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ABSTRACT
Download time has been recognized as one of the most important technological impediments to electronic commerce (EC). Unfortunately, the exact consequences of this impediment are currently ill-defined. The goal of this study is to extend the work of Rose (2000) and Rose and Straub (1999) to examine how the capabilities of technological delivery impacts the success or failure of EC initiatives. Using theories from marketing and the systems response time literature, it is hypothesized that download delay in an e-Service retailer's Web application has a negative impact on consumer attitude toward that Web retailer. Counter to anecdotal evidence in the press and our theoretical arguments, results from a laboratory experiment do not support this stance. Interpretations of this outcome, new research directions to tease out a deeper explanation, and managerial implications are discussed.
Keywords: *Electronic Commerce, Technological Impediments, Software Development Issues, IT Problems, Download Time*

INTRODUCTION

A recent analysis of business-to-consumer Electronic Commerce (EC) literature found six key technological impediments to Electronic Commerce (TIECs) (Rose, et al., 1999). These are: (1) download time; (2) measurement of web application success; (3) security (or perceived security) weaknesses; (4) lack of internet standards; (5) limitations in the interface; (6) and requests for hypermedia. This set of TIECs has been widely recognized in the academic and practitioner literatures as being problematic for EC initiatives, both in e-Services and e-Manufacturing.

While recognized as barriers to EC success, the exact nature of the consequences is less clear. A review of literature to date [as chronicled in (Rose, et al., 1999)] finds that the consequences of these six TIECs are generally ill-defined or have only anecdotal support. Therefore, it is important for researchers to identify the impacts of these impediments, and to do so empirically. In this way, EC professionals will be better able to manage these impediments effectively.

Many TIECs are simply unavoidable. As a result, certain deleterious effects are inevitable. Nevertheless, if the consequences of technological impediments remain ambiguous and ill-defined, managers of EC initiatives will be unable to take appropriate actions to counteract such negative effects. Just as troubling would be managers addressing perceived problems that do not actually exist. In either case, it is important to empirically identify the causes and impacts of TIECs. If impacts are understood, expenditures for countervailing measures can be appropriated where needed (and avoided when not needed).

Likewise, while some impediments may be unavoidable, other TIECs, at a given level of cost, can certainly be mitigated. But, once again, a proper cost/benefit analysis cannot be performed until the benefits are known. Thus, until all outcomes for TIECs are identified, benefits of spending to counteract or reduce these TIECs cannot be assessed nor can appropriate strategies be devised.

Research into all TIECs is desirable, but this effort is too ambitious for a single study. An incremental approach is more practicable. Thus, the current study deals with one impediment—download time. Download time has been recognized as one of the most critical TIECs. Rose, Huoy, and Straub (1999) rank download time as the second most important TIEC. Similarly, a recent panel of experts participating in a Delphi study ranked download delay as the single most worrisome issue "affecting the overall utilization and management of Web-enabled technologies" (Khosrowpour and Herman, 2000, p. 1).

As a result of this generally accepted view, our study deals with better understanding the impacts of download delay on EC. Download time is the time it takes for a Web client to fully receive, process, and display files submitted by a Web server once those files are requested. Download time impedes the use of large files in EC applications. E-Retailers often avoid the use of large files because download time is a function of both the size of the data files being transmitted and the technological configuration of the client, server, and Internet infrastructure. These large files are avoided because EC managers have control over only two of the causes of download delay: (1) the file size; and (2) the server side technology. If excess delay is a problem for an IS manager, s/he has no choice but to reduce file sizes or improve server technology or both.

The size of a Web application can be reduced by eliminating content such as multimedia files. Likewise, server side technology can be improved through increased expenditures on servers and advanced database technologies. What are beyond the control of managers, however, are client side and infrastructural technologies used for reception of pages and transmission of pages/requests across the Internet. And delays caused by client side and the Internet infrastructure are expected to persist into the foreseeable future (Anonymous, 2000; Pollack, 1999; Robinson, 1999).

On the client side, delays are directly related to limitations in bandwidth. Specifically, modems with speeds of 56Kbps and below are generally acknowledged as the primary limitation to rapid Internet downloads (Rose et. al, 1999). While high-bandwidth (a.k.a., broadband) alternatives do exist in some places in the world, modem-based Internet connection is expected to remain commonplace well into the next decade. In the US alone, the majority of home Internet connections are currently at speeds of 56K or less (Hu, 1999) and in 2000 the pace of adoption for narrow-band connections far outpaced that for broadband (Trager, 2000).

Likewise, modem connections in the US are projected to remain in the majority, at least through 2005 (Borland, 2000). It is expected that e-Consumers are choosing narrow-band solutions because of price. A full 52% of consumers are not willing to pay any sort of premium to get faster Internet connections (Trager, 2000). For whatever reason, 73% of Americans surveyed in 2000 had no plans of adopting a broadband solution (Lake, 2000). And outside of the US, it is expected that excessive client-side download delays will persist. Similar patterns of price sensitivity about Internet bandwidth have shown up in countries outside of the US (Lawson, 2000).

The persistence of the problem of client side delay is compounded by the expected continuation of infrastructural delay. However, unlike client side delay, infrastructural delay should actually worsen in the future before it gets better. Infrastructural delay has been recognized as an increasingly difficult TIEC (Foley, 2000). Infrastructural delay, which increases as more data is sent across the Internet (Pollack, 1999; Robinson, 1999), contributes to the general sense that download delay is a problem. Ironically, as dialup connections are being replaced by faster connections, difficulties with infrastructural delays are growing worse. Broadband computing encourages larger files to be transferred, which, in turn, causes data traffic jams (Foley, 2000; Robinson, 1999). As narrowband solutions continue to be eliminated, such bottlenecks in the infrastructure are expected to become exacerbated. As a result, infrastructural delay is not expected to be remedied any time soon (Robinson, 1999).

Despite the recognition that delay is a continuing impediment to EC, little is known about its actual consequences. Delay is cited as a problem by numerous sources in the practitioner literature (see Rose, et al. (1999) for a review). Yet, little actual empirical evidence has been offered in this literature, and fewer still insights as to exactly how download time detracts from EC are available (beyond the presumption that e-Consumers do not like it, as reported in (Dembeck, 1999; Wong, 1999). While most trade press reports are vague as to the impact of excessive download delay, there are precious few articles that deal specifically with this issue. And, in fact, some have reported that download time is linked to the utter failure of EC initiatives. Recent press reports attribute the celebrated failures of e-Retailers Boo.com and DEN.com to consumer responses to excessive download times (Rosenberg, 2000; Sorkin, 2000). In essence, excessive delay is thought to have caused the fatal loss of consumer patronage for these retailers.

Finally, almost no academic work to date has studied the impacts of download time on e-Consumers. One of the few studies in this area is experimental research that finds increases in download time have a negative impact on brand attitude and subsequent brand purchase intentions (Rose, 2000; Rose and Straub, 1999). However, the small amount of empirical work available does not provide a rich enough explanation of this TIEC for it to be managed properly.

LITERATURE REVIEW

Going beyond previously identified negative links between download delay and brand attitude, we argue that download time will lead to other significant, negative consequences. While the evidence that download time leads to negative impacts on e-Retailers is only anecdotal, it is consistent with research from marketing and system response time research, as well as the IS literature. Research in these areas, which should transfer readily to the EC realm, suggests that download time caused by EC technology will negatively impact e-Consumer attitudes toward the retailer.

Managers of EC applications need to understand how the design of their systems impact retailer attitude. The reason that understanding influences on retailer attitude is so important is that attitudes toward a retailer have been shown to predict store patronage (Korgaonkar, et al., 1985). Ultimately, store patronage is one of the primary measures of success for an e-Retailer. If customers stop patronizing a retailer, that retailer will go out of business. So understanding whether or not delay has an impact on retailer attitude is of the utmost importance. And existing literature suggests that this relationship between excessive download time and negative attitudes toward the retailer exists.

In a study of traditional brick and mortar stores, Yoo (1998) found, for example, that in-store characteristics cause emotional responses which impact attitude toward a retailer. In the e-Commerce realm, attitudes toward e-Retailers are likely analogous to attitudes toward traditional retailers. Furthermore, it seems reasonable to expect that download time would be interpreted as a characteristic of the store (in this case the store is characterized both as a Web site design and the delay is associated with it). Therefore, any emotions caused by delay in that Web site should impact attitudes toward the associated e-Retailer.

System delay has been shown to negatively impact emotions (Guynes, 1988). Likewise, these "in-store" emotions on the Web may consequently carry over to attitudes toward e-Retailers. Thus, increased download time should negatively impact attitudes formed about an e-Retailer.

These suggestions are consistent with research on delays in general. In work across many fields, increase in delay time has been shown to negatively impact attitudes formed about objects associated with that delay. Examples include computer software (Wirtz and Bateson, 1995), banking (Chebat and Filiatrault, 1993), and computer hardware (Rushinek and Rushinek, 1986). And as stated above, increases in download time delay specifically were shown to negatively impact brand attitudes in EC [in Rose (2000), which provides the basis of this study extension]. Given these prior studies, it is suggested that attitudes toward an e-Retailer will be more negative when the Web pages for that e-Retailer are characterized by a lengthier delay. Collectively, prior research leads us to posit $\mathbf{H_1}$.

> $\mathbf{H_1}$. Increased download time in a retailer Web page has a negative impact on attitude toward the retailer (A_{ret}).

In order to test the hypothesis outlined above, a lab experiment was performed. The hypothesis was amenable to experimental testing, the methodology of choice for this study, as described in the next section.

RESEARCH METHODOLOGY

Inasmuch as the hypothesis implies a causal model where ensuring internal validity is important, an experiment is a suitable choice for examining download time impact. A lab experiment is appropriate for isolating causation (Stone, 1978) and so to test $\mathbf{H_1}$, subjects interacted with desktop personal computers as part of their experimental task. An experimental artifact was required to emulate the retrieval and use of Web pages from the Internet, and, most importantly, to expose subjects to experimental treatments with differing download delays.

For implementation, a simulated e-Commerce environment controlled the delivery and homogeneity of treatments for subjects — in this case Web pages with controlled levels of download delay. Download delay needed to be programmatically controlled because delays can differ widely on the Web. Changes in delay times are a result of rapidly changing server and infrastructural demands; therefore, having subjects use the Internet itself for the experimental task could easily have been a confound in this case.

The simulated environment involved applications and data files fashioned for use on standalone PCs. It was important to build an artifact that did not run on a local area network because a LAN is susceptible to the same delays as the server and infrastructure on the Web. Included in the application was a mock browser that emulated Web page retrieval and associated downloads. Web pages were developed specifically for use by this browser. The browser artifact also identified download delay treatments.

The artifact, Web pages, and download time treatments were also utilized in Rose (2000) to identify causal relationship between increases in download delays and negative changes in brand attitudes. Development and validation of the Web pages, browser, and delay treatments, which are described in full detail in Rose (2000) are repeated below. Following that are descriptions of the experimental procedures designed for the testing of H_1.

Web Page Development

Experimental Web pages for the artifact emulated real world retail Web pages and were designed with actual retail Web pages and graphics as templates. The mock browser and pages allowed for manipulation and control of the key variable of interest, i.e., download time. A computer program accurately controlled download time in the experiment.

Web pages mimicked a real world e-Commerce experience. For purposes of critical realism in the experimental task (Fromkin and Streufert, 1976), actual commercial Web pages, actual brands, and actual graphic files were sought out whenever possible for templates in the construction of experimental Web pages. The first step in the process of building the four pages was to find a basic page to serve as the primary template.

The Web page eventually adopted as the template was that of the e-Retailer Central Camera Company, specifically the Kodak brand film (http://www.central-camera.com/kodak.htm) pages. Several factors led to this choice. First, this site already contained an e-Commerce page for selling Kodak film in the real world marketspace. Second, it contained no cues that might be overly powerful (such as moving graphics or multimedia) or might confound results. The idea was to find as unremarkable a page as possible so the page would not dampen or confound the experimental treatments. Third, the page had to be long enough and with a sufficient number of graphics in order not to arouse suspicion when the experimental treatment required a lengthy download time. This page was approximately seven printed pages long and contained over 20 graphics. Fourth, the template page was for a brand page for a retailer instead of a brand page for a manufacturer. This was important since much of e-Commerce on the retail level is conducted through retailers, and not directly through the manufacturer. (This element also allows us to see the effects of download time on responses to an e-Services establishment.) Finally, the retailer, a local shop in Chicago, Illinois, was not a commonly-recognized retailer (certainly in the region of the country where the experiment was conducted, i.e., the southeastern USA), and cues from the retailer were not uniquely identifiable retailer images. In other words, images from its site would not evoke any pre-existing biases toward the e-tailer.

With Central Camera page as a template, experimental pages were built with similar length, layout, graphical content, and textual content. Each experimental page has intact or modified versions of actual graphics files from e-Commerce pages on the Web, as described above. Furthermore, text information such as product descriptions and prices were based on actual promotional material.

Two fictional e-Retailers were created, one a camera retailer that sells film (here forth referred to as "film retailer" and the other an electronics retailer that sells video tapes (referred to as the "VHS retailer"). Fictional retailers in the experiment eliminated any potential impacts from biases held toward existing retailers. Each subject in the experiment was given two Web pages—one from each retailer. Pages for each retailer were based on the same template page. To avoid any unnecessary biases, the only major differences between the two retailer's pages were brand and retailer specific cues such as names, images, prices, etc. (a summary of the similarities between pages is listed in Table 1).

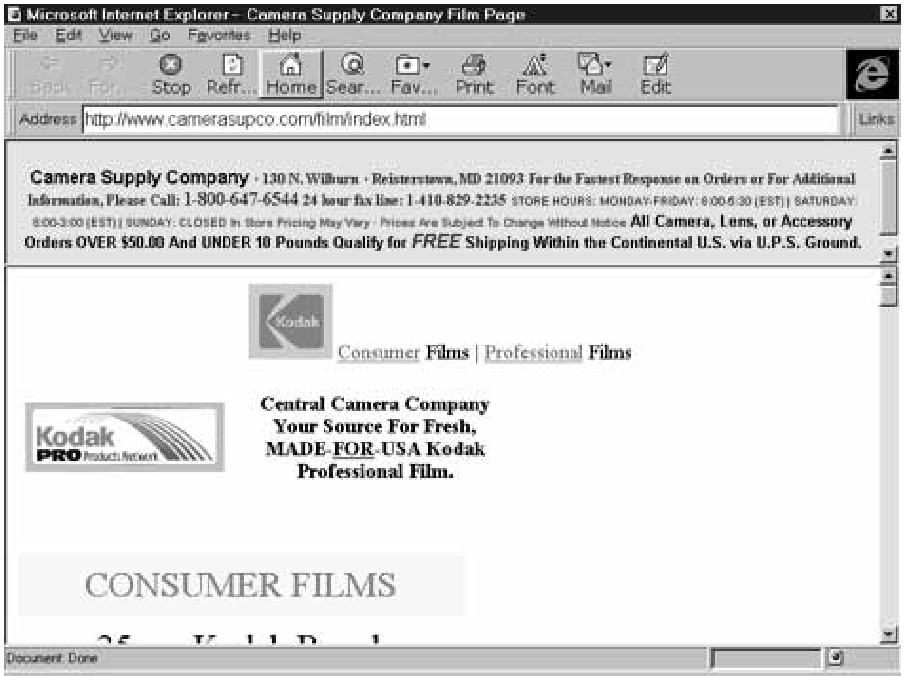
For the requisite experimental pages, it was necessary to incorporate trivial but key differences in brand category characteristics. Because two different brand category pages were shown to each subject, some less significant cues needed to be changed to make the pages seem dissimilar enough not to arouse suspicion (Orne, 1962). Characteristics that were purposefully changed were fonts, font sizes, background colors, orientation of graphics (i.e., larger left to right or larger top to bottom), width of colored blocks, and the distance from the left edge of the screen of tables. Screen shots of the headers of both of the retailer pages are shown in Figure 1.

Table 1. Similarities Between Retailer Experimental Pages

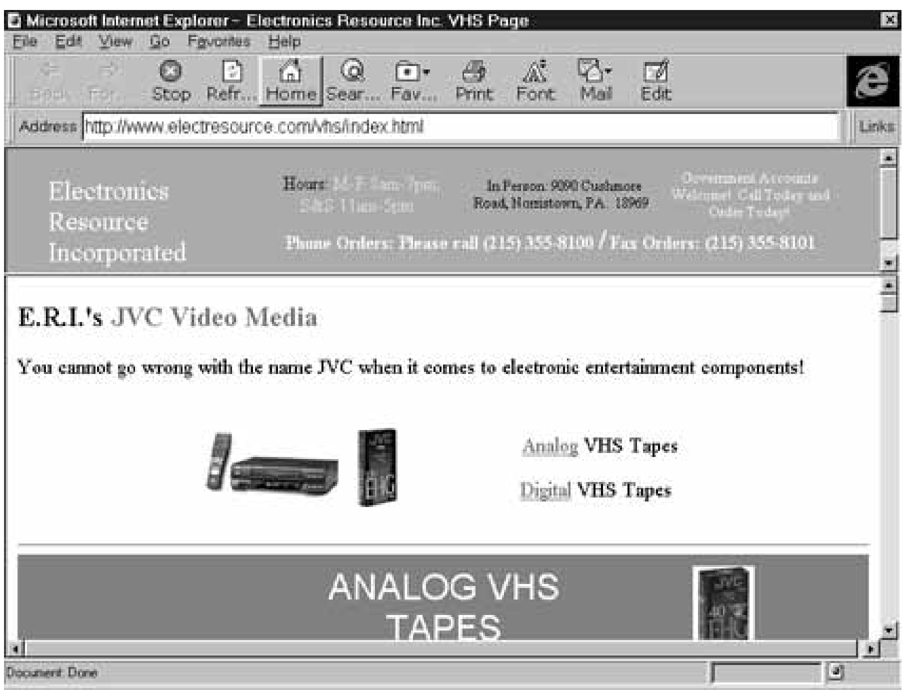
▪ same number of types of brands (professional vs. consumer for films; analog vs. digital for VHS tapes
▪ same number of graphics files on the page (15)
▪ similar tables with five subtypes per page
▪ similar variety of items within subtypes
▪ similar distribution of tables with the same number of cells within the tables
▪ similar distribution within the page of the types and subtypes
▪ similar variety of prices per item (e.g., discounts at different quantities purchased)
▪ use of colored blocks to distinguish between groups of subtypes
▪ similar distribution, size, and location of the graphics
▪ similar distribution of text
▪ same size and style Web browser frame for vendor banner
▪ same number and location of hyperlinks to navigate within the Web page

Once completed, the Web pages were integrated into a mock Web browser application, and the Web pages and the browser together formed the experimental artifact in this study. This artifact nicely simulated an e-Commerce environment for experimenting with impacts of download time.

Figure 1. Screen shots of headers for both retailers



(Film retailer screen shot)



(VHS retailer screen shot)

Experimental E-Commerce Environment

As noted, a Visual Basic program was written to mimic Microsoft Internet Explorer version 3.0. Test subjects navigated between treatment Web pages with this mock browser. The artifact was intended to make the subject believe that the experimental Web pages existed on, and were retrieved from the World Wide Web. Part of this realism, of course, includes download time.

In order to present a realistic simulated browser, a screen capture of Microsoft Internet Explorer version 3.0 formed the background graphic on a Visual Basic form. The graphic includes grayed-out function buttons and pull-down menus. The result was what appeared to be an actual MS browser with its functionality customized so as not to allow manual navigation by the user. A screen capture of the running browser application is shown in Figure 2.

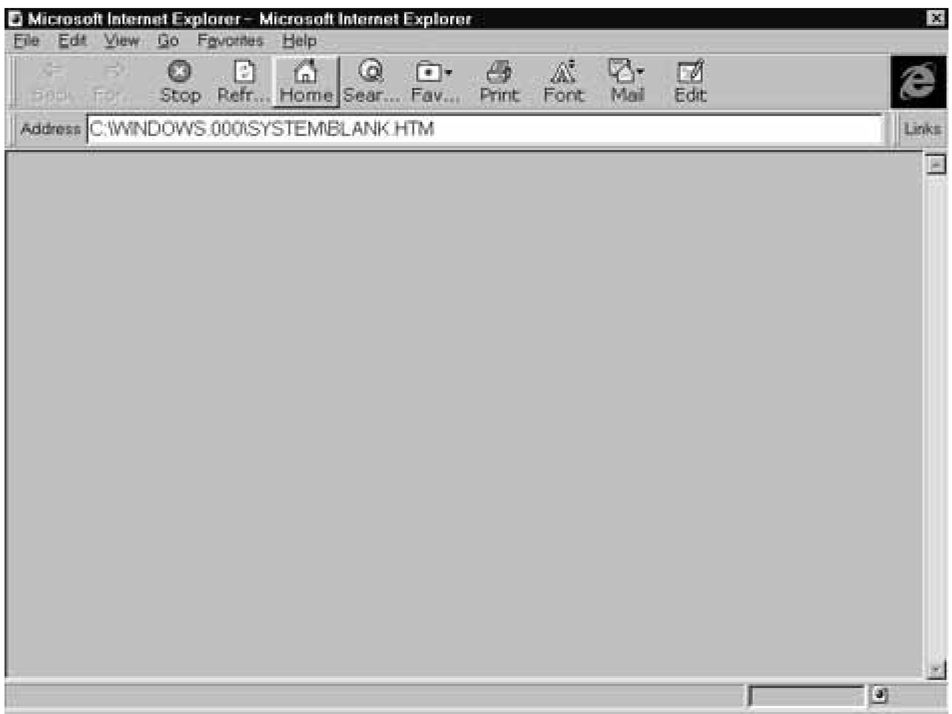


Figure 2. Experimental Browser Appearance

The browser application needed to realistically imitate downloading of Web pages. The objective was to identify those cues produced by a typical Web browser during a download, so that they could be included in a mock browser. By including these stimuli, the mock browser has the same appearance as an actual browser. It was feared that exclusion of these cues might suggest to subjects that the browser was, indeed, not real and not accessing the Internet.

To isolate the events that take place during an actual page download, the functionality of real browsers was observed. Events and associated cues from Web page downloads were gathered by viewing multiple page downloads in a variety of Web browsers. The cumulative observations yielded a list of cues, the sequences of these stimuli, and their approximate duration and frequency during a typical Web download.

In order to emulate these stimuli, Visual Basic objects that appeared to function as objects on an actual Web browser were built onto the screen capture of the browser. Specifically, the following objects were added:

- title bar label
- status label
- status bar
- URL address label

Each of these objects provides functions or cues necessary in emulating the real world browsing experience. The title bar label is an object in a browser that changes its text to the title of a Web page as it is loaded. A status label lists the status of a page while it downloads, including file packet size and percent loaded. A status bar is an indicator that goes from 0% to 100% as a page is loading to show what percent of the page is completely loaded. The URL address label shows the URL of the Web page loaded or loading.

In addition to the above objects for cue emulation, two additional objects were added for subject navigation within the browser environment:

- "home" command button
- exit command button

Both objects are also based on a typical Web browser. The home button is a command button that invokes a pre-defined home page. The exit command button is the small "x" button in the top right corner which closes a Windows application.

For the pseudo-browser interface, code was added to emulate the cascade of cues with the right sequences and durations. In the experimental artifact, Web pages load incrementally with fixed delays between partial loads. While that occurs, information changes in the status bar to indicate that a fraction of the total page has loaded. Likewise, the title of the page changes in the title bar and the URL changes in the URL text box. Each of these changes occurs in a sequence and with a delay in between each change. The frequency of changes and the associated delay durations built into the artifact were modeled after those of actual browsers.

A snapshot of the browser with cue changes taking place is shown in Figure 3. Note the differences from Figure 2 to the title bar, address (URL) bar, home button, status label, and status bar. This is the same sequence of events found in traditional Web browsers during actual page downloads. Their inclusion into the experimental browser artifact was an effort to mimic reality.

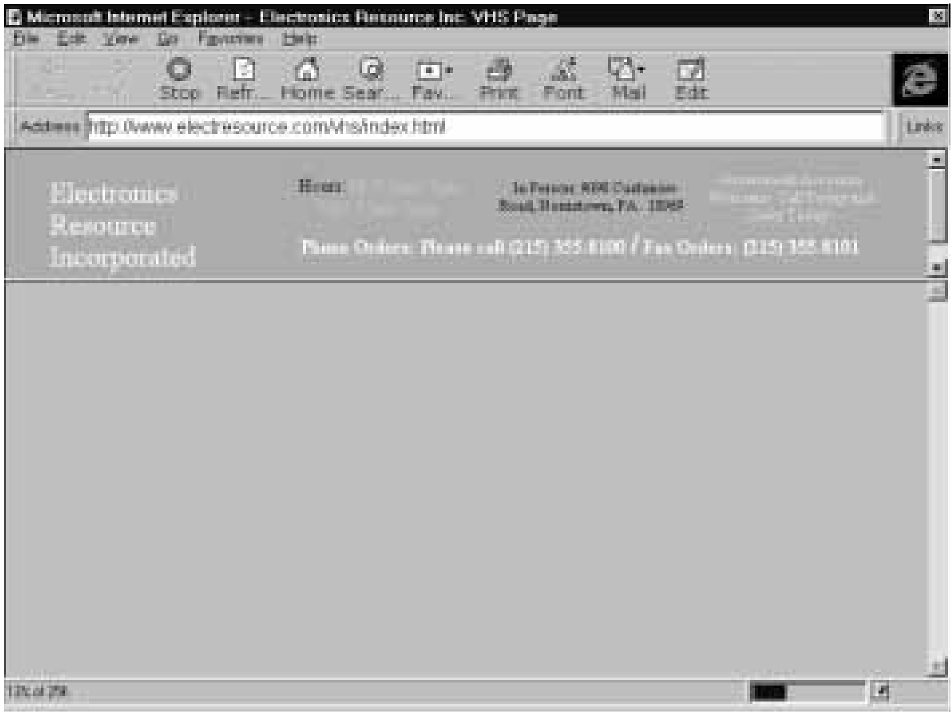


Figure 3. Browser With Cue Changes

The mock browser itself incorporated the Web pages specified above. For realism, the pages needed to load into the mock browser in a fashion similar to what would occur on the Web. When a page downloads into a browser over a period of time, the page generally loads from top to bottom in fragments, with delay between the fragments. Similarly, in order to simulate page delay, the experimental Web pages were displayed by the Web browser a fraction at a time, from top to bottom. At designated time intervals, additional pieces of the Web page would appear much like pieces to a jigsaw puzzle. Each subsequent part of the page load would further complete the page being built from the top down. Controlled delay functionality was programmed into the mock browser based on these observations.

The page download effect is similar to the pseudo-animation of a picture flip book. In a flip book, each page contains a picture that differs only slightly from the page that precedes it. When the pages of the book are flipped, the pictures appear to be animated. To simulate how a Web page actually appears when it downloads, a similar process was adopted. A set of eight partial pages, which downloaded one on top of the other, was assembled. Each subsequent picture was a more complete page than the prior one. The sequence of pages loading on top of each other give the appearance of one Web page loading and becoming more complete as it loads. As a result, it perfectly simulates a Web page being loaded by a real browser, displaying more complete pages as it receives data from the network.

Once the page load sequence was completed, the timing of the cascade was added to the browser application. There is a pause between each step in a page load. The amount of delay for each step was important for a natural-appearing download. The key to realistic delay was to make the proportions between partial loads true to those on the Web. Once the proportionate delays were incorporated into the browser environment, a multiplier could increase or decrease delay as needed. However, because the proportions were true to an actual load, the delay could be increased or decreased to any level while maintaining a realistic download sequence. Together with these cascading pages, the artifact now was capable of meeting the specific needs of the experimental treatments for testing the impacts of download time.

Download Delay Treatment Levels

In addition to the browser and experimental pages, delay treatment times needed to be selected for testing H_1. In Rose (2000), delay levels of 5 seconds were chosen as the control delay level and 30 seconds for the moderate delay level. These were the levels of download delay that identified the predicted relationship between download time and brand attitude. In order to extend this research to test for impacts on A_{ret}, the same delay levels for testing the impacts on brand attitude were used. Times of 5 and 30 seconds were based on an experimental pretest, as detailed in Rose (2000) and summarized below. This pretest experiment captured attitudinal changes toward increased delay. These attitudinal scores served to identify the delay treatment levels.

A pretest established the appropriate delay times to each of the two treatment levels. Hui and Tse (1996) provided guidance into how to identify delay treatment levels for a system response time experiment. To find a long delay treatment for their study, a pretest was run with a mock, computerized, university class registration system. The system controlled delay. Subjects were asked to judge when the wait time for the system was too long (i.e., when their attitude turned negative). High delay was designated as the point at which attitude toward delay was judged by most subjects to be negative. Similar methods identified the delay treatment times for this study.

To identify delay times in Rose (2000), subjects were exposed to multiple levels of delay for a series of Web pages. The page order and delay levels were randomized. Delay levels ranged from 15 to 90 seconds and varied by increments of 15 seconds. The high level of 90 seconds was within the bounds of actual load times for the experimental pages via a 28.8k modem and seemed like a reasonable upper limit.

Once exposed to each page, subjects were asked their attitudes toward these delays on a four-point scale. Consistent with Hui and Tse (1996), Web page delay attitude was the dependent variable for isolating delay treatment levels. The scale ranked delay attitude as: "not significant delay," "acceptable delay," "excessive but still tolerable delay," and "intolerable delay." Differences between delay attitudes indicated which delays should be assigned to the control and moderate delay levels in the main experiment.

The delay level of 30 seconds was selected to represent a typical delay level on the Web. Delays that are moderate, or typical delays, were conceptualized as evoking comparatively neutral feelings. Indeed, at thirty seconds, there was an almost a perfect bell curve distribution between attitude levels and an almost perfect true mean (2.46 vs. 2.50). On average, subjects took almost as neutral a position toward this delay as was possible.

Support for thirty seconds as a moderate delay level can also be found in reports about the Web itself. According to Nielson/Netratings, twenty-eight seconds was the typical delay experienced by e-Consumers downloading pages at the time this experiment was conducted (Tedeschi, 1999). Since twenty-eight seconds is the typical e-Commerce delay, thirty seconds is an appropriate delay level to test the impacts of download time. Any findings at the thirty-second level would be applicable to understanding typical Web pages.

The second delay treatment level identified was the control. Ideally, a control delay would be zero seconds. However, programming in no delay was dismissed for reasons of critical realism. A review of downloads on a T1 connection showed even the fastest download took a few seconds. Therefore, a delay of five seconds was realistically close to zero delay. In contrast to moderate delay, the control level represented the ideal level of delay (approaching zero seconds). Literature on delay suggests that negative impacts should be lowest as wait time approaches zero. The control level tests that hypothesis. Confirmation would suggest benefits to reducing download time as much as possible. If attitudes from a control delay are better than those for a moderate (or typical) delay, it suggests that benefits from delay reduction are possible for the most common Web pages. The five-second level was also supported by statistical analysis of the delay treatment experiment data. While five seconds was not one of the delay levels included, attitudinal responses differed significantly between the lowest level (fifteen seconds) and the designated moderate delay level (thirty seconds).

Validation of the Web Browser, Pages, and Download Delay

In addition to identifying download time treatments, the pretest experiment in Rose (2000) also validated the Web browser environment, pages, and controlled delay. Informal exit interviews gave no indication that subjects believed there had been anything unusual about the browser, pages, or download delay. Of the 42 pretest subjects, none perceived an unusual browsing experience.

Further validation occurred in the main experiment in Rose (2000). Exit interviews with subjects who participated in the Rose (2000) main experiment reconfirmed the validity of the browser, its pages, delay, brands, and fictitious film and VHS retailers. One group of 32 subjects was interviewed individually to verify that their experience was realistic. To a person, subjects believed their browsers, the download delay, the pages viewed, and the contents therein, were part of a real Internet experience.

Experimental Procedures

With the experimental artifact and treatments in place, it was necessary to plan the experiment. The first step was to identify appropriate subjects. The second step was assignment of different treatments to each subject. The third step was to develop a measure for A_{ret} and validate it in a pretest.

1. Acquiring Subjects. In order to collect the necessary data, a target group of subjects was identified. The first criterion for subjects was that they were familiar with the Web. Subjects would have to be Web-aware so that they would be able to easily navigate through the experimental procedures, and so that they would be a representative sample group of potential e-Consumers. The second criterion was that each subject have access to a desktop client machine, which would have the necessary experimental software files loaded onto it prior to the experiment. It was important that the machines be in a controlled environment where the software would be stable and not subject to tampering. In a secured environment, software and data files would be identical between tasks and across subject groups.

Subjects qualified by the two criteria above were upper level undergraduates (juniors and seniors) and MBA students in Computer Information Systems (CIS) classes at a large, urban US southeastern university. Students attending graduate and undergraduate classes in the CIS program at this university are predominantly working adults. Those people who participated in the main experiment had a median years of work experience of 6 and a median age of 28.

The use of CIS students seemed appropriate for testing a model in e-Commerce, since it is, by definition, a phenomenon involving computer literate consumers. Furthermore, e-Consumers are, on the whole, more highly educated than the average American (Anonymous, 1998). Therefore, it was also sensible to use a sample drawn from computer-literate, college-educated individuals for this experiment (Gordon, et al., 1986; Remus, 1986).

The use of upper level undergraduates and MBA students was appropriate for several other reasons. The university requires students to take several computer classes as prerequisites to enrolling in upper level CIS and MBA classes. These classes require the use of the Web. As such, these subjects were not only well-educated, but also Web-savvy, with an average of 20.0 hours of Internet use per week.

Once it was decided that upper level CIS and MBA students could serve as subjects, specific sections were chosen for the experiment. It seemed reasonable that classes chosen should be those that were held in student-workstation classrooms at the university. There are several advantages to this arrangement. Student-workstation classroom computers are under the control of the network administrator. The network administrator controls which files can be added to, modified on, or deleted from client machines in the computer lab. Being under the administrator's control, these computers could securely hold the necessary experimental computer files. As a result, students taking classes in these rooms were selected to participate in the experiment to test $\mathbf{H_1}$.

2. Assignment of Treatments. To limit bias in the experimental test of $\mathbf{H_1}$, treatments were randomized. Within each group, subjects were randomly assigned delay treatments and the sequence of pages to view. These treatments were then embedded into a login ID code assigned to each subject. The browser program interpreted the login ID code which dictated Web pages chosen, download delay, and page order.

Consistent with Rose (2000), each subject was exposed to two pages, one from each retailer. After reviewing the pages, subjects filled out a research instrument with demographic questions and items about A_{ret}.

3. Measurement and Validation of Attitude Toward the Retailer. A_{ret} was measured with three items. Each item has a Likert scale from one to seven. The anchors for the items were: bad and good; like and dislike; and unfavorable and favorable. A pretest group of 29 subjects were asked to evaluate their attitudes toward the two fictional retailers based on a description of them. Results from the 58 responses (2 per subject) found the items to correlate well with each other and suggest a valid measure.

A reliability analysis from the pretest data provided strong support for the validity of the developed A_{ret} construct. Coefficient α for the measure was (0.88). Nunnaly (1978) suggests that αs in excess of 0.70 are acceptable for support of internal consistency reliability. The items for A_{ret} easily exceed this 0.70 threshold and were valid for collecting data from appropriate test subjects.

DATA ANALYSIS AND RESULTS

Based on the experiment described above, a total of 134 valid observations were obtained for the data analysis. Analyses included a revalidation of the A_{ret} construct. They also tested $\mathbf{H_1}$.

Revalidation of Construct

Reliability Analysis. Data from the main experiment were analyzed to confirm the reliability statistics from the pretest. Results of reliability analysis from experiment data reconfirmed the outcomes of the pretest. Coefficient α for the A_{ret} measure was .95. Again, this value is in excess of Nunnaly's (1978) recommended threshold of .70.

Discriminant and Convergent Construct Validity. Beyond a reliability analysis, a principal components factor analysis also validated A_{ret}. The factor analysis confirmed the discriminant and convergent construct validity of the measure A_{ret} (Straub, 1989). For the purpose of this validation, three items were included in the research instrument to measure attitude toward the Internet. A principal component analysis with a Varimax rotation factored the six items (three for A_{ret} and three for attitude toward the Internet). The analysis identified the two predicted factors and validated the A_{ret} construct. Results of this analysis are in Table 2.

Table 2. Validation of Attitude Toward the Retailer—Factor Analysis Results

Item	Factor 1	Factor 2
Attitude toward the Internet—Item # 1	-.043	.888
Attitude toward the Internet—Item # 2	-.034	.719
Attitude toward the Internet—Item # 3	-.010	.874
A_{ret}—Item # 1	.957	.065
A_{ret}—Item # 2	.967	.050
A_{ret}—Item # 3	.964	.019

Analysis of Model

In order to test $\mathbf{H_1}$, a regression (n = 134) was run. The model in question tested the impact of the independent variable download delay on the dependent variable A_{ret}. A_{ret} was represented as a sum of three component items described previously.

Results of the regression found *no relationship between download delay and A_{ret}*. The p-value is well outside of the .05 threshold for significance. Likewise, the observed power of the test ($1-\beta$) is .052 (for $\alpha = .05$) which indicates the probability of a type II error is remote. As a result, it seems there is no support that there is any correlation between increases in delay on the Internet and changes in attitude toward a retailer that cannot be explained by chance.

Table 3. Regression Model Summary for Impact of Download Delay on Attitude Toward the Retailer

Predictor variable	b	T	p-value
(Constant)		32.202	.000
DOWNLOAD DELAY	.020	.230	.819

Dependent Variable: ATTITUDE TOWARD THE RETAILER
Overall F = .053 Adjusted R^2 = .007 Total df: 133
Overall regression p-value = .819 Observed power of the test = .052

IMPLICATIONS

We know from other empirical research that download delay has an impact on consumers (Rose, 2000; Rose and Straub, 1999) — specifically their attitude toward the brand. Given this strong evidence of delays impacting objects associated with a Web page, it is interesting that this negative perception does not carry over to attitudes toward the retailer. Marketing and system response time literatures suggest that it would. But the excellent power of the test indicates that the effect is just not there.

The value of a scientific finding of no effect can be just as great as an expected significant outcome. Without scientific disconfirmation, our research suffers from a "file drawer" problem, wherein insignificant findings are never published and the field holds a distorted view of the linkages between key constructs (Rosenthal, 1979). The essential element in the scientific community trusting this lack of correspondence is that the power of the test be high, as it is in this case. This means, once again, that the possibility of a type II error, that the insignificant finding is due to chance, is low (.052).

While it must be noted that the results of a single experiment are not conclusive, in this particular case the finding is also consistent with other counterintuitive findings in e-space (Lee, 1998). However, there may be other explanations for the results which need to be considered. Of the many possible interpretations for the outcome of this study, at least four plausible explanations are worth considering and are discussed further. These four interpretations, and their associated implications and suggested future research, are summarized in Table 4.

Four Interpretations of Disconfirmation of H_1

Interpretation #1: The first possible interpretation is that anecdotal evidence and analogues to related marketing literature are incorrect. Indeed, download time delays do ***not*** have this kind of impact on attitudes toward vendors. It may be that customer loyalty is not as fragile as believed.

Interpretation #2: The second interpretation might be that impacts of delay are limited to a decision to select and then allow a page to load, and not to attitudes toward a retailer once the page has loaded. If so, then there appears to be no lingering adverse effect on A_{ret} once the page has finished loading. So if it is possible to convince consumers to load the page via one incentive or another (such as having free email accounts, offering interesting chat communities, or providing useful links, etc.), then there may be no negative impact on the patronage behavior after the point that the page has finished loading.

Interpretation #3: A third possibility is that there are differential responses to delay depending on attribution. In this case, delay was replicated but gave no specific indication that it was attributable to the retailer or to the Web page (or even to the Internet). As a result, it is possible that subjects might have different responses in situations where the cause of the delay is more obviously attributable to the retailer (heavy graphics, etc.). The source of this effect may be termed *"attributable delay."*

Table 4. Four Interpretations of Disconfirmation of H_1, Implications and Future Research Suggested

	Interpretation	Implications if Correct	Future Research Suggested
#1	Download delay has no impact on A_{ret} and consumer loyalty is not as fragile as thought.	No remedies for counter-acting impacts on A_{ret} are needed. Offers more degrees of freedom to include extra content (with their associated delays).	▪ Extend the current study to include different delay levels, experimental pages, experimental retailers, test subjects, etc.
#2	Only effect is on the load/no-load decision. No effect occurs after the page loads with regard to A_{ret}.	Remedies are focused on overcoming possible decisions not to select and load the page. These remedies might include having free email accounts, offering interesting chat communities, or providing useful links, etc.	▪ Confirm if e-Consumers actually abort page loads for retailer pages with excessive delays. ▪ See whether e-Consumers who stop a page load go to competitor's site or back to the retailer page with reduced expectations. ▪ Research into how to encourage a "load decision" in spite of excessive delays
#3	There are differential responses to delay, depending on attribution.	Increased delay might only hurt A_{ret} when excessive download time is obviously the fault of the retailer.	▪ Test the impacts of an expanded list of independent variables and their impacts on A_{ret}. Specifically, measure the impacts of attributable delay, perceived wait time, and attitude toward the delay.
#4	Impacts of delay only occur after multiple exposures to a page with a lengthy delay.	Delay might hurt A_{ret} over time.	▪ Test if there are impacts on A_{ret} when the page is visited repeatedly.

Interpretation #4: A fourth interpretation is that the effect occur only after multiple exposures. In other words, negative impacts from delay may be cumulative. If consumers are not biased against the retailer after one experience, it is still possible that repeated exposures to long delays might have an impact. If this is true, a test of a single exposure, as in the experiment described here, would not be adequate to isolate the negative effect of delay on attitude toward the retailer.

Implications if Interpretations are Correct

If either interpretation #1 or #2 is correct, it appears that no change in strategy is needed to counteract negative impacts of delay on attitude toward the e-Retailer. Thus, based on interpretation #1, disconfirmation of H_1 suggests that no management action with respect to Web design to speed up downloading of the vendor's web pages is necessary. And while interpretation #2 does not completely exonerate download delay, it too indicates that, contrary to conventional views, e-Retailers have more degrees of freedom to include additional content on their Web sites, even if the files sizes were to increase as a result. This flexibility to increase content, and, concomitantly, delay, would especially be true for those sites that offered incentives (such as free e-mail; chat rooms; etc.) to allow the page to load completely. The delay experienced while waiting for the incentive-laden web page would have no lasting impacts on A_{ret}. This is not to say that a retailer will not be impacted by excessive delay in other respects, since there is evidence that download time negatively impacts brand attitudes (Rose, 1999; Rose, 2000). However, the impact on overall retailer attitude (and, likely, subsequent patronage) does not appear to be harmed.

Contrary to interpretations #1 and #2, interpretations #3 and #4 would suggest that, indeed, delay should be managed by e-Services professionals to specifically control the impact on A_{ret}. Further, it would suggest that content of Web pages should be reduced and more resources should be allocated to upgrading server-side technology. Likewise, strategies for improving A_{ret} would be needed to counteract negative impacts of delay on A_{ret}—such as giving consumers gifts for site visit. Free gifts in the brick and mortar world have been shown to counteract the effect of negative cues like delay (from waiting in lines) on A_{ret} (Yoo, et al., 1998).

Based on the evidence of this study, however, it appears that e-Retailers should tentatively proceed under the assumption that there are no effects from increases in delay on A_{ret}. But, as the multiple plausible interpretations above indicate, the findings of one experiment are not in themselves conclusive. More work needs to be done to test which, if any, of the four possible interpretations for this outcome is accurate.

FUTURE RESEARCH

More work needs to be done to confirm or disconfirm the four interpretations outlined in the implications section. Even interpretation #1, that this study is correct and that conventional views about delay are uninformed, needs to be investigated further. The current experiment includes a limited number of delay levels, experimental pages, experimental retailers, test subjects, etc. Future research should be conducted to extend this study to include new treatments and subjects to confirm or disconfirm the findings outlined above.

Beyond repeating the current experiment, a study needs to be performed to test the validity of interpretation #2. If interpretation #2, that delay causes problems with patronage but is limited to a load/no-load decision, were supported by future research, it would confirm the outcome of this experiment while lending some support for the general belief that delay has a negative impact on patronage of an e-Retailer. If true, once the page is loaded, the impacts on patronage appear not to occur. A study would need to be conducted that measures whether excessive download delays: (a) cause e-Consumers to stop a retail page from loading; and (b) impact what consumers do after they stop the page load (and see if the reaction is detrimental to the e-Retailer). Specifically, it would be important to see whether e-Consumers who stop a page load then go to a competitor's site or simply return to the retailer page with reduced expectations of how long a page will take to load. Research into how to encourage a decision to allow a page to load in spite of excessive delays should also be pursued.

To test for the possibility of interpretation #3 (i.e., impacts of download time on A_{ret} are moderated by attribution of delay), the independent variables of the study need to be extended in future research. As stated above, download delay varies by source (client, infrastructure or server technologies, or file size). Delay may not be attributed to the e-Retailer in the minds of e-Consumers. In other words, consumers may not realize the extent to which delay associated with a Web page is an in-store characteristic and under the control of e-Commerce managers. It is likely that the less delay is perceived to be an in-store characteristic, the less is the impact on in-store emotions and attitudes toward a retailer. But it is possible that certain Web design characteristics (such a java applets or multimedia) may cause consumers to attribute more delay to the site and increase the negative A_{ret}. For future research, it is important to study attributable delay and determine, therefore, if increases in delay attributed to the site lead to more negative attitudes toward the retailer.

Other types of delay should be measured as well. This experiment measured only changes in actual delay. Insight would be gained by analyzing the effect of changes in both perceived wait time and attitude toward delay on A_{ret}. These are more subjective measures of delay than actual delay. By understanding these independent variables, it might be clearer when certain conditions mitigate or exacerbate the impact of download delay on attitudes.

Finally, interpretation #4 needs to be subjected to empirical testing. In order to understand the effects of excessive download time, it is necessary to examine the impacts of multiple exposures to the same page with repeated long delays. Results of that experiment would indicate if impacts are cumulative. Likewise, interpretation #3 and #4 may not be correct separately, but be correct in combination. Specifically, it may be that repeated exposures to long delay impact attribution of delay to the retailer. This consistency in delay may, in turn, negatively impact A_{ret}.

By no means do the four interpretations above represent a comprehensive list of all possibilities. Future work should also explore additional reasons for the conflict between conventional wisdom about the impacts of delay on A_{ret} and the outcome of this study. However, the research agenda proposed here will, hopefully, offer clarification and insight into what appears to be the some of the most plausible alternative interpretations.

CONCLUSIONS

Excessive download delay has been identified as a major concern for EC. Unfortunately, because its impacts are unclear, managers are still not entirely sure how to design Web sites to control consumer responses. Hopefully, the counterintuitive results of this study and the future research proposed here will allow for better understanding of this impediment.

If future studies find that, indeed, download time does not affect attitude toward retailers under any circumstances, then results of this research might be sufficient justification for Web designers to place more content (increasing download delay, of course, and negative attitudes toward brands), on e-Services Web sites. Likewise, if subtler effects are uncovered in other work, we can learn when download delay does adversely affect consumer views of the firm and when targeted reductions in content are needed.

The present study is one of, hopefully, a fruitful stream of studies trying to tease out the conditions under which download time influences commercial activity. Together with other TIEC research, managers and developers of EC initiatives will be able to make more informed and effective decisions in the near future.

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