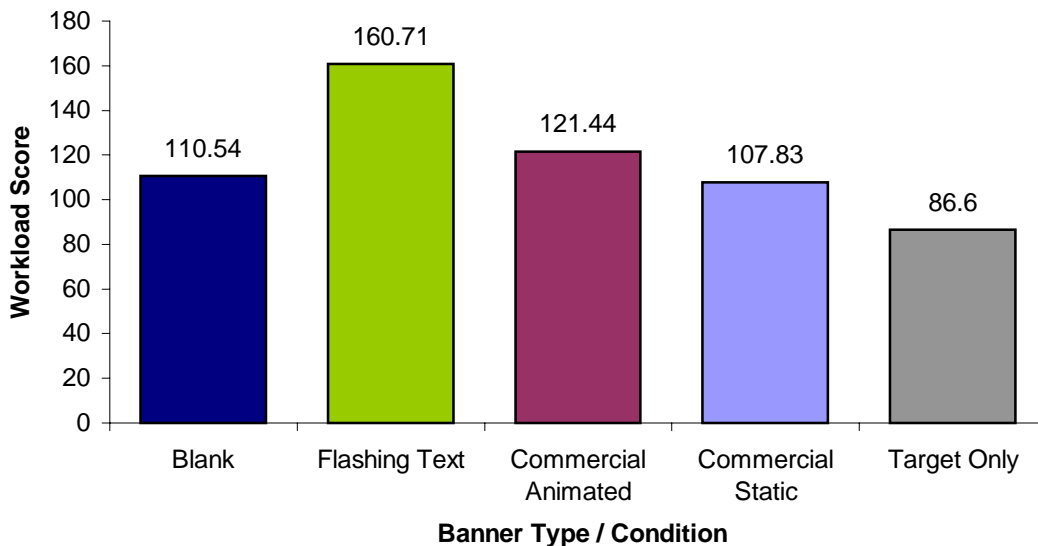


Figure 10. Overall TLX workload scores for the five conditions participants rated in Experiment 2.

Participants again reported a higher mental demand for all but the target-only condition, and all conditions required effort and temporal demand. Figure 11 shows the contribution of each of the six TLX factors to the overall workload.

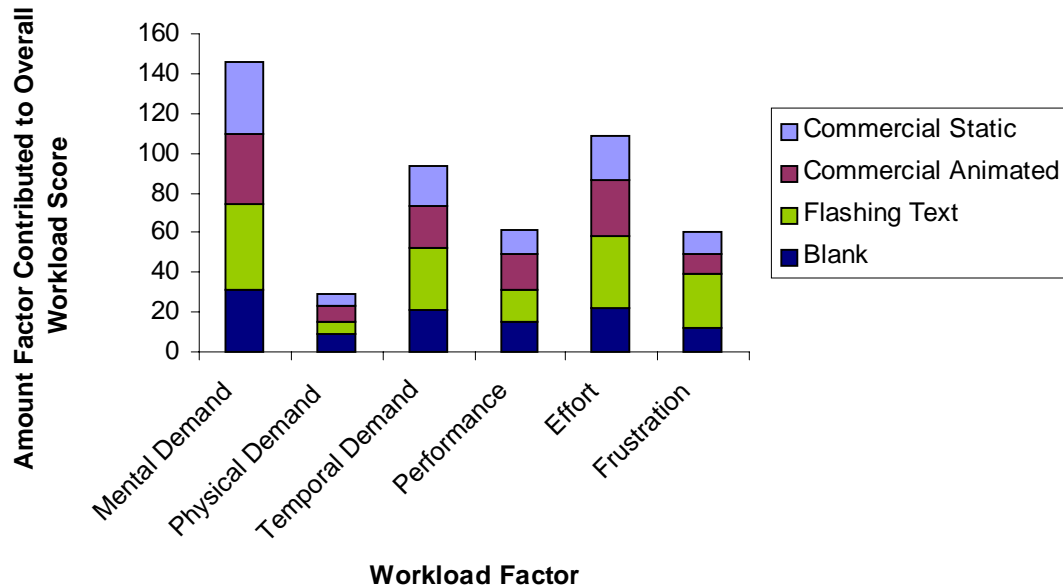


Figure 11. Amount each of the six TLX factors contributed to the overall workload for each banner type.

Discussion

Search Times and Error Rates

As in Experiment 1, participants searched just as quickly in the presence of animated banners as with static or blank banners. These results suggest that animation does not capture attention to the point of impeding a simple visual search task. While more ostentatious banners might potentially produce an effect, the banners used in this experiment came from popular professional sites, and thus comprise a representative sample of advertisements accepted by influential members of the Web community.

Greater differences in search time might have been found if there had been more participants in the experiment. Statistical power was low, and so only a large effect could have been detected. However, these results are a fair indicator that if animation does have an impact on the task, the effect is small.

Furthermore, this experiment only delves into one particular visual search task in which people are looking for an exact word they know it will appear in a black and white rectangle, not in a banner. The experiment does not consider the effect of peripheral animation on a more demanding search task or cognitive task such as reading. Quite frequently, websites list their internal links at the top of the page, just below an animated advertisement, which presents a task similar to that performed in the experiment, but different results could occur on a reading-intensive site.

Also, this experiment intentionally negates the appeal of banner content; participants had no incentive to look at the banners, and they were encouraged to complete their search task quickly. Web surfers are often lured by the content of ads rather than the medium, especially when ads are carefully aimed at a target audience.

Interestingly, one experimental result calls into question previous advertising tips suggested by WebWeek. In 1996, the online magazine recommended that site designers "bracket important content between two banners" ("Research," 1998). However, this experiment shows that content sandwiched between two flashing banners takes significantly longer to find. Perhaps WebWeek's suggestion was prudent in 1996, but five years of animated advertisements have since dulled consumers' attention.

TLX Workload Scores

Even though participants completed their search tasks just as quickly in the presence of animated ads, they reported a greater sense of workload afterward through the TLX scores. Both the flashing text and animated commercial banners were considered more mentally demanding than the other banners.

However, the static commercial banners had fairly low workload scores. In Experiment 1, the static banners were slightly higher than the blank banner condition, and in Experiment 2, the static banners came in (nonsignificantly) lower than the blank condition. Since the content of the animated and static commercial banners was virtually the same, the animation must have contributed to the increased workload. Thus, advertisers should be wary of using animation, since in this case it required greater mental demand, but did not capture attention insofar as it did not slow people in their task.

Since the flashing text banners contained four-letter words from the list of targets and distractors, the Contingent Involuntary Orienting hypothesis may have led to the increased workload scores. Participants might have noticed the flashing words and recognized some of them from the precue list or distractor set, and thus needed to use more mental capacity to filter them out. Perhaps if the flashing text on the banners had been the same size and/or color as the target and distractor set, search times might have been significantly greater, as well.

Post-Experiment Questionnaire

Participants detailed even more factors to their search experience through the post-experiment questionnaire. In general, participants reported being able to "tune out" the banners, although some found the flashing text and brightly colored banners difficult to ignore. One participant even admitted to intentionally clicking on the wrong word if she had not found the target within a few seconds just to make the banners disappear. Her error rate was similar to that of other participants, so perhaps she just wanted to click on the wrong word, but did not.

When asked to rank banners from most distracting to least, nearly every participant ranked the flashing text banners as the most distracting. From there, participants varied in rankings, often citing color and type of animation as important factors. Many participants found the blank banners easiest, but several others preferred having static commercial banners to break up the visual field. According to one participant, blank banners led to "too much of the same," making the search more difficult.

The questionnaire also revealed the robustness of the PCD and the various strategies that participants used to perform well. When asked if they were able to move the mouse before finding the target word, participants reported being buzzed nearly every time. The only exception occurred for two participants when they began moving the mouse to a word they thought was the target, and then realized that an adjacent word was actually the correct target, which they were able to reach in time. Most participants searched the columnar layouts from left to right, scanning either down or up each column, although some performed a preliminary overall inspection around the center of

the screen first. Such a strategy, if successful, would account for the dip in search times (seen in Figure 7) for the center elements of the columns in the columnar layout.

CONCLUSION

Future Research

This study strongly indicates the need for future research. Animation may not have had an effect on search time in this experiment; however, in a more difficult task, it might play a larger role. Reading is a common Web task, and it requires a much greater cognitive demand than simple visual scanning. Even filling out of an online form entails more mental processing; investigating the effect of animated banner ads on either of these two tasks would be worthwhile to the Web community.

Furthermore, these experiments isolated participants from the Internet; the search area did not particularly resemble a real webpage, and banners were not really linked to advertisers' sites. Here, banners were investigated from a more traditional standpoint, in which many other factors are removed to distill the pure effect of the animation. Targets and distractors were written in 18-point Helvetica, which is almost twice as large as typical Web fonts such as 10-point Arial and 12-point Times. Rarely are Web links enclosed in black bounding-boxes.

Also, on the Web, people have incentives for looking at banners, which were not present here. Benway and Lane's (1998) banner blindness study put relevant information in banner-like images; if participants in future experiments knew they would need to look at banners occasionally to complete their task, the different banner types might then show an effect.

This study bridges the bodies of traditional attention-capture and Web marketing research. The Web imposes myriad factors on banner effectiveness, each of which could be investigated separately, in the vein of traditional studies, or as a gestalt entity, as in the banner blindness study and other advertising surveys. This experiment probed a few individual features of the Web; subsequent studies will add more to the animation discussion.

Future of Web Advertisements

Advertisers have already begun to seek new ways to attract consumers. Last February, the IAB released new banner standards, featuring "skyscrapers," wide ads that run down the side of a page (taking up either 120 x 600 or 160 x 600 pixels, depending on the type of ad), large rectangles (336 x 280), and pop-up windows (250 x 250) (Olsen, 2001a). The vice chairman of the IAB reported to CNET that "'agencies need more space to get some emotion in there', although he hastened to clarify that the new standard was not meant to imply banners are not working" (Olsen, 2001b).

CBS MarketWatch has introduced another form of advertisement: the banner background. In March, CBS began tiling a faded Budweiser logo across the background of its financial website (see Figure 12). While the repeated logo adds to the visual clutter of the page, the lack of animation might be appreciated by consumers. However, because the Budweiser background cannot be directly linked to the advertiser's site, only well known advertisers could successfully employ this strategy.

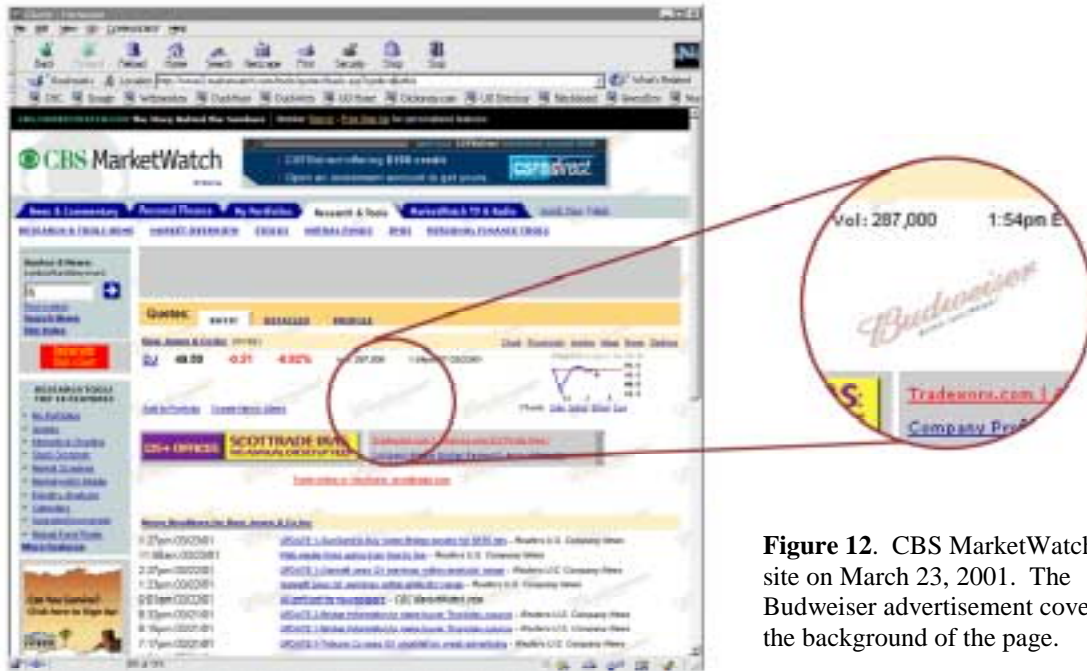


Figure 12. CBS MarketWatch site on March 23, 2001. The Budweiser advertisement covers the background of the page.

Interestingly, a CNET article discussing the new background advertisements has a large ad in the middle of the story (see Figure 13), to which one critic responded, "CNET seems to treat the advertising as the main content, and the story as a convenient wrapper" ("Mmmm, beer," 2001).



Figure 15. CNET article with large rectangular advertisement in the center of the text.

Though many people consider advertising a necessary evil to keep the Web cost-free, much thought should be given to its implementation. This research shows that for a simple visual search task, animation did not catch peoples' eyes to the extent that they were slowed in their task. While further investigation is warranted, this study reveals that advertisers should not automatically equate animation with attentional capture, especially considering the increased mental demand reported by participants. Advertisers using animated banners should be wary of irritating their audience with a potentially ineffective technique.

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APPENDIX A
EXPERIMENT DOCUMENTS

Preliminary Questionnaire

Visual Search Study
Investigator: Moira Burke

This information will be kept confidential.

Age: _____

Sex: Male: _____ Female: _____

How many years of experience do you have using a graphical user interface, such as Macintosh or MS Windows? _____

How many years have you been using the World Wide Web? _____

How often do you do the following on the World Wide Web:

	<i>Daily</i>	<i>Weekly</i>	<i>Rarely</i>	<i>Never</i>
Browse for information	_____	_____	_____	_____
Surf for entertainment	_____	_____	_____	_____
Check email	_____	_____	_____	_____
Shop online	_____	_____	_____	_____
Use a search engine (e.g. Yahoo!, AltaVista, Google)	_____	_____	_____	_____
Play games	_____	_____	_____	_____
Other (specify) _____	_____	_____	_____	_____

Instructions

Visual Search Study Investigator: Moira Burke

Precue and target:

When you begin the experiment, you will see a four-letter word on the computer screen, called a *precue*. Remember the word shown on the precue, and when you are ready, use the mouse to click on it. The precue will disappear and several boxes with four-letter words in them will appear on the screen. The word that had been displayed on the precue will be in one of these boxes; your job is to find that *target* word and click on it.

Sometimes there will be more than one precue. Only one of the precues has the target word, but you won't know which one it is, so you'll have to remember all of them. Click on the empty box beneath the precues to make the precues disappear.

Only move mouse when you see the target:

You can take as long as you like to study the precue(s). But, once you click on the precue and the other boxes appear, you should find and click on the target as quickly as possible but with no mistakes. Do not move the mouse until you have spotted the target. If you move the mouse earlier, the computer program will interrupt you and a buzzer will sound.

Other items on the screen:

In many of the screens an animated image, or *banner* will appear. In some cases, the text or the colors on the banner will change over time.

Block structure and practicing:

The experiment is grouped into blocks. The target and other words on the screen will be arranged the same way across an entire block. So, if the words are lined up in columns, you can be certain that they'll be in columns for all of the screens in the block. If the words are scattered around the screen, they'll be scattered for all of the screens in the block.

You will be warned when you are about to start a new block, and you will be given five practice screens at the beginning of each block before the timed trials begin. Also, you can take as much time as you'd like to practice at the beginning of the experiment.

Payment and bonuses:

You are guaranteed to make ten dollars, but depending on how well you perform, you could possibly make up to five dollars more. Every time that you click on the precue and a new screen appears, you are given a few cents. But you lose money continuously, at a rate of one cent per second, up until the moment that you click on the target. If you take too long, you will start to lose money.

You can also lose money if you miss the target or if you move the mouse before you found the target. In either case, a buzzer will sound and you will lose all of the money for that screen plus an additional five cents. Every time you hear the buzzer, you lost five cents.

At the end of the experiment, the computer will tell you your total earnings. Your participation is entirely voluntary, and you may withdraw from the experiment at any time and still receive the base pay of ten dollars.

Instructions

Workload Evaluation

Please evaluate the workload you experienced during the previous tasks. Workload has six main factors, defined below.

During the course of the experiment, you experienced several conditions that I'd like you to consider. These may include the types of banners you saw, the organization of the target and distractor boxes, and how many items appeared at once.

I'll ask you to evaluate the workload for each of these conditions separately.

Please do the following:

1. Read the workload definitions below, and be sure you understand them.

For each of the conditions:

2. I'll give you a block of untimed trials to refresh your memory. Take as many trials as you need to remember how the condition felt.
3. Fill out Form A, ranking each of the six workload factors.
4. Fill out Form B, comparing each of the factors.
5. Let me know when you've finished filling out the forms for that condition, and I'll set the software to the next condition for you to try, and give you the next set of forms.

Workload Factor Definitions

Title	Endpoints	Descriptions
MENTAL DEMAND	Low/High	How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?
PHYSICAL DEMAND	Low/High	How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?
TEMPORAL DEMAND	Low/High	How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?
PERFORMANCE	Good/Poor	How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?
EFFORT	Low/High	How hard did you have to work (mentally and physically) to accomplish your level of performance?
FRUSTRATION LEVEL	Low/High	How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

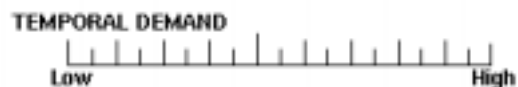
FORM A

Please evaluate the task by marking each scale at the point which matches your experience for this condition. Each line has two endpoint descriptors that describe the scale.

Note that "own performance" goes from "good" on the left to "poor" on the right.

Please consider your responses carefully in distinguishing among the task conditions. Consider each scale individually. Your ratings will play an important role in the evaluation being conducted, thus your active participation is essential to the success of this experiment, and is greatly appreciated.

CONDITION _____



Note that "own performance" goes from "good" on the left to "poor" on the right.



FORM B

Please help me to assess the relative importance of six factors in determining how much workload you experienced. The procedure is simple: You will be presented with a series of pairs of rating scale titles (for example, Effort vs. Mental Demands) and asked to choose which of the items was more important to your experience of workload in the task(s) that you just performed.

For each pair, please mark the factor that contributed more to your workload experience for this condition.

Please consider your choices carefully and make them consistent with how you used the rating scales during the particular task you were asked to evaluate. Don't think that there is any correct pattern; I am only interested in your opinions. If you have any questions, please ask them now. Thank you for your participation.

CONDITION _____

___ Mental Demand	___ Physical Demand
___ Temporal Demand	___ Performance
___ Effort	___ Frustration
___ Physical Demand	___ Performance
___ Temporal Demand	___ Frustration
___ Performance	___ Mental Demand
___ Temporal Demand	___ Effort
___ Effort	___ Mental Demand
___ Physical Demand	___ Temporal Demand
___ Effort	___ Physical Demand
___ Physical Demand	___ Frustration
___ Effort	___ Performance
___ Temporal Demand	___ Mental Demand

___ Mental Demand	___ Frustration
___ Frustration	___ Performance

Post-Experiment Questionnaire

Visual Search Study Investigator: Moira Burke

The experimenter will verbally ask these questions to the participant.

What did you think? (Easy? Hard? But not: How did you do?)

Do you feel like the animated banners caught your attention? Do you think you got used to them after awhile?

Were some of them more distracting than others? Which was/were the worst?

Was it easier when the boxes were lined up, rather than scattered randomly?

Did you have any tricks or strategies that you used to perform well?

Were you able to fool the computer and sometimes begin moving the mouse before you found the target? Did you do this intentionally?

Please share any other comments at all that you have regarding this experiment.

APPENDIX B
ADDITIONAL EXPERIMENT RESULTS

Mean Search Times:

Experiment 1: Mean search times (in msec) for each target position, split by banner type and layout. See text for a description of target position in scattered layouts.

Target Position	Columnar Layout				Scattered Layout			
	Blank	Anim Comm	Static Comm	Flashing	Blank	Anim Comm	Static Comm	Flashing
1	1000	1729	3495	1679	1045	741	1141	1145
2	804	906	808	770	956	954	933	816
3	1583	2483	1412	2150	2229	761	983	1800
4	1108	929	2383	1320	1466	2687	1983	2045
5	1275	1154	2427	1925	3858	1308	2849	2130
6	1362	1395	2587	1233	1720	3062	1612	1654
7	2437	1454	1845	1983	1723	1966	2591	3599
8	3116	2237	2833	1995	2216	3654	2099	2350
9	3296	1995	2241	2604	3233	3388	2895	2579
10	2283	1633	2045	2575	2487	2308	1699	1425
11	1979	2237	2133	1887	2444	2112	3133	2037
12	3750	1933	2756	2650	2570	2954	2633	2127
13	1958	3370	2366	2555	2829	2812	4079	4579
14	2516	2875	3175	3820	2858	2075	3358	2033
15	3595	3162	3141	3120	3087	2833	3495	3466
16	2579	3283	2150	3744	1841	2150	4326	3091
17	3308	2877	3020	2724	2208	3254	3229	2716
18	3404	3291	2595	3287	2883	2400	3449	3387
19	2933	4195	3291	4091	2804	2403	3155	2600
20	3050	3354	4145	2512	3091	2672	3854	3250
21	3162	3437	3183	2675	2137	2741	3937	4049
22	3272	3520	4183	3820	2466	2650	2344	2183
23	3137	3625	3254	3391	3529	2816	3120	2540
24	4277	3500	3520	3654	2745	3404	3383	3370

Experiment 2: Mean search times (in msec) for each target position, split by banner type

Target Position	Blank	Animated Commercial	Static Commercial	Flashing
1	6925.758	1621.21	1176.924	2562.498
2	3172.222	4701.389	2418.056	3946.667
3	8254.999	2579.166	4926.922	9415.278
4	3043.055	3443.054	3403.029	9651.389
5	3422.223	4170	3056.06	6256.409
6	5906.411	2828.205	5322.222	3247.221
7	6133.333	3301.515	6528.571	4354.445
8	4524.243	5514.102	5239.744	5127.778
9	4029.486	3657.142	4721.429	5010.256
10	6411.11	4104.167	5138.889	4694.872
11	7883.333	3825.556	5612.819	9977.273
12	5419.444	5320.832	8347.222	3615.15
13	6929.487	8337.501	4954.761	4729.488
14	6712.5	3738.461	3734.615	6180.952
15	4947.435	7698.612	6693.054	4281.945
16	9575.757	3993.055	4610.605	5383.334
17	5616.666	4971.795	5265.152	4223.077
18	7123.809	5726.39	4719.232	5713.635
19	5428.788	4193.94	3481.818	6912.501
20	6167.777	4772.619	8480.768	5184.525
21	5058.974	4636.666	7101.19	6502.778
22	4556.945	6737.18	6632.053	7946.429
23	5178.789	8312.5	7378.334	6536.111
24	8168.181	6922.221	8605.556	6970.833