CHOOSING YOUR OWN ADVENTURE:

HYPERLINKS AND THEIR EFFECTS

ON MEMORY

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The undersigned, appointed by the dean of the Graduate School, have examined the thesis entitled

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Abstract

For this experiment, 39 students from a large Midwestern university were exposed to a total of ten articles, two main articles about 150 words in length, called parent page articles, and eight linked articles. Each of the articles contained four embedded links each. Two of the linked articles contained related content, while the other two contained unrelated content. Readers were then tested on their cued recall and recognition of the articles to gauge how the embedded linked articles affected those two aspects of memory. Lang's Limited Capacity Model for Mediated Message Processing (LC4MP) was used a basis for the hypotheses. This experiment also made hyperlink cuts analogous to television cuts as in Lang, Geiger, Strickwerda and Sumner (1993). Based on those two factors, the hypotheses predicted that readers would better remember related information. The results found were counterintuitive. Readers showed better overall recognition and recall for parent pages when compared to linked pages. They also had better recall of unrelated linked information when compared to related linked information and when compared to both related and linked information.

Chapter 1: Introduction

Newspaper Web sites have seen considerable growth in both readership and content since their inception. Readership is at a record high with an average of 62.8 million readers a month in the last months of 2007 (Sigmund, 2008). With younger readers increasing their reliance on the Web as their primary news medium, newspapers are likely to augment their Web presence in the future. But the Internet is a vast medium, and newspapers seem unsure of what kinds of content to offer their readers. Furthermore, there are several technological features that distinguish the Web from traditional media. One such feature is hyperlinking, or the ability to link different content nodes to a particular word or phrase in a news story. Newspaper Web sites, such as the *New York Times*, as well as other information-disseminating Web sites, such as Wikipedia, have begun to use hyperlinking within the text of the articles as part of this push toward a more interactive medium. While hyperlinking is now a common feature that even novice Web users are familiar with, there is little research examining how this method of connecting information affects cognition. Do these embedded links distract? Or do they help readers learn? And what exactly is it helping readers learn and process, if anything? Do readers even take note of these hyperlinks? This study attempted to answer the following research question: How do embedded hyperlinks affect memory on newspaper Web sites?

An Internet standard, hyperlinks are a crucial part of navigating the Internet. They help readers browse and scan content on the Internet as well as allowing readers to, in a

sense, "choose their own adventure" (Harper, Yesilada, Goble and Stevens, 2004). This means that when newspapers place hyperlinks in more visible locations on their Web sites, the nuances of hyperlink placement begin to raise questions of how such links affect readers' browsing patterns, and ultimately, what they remember. *The New York Times* offers a popular example of nuanced hyperlinking. On its Web site, the *Times* embeds links in articles. These links, when clicked, lead readers to more information on the subject. At times, the content that embedded links lead to is related. But other times, these links merely connect to a fleeting mention of an unrelated topic that gets tossed into the mix. As visitors read an article, they may stop at these highlighted links and choose to follow them, essentially interrupting how they read the initial article, referred to hereafter as the "parent page" article, and possibly hindering their chances of returning to the original, or parent page.

The effects of these links on memory could be substantial, and subsequent research could be significant. On a practical level, the research proposed here could help online news editors understand the effects of hyperlinks. Are hyperlinks allowing editors to disseminate information more effectively, or do they distract readers and hamper the dissemination of information? Professional research on specific elements found on newspaper Web sites is limited. Often, the research addresses interactivity as a whole, leaving out a specific analysis of hyperlinks, even though they are often considered an essential component of interactive media. The research conducted in this paper attempted to fill in that gap and add to knowledge on a prevalent yet overlooked element of online news. On a scholarly level, this paper aimed to figure out what effects hyperlinks have on

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information processing and memory. Prior research in memory and cognition of media has primarily focused on televised media, with very few studies addressing how readers process information on the Internet. Fewer still have looked at the connection between hyperlink-based navigation and memory. This research worked to add to that knowledge and prompt further research on this subject.

In an attempt to fill this gap, embedded hyperlink use was addressed from the perspective of the Limited Capacity Model of Motivated Mediated Message Processing (LC4MP; Lang, 2006), which theorizes that the mind has a limited amount of space with which to process information. This thesis briefly outlined the model and applied it to the question proposed above. It described the role of hyperlinks and how hyperlinks may affect memory. Finally, it presented hypotheses derived from this discussion as well as methods, results, and discussion based on tests of these hypotheses.

Limited Capacity Model for Motivated Mediated Message Processing (LC4MP)

The LC4MP is one possible framework for understanding how hyperlinks might affect memory. The model explores media effects from the perspective of information-processing models that have been developed in cognitive psychology for more than 50 years (Lang, 2000). Such models suggest that the human capacity for information processing is limited. As a result, stimuli in the environment compete for these limited processing resources. The determination of which stimuli undergo cognitive processing and which do not depends on both features of the stimuli and features of the person encountering those stimuli. The LC4MP has applied these ideas to questions of media

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effects. Mediated stimuli compete for limited resources, just as stimuli in the real world do. Likewise, the extent to which mediated stimuli undergo cognitive processing is a function of both features of the media and features of the individual being exposed to said media. When readers have exhausted their limited capacity, their processing ability weakens (Lang, 2006).

The LC4MP describes the cognitive processing of media as the continuous interaction of three distinct subprocesses: encoding, storage, and retrieval. Encoding is the process through which the mind perceives a mediated message and translates it into a mental representation in working memory. Storage is the linking of new information in working memory to old information in long-term memory. Retrieval is the ability to reactivate information from long-term memory for use in working memory (Lang, 2000). This experiment focused on encoding and storage, the subprocesses linked to learning (Lang, 2006).

According to Lang (2000), encoding begins at the moment of exposure and deals with the transfer of information from the medium (in this case, a Web page) to the reader (pp. 48). By looking at encoding, we are looking at how much the medium is connecting with the reader. To test this, Lang (2000) proposes the use of recognition tests. These tests assess whether or not a reader can distinguish information that has been seen before from information that has not been seen before. On a deeper level, such tests assess whether the information has made the transition from sensory perception to cognitive elaboration because of the many cues provided in the question. The recognition tests pair pieces of information – one already seen and one new to the readers – and ask the reader to point

out the previously seen information. This is significant because it shows cursory

familiarity with something – that the brain has made a connection, however small, with

the presented information.

After information is encoded, it is then linked to other, older information in the

subprocess known as storage (Lang, 2000). In this subprocess, the more prior knowledge

a reader has on a subject, the better stored a piece of incoming information will be. This

connection could be particularly relevant to our discussion of hyperlinks. If the embedded

hyperlinks link to related material, then the reader already has background information on

the subject, which was, in this case, would be presented in the parent page, to which to

link the information. Because of the repetition of information, the reader will likely have

an easier time connecting new information to old information. Furthermore, if the

information is related, then readers will have an increased likelihood of remembering it,

according to Lang, Geiger, Strickwerda and Sumner (1993), who looked at the effects of

relationship on memory in a similar field — television.

Much of the research using the LC4MP has focused on television and radio, but

recent research has supported the application of this model to new media (Lang, 2000;

Wise & Pepple, 2008). The LC4MP may help explain how hyperlinks might affect

memory by offering an explanation of how people process information on television. In

much the same way that television consists of a continuous series of related and unrelated

scene changes, or edits, navigating the Web consists of a continuous series of related and

unrelated content (page) changes. This is relevant because, as just explained, Internet

hyperlinks work similarly to television cuts and edits in the ways they replace

information with which the viewer is presented.

These edits, or cuts, in television were among some of the earliest elements studied through the LC4MP's lens. Lang and colleagues (Lang, Geiger, Strickwerda, & Sumner, 1993) divided edits into two types: related and unrelated. Related edits feature a change in the visual field, while the content is still related. For example, a local television news story on mail delivery may show a few seconds of film of a mailman carrying mail before replacing that image with a close-up shot of the mailman's hand as it goes into the mailbox. The visual field changes, but the subject matter remains the same or similar. Unrelated edits have no connection. In a story on mail delivery, the short footage of the mailman at a mailbox could abruptly be replaced with footage of a dog wagging his tail.

Lang, et al. (1993) found that both types of cuts prompted resources allocated towards encoding in readers, but that readers showed better memory of the information presented after a related cut. On the other hand, readers showed less memory of information presented after an unrelated cut (Lang, et al. 1993). Similarly, content changes on the Web are commonly executed through the use of hyperlinks. To the extent that content changes on the Web are analogous to content changes on television, a logical starting point for applying the LC4MP to the study of hyperlinks includes a review of research on television scene changes.

Applying these ideas to online news browsing, the click of a hyperlink may prompt arousal similar to that of a television edit as both present complete changes of the environment being viewed. While this idea has not been tested using the LC4MP, its application to television and the theories it presents could be beneficial to theorizing

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hyperlinks' effects on memory. Lang, Zhou, Schwartz and Bolls (2000) searched for a link between memory and cuts. By measuring response time, the researchers found that subjects took more time to respond to unrelated cuts than to related cuts, thus showing that unrelated cuts took up more resources than related ones. They also found that unrelated information presented after a cut was less well remembered than the information before the cut.

Hyperlinks and Memory

For the purposes of this thesis, hyperlinks will be defined as highlighted hypertext found within a story posted on a newspaper Web site that, when clicked on, changes the environment the user is viewing. Agosti, Crestani and Melucci (1997) divided hyperlinks into three main types of links: associative, referential and structural. This thesis will primarily focus on referential links, or links that focus on a reference that the author of the original document has made. The researchers described it as a link, which connects a citation with an original article, but similarly, for the purposes of this study, it will be an article referencing a person, place or thing which will be linked to greater explanation of the selected object.

Memory processes and cognitive overload

The mind uses a great deal of cognitive resources when encoding and storing information. When processing information, if a certain amount of information is encoded, only part of it will be stored and even less of the originally encoded material will be

available for retrieval (Lang, 2006). When presented with a great deal of information, subjects may experience cognitive overload, or the overwhelming of resources related to processing information. This generally occurs when the subject has too much information to process and may result in the subject becoming distracted. Dee-Lucas and Larkin (1995) found that hypertext (text that includes hyperlinks) distracts readers from the text they are reading by interrupting information processing. This suggests that information encoded from parent pages will be overwritten when people click on a hyperlink and begin encoding new information. As recognition accuracy has been previously identified as a measure of encoding (Lang, 2000), it is proposed that:

H1a: Recognition accuracy for information presented on hyperlinked pages will be greater than recognition accuracy for information presented on parent pages.

As Dee-Lucas and Larkin (1995) noted, the presence of embedded hyperlinks on a standard Web page could distract readers. While reading, subjects may stop to click on links in the middle of a story, thus interrupting their cognitive processing of the parent article and the process the LC4MP describes. As the linked information will not feature any hyperlinks that could distract, and as readers will already be encoding information as a result of the mediated environment change, they will be allocating more resources to focus on the linked articles, and storage will benefit. As cued recall has been previously identified as a measure of storage (Lang, 2000), it is proposed that:

H1b: Cued recall accuracy for information presented on hyperlinked pages will be greater than cued recall accuracy for information presented on parent pages.

As previously discussed, the relationship between the content on the parent page

and the content on the hyperlinked page may have an impact on how information is remembered. Hyperlinks on the Web work in a similar manner as television edits, navigating readers and viewers through content in a visually based environment. When a reader clicks on a hyperlink, they are, in essence, directing a cut to new information. Lang and colleagues (1993) showed that information in related cuts was better remembered than both unrelated cuts and the information before the cuts. Based on this research, it is proposed that:

H2a: Information presented on related hyperlinked pages will be recognized more accurately than information presented on the unrelated hyperlinked pages.

H2b: Information presented on related hyperlinked pages will be recalled more accurately than information presented on the unrelated hyperlinked pages.

H3a: Information presented on related links will be more accurately recognized than parent pages, which will be more accurately recognized than the information on the unrelated links.

H3b: Information presented on unrelated links will be recalled less accurately than the information on both parent pages and related linked pages.

The proposed hypotheses were explored in an experiment in which participants read stories from an online news Web site. The parent, or main, pages had links, while subsequent linked articles did not. Some of the links were attached to material related to the parent article while other links were attached to material unrelated to the parent article. Participants were given recognition and cued recall tests on the content contained

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in the original story as well as the hyperlinked material in order to assess encoding and

storage.

Chapter 2: Methodology

Participants

Thirty-nine students from undergraduate journalism lecture classes at a large Midwestern university were recruited to participate in this experiment. Students were appropriate for this experiment because they are more familiar with navigating the Internet. They, on average, have been exposed to it since youth (Jones, 2002)**.** Students ranging in age from 18 to 25 have been found to rely on the Internet heavily with the majority of students using it "every day" or "several times a week." Students have also reported Internet news as being more credible than non-students (Metzger, Flanagin and Zwarun, 2003), indicating that they might be more engaged while reading news than those who may discount the credibility of online news. Finally, students are among the highest consumers of the Internet (Jones, 2002). By using university students for this study, the findings will be applicable to educated, Web-savvy consumers of the news.

Design and stimulus materials

This experiment had a 2 (location) x 2 (relevance) x 2 (repetition) + 1 (hyperlinks) within-subjects design. Location referred to the relative location of the article and had two levels: parent and linked. Parent pages were about 150 words in length and contained four embedded links, two related and two unrelated pages. Linked pages were similar to the parent pages in length but did not have any related articles. Relevance referred to the

thematic connection between a particular linked article and the parent article to which it was linked. Relevance had two levels: related and unrelated. Both related and unrelated articles were approximately 150 words in length.

Stimuli

Parent pages: Readers were presented with two parent-page articles. These articles contained the related and unrelated embedded links and at one time had longer versions printed in a reliable news outlet. These longer versions were edited down to about 150 words and presented on a computer screen similar to how articles are presented on newspaper Web sites like The New York Times online, NYT.com. Each article had a headline, byline and main text. They were formatted to have a similar look and feel as an article on a newspaper Web site. The two parent pages had four embedded hyperlinks in each of their texts. Two of the hyperlinks linked to unrelated, or loosely related content, while the other two hyperlinks linked to content that closely related to the parent-page article, for a total of eight embedded hyperlinks in the entire project – four to unrelated content, four to related content.

Linked pages: The linked pages did not have any embedded hyperlinks. These linked pages looked exactly like the parent pages. They, too, featured 150-word articles. Half of these linked pages featured content unrelated to the articles. The other half had content that was closely related to the articles' content.

Dependent variables

Memory: This research focused on the encoding and storage subprocesses of memory. Encoding was measured using forced-choice recognition tests, which assessed whether a reader encoded information well enough to distinguish it from unseen material (Lang, 2000; Grabe, et al., 2003; Grabe, et al., 2000). The participants were presented with a total of 12 questions, four for each parent page, two for each of the related pages and two for each of the unrelated pages. They were given four possible answers and asked to choose the correct one. The questions were then grouped by category (related, unrelated and parent), and the answers will be added to give each category a score. The scores of the embedded linked stories and the parent pages were later compared.

Storage was measured using cued recall tests (Lang, 2000; Grabe, et al, 2003). Participants were presented with questions that offered a kind of cue to the information presented in the articles they read, such as "Name the world leaders involved in this story." Participants received 12 cued recall questions. These questions were grouped together to create a variable, and each story was assigned a score based on the number of correct responses the participant gave.

Cued recall tests look past the encoding stage and at how well information is stored. Because recognition is more sensitive (requires a stronger cue) than cued recall, the cued recall test will take place before the recognition test. Using the Princess Diana example, readers might be asked to write down the names of her sons presented in the article in the cued recall section. For the recognition section, a question might offer a list

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of four names and ask which of the following were not members of the royal family mentioned in the article.

Experimental procedure

Pretest: Article relevance was established in a pretest, in which eleven participants were presented with fourteen articles: two articles which would eventually be the parent-page articles in the final experiment, and twelve contenders to be the articles on the linked pages. Readers were asked to read six of these possible linked articles and rate the relevance of each of the possible linked articles to one parent-page article on a seven-point Likert scale. Readers were then presented with six more articles and asked to rate their relevance to a second parent-page article on a seven-point Likert scale.. The Likert-scale test was used to determine which of the possible linked articles contained content that was more related to the content on the parent pages and which of the possible linked articles contained content that was more unrelated to the parent pages. Four pairwise comparisons were then made between related and unrelated stories. Each of the comparisons yielded a significant (all $ps<.01$) difference between the stories in each pair for relevance.

Experiment: Participants signed a consent form upon entering the lab, and were then logged in to a computer with a numerical identifier. Once they were logged in, they were presented with one of two parent pages. Readers were given two parent pages, each of which featured four embedded hyperlinks. Two of these hyperlinks led to unrelated content, and the other two led to related content. The participants were then prompted to

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Table 1
Pretest means of related and unrelated stories

|	Mean	SD
Related 1.1**	**6.55**	**.688**
Related 1.2	**5**	**1.183**
Related 1.3	4.27	1.679
Related 2.1	**5.82**	**1.537**
Related 2.2	**5.73**	**1.272**
Related 2.3	5.36	2.063
Unrelated 1.1	**1.18**	**.405**
Unrelated 1.2	**2**	**.632**
Unrelated 1.3	4.45	1.508
Unrelated 2.1	**1.09**	**.302**
Unrelated 2.2	3.09	1.640
Unrelated 2.3	**1.10**	**.316**

** Articles in bold were the ones selected for the experiment.

click on all of the links embedded in the story. Once they finished with the first parent

parent page and its links, subjects were given another parent-page article and instructed to

click all the links in that story as well. All readers received a total of ten articles each, two

parent pages and eight linked pages. On each parent page, two of the embedded

hyperlinks led to an article related to topic addressed in the parent page. The other two

were only loosely related to the content on the parent page. For example, an article on

English royalty would have had four referential hyperlinks: one would link to an article

on Princess Diana, another to Prince Charles, and a third may have linked to The Beatles,

who are referenced in a quote reading "Princess Diana was as big as The Beatles." A

fourth link was similarly unrelated. As such, the hyperlink reading "Princess Diana"

would have taken readers to a brief, 150-word article on Princess Diana, which would not

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have contained any embedded hyperlinks. From that article, readers could return to the main page and either click another embedded hyperlink or continue to the next story once they were done reading the five articles, the parent page and the two related and unrelated pages.

All the stories were presented to participants in a random order to prevent observer bias on the part of the participant. In the case that the readers navigated off of the parent articles, they could return to it via the browser's back button, where they had the option of clicking on the other links embedded in the article's text or continuing on to the next main article. Readers could use their browser's back button or a button provided on the linked pages to navigate back to the parent article. The participants were observed as they navigated through the pages. Once they were finished reading through all of the articles, the subjects watched a 5-minute newsreel from the 1960s to clear short-term memory prior to the recognition and cued recall tests. Once they finished that, they were given recognition and cued recall tests which assessed their encoding and storage of information.

Model 1
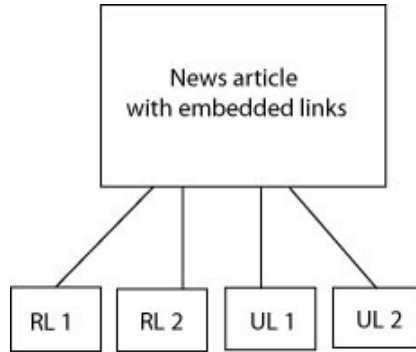
This model shows the possible navigation path a reader can take from the article with embedded links. They can click on one of four links listed on the home page.

Chapter 3: Analysis

Data Preparation

  Answers in the recognition portion were coded as either 0 (miss) or 1 (hit). In the cued recall portion, subjects were given partial credit for questions with multiple answers. For example, if a question required three answers and only one given answer was correct, the subject would be receive a score of .33 for the question. Scores for each of the conditions were then averaged based on the number of questions in each condition. The averages were converted into percentages. Using this method, each subject received a score (ranging from 0 to 1) for the number of details from main stories, related articles and unrelated articles they recalled correctly. These scores were then used in the data analysis. An examination of each subject's scores in each of the conditions found no outliers.

Analysis and Results

  A paired-samples T-test was used to test Hypotheses 1a through2b. A repeated-measures ANOVA was used to test H3a and H3b. Hypotheses 1a, 2a, and 3a all dealt with recognition. Hypotheses 1b, 2b and 3b dealt with cued recall. Cohen's d was calculated as a measure of effect size for H1a to H2b, and partial eta-squared was used as a measure of effect size of H3a and 3b.

  Hypotheses 1a predicted that the information presented on hyperlinked pages

Table 2
Recognition and cued recall of parent, related and unrelated linked pages

| | Recognition | | Cued recall | |
	Mean	SD	Mean	SD
Parent	.79	.20	.39	.14
Related	.58	.26	.39	.22
Unrelated	.56	.22	.52	.18
Linked	.57	.19	.30	.11

would be more accurately recognized than the information on parent pages. This analysis yielded a significant main effect for Location on recognition accuracy ($t(39)$=5.93, $p<.01$, d=1.1), but in the opposite direction than that which was predicted. Details from parent pages (M=.79, SD=.20) were recognized more accurately than details from linked pages (M=.57, SD=.19) were. This was the opposite of what had originally been predicted. Thus, H1a was not supported.

H1b predicted that information on hyperlinked pages would be better recalled than information on parent pages. This analysis yielded a significant main effect for Location on cued recall ($t(39)$=4.36, $p<.01$, d=.64), but in the opposite direction of that which was hypothesized. Details from articles on the parent pages (M=.39, SD=.14) were better recalled than those on the linked pages (M=.30, SD=.11). Thus, the analysis did not support H1b.

H2a predicted that information presented on the related hyperlinked pages would be more accurately recognized than information presented on unrelated hyperlinked pages. The main effect of Relevance on recognition accuracy was not significant (p=.69,
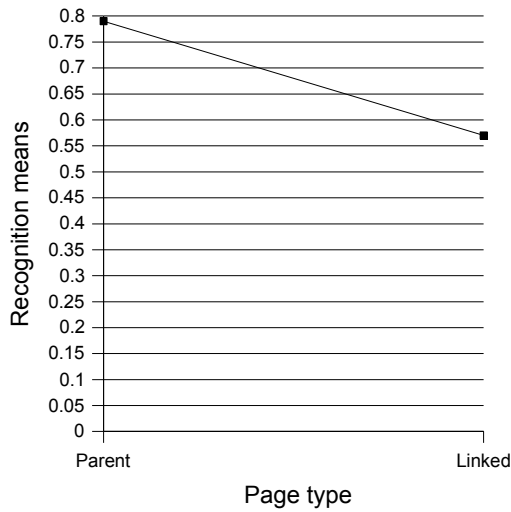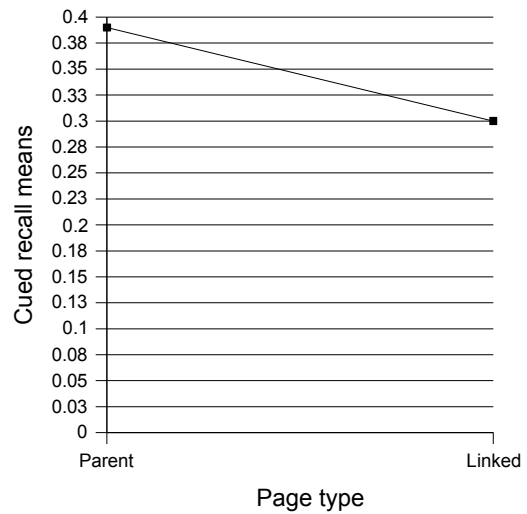
Figure 1
Plot of recognition means by page type

Figure 2
Plot of cued recall means by page type

t=.40, d=.08).

H2b predicted that information presented on related hyperlinked pages would be recalled more accurately than information presented on unrelated hyperlinked pages. This analysis yielded a significant main effect for Relevance on cued recall accuracy (*t(39)*=-3.62, *p>.01, d=-.54*), but in the opposite direction of that which was hypothesized. Articles on unrelated linked pages (*M=.52, SD=.18*) were better remembered than articles on related linked pages (*M=.39, SD=.22*). Thus, H2b was not supported.

H3a predicted that information on related links would be more accurately recognized than information on the parent pages, which would be more accurately recognized than the information on the unrelated links. The analysis found a significant main effect for Relevance on recognition accuracy (*F(39,78) = 15.76, , p<.01, partial eta squared=.29*). A Tukey HSD post-hoc test demonstrated that articles on the parent pages (*M=.79, SD=.20*) were more accurately recognized than the related pages (*M=.58,*

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Figure 3
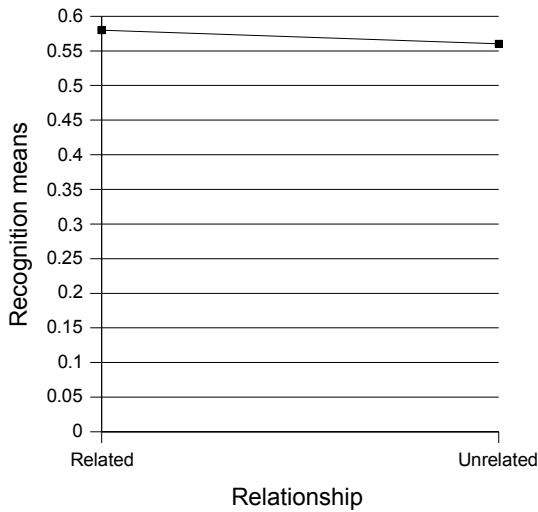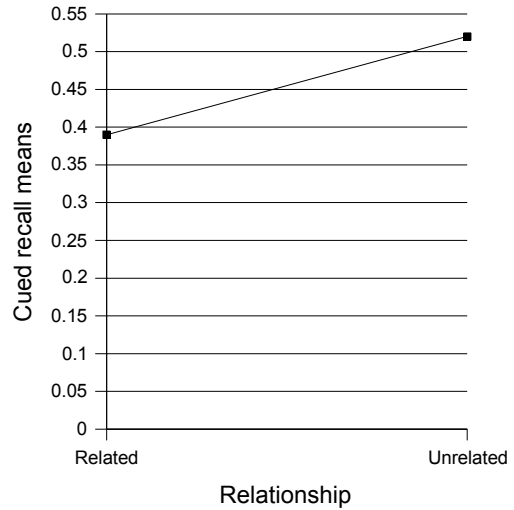*Plot of recognition by relationship*

Figure 4
Plot of cued recall by relationship

SD=.26), (*Tukey Q(78)*=6.53, p<.01), but there was no significant difference between the related pages and the unrelated pages (*M*=.56, *SD*=.22), (*Tukey Q(78)*=.59, *ns)*. This again was the opposite of what had been predicted. Thus, H3a was not supported. H3b predicted that information presented on unrelated links would be recalled less accurately than information on parent pages and related linked pages. The analysis found a significant main effect for Relevance on cued recall accuracy (*F(39,78)* = 10.73, *p<*.01, *partial eta squared*=.22), but the result was one in the opposite direction of what was hypothesized. A Tukey HSD post-hoc test demonstrated that unrelated stories (*M*=.52, *SD*=.18) were more accurately recalled than both the related pages (*M*=.39, *SD*=.22) (*Tukey Q(78)*=6.07, *p<*.01*)* and the parent pages (*M*=.39, *SD*=.14) (*Tukey Q(78)*=6.27, *p<*.01). Thus, H3b is not supported.

Chapter 4: Discussion

This experiment aimed to see how embedded hyperlinks affected memory of newspaper Web sites. As newspapers continue to find a place for themselves on the Web, many have turned to different forms of Web-based features for value-added Web content. Prevalent as a navigation tool on the Web, hyperlinks were among the features some large media outlets, such as the New York Times and CNN.com, had begun to use. This experiment hoped to measure how readers processed content on linked pages versus parent pages and how readers processed content on related and unrelated hyperlinked pages. To answer this, subjects were told to read a total of 10 articles, two parent pages, four related linked pages and four unrelated linked pages. They were then given a test to measure recognition and one to measure recognition. The hypotheses posed were based on Lang's Limited Capacity Model for Mediated Message Processing, with some focus on research by Lang, et al. (1993) on related and unrelated television cuts. Based on their findings, which showed subjects having less memory of unrelated cuts, we hypothesized that related and parent pages would be better remembered. In this case, the hypotheses posed in this experiment were guided by defining cuts caused by hyperlinks as being analagous to television cuts. The hypotheses were also formed using Dee-Lucas and Larkin (1995) as background. The researchers found hyperlinks to be a distraction, taking away from cognitive resources. As such, the hypotheses we posed assumed information on the links would be better remembered because of the shift in cognitive resources to

focus on the information there. What we found was counterintuitive to these prior results. Subjects better remembered information on unrelated and parent pages, rather than related linked pages.

Lang, Zhou, Schwartz and Bolls (2000)'s findings showed unrelated cuts using more cognitive resources to process. Because of this, we assumed they would not be as well remembered as the related and parent pages. Since cognitive resources would be used up processing the information, there would be fewer resources available to store the information to memory. But even with these studies as a basis, the results of this study were consistently in the opposite direction of our hypotheses. Although the 1993 study found subjects had better memory of related television cuts, the results of this study found readers better recalling and recognizing unrelated stories, findings that did not support the hypotheses posed. While subjects had better recall of unrelated stories, they had better recognition of the parent pages than related or unrelated linked page. In this case, there was nothing to show that readers were building on prior information.

This experiment's findings built on LC4MP by suggesting that how it applies to the Web might contradict how it applies to television and other forms of mediated message processing. Readers on the Web do not necessarily use fewer cognitive resources when presented with related information. Because of its relationship with previous information, they may not put the cognitive resources forward to fully understand the information. In these cases, they may merely skim the information, giving them only information worthy of encoding. On the other hand, when presented with unrelated material, subjects may allocate all their cognitive resources to focusing on that one article

because of it does not build on prior information. Furthermore, the repetition of returning to the main page which may have prompted better recall and recognition. As such, LC4MP on the Web may take into consideration the user-controlled experience. As readers can go back and forth on the Web, spending as much time as possible on a story, they may be choosing to use their resources as they choose.

In this experiment, rather than build on prior information, the reader seemed to encode the information on the parent pages which they returned to when navigating, but stored the unrelated information to memory. When looking at the cued recall and recognition, the unrelated stories were so different in content than the original topic that the reader may have used more cognitive resources to process them, thus taking away from other subjects. For example, one of the parent page stimuli readers were presented with dealt with No Child Left Behind, but one of its unrelated links addressed shooting in Texas. The stark contrast between the subject matter in these two articles may have meant more cognitive resources were allocated to committing the unrelated article to memory. While the exact reason for these counterintuitive findings is unclear, some explanations can be gathered from looking at other researchers' work. For example, the novelty of the unrelated articles may have been more arousing and thus prompted the reader to allocate more resources to the unrelated articles. Taylor, Fiske, Etcoff and Ruderman (1978) addressed this occurrence in one of their studies of race and sex's effects on encoding. They found when looking at groups of different races, the differences found between the two groups was greater. As a result of a similar effect, the novelty presented by the unrelated links may have been better recalled as a direct result of their unrelated nature,

in part explaining the counterintuitive findings. Another explanation for the strong recall

and recognition of the unrelated stories be a result of a high number of what Erdelez calls

"super-encounterers." In her research on the "accidental discovery of information",

Erdelez and Rioux (2000) looked at those who come across information they may

consider useful or interesting and then become interested interested in that. For example,

if on a newspaper Web site, a reader may come across a link to information on Woody

Allen in a health story about heart surgery. Although the link is unrelated, after

encountering the information on the page, Woody Allen becomes a new focus and topic

of interest. "Super-encounterers" are more likely to continue on this trend, looking for

more information for themselves and others, though it may be unrelated to their interests.

As such, the more "super-encounterers" interested in unrelated articles, the higher the

recognition and cued recall scores for the unrelated articles could be.

Furthermore, researchers have had similar results as those presented in this study

when looking at memory and hyperlinks. In their study of in-text hyperlinks, Eveland,

Marton and Seo (2004) found that there was higher factual knowledge for articles with no

links in them. In their case, though, readers did not necessarily navigate back to a main

page repeatedly. They first navigated to articles using a page which featured almost

exclusively hyperlinks and navigated to other stories from by using that stimulus page or

with embedded hyperlinks. Furthermore, when looking at recall and computer text

structures, Lee and Tedder (2003) had similarly unexpected results. The researchers

hypothesized recall information on "structured hypertext" documents, which led the

reader in a logical path, would be better than the same information on "networked

hypertext" documents, which created a complex navigational web, because links would disorient the reader. They instead found that readers better recalled the networked hypertext documents.

The repeated exposure to the main page may have also played a large role in how the parent pages were later recalled and recognized. Lang (2006) calls up the example of Sesame Street to discuss how repetition can improve message processing. She notes that repetition is a factor in helping because it reduces the amount of stress on cognitive resource allocation. Likewise, returning to the parent pages may have created a similar effect, repeating the message on that one page and making it more memorable than the others.

But beyond these reasons, the counterintuitive findings may also be a result of this experiment's limitations. Because the closed nature of the experiment forced the reader to return to the page several times to continue clicking on links, they were exposed to the parent pages more frequently than the linked pages, thus likely increasing their memory of the parent pages. If in the real world, the reader may continue navigating away from the parent page altogether, never finishing it and instead moving onto another set of articles altogether. If this experiment were to be replicated, adapting the conditions so the reader would have the option of navigating away from the parent page permanently may be advised as future research could give great insight into the Internet's impact on memory.

As a most fundamental part of navigating the Web, hyperlinks are largely unexplored. All the while, their considerable presence on the Web makes them a strong

contender for research inside and outside the world of media. Hyperlink research would give insight on how information presented online is remembered in the long term, findings that could grant us greater information as to how cognitive processes react to the selection of information and more practically, potentially restructure how the Web operates. With more hyperlink research in hand, groups on the Web could change the purpose and placement of hyperlinks as well as reconsider embedded hyperlinks as a navigation tool as a whole, opting instead to use options such as side toolbars or hyperlinked images.

Although the quick, controlled distribution of information can be compared to a television cut, as researched by Lang, et al. (1993), they are an entirely different beast. Further academic research could look at how readers remember a greater Web of hyperlinks, giving readers the option to click on several levels of hyperlinks. How does memory of information change as the number of levels increase? For example, how much parent page information does a reader remember five linked pages later? Oostendorp and van Nimwegen (1998) attempted to answer this question by looking at how information was remembered based on the information's location on an online newspaper's Website. The researchers found a decrease in recognition after two levels of hyperlinks. With that in mind, a greater Web of hyperlinks may absorb more cognitive resources and thus decrease the processing of information.

Academic research could also focus on volition and memory. Since hyperlinks allow readers to control their Web experience themselves, it may be worthwhile to look into the role of their effectiveness. Given the option, would readers choose to use them?

And if they did, how far into the Web would they go? Would those who voluntarily chose the links have better recall and recognition of the linked information? Does volition play a role in how information is processed? Looking at this using LC4MP, volition may cause readers to use fewer cognitive resources to process why they are clicking the link, causing a smaller interruption in resource allocation and memory. Thus, readers may very well better remember links they chose to click themselves.

Despite the counterintuitive findings, the information found in this experiment could be beneficial in a practical sense to journalism outlets further establish their Web site and online presence. Burgeoning new media outlets have prompted traditional print journalism outlets to take note and try to bulk up their Internet counterparts. But many of these outlets' attempts to broaden their online presence lack the backing of academic research that would help journalists make educated decisions about their Internet content. If online journalists view their role primarily as disseminators of information, these findings about memory offer insight into the information processing. While the parent page message is still processed best, the reception of subsequent related messages is muddled.

From a news media standpoint, this research could help newspapers restructure their Web sites by eliminating unrelated links. If they feel that their job is primarily to disseminate accurate information, then adding related hyperlinks can be helpful and reinforce a message, but unrelated hyperlinks could confuse the reader and cause them to most remember the messages most unlike the others.

Also on a practical level, further research on this subject could assess the value of

a text-only page. Is a page with a singular, focused message remembered better than one that pulls the reader in different directions? This could also be applied to the advertising world, by looking at how powerful a hyperlinked ad is when put on a Web page. Are they remembered better than the message? And what combination of factors makes their message most powerful? One thing is sure. Hyperlinks are an unexplored, yet fundamental part of how the Web operates. Further research will help to address their function and their value to the Web so they may be used intelligently and to their fullest potential. With more research in this field, journalists and online developers will have a chance to see how worthwhile it is to allow readers to direct their own Web experience. Using the information in this study as a guide for embedded hyperlink use and looking at how parent pages were often best recalled, we can now know when it is best to allow users to, so to speak, choose their own Web adventure.

Works Cited

Agosti, M., Crestani, F., and Melucci, M. (1997) On the use of information retrieval techniques for the automatic construction of hypertext. *Information Processing and Management*. 33(2) 133-144.

Dee-Lucas, D. and Larkin, J. (1995) Learning from electronic texts: Effects of interactive overviews for information access. *Cognition and Instruction.* 13(3) 431-468.

Grabe, M., Lang, A. and Zhao, X. (2003) News Content and Form: Implications for memory and audience evaluations. *Communication Research*. 30(4): 387–413.

Erdelez, S., & Rioux, K. (2000). Sharing information encountered for others on the Web. *The New Review of Information Behaviour Research*, 1, 219-233.

Eveland, W., Marton, K. and Seo M. (2004) Moving beyond "Just the Facts": The influence of online news on the content and structure of public affairs knowledge. *Communication Research.* 31(1): 82-108.

Grabe, M.E., Lang, A., Zhou, S., and Bolls, P. (2000) Cognitive access to negatively arousing news: An experimental investigation of the knowledge gap. *Communication Research*. 27(3) 3-26.

Harper, S., Yesilada, Y., Goble, C. and Stevens, R. (2004) How much is too much in a hypertext link? Proceedings of the fifteenth ACM conference on Hypertext and hypermedia.

Jones, S. (2002) The Internet goes to college: How students are living in the future with today's technology. Pew Internet and American Life Project. Retrieved 19 March 2008 from http://www.pewinternet.org/pdfs/PIP_College_Report.pdf.

Lang, A. (2000) The limited capacity model of mediated message processing. *Journal of Communication*. 20(4): 46-70.

Lang, A. (2006) Using the limited capacity model of motivated mediated message processing to design effective cancer communication messages. *Journal of Communication.* 56: S57-S80.

Lang, A., Bolls, P., Potter, R., and Kawahara, K. (1999) The effects of production pacing and arousing content on the information processing of television messages. *Journal of Broadcasting and Electronic Media*. 43(4): 453-475.

Lang, A., Geiger, S., Strickwerda, M. and Sumner, J. (1993) The effects of related and unrelated cuts on television viewers' attention, processing capacity and memory. *Communication Research*. 20(1) 4-29.

Lang, A., Zhou, S., Schwartz, N., Bolls, P., and Potter, R. (2000) The effects of edits on arousal, attention and memory for television messages: When is an edit an edit can an edit be too much? *Journal of Broadcasting and Electronic Media*. 44(1) 94-109.

Lee, Moon J. and Matthew C. Tedder (2003) The effects of three different computer texts on readers' recall: based on working memory capacity. *Computers in Human Behavior* 19: 767-783.

Metzger, M., Flanagin, A. and Zwarun, L. College student Web use, perceptions of information credibility, and verification behavior. *Computers & Education*, 41(3), 271-290.

Oostendorp, H. and van Nimwegen, C. (1998) Locating information in an online newspaper. *Journal of Computer-Mediated Communication*. 4(1) http://jcmc.indiana.edu/vol4/issue1/oostendorp.html"http://jcmc.indiana.edu/vol4 /issue1/oostendorp.html

Sigmund, J. (2007) Online newspaper readership reaches record in 2007. Newspaper Association of America. Retrieved 25 Feb. 2008 from http://www.naa.org/PressCenter/SearchPressReleases/2008/Online-Newspaper-"http://www.naa.org/PressCenter/SearchPressReleases/2008/Online-Newspaper-Viewership.aspx

Taylor, S. E., Fiske, S. T., Etcoff, N. L., & Ruderman, A. J. (1978). Categorical and contextual bases of person memory and stereotyping. Journal of Personality and Social Psychology, 36, 778–793.

Appendix

Article set 1

Parent page article 1

Read the following story, clicking on the links within the story. Make sure to read all of this story and all of the linked stories. When you are finished reading, alert the student researcher.

An Initiative on Reading Is Rated Ineffective

By SAM DILLON

President Bush's $1 billion a year initiative to teach reading to low-income children has not helped improve their reading comprehension, according to a Department of Education report released on Thursday. The program, known as Reading First, drew on some of Mr. Bush's educational experiences as Texas governor, and at his insistence Congress included it in the federal No Child Left Behind legislation that passed by bipartisan majorities in 2001. It has been a subject of dispute almost ever since, however, with the Bush administration and some state officials characterizing the program as beneficial for young students, and Congressional Democrats and federal investigators criticizing conflict of interest among its top advisers.

"Reading First did not improve students' reading comprehension," concluded the report, which was mandated by Congress and carried out by the Department of Education's research arm, the Institute of Education Sciences. "The program did not increase the percentages of students in grades one, two or three whose reading comprehension scores were at or above grade level."

Once you have read this story and all of the linked stories, tell the student researcher.

Related linked article 1.1

Federally funded Reading First called into question

By GREG TOPPO

The U.S. Department of Education's internal watchdog has opened a preliminary investigation into possible mismanagement of President Bush's $1 billion reading program amid complaints of conflict of interest.
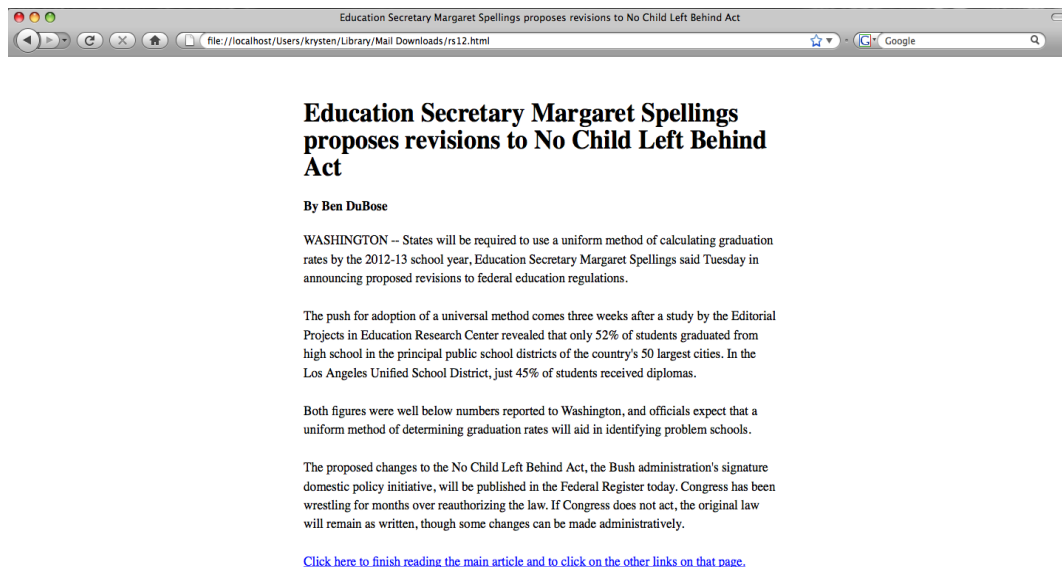
Education Department officials would not confirm that the department's inspector general is investigating Reading First, but a spokesman for Sen. Richard Lugar, R-Ind., confirmed that an audit was taking place.

Lugar, a Reading First supporter, wrote to Education Secretary Margaret Spellings in June with "considerable concern" about the program, which a few opponents say pressures schools to adopt unproven, textbook-based reading programs.

One of Bush's signature education initiatives, Reading First provides more than $1 billion annually to public schools to help teach reading to disadvantaged children through third grade. Unprecedented in size, it is one of the few federal programs that isn't shrinking in this time of budget cuts. Congress is expected to distribute about $6 billion to schools by 2007.

Click here to finish reading the main article and to click on the other links on that page.

Related linked article 1.2

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Google

Education Secretary Margaret Spellings proposes revisions to No Child Left Behind Act

By Ben DuBose

WASHINGTON -- States will be required to use a uniform method of calculating graduation rates by the 2012-13 school year, Education Secretary Margaret Spellings said Tuesday in announcing proposed revisions to federal education regulations.
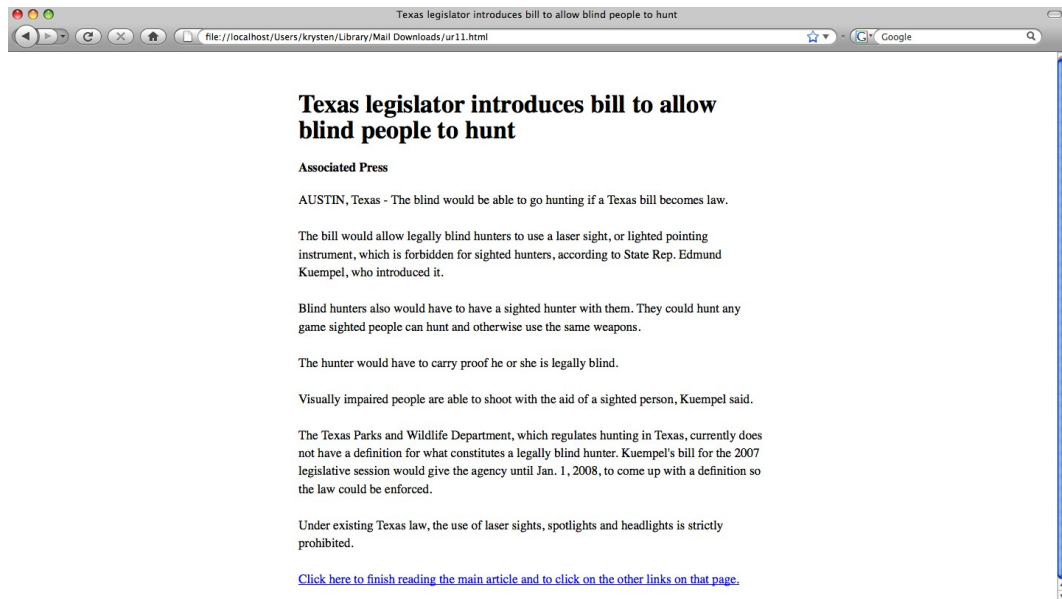
The push for adoption of a universal method comes three weeks after a study by the Editorial Projects in Education Research Center revealed that only 52% of students graduated from high school in the principal public school districts of the country's 50 largest cities. In the Los Angeles Unified School District, just 45% of students received diplomas.

Both figures were well below numbers reported to Washington, and officials expect that a uniform method of determining graduation rates will aid in identifying problem schools.

The proposed changes to the No Child Left Behind Act, the Bush administration's signature domestic policy initiative, will be published in the Federal Register today. Congress has been wrestling for months over reauthorizing the law. If Congress does not act, the original law will remain as written, though some changes can be made administratively.

Click here to finish reading the main article and to click on the other links on that page.

Unrelated linked article 1.1

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Google

Texas legislator introduces bill to allow blind people to hunt

Associated Press

AUSTIN, Texas - The blind would be able to go hunting if a Texas bill becomes law.

The bill would allow legally blind hunters to use a laser sight, or lighted pointing instrument, which is forbidden for sighted hunters, according to State Rep. Edmund Kuempel, who introduced it.

Blind hunters also would have to have a sighted hunter with them. They could hunt any game sighted people can hunt and otherwise use the same weapons.

The hunter would have to carry proof he or she is legally blind.

Visually impaired people are able to shoot with the aid of a sighted person, Kuempel said.

The Texas Parks and Wildlife Department, which regulates hunting in Texas, currently does not have a definition for what constitutes a legally blind hunter. Kuempel's bill for the 2007 legislative session would give the agency until Jan. 1, 2008, to come up with a definition so the law could be enforced.

Under existing Texas law, the use of laser sights, spotlights and headlights is strictly prohibited.

Click here to finish reading the main article and to click on the other links on that page.

Unrelated linked article 1.2
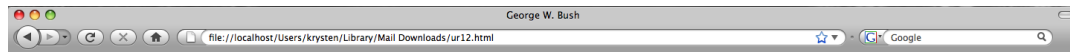
George W. Bush

Associated Press

Bush, George W. b. New Haven, Conn., 1946. Forty-third U.S. president. A former governor of Texas, George Walker Bush was the second son of a former president to ascend to the top office, winning the controversial 2000 election despite losing the popular vote to the sitting vice president, Al Gore.

Bush didn't capture a majority in the Electoral College until five weeks after the election, when the U.S. Supreme Court voted 5-4 to suspend recounts in Florida, which Bush appeared to win by fewer than 1,000 votes. Despite running as a "compassionate conservative," he pushed a pro-business agenda, deep tax cuts (with resulting high deficits), and, after the terrorist attacks of 9/11, an aggressive military policy in Afghanistan and Iraq.

Mounting controversies surrounding the buildup to and the aftermath of the Iraq war clouded the final days of his first term. Click here to finish reading the main article and to click on the other links on that page.

Article set 2

Parent page article 2
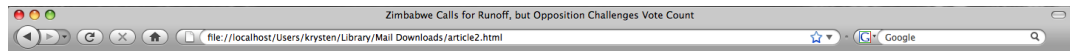
Read the following story, clicking on the links within the story. Make sure to read all of this story and all of the linked stories. Once you have read all five of the stories and are ready to move on, tell the student researcher.

Zimbabwe Calls for Runoff, but Opposition Challenges Vote Count

By CELIA W. DUGGER

JOHANNESBURG -- After more than a month's delay, the Zimbabwe Electoral Commission on Friday officially announced the results of the disputed presidential election, saying that the opposition candidate, Morgan Tsvangirai, had won more votes than the incumbent, Robert Mugabe, but not enough to force a runoff.

Mr. Tsvangirai, leader of the Movement for Democratic Change, won 47.9 percent of the vote to Mr. Mugabe's 43.2 percent, the election officials said. The third major candidate, Simba Makoni, who broke away from the governing party, ZANU-PF, to run as an independent, took 8.3 percent of the vote.

Nelson Chamisa, a spokesman for the opposition, immediately denounced election officials for short-circuiting the vote verification process and "arrogantly" releasing the final tallies before the opposition had a chance to challenge them. But he was noncommittal on the crucial question of whether Mr. Tsvangirai would participate in a runoff.

Once you have read this story and all of the linked stories, tell the student researcher

Related linked article 2.1
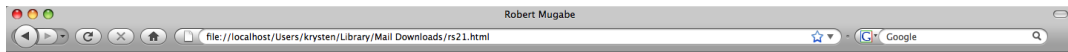
Robert Mugabe

Associated Press

Robert Mugabe, 84, the President of Zimbabwe, is a hero of his nation's liberation struggle and one of the last of Africa's ruthlessly autocratic "big men."

In a country suffering rampant hunger, the government bolsters its standing by distributing subsidized food, routinely favoring, critics allege, members of Mr. Mugabe's party, the Zimbabwe African National Union-Patriotic Front (ZANU-PF). In a country enduring epic inflation of more than 100,000 percent, the campaigning president has been able to bestow tractors and plows on village chiefs whose gratitude is expected to be a reciprocal harvest of votes.

While authorities have yet to announce who won the presidential election, independent monitors say it was won by the opposition. Opposition and civic groups have charged that the military has taken a leading role in seeking to ensure that ZANU-PF remain in power and have described events since the election as a slow-motion military coup. Western diplomats have openly questioned whether President Mugabe is still in charge.

Click here to finish reading the main article and to click on the other links on that page.

Related linked article 2.2
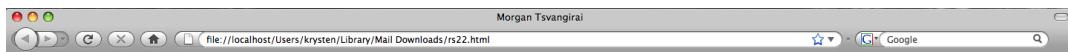
Morgan Tsvangirai

Associated Press

Morgan Tsvangirai is the leader of Zimbabwe's main opposition party, the Movement for Democratic Change (MDC).

Mr. Tsvangirai formed his party in 1999 with union workers, rich white farmers and ethnic Ndebeles from Zimbabwe's southwest. The next year, it won almost half of the contested primary seats in parliamentary elections. Mr. Tsvangirai narrowly lost the presidential race in 2002 in an election that observers denounced as either flawed or fraudulent.

Since then, he has been charged and acquitted with plotting to assassinate President Robert Mugabe, a charge that carried a possible death penalty, and was beaten severely by state security forces.

Though he has campaigned largely without interference for the presidential election scheduled for March 29, 2008, members of MDC alleged that nine million ballots have been printed, even though there are only 5.9 million voters. They suggested that the surplus would end up marked for Mr. Mugabe, and insisted that unofficial election results showed that the Movement for Democratic Change had unseated him.

Click here to finish reading the main article and to click on the other links on that page.

Unrelated linked article 2.1

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Three injured in Johannesburg cafe shooting

Associated Press

Three men were injured following a shooting incident at a Rivonia Boulevard News Cafe in Johannesburg on Sunday, this includes the alleged shooter, paramedics said.

"Paramedics found a 32-year-old man lying on the floor by the door at news cafe around 6pm. He had a gunshot wounds on his legs, his head, chest and arm," said spokesperson Werner Vermaak.

He said the man was being attended to by an off duty paramedic who sustained a graze wound to his arm, who was also taken to hospital.

The two were believed to gave been sitting together when the shooting ensued.

It emerged that the shooter was also possibly wounded, however, he was not at the scene when paramedics arrived, said Vermaak.

Details about the incident were sketchy.

According to Sandton police, only two people were involved in the shooting.

Click here to finish reading the main article and to click on the other links on that page.

Unrelated linked article 2.2

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Google

Official Says U.S. Energy Agency Is Arrogant

By MATTHEW L. WALD

A New York State official yesterday called a Federal agency "arrogant and incompetent" for voting late Wednesday to invalidate a state law intended to encourage the production of electricity by non-utility companies.

The official, Peter A. Bradford, the chairman of the New York Public Service Commission, also said the agency, the Federal Energy Regulatory Commission, is "pro-utility."

The agency's vote was a setback for new plants that produce electricity for sale to utilities, often as a byproduct of other industrial processes. It also appears to halt states' ability to price the electricity high as an incentive to build garbage-to-energy plants and similar operations that state governments believe are of broad benefit.

Click here to finish reading the main article and to click on the other links on that page.