

MULTIMEDIA EFFECTS ON PROCESSING AND PERCEPTION OF ONLINE NEWS: A STUDY OF PICTURE, AUDIO, AND VIDEO DOWNLOADS

By S. Shyam Sundar



Do multimedia enhancements affect how much individuals learn from online news websites? Do audio and video downloads generate positive impressions of the website in the minds of users? A five-condition, between-participants controlled experiment (N = 60) was designed to address these questions. Each study participant read three news stories from a news website created for the experiment; he or she was given either a text-only version of the news site; a version with text and pictures; one with text and audio; one with text, pictures, and audio; or one with text, pictures, and video. Following exposure, participants filled out a paper-and-pencil questionnaire assessing their memory and perceptions. Results suggest that pictures and audio are particularly powerful psychological cues. In general, multimedia tends to hinder memory for story content and leads to negative evaluations of the site and its content, but improves memory for advertisements. Theoretical and practical implications of these findings are discussed.

The rising potential of the World Wide Web to serve as a mass medium¹ has attracted many, if not most, news organizations to the net.² In adapting to the unique features of this new medium, these organizations have altered their news-gathering and news-dissemination processes to make better use of the Web's multimedia capability.³ The current use of multimedia enhancements on news websites spans the whole range, from posting pictures, graphics, and maps to audio downloads of news stories, including quotes and reporters' phone interviews, as well as video downloads of important news events.⁴

This growth in the nature of online journalism mirrors the short history of the development of Web technology, whose chronology is punctuated by dramatic introductions of new modalities into online communication. While initially the Web was text only, it has rapidly advanced to incorporate other modalities such as audio and visuals.⁵ Although these advancements are true technical accomplishments and are touted as such by technologists, very little

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work has been done to understand the psychological importance of these new additions to online communication. For instance, it is not clear if multimedia helps or hinders cognitive processing of news and information on websites. Nor is it known if, and to what extent, Web users appreciate the addition of multimedia functionality.

As Hoogeveen points out, designers of websites seem to be operating under an assumption—or “dominant conviction”—that multimedia is desired by users and conducive to better communication.⁶ He criticizes the “strong paradigmatic belief...in the benevolent effects of multimedia,”⁷ and questions whether adding multimedia functionality to information systems necessarily leads to improved transfer of information from sender(s) to receiver(s).

The present study is a modest first attempt at answering this question in the domain of online news sites. Given that the primary function of news sites is to disseminate information, this is an ideal domain for investigating the cognitive effects, if any, of multimedia. And, since news sites, just like television news programs, compete for audience share,⁸ they serve as good testing grounds for relative perceptual effects of different multimedia enhancements upon users. That is, we can study whether users differ in their evaluation of a website and its content depending on the presence or absence of certain multimedia features. In order to fully address these concerns, the current study was designed to investigate the effects of multimedia on not only the *processing* of online news, but also on users' *perception* of online news sites.

This article will first review the available literature pertaining to both these areas of effects, explore the application of theories from related domains, and propose a set of focused research questions. It will then describe the methods and results of an experiment designed to answer those questions. Finally, it will discuss the findings and point out their implications for theory as well as practice.

In reviewing the relevant literature, it appears that the term “multimedia” is somewhat misleading because it is *not* used to indicate the existence of multiple *media*. Rather, as Marmolin notes, multimedia implies multiple senses used in processing a stimulus, or multiple modalities or channels used in transmitting a message.⁹ Hoogeveen treats multimedia as a property of a system or object wherein “multiple perceptual representation media, such as speech, music, text, graphic, still, animation and video, are used in an integrated manner.”¹⁰

But, regardless of which definition of multimedia one adopts, there appears to be considerable controversy surrounding the effectiveness of multimedia presentations. Prior research is inconclusive about the direction of measurable effects, if any, of multimedia functionality upon online users' memory as well as their perceptions of the interface.

Multimedia and Memory. Information processing of Web-based information is a complex phenomenon, and researchers have only recently begun to systematically study it.¹¹ However, extant literature in communication and psychology pertaining to effects of modality may be invoked to understand the relative cognitive effects of different multimedia combinations. As Unnava, Burnkrant, and Ervelles point out, previous research in psychology suggests that each individual modality (e.g., text, picture, audio, etc.) contains unique characteristics, and “people encode this modality-specific con-

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tent when they process information."¹² That is why information is considered more memorable when presented in certain modalities than in others. For example, scholars testing the "separate-streams" hypothesis have shown that auditory information is recalled better than visual information.¹³

Some researchers have used the concept of "redundancy" (a concept that should resonate well in the journalistic community) to argue that information presented in multiple modalities has a stronger chance of "getting through" to receivers than information presented in a single modality.¹⁴ This is because repetition of content, in different forms, contributes to cognitive rehearsal, thereby enhancing its likelihood of storage in memory. There is some support for this notion in broadcast news research which shows that the addition of pictures that are redundant with audio serves to enhance memory for content.¹⁵ However, as Lang notes, forty years of research on audio/video redundancy has yielded strikingly contradictory results, with about half the research showing that redundancy enhances memory and the other half showing that it hurts memory.¹⁶

Two theories shed some light on memory processes pertaining to multiple modalities of presentation. The dual-coding theory¹⁷ assumes that there are two cognitive sub-systems—one specialized in processing verbal stimuli, and the other specialized in non-verbal or image stimuli—that operate independently as far as encoding into memory is concerned. Therefore, this theory would predict that delivering information in two modalities (instead of one) acts as a "double dose" thereby enhancing the storage potential of that information. The general theoretical perspective of multiple modalities resulting in cognitively superior outcomes (in comparison to individual modalities) has a long history of support in psychology, ever since Broadbent documented evidence that messages presented to study participants in bi-sensory modality had higher recall than those presented to appeal to a single sense.¹⁸

The cue-summation theory posits that when textual information is presented along with images it provides additional learning cues, particularly at the time of retrieval from memory.¹⁹ There is some evidence in the journalism literature to support this notion. It has been shown, for example, that addition of pictures and graphics serves to enhance memory for print news²⁰ as well as broadcast news.²¹

On the other hand, the Limited-Capacity Information Processing theory²² and the Multiple Resource theory²³ argue that media messages, delivered simultaneously in a number of modalities, are cognitively complex and serve to overload the processing system. This theoretical perspective posits that the availability of resources for encoding, rehearsal, and storage tasks are finite, and that formal features of media messages will eat into this resource base by commanding more resources for encoding, at the cost of thorough rehearsal and storage. In this formulation, recognition measures of memory indicate how much information was encoded whereas recall measures index how much information was stored and is available for retrieval.²⁴ According to this perspective, the addition of multimedia to text-only systems should result in superior recognition memory but inferior recall memory.

A number of studies comparing different modalities lend credence to the notion that adding extra modalities to text degrades memory for content.²⁵ A variety of explanations has been offered for this effect, including interference, distraction, overstimulation, cognitive overload, and fatigue.²⁶ Research comparing the relative cognitive efficacy of print and audio has long shown that text-only presentations are more effective, either because

they permit greater mental elaboration due to self-paced reception²⁷ or because they allow readers to re-read parts of the message.²⁸

Despite the volume of prior research on modality in communication and psychology, its applicability to current multimedia systems is somewhat limited because of two primary reasons: (1) Much of the work, especially at the theoretical level, pertains to presentation of multiple modalities in a simultaneous fashion (as in older media such as television which presents two modalities—audio and video—at the same time). But, in websites, these additional modalities are downloadable and typically attended to separately, not simultaneously; (2) Much of the research concerns the competition between one modality and another, or at best a combination of two modalities.²⁹ Therefore, they may not adequately address the complexity of the Web medium which can feature a number of modalities on a single site, and a unique ability to switch back and forth between these modalities.³⁰

Theory and research that directly address the effectiveness of multimedia in Web-based communication are relatively scant.³¹ A recent doctoral dissertation showed that the addition of sound to a website resulted in lower retention of the content of the Web page than a control site without sound.³² Another laboratory experiment comparing a text-only news website with a multimedia version of the same site failed to show any difference in audience recall.³³ But, neither of these studies performed a systematic evaluation of the relative contribution of each specific multimedia element (i.e., text vs. picture vs. audio vs. video). Nor did they address the psychological effects of particular combinations of various modalities.

The current investigation is an attempt to develop this literature further by performing a focused study of the following research question:

RQ1: For users of a multimedia website, controlling for content and time spent on the site, what is the relationship between the type of modality used on the site (text only vs. text+picture vs. text+audio vs. text+picture+audio vs. text+picture+audio+video) and their level of memory for news and ad content on the site.

The independent variable in this question is modality (or multimedia) with five values, while the dependent variables are news story recognition memory, news story recall, ad recognition, and ad recall.

Multimedia and Perception. The hype surrounding the arrival of multimedia has led some scholars to propose that the value added by introducing multimedia to existing interfaces is merely perceptual. That is, multimedia enhancements will serve to generate positive impressions about a website because of their sheer presence and not because of their greater cognitive utility. Hoogeveen calls this the “self-fulfilling prophecy” hypothesis.³⁴ A recent experimental study offers limited support for this notion by showing that individuals exposed to a multimedia news site expressed greater likelihood of re-visiting the site than their counterparts exposed to a text-only version of the same site even though the two groups did not differ in the amount of information learned from the site.³⁵

Some have theorized that adding multimedia components to a computer program will foster positive attitudes toward the program because their dynamic presence facilitates greater involvement and engagement with the system.³⁶ Biocca argues that the senses are channels to the mind, and since multimedia appeals to a variety of senses, it might generate more immersion

with the interface.³⁷ This is akin to the “being there” effect documented by Reeves and Nass, whereby formal features of media, such as those used for building multimedia websites, have the potential to create the illusion, at least momentarily, of being transported to the world portrayed in media.³⁸ Reeves and Nass argue that such perceptions can be generated with relatively low-tech interfaces involving “simple textual and pictorial material shown on garden-variety technology.”³⁹ Similar ideas characterize the notion of “parasocial interaction” in the television research literature⁴⁰ and the concept of “social presence” in technology studies.⁴¹

In his dissertation, Steuer argues that vividness is the key.⁴² He conceptualizes the vividness of an interface in terms of its sensory breadth (i.e., the number of senses engaged by it) and sensory depth (the resolution within each perceptual channel). He operationalizes vividness in terms of modality, and ranks text as being low in vividness and moving images with voice as being high in vividness. However, in his experiment that involved presentation of an educational tutorial in a variety of modalities (ranging in vividness from low to high), participants in his text-only condition showed the most positive attitudes toward the system and the most positive affect toward the computerized tutor. Similarly, another recent dissertation experiment showed that attitudes toward a Web page with text and graphics were more positive than attitudes toward an identical page that featured animation in addition to text and graphics.⁴³

On the other hand, research with instructional technology and computer games has shown that adding multimedia leads to positive attitudes such as greater confidence,⁴⁴ motivation,⁴⁵ and enthusiasm⁴⁶ among users.

So, the jury is still out on the perceptual consequences of adding multimedia functionality to new media. It is not clear whether users appreciate the extra cost and effort involved in designing, producing, and placing multimedia enhancements in text-only sites, and whether this appreciation leads to more positive attitudes toward the sites and more positive evaluation of content on those sites.

The present study was designed in part to address this issue by investigating the following research question:

RQ2: For users of a multimedia website, controlling for content and time spent on the site, what is the relationship between the type of modality used on the site (text only vs. text+picture vs. text+audio vs. text+picture+audio vs. text+picture+audio+video) and their level of positive perceptions about the site.

The independent variable here is the same as the one used in studying RQ1. However, the dependent variable seeks to assess users' ratings of the site. In particular, this study examined two species of perceptions—those pertaining to the website as a whole (Website Evaluation) and those pertaining specifically to the news content featured on the site (Content Perception).

Method

All participants ($N = 60$) in a between-participants experiment were exposed to one of five versions of a news website, each with identical textual content but differing in the type of multimedia featured on the site. After exposure, they filled out a paper-and-pencil questionnaire eliciting their

perception of news content on the site, their evaluation of the website as a whole, and their memory for details in the news stories as well advertisements on the site.

Participants. Sixty undergraduate students enrolled in communication theory classes participated in the experiment for extra course credit. They were randomly assigned to one of the five conditions. All participants signed an informed consent form prior to their participation in the experiment.

Stimulus Material. A news website was especially constructed for use as stimulus material in the experiment. In order to avoid any story-specific effects and extend the study's generalizability, the site contained three news stories instead of one, and their headlines were displayed on a left-hand-side frame at all times in all five treatment conditions. These three stories were downloaded from websites of major news organizations such as CNN. The criteria for selection included presence of picture, audio, and video downloads along with the story. In addition, we made sure that the stories were not time-sensitive or of particular local or community interest. Care was taken to ensure that the stories included only typical, routine content which would be unlikely to evoke strong positive or negative emotions.⁴⁷

The website was laid out in such a way that it had no masthead. A banner ad for CNN and Time's *NewsStand* program took its place. Additional ads for Showbiz, Barnes & Noble books, and E-Card occupied the left-hand-side of the screen. Animation served to refresh the ads periodically with new messages.

On the main frame of the site was the news story, accessed by clicking on one of the headlines on the left-hand-side frame. The story was rendered navigable through a scroll bar on the right.

Experimental Treatment Conditions. All versions of the stimulus site were made to look similar in order to optimize treatment equivalence. The only difference was the independent variable of modality. Five sites were created, each designed to take on one and only one of the following five values of the independent variable: text only; text plus pictures; text plus audio; text plus pictures plus audio; and text plus pictures plus video.

In the first condition (henceforth referred to as *text-only*), all three stories were posted on the site without any multimedia accompaniment, i.e., it was purely textual. For the next condition (henceforth referred to as *picture*), each of the three stories was accompanied by a color photograph. The third condition (henceforth referred to as *audio*), the stories were all accompanied by audio downloads. There was one audio download per story, and it was accessible by clicking on a hyperlink that said, "Click here for related audio," placed in the same spot that was occupied by the photograph in the previous condition. Upon clicking, the audio file was designed to directly access the necessary plug-in and start playing the recording while simultaneously displaying a small window showing progression of the audio as well as volume control. The next condition (henceforth referred to as *picture+audio*) combined the modalities in the previous two conditions, and featured a photograph along with a link for audio download placed next to it for each of the three stories. The final condition (henceforth referred to as *video*) was identical to the previous condition, but for the replacement of a video download instead of an audio download. The accessing and functioning of the video downloads were identical to that for audio downloads.

Procedure. The experiment was administered to groups of participants in a computer training facility, which had a series of computers with internet

connection and equipped with headphones. All participants in a given group administration belonged to the same experimental condition. Upon arrival, participants were welcomed, asked to furnish informed consent forms, and told that they would be reading news stories online and answering questions based on these news stories. They were then instructed, as a group, to turn on their respective computer monitors and browse the site in front of them at their own pace, making sure to read each of the three news stories on the site in the next fifteen minutes. Participants in conditions that involved audio and video downloads were given additional instructions about the downloads and asked to wear headphones while accessing them. Participants in all conditions were instructed to raise their hands to let the experimenters know if they finished browsing the site ahead of the allotted time of fifteen minutes. Once a participant raised his/her hand, he/she was handed the study questionnaire comprising control measures as well as dependent variables.

Dependent Measures. The dependent variables used to address RQ1 were Story Recall, Story Recognition, Ad Recall, and Ad Memory. Three recall questions (e.g., At what age did Patricia Henley smoke her first cigarette?), each followed by an open-ended response option, tested participants' memory for each of the three news stories. Combined across all three news stories, there were a total of nine story recall questions. Four recognition items (e.g., Which cigarette manufacturer did Henley sue?), each with five multiple-choice, closed-ended response options (e.g., a. RJ Reynolds; b. Brown & Williamson; c. American Tobacco Company; d. Liggett & Myers; e. Phillip Morris), measured participants' recognition memory for each of the three stories. Combined across all three stories, there were a total of twelve story recognition questions. In addition, two recall questions and three recognition questions measured participants' Ad Recall and Ad Recognition respectively. All memory measures were extensively pretested with the students from the same campus, and modified, when necessary, to ensure variance across the four memory scales.

The dependent variables used to address RQ2 were Website Evaluation and Content Perception. Thirteen items, placed toward the front of the questionnaire (i.e., before the memory questions described above), were used to assess each of the two dependent variables.

For Website Evaluation, the following measures were used:

(1) "Thinking about the news website you browsed today as a whole, how well would you say it utilized the multimedia capabilities of the WWW medium?" followed by a 10-point scale anchored between "Not Well At All" and "Extremely Well."

(2) "How much do you think the layout of the website affected your browsing of the information on it?" followed by a 10-point scale anchored between "Did Not Affect" and "Affected Very Much."

(3) "How likely are you to visit this site for your daily news needs?" followed by a 10-point scale anchored between "Not At All Likely" and "Very Likely."

(4) "How likely are you to recommend this site to friends/relatives for their daily news?" followed by a 10-point scale anchored between "Not At All Likely" and "Very Likely."

(5) "In what ways would you improve this site?" followed by three blank lines for participants to fill out. If a participant made one suggestion, it was coded as one; if he/she made two, it was coded as two, and so on. Therefore, the greater the number of improvements suggested by the participant, the poorer his/her evaluation of the site.

(6) "For each word below, please CIRCLE THE DOT to indicate how well the word describes the web site you just browsed" followed by a series of eight adjectives (Organized, Interactive, Useful, Coherent, Confusing, Enjoyable, Sophisticated, and User-Friendly), each placed next to a 10-point scale anchored between "Describes Very Poorly" and "Describes Very Well."

In addition to these thirteen items, we included an open-ended question asking participants to list what they thought was "the best part of the site." Responses to this question were not used in statistical analyses.

For Content Perception, all thirteen measures were derived from Sundar⁴⁸ and administered to participants in the following form: "For each word below, please CIRCLE THE DOT to indicate how well the word describes the **news stories** you just browsed" followed by a series of thirteen adjectives (Accurate, Believable, Biased, Clear, Comprehensive, Factual, Fair, Informative, Important, Objective, Persuasive, Sensationalistic, and Well-Written), each placed next to a 10-point scale anchored between "Describes Very Poorly" and "Describes Very Well."

Control Measures. In order to statistically account for the variance contributed by the amount of time spent by each participant on the stimulus website, an unobtrusive measure of time was recorded for each participant from the computer's clock. As soon as an experimenter handed a participant his/her questionnaire, she noted down the time on the participant's computer, and later subtracted the same from the starting time for that session.

In the first couple of pages of the questionnaire, prior to the dependent variable measures, we included four questions about participants' media habits. They asked participants to report their frequency of newspaper reading, computer use, accessing the Web, and accessing online news sites on the Web in an average week. Ten response options were provided for each question: Never, Rarely, Occasionally, Once a week, Twice a week, Three days in a week, Four days in a week, Five days in a week, Six days in a week, and All seven days of the week.

Scale and Index Construction. Measures designed to elicit participants' memory for various aspects of the three stimulus news stories were additively combined to form two scales: "Story Recall" was obtained by summing participants' scores on those items that measured recall memory, and "Story Recognition" was a combination of those questions that measured recognition memory. Similarly, two more memory scales were created for assessing participants' recollection of the advertisements on the website. These were labeled "Ad Recall" and "Ad Recognition."

An exploratory factor analysis was conducted upon the thirteen items relating to Website Evaluation. A matrix of Pearson's product-moment correlations was first generated from participants' ratings of the thirteen measures. Unities in the diagonals were maintained and a principal components analysis with varimax rotation was performed. The number of under-

lying factors was determined by the number of components with eigenvalues greater than or equal to one. The resulting factors were then examined for common, rather than specific, variance by applying the items-on-factor criterion (i.e., at least two items with their highest loading on a given factor). An item was said to load on a given factor provided its loading on that factor was 0.6 or higher, with secondary loadings on other factors being no greater than 0.4.⁴⁹ Since the measures were devised by the experimenters and the analysis was exploratory in nature, these conservative criteria were adopted.

The factor analysis with the thirteen Website Evaluation measures yielded four principal components with eigenvalues greater than one, together accounting for 70.19% of the variance. Upon rotation, nine of the thirteen measures were clearly differentiated, with their primary loading exceeding 0.6 and all other loadings below 0.4. Four measures (Multimedia, Organized, Useful, and User-Friendly) cross-loaded across factors and were therefore dropped from all further analyses. One of the factors failed to meet the items-on-factor criterion, and the lone measure (Layout) loading on that factor was also dropped from further analyses. The remaining eight items loading on the three remaining factors were additively combined (after reverse-coding negatively valenced items) to form the following three indices: "Site Design" comprising Interactive, Enjoyable, Sophisticated, and Number of Improvements (Cronbach's $\alpha = 0.75$)⁵⁰; "Coherence" comprising two items—Coherent and Confusing (Pearson's $r = -.50$); and "Intent to Revisit" comprising Likely to Visit and Recommend (Pearson's $r = 0.67$).

Similarly, a factor analysis was performed on the thirteen measures related to Content Perception. It yielded two principal components with eigenvalues greater than one, together accounting for 60.42% of the variance. Upon rotation, all but one of the measures were clearly differentiated based on the 0.6-0.4 criterion. One measure (Persuasive) cross-loaded across factors and hence dropped from further analysis. Of the remaining twelve measures, ten loaded under the first factor. They were Accurate, Believable, Clear, Comprehensive, Factual, Fair, Informative, Important, Objective, and Well-Written. These were additively combined to form an index labeled "News Quality" (Cronbach's $\alpha = 0.93$). The other two items, Biased and Sensationalistic, were summed to form an index labeled "News Credibility" (Pearson's $r = 0.45$).

In sum, four scaled items (Story Recall, Story Recognition, Ad Recall, and Ad Recognition) and five indices (Site Design, Coherence, Intent to Revisit, News Quality, and News Credibility) were used as dependent variables in this study.

Data Analysis. All nine dependent variables were first entered together in a one-way repeated-measures multivariate analysis of variance (MANOVA), with the five-level multimedia manipulation as the independent variable.

In order to answer the research question relating to memory differences as a function of the multimedia manipulation, a series of four one-way analyses of variance (ANOVA) were performed separately on the following four dependent variables: Story Recall, Story Recognition, Ad Recall, and Ad Recognition. In analyses that yielded statistically significant results, post-hoc comparisons were made between the five multimedia conditions using the Tukey-Kramer HSD test.

Similar one-way ANOVAs with the five indices described above were conducted to assess the effects of multimedia upon Website Evaluation and Content Perception.

TABLE 1
*Summary Table of Means and F-values for Story and Ad Memory
as a Function of Multimedia Manipulation*

| Dependent Variables | Multimedia Conditions | | | | | F ¹ |
|---------------------|-----------------------|-------------------|---------------------|--------------------|--------------------|----------------|
| | Text Only | Picture | Audio | Picture+ Audio | Video | |
| Story Recall | 6.5 ^{ab} | 6.81 ^b | 5.16 ^{ab} | 4.58 ^{ac} | 4.66 ^{ab} | 3.57* |
| Story Recognition | 8.41 ^a | 8.91 ^a | 7.16 ^{ab} | 7.58 ^{ab} | 6.33 ^b | 4.42** |
| Ad Recall | 1.08 ^a | 0.83 ^a | 0.58 ^a | 1.0 ^a | 1.08 ^a | 1.61 |
| Ad Recognition | 0.5 ^{ab} | 0.25 ^a | 0.83 ^{abc} | 1.0 ^{bc} | 1.25 ^c | 4.91** |

¹ * $p < .05$; ** $p < .01$

Note: Higher scores indicate higher memory. Comparisons between means, specified by lowercase superscripts, are horizontal only. Cell means that do not share a letter in their superscripts differ at $p < .05$ according to Tukey-Kramer HSD test.

The one-way repeated-measures MANOVA, using all four algorithms (Wilks, Pillai, Hotelling, and Roy) showed a significant effect for the multimedia manipulation on all nine dependent variables considered together, $F(4, 55) = 5.04, p < .01$.

When the memory scales were subjected to separate one-way ANOVAs, significant effects were obtained for Story Recall, Story Recognition, and Ad Recognition (see Table 1). In particular, participants in the *picture+audio* condition recalled significantly fewer details about the three news stories than their counterparts in the *picture* condition. On recognition memory for details in the news stories, participants in the *video* condition fared significantly poorer than those in the *text-only* and *picture* conditions. However, for ad memory, a strikingly similar pattern, but in the reverse direction, was noticed. Participants in the *video* condition scored significantly higher on ad recognition items than their counterparts in the *text-only* and *picture* conditions. Furthermore, participants in the *picture+audio* condition recognized significantly more ad material than those in the *picture* condition (See Table 1).

One-way ANOVAs with the Website Evaluation indices yielded a significant effect for Coherence as well as Site Design. Participants in the *picture+audio* condition rated the website as being significantly less coherent than their counterparts in the *text-only* and *picture* conditions. Furthermore, they were significantly more negative in their evaluation of site design compared to participants in the *picture* condition (see Table 2).

Similar analyses with the Content Perception indices showed a significant effect of multimedia upon participants' perception of News Quality across all three news stories. Specifically, participants in both the *picture+audio* and the *video* conditions gave significantly lower ratings than those in the *picture* condition (see Table 3).

Results

TABLE 2

Summary Table of Means and F-values for Website Evaluation Indices as a Function of Multimedia Manipulation

| Dependent Variables | Multimedia Conditions | | | | | F ¹ |
|---------------------|-----------------------|--------------------|---------------------|---------------------|---------------------|----------------|
| | Text Only | Picture | Audio | Picture+ Audio | Video | |
| Site Design | 13.5 ^{ab} | 16.41 ^b | 14.66 ^{ab} | 10.66 ^{ac} | 15.08 ^{ab} | 2.86* |
| Coherence | 15.33 ^a | 17.0 ^a | 14.25 ^{ab} | 11.91 ^b | 13.83 ^{ab} | 5.00** |
| Intent to Revisit | 6.25 ^a | 9.91 ^a | 8.66 ^a | 8.08 ^a | 7.91 ^a | 1.20 |

¹ * $p < .05$; ** $p < .01$

Note: Higher scores indicate more positive evaluations. Comparisons between means, specified by lowercase superscripts, are horizontal only. Cell means that do not share a letter in their superscripts differ at $p < .05$ according to Tukey-Kramer HSD test. (See Note 50 for details on interpreting the Site Design means).

Given the preponderance of effects pertaining to the *picture*, *audio*, and *picture+audio* conditions, we conducted a set of factorial analyses to specifically investigate the relative as well as combinatory effects of audio and picture. The video condition was dropped from these analyses because it confounds moving pictures with audio (and having a video condition without audio would be ecologically invalid). The remaining four conditions were organized as a fully crossed 2 (audio, no audio) x 2 (picture, no picture) factorial design. First, all nine dependent variables were entered together in a 2x2 repeated-measures MANOVA, with the two-level audio variable and the two-level picture variable serving as independent factors. They were then entered separately, one at a time, in a series of 2x2 ANOVAs to detect main effects of audio and picture as well as the interaction effect of audio and picture on each dependent variable.

The 2x2 repeated-measures MANOVA showed a significant main effect for audio, $F(1, 44) = 8.59, p < .01$, but not for the picture factor, $F(1, 44) = 0.20, p > .10$. In addition, it revealed a significant two-way interaction between audio and picture, $F(1, 44) = 9.20, p < .01$.

When the Story Recall scale was entered separately in the factorial 2x2 ANOVA, a significant main effect was obtained for audio, such that participants who received the audio download scored significantly lower ($M = 4.87$) than those who did not ($M = 6.65$), $F(1, 44) = 9.47, p < .01$.

In a similar analysis with the Story Recognition scale, the same main effect for audio was replicated, $F(1, 44) = 7.31, p < .01$. Participants who received the audio download scored significantly lower ($M = 7.37$) on recognition memory than those who did not ($M = 8.66$).

When the Ad Recall scale was subjected to the 2x2 factorial ANOVA, a significant interaction between audio and picture emerged, $F(1, 44) = 5.10, p < .05$, such that, when news stories were accompanied by pictures, the presence of audio downloads tended to increase recall memory for advertisements on the site ($M = 1.0$ compared to $M = 0.83$ without audio downloads),

TABLE 3
*Summary Table of Means and F-values for Content Perception Indices
as a Function of Multimedia Manipulation*

| Dependent Variables | Multimedia Conditions | | | | | F ¹ |
|---------------------|-----------------------|--------------------|---------------------|---------------------|---------------------|--------------------|
| | Text Only | Picture | Audio | Picture+ Audio | Video | |
| News Quality | 59.5 ^{ab} | 66.75 ^b | 61.41 ^{ab} | 49.16 ^{ac} | 50.25 ^{ac} | 4.10 ^{**} |
| News Credibility | 13.91 ^a | 12.91 ^a | 12.83 ^a | 11.5 ^a | 11.33 ^a | 1.13 |

¹ ^{**} $p < .01$

Note: Higher scores indicate more positive perceptions. Comparisons between means, specified by lowercase superscripts, are horizontal only. Cell means that do not share a letter in their superscripts differ at $p < .05$ according to Tukey-Kramer HSD test.

whereas when stories were *not* accompanied by pictures, the presence of audio downloads served to inhibit ad recall memory ($M = 0.58$ compared to $M = 1.08$ without audio). Put another way, the addition of pictures positively affected ad recall when audio downloads were present on the site and negatively affected ad recall when audio downloads were absent.

In the analysis with the Ad Recognition scale, a significant main effect for audio emerged, $F(1, 44) = 9.15, p < .01$, but in the opposite direction of what was obtained with the story memory scales. Participants who received the audio downloads recognized significantly more details of the advertisements on the site ($M = 0.91$) compared to those who did not receive the downloads ($M = 0.37$).

Similar factorial ANOVAs with the Website Evaluation indices yielded significant results for Coherence and Site Design, and a near-significant effect for Intent to Revisit.

Participants who received the audio downloads rated the site as being significantly less coherent ($M = 13.08$) compared to their counterparts who did not receive the downloads ($M = 16.16$), $F(1, 44) = 14.34, p < .01$. Moreover, a significant two-way interaction between audio and picture, $F(1, 44) = 6.03, p < .05$, indicated that the negative effect of audio upon perceived coherence was more pronounced when pictures were present on the site ($M = 17.00$ vs. $M = 11.91$) than when they were absent ($M = 15.33$ vs. $M = 14.25$).

The 2x2 analysis with the Site Design index also yielded a significant interaction, $F(1, 44) = 5.04, p < .05$. When pictures were present on the website, participants' perceptions of site design seemed to be negatively affected by the addition of audio downloads ($M = 10.66$ compared to $M = 16.41$ for no audio), but when pictures were absent, their ratings of site design seemed to be positively affected by audio ($M = 14.66$ compared to $M = 13.55$ for no audio). In addition, there was a near-significant main effect for audio such that participants who received the downloads gave lower ratings on Site Design ($M = 12.66$) compared to those who did not receive the audio downloads ($M = 14.95$), $F(1, 44) = 3.30, p < .10$.

The analysis with the Intent to Revisit index yielded a near-significant interaction between audio and picture, $F(1, 44) = 3.16, p < .10$, such that when

audio was present, participants' self-reported intention to revisit the site did not vary much as a function of the presence ($M = 8.08$) or absence ($M = 8.66$) of pictures. However, when there was no audio, the presence of pictures served to enhance their desire to revisit ($M = 9.91$) whereas the absence of pictures served to diminish this tendency ($M = 6.25$).

Similar analyses of the Content Perception indices showed no significant effects with the News Credibility index but two significant effects with the News Quality index. There was again a significant main effect for audio, $F(1, 44) = 4.47, p < .05$, such that participants who received the audio downloads rated the quality of news as being significantly lower ($M = 55.29$) than those who received no audio ($M = 63.12$). Furthermore, a significant interaction between audio and picture suggested that when there were no pictures on the site, the presence ($M = 61.41$) or absence ($M = 59.5$) of audio downloads did not seem to affect quality ratings much, but when pictures were included in the stories, the journalistic quality of the site was evaluated significantly more negatively if audio downloads were present ($M = 49.16$) than if they were absent ($M = 66.75$).

Follow-up analyses using the control measures as covariates yielded essentially redundant results. In addition, analyses using perception variables as covariates and memory items as dependent variables suggested that user perceptions of the site did not mediate their processing of the site's content.

In summary, results of this study suggest that audio and video downloads on news sites tend to hinder memory for news stories but enhance memory for advertisements on the site. Moreover, they appear to contribute to more negative perceptions of the website as well as the quality of its content. When two modalities (picture and audio) are directly compared, results strongly suggest that audio downloads reduce memory for story content whereas they tend to increase memory for advertisements, especially when pictures are present on the site. Audio downloads also result in more negative evaluations of the site's coherence and the journalistic quality of stories featured on the site. Furthermore, it appears that the interplay of audio and picture can have significant effects on users' perception of the site and its content. The addition of pictures, in general, serves to exaggerate the negative evaluations caused by the presence of audio downloads.

Discussion

It appears that the psychological effects of multimedia downloads on a news site, especially audio downloads, are similar to those of "taped communications" or "radio information" presented to study participants in early psychology and consumer research on modality differences. These studies have repeatedly shown that auditory and audio-visual presentations are cognitively inferior than textual presentations.⁵¹ Our findings with multimedia downloads are also consistent with research in broadcasting which show that people learn comparatively less about news content from audio-visual media than from print communications.⁵²

Consistent with findings in recent computer-based experiments,⁵³ the text-only and text-with-picture conditions in the present study were the psychological favorites on most of the dependent variables. The addition of pictures to text appears to have a positive effect overall, thereby replicating prior research on the memory-enhancing properties of pictorial cues⁵⁴ and lending support to the cue-summation hypothesis. However, contrary to the prediction of dual coding theory, the addition of newer modalities such as audio and video appear to take away the advantage offered by pictures. But,

this is probably not because they exhaust the limited human capacity for information processing, given the absence of a systematic difference between multimedia's effects on recall memory and its effects on recognition memory.⁵⁵

A simpler explanation for the results may be the novelty effect of adding these newer modalities to a predominantly text-only medium. However, post-hoc analyses showed no systematic association between the level of habitual use of the Web, including online news sites, and participants' reactions to audio and video downloads. Moreover, participants in our study reported using the Web on four to five days of the week, and visiting online news sites nearly once a week.

Another explanation for the somewhat disappointing effects of audio and video downloads may be related to the quality of stimulus materials used in this study. Upon data analysis, we reviewed the audio and video files for all three news stories once again and found them to have no particular technical problems. After all, these were professionally produced clips downloaded from major news sites specializing in broadcasting, such as CNN and MSNBC. Moreover, in their response to the open-ended question asking them what they thought was the best part of the site, a majority of the participants in the audio and video conditions cited these downloads, without any experimenter prompting.

Therefore, the explanation for differential psychological effects between conditions appears to be linked to certain inherent characteristics of multimedia. As has already been suggested by some multimedia researchers,⁵⁶ the addition of audio and video may have caused enough distraction in the minds of participants as to either bombard the cognitive system with too much extra information or "over-write" the information gained from reading the textual version of the news.⁵⁷

A related explanation is that the addition of audio and video downloads may have triggered automatic processing among study participants. As Reeves argues, mediated stimuli that appeal directly to perceptual channels such as audition and vision automatically tend to be perceived similarly to their real-world counterparts (i.e., a greater tendency to indulge in mindless parasocial activity).⁵⁸ However, textual stimuli, even at the most basic level, demand controlled processing.⁵⁹ It may be posited that participants in the multimedia conditions were diverted from this controlled response by way of downloads, which, by evoking automatic responses, allow their minds (and perhaps even their eyes) to wander across the screen and the site.

Furthermore, in keeping with the "contextual interference" phenomenon documented in the broadcast news literature,⁶⁰ participants' reception of audio and video downloads may have resembled their habitual reception of radio and television. That is, once the downloads commenced playing, they may have triggered the radio-listening or TV-viewing schema in participants' minds, which is characterized by passivity and comparatively low levels of attention and engagement. And, as is customary in such media situations, participants may have succumbed to such elements of "contextual interference" in their visual field as the advertisements on the site. That is why, it may be argued, their memory for advertising in multimedia situations tended to increase whereas their memory for news content tended to diminish.

Another possibility is that the differences noticed in this study could be due to the inherently different navigational structure imposed by the presence of downloads. The arrival of audio and video downloads on the screen, at least in this experiment, was not seamless. Participants had to click on a

hyperlink for downloading the audio and video, which would then trigger the plug-in with its own window containing volume control, etc. This extra step of navigation was not undertaken by participants in the text and picture conditions. Therefore, it may be argued that, by requiring more navigation, audio and video downloads may have led to a perceived reduction in local as well as global coherence in the site⁶¹ thereby increasing cognitive overhead and user disorientation.⁶² This may have caused some confusion in the minds of study participants, leading to more negative evaluations of the site as a whole.

Yet another possibility for our results could be related to the type of comparison standards used by participants in the experiment. The most available comparison standard for audio downloads is radio. For video downloads, it is TV. However, for text and still pictures, it is print media. Given that the display of text and pictures compare extremely well with the glossiest of color print media, it may be argued that participants in the text and picture conditions were generally satisfied with the quality of resolution. But, it's an entirely different story for audio and video downloads. Despite considerable technical advancements in multimedia, the audio quality of audio downloads do not compare well with the quality of FM radio broadcasts. Similarly, the video fidelity of video downloads seldom matches the crisp quality of image presentation on cable television. Additionally, their display size via a window on a computer screen compares poorly with standard television screens. Participants in the audio and video conditions may have been comparing the audio and video quality of the downloads to the quality they are used to getting from mainstream broadcast media, and therefore been disappointed with the multimedia experience in the study. As Reeves and Nass point out, sensory immersion begins with audio. If the fidelity is less than standard, it serves to break down our sensory immersion in the site, which then translates to negative perceptions of content. As they show in their synchrony experiments, when the lips and voice of a video-mediated speaker don't match, viewers seldom blame the technology. They think, "What's wrong with the speaker?" and tend to make a negative evaluation of the person portrayed in the video.⁶³ Similarly, in the present experiment, comparatively low fidelity of audio may have resulted in negative evaluations of news content, not the downloads themselves.

In summary, the overwriting and distraction explanations may be cited for the differential scores on story memory across multimedia conditions, the interference phenomenon for explaining differences in ad memory, the navigation explanation for website evaluation, and the fidelity argument for explaining differences in content perception. All these explanations have important theoretical implications for scholars interested in systematically unraveling the psychological mechanisms involved in assessing effectiveness of various technological features of new media, such as multi-modality and navigability. But the central conclusion one can draw from this experimental study is that multimedia matters. The addition of extra modalities to text-only news websites has significant psychological consequences. The direction of effects noticed here is perhaps less important than the overall theoretical implication that a non-content (or technological feature) of new media is capable of contributing significant variance to individuals' overall psychological experience of mediated content. This lends credence to claims made by technological determinists such as McLuhan who have long argued that the psychosocial effects of media on audiences are no less significant than the effects of "content."⁶⁴

In addition to theoretical significance, the present study has some useful practical implications for website designers, news organizations, and advertisers. Given that this study suggests that audio and video downloads are powerful cues, and are likely to be noticed and scrutinized more by users than a few paragraphs of text, extreme care should be taken when considering multimedia enhancements for existing websites. Therefore, it is imperative that site designers exercise strict gatekeeping vis-à-vis technical quality in order to assure positive perceptions of the site.

This study sends contradictory signals to news organizations. On the one hand, it suggests that adding multimedia may hinder readers' memory for news story content. But, on the other hand, it has evidence to suggest that multimedia positively impacts their memory for advertisements on the site. Like in the previous scenario with audio and video downloads, multimedia appears to be a double-edged sword. News organizations would have to include enough multimedia features to attract advertisers, but not so much as to hinder their social responsibility of transmitting news information to the public.

The direct statistical comparisons between audio and picture have particular implications for radio stations and print newspapers, both of whom have converged on the Web with their own twenty-four-hour news sites. It is typical for radio stations to package news in audio format. Therefore, they send audio recorders for every story they report. However, radio stations do not hire photographers because they produce no audio product. Print newspapers have the opposite scenario. They routinely have photographers on their staff, but rarely, if ever, record stories on audiotape. Our findings suggest that radio stations would do well by cutting back on audio downloads and including pictures instead (perhaps gathered from wire services) whereas newspapers might benefit, at least on the advertising side, by including a few audio downloads. Moreover, it appears best to use either audio or picture to accompany a given news story, not both at the same time.

Advertisers can find some comfort in the results of this experiment. The addition of multimedia on a website appears to positively affect user memory for advertisements on the site. At least one recent study showed that memory for a Web ad is lower than that for the same ad in print form.⁶⁵ In outlining their study's implications for online advertisers, the authors wrote, "To the extent advertisers use the new features of the online medium that are non-existent in print (audio and video downloads, animated images, hyperlinks, site-maps, etc.), they are probably more likely to enhance user attention to advertising."⁶⁶ What the present study implies is that, more than creating multimedia ads themselves, advertisers need to worry about which sites to place their ads in, so that they can benefit from the multimedia features of the surrounding news or other content.

The usual external-validity limitations of a controlled lab experiment preclude us from extending the study's findings to non-news websites and non-college-going users at this time. But the connection between various multimedia combinations and users' psychological responses appears to be quite robust and warrants further investigation in a variety of settings.

NOTES

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49. James C. McCroskey and Thomas J. Young, "The Use and Abuse of Factor Analysis in Communication Research," *Human Communication Research* 4 (summer 1979): 375-82.
50. Three of the four items in the "Site Design" index (Interactive, Enjoyable, and Sophisticated) were measured on the same 10-point scale ranging from "Describes Very Poorly" to "Describes Very Well." However, the fourth item, Number of Improvements, was an open-ended measure wherein the number of suggestions for improvement given by the participant was scored (rather than the qualitative suggestions themselves). Because of this difference in response options, the four items in this index were first standardized. The Z scores were then combined additively and entered into statistical analyses. However, the cell means for Site Design in Table 2 and in the text of this article are based on unstandardized scores in order to ease interpretability. (The interpretation of means is as follows: The maximum possible score on this index is 30, which indicates the most positive rating of Site Design because it means a 10 on each of the three positive attributes—Interactive, Enjoyable, and Sophisticated—with zero suggestions for improvements. If a participant had marked 10 on all three scales but made two suggestions for improvements, then his/her score for Site Design would be

28).

51. Unnava, Burnkrant, and Erevelles, "Effects of Presentation Order," 481.

52. DeFleur et al., "Audience Recall of News Stories," 1010-1012.

53. Steuer, "Vividness and Source of Evaluation"; Gopal, "Selling in Cyberspace."

54. See, for example, Severin, "Pictures as Relevant Cues."

55. It must be noted, however, that a multimedia website may not constitute an ideal testing ground for theories such as dual-coding and limited-capacity because the reception of audiovisual modalities in this medium, unlike in traditional broadcast media, is not simultaneous, as indicated in the literature review.

56. For example, Heller, "The Role of Hypermedia."

57. This implies that the memory for content in the downloads is stronger than memory for textual material. Given that all memory measures in the present experiment were constructed from the textual portion of the news stories (in order to enable comparisons with the text-only condition), the data reported here cannot be used to test this speculation. Future research on multimedia effects should include memory measures that test for learning from the audio and video downloads of online news stories in addition to those pertaining to the textual portion.

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