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ABSTRACT

As publishers make the transition from ink-on-paper to digitalized messages, researchers must ask whether the system is the solution. Are there advantages to presenting newspaper content on computers? Or do people prefer to handle paper? A study reported subjects' self-report responses regarding interface between people (experimental subjects) and modality (paper, computer, multimedia). Each of the 75 subjects participating in the study were given questionnaires to rate their responses to the different media. Fifty-five of the participants were U.S. undergraduate students enrolled in journalism classes. Twenty subjects were university library employees, recruited as "expert" searchers. The study revealed significant effects for interestingness, pleasingness, image interestingness, and image pleasantness as a function of modality. For each of these measures, multimedia was rated the highest, followed by computer and paper. Although the study did not address memory, the results suggest that the primacy of print theory may be losing its predictive power. No effect was found for text as a function of modality. Perhaps perceived differences between modalities are diminishing. Further research might confirm this suggestion. Researchers may begin to notice less and less cognitive and behavioral resistance to computerized information delivery systems. And they may notice more resistance to ink-on-paper. To meet such evolving expectations, researchers and newspaper professionals may apply results of this study to design effective interactive multimedia systems and content. (Seven figures and two data tables are included. Contains 53 references.) (TB)

The Digital Daily: How will readers react?

by

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The Digital Daily: How will readers react?

ABSTRACT

This study anticipates a possible future method of newspaper design and delivery. Some "digital dailies" may include multimedia content -- computer-based information that includes audio and video presented by interactive technology.

As publishers make the transition from ink-on-paper to digitized messages, researchers must ask: Is the system the solution? Are there advantages to presenting newspaper content on computers? Or do people prefer to handle paper?

This paper reports subjects' self-report responses regarding the interface between people (experimental subjects) and modality (paper, computer, multimedia).

The study revealed significant effects for interestingness, pleasingness, image interestingness, and image pleasingness as a function of modality. For each of these measures, multimedia was rated the highest, followed by computer and paper.

Although this study does not address memory, these results suggest that the primacy of print theory may be losing its predictive power. No effect was found for text as a function of modality. Perhaps perceived differences between modalities are diminishing. Further research may be conducted to confirm this suggestion.

Researchers may begin to notice less and less cognitive and behavioral resistance to computerized information delivery systems. And they may notice more resistance to ink-on-paper. Yesterday's students have grown up with television in the home. Today's students are growing up with computers in the home and in the classroom. Tomorrow's media consumers may expect interactive multimedia systems to deliver news and information.

To meet such evolving expectations, researchers and newspaper professionals may apply results of this study to design effective interactive multimedia systems and content.

Introduction and Literature Review

This baseline study anticipates a possible future method of newspaper design and delivery. New computer and telephone technologies have made it possible to conceive of newspapers as computer-based information delivery systems that include audio and video presented by interactive technology systems.

"New media," or interactive technologies are often referred to as multimedia. Multimedia is a system that "supports data other than text" (Nelson 1991, p. 3). Multimedia is sometimes called "hypermedia." The two terms are used interchangeably in this study.

The ink-on-paper newspaper may never be replaced (Fidler 1991b, p. 121), but news is already being presented using interactive technology. Multimedia technology is here and in use (Brand, 1988; Cook, 1984; Don, 1992; Elmer-Dewitt, 1993; Fidler, 1991a, 1991b, 1992; Glushko, 1990; Marchionini, 1989; Matazzoni, 1992; Todd, 1993; Zoglin & Elmer-Dewitt, 1993). But, as researchers, we must ask: Is it better?

Although some research has tested memory and information location across print and computer modalities, this researcher's literature review has failed to disclose research that applied subjective, self-report measures to multimedia.

Actually, this research begins to challenge the primacy of print theory. The primacy of print theory states that information is read faster and remembered better when presented in a print modality than in other modalities (DeFleur, Davenport, Cronin, & DeFleur, 1992; Furnham, Benson, & Gunter, 1987; Furnham & Gunter, 1985; Furnham, Proctor, & Gunter, 1988; Gunter & Furnham, 1986; Gunter, Furnham, & Gietson, 1984; Gunter, Furnham, & Leese, 1986).

Several possible explanations may account for the primacy of print. These include depth of processing, self-pacing, and interference (Furnham & Gunter 1989, p. 309).

Furnham, Proctor, & Gunter (1988, p. 935) present possible explanations for the "superiority of written communication for memorizing material":

> It is argued that reading is self-paced while the speed of a radio or television broadcast is determined by the producer. The reader is able to go back over material which he may find difficult to understand. The viewer or listener, on the other hand, has only one chance to comprehend information. Reading, and to some extent listening, involves more sophisticated mental processing since the reader and listener have to conjure up their own mental images to accompany what they read and hear. The television viewer has both picture and sound arranged in a form which requires a more passive form of attention. When asked to recall information, it is argued that the greater mental activity involved in reading and listening will result in better retention.

Multimedia may change this argument. With an interactive multimedia system, the user is both reader and viewer. And television-type content may be seen "on demand" -- a more active form of attention.

The interactive multimedia system used for this experiment is self-paced. The "viewer" controls if, when, and how often the audio-video content is played.

By extension of the primacy of print theory, active involvement with a message and its medium may be perceived as simple, interesting and pleasing. Perhaps, multimedia content and the modality itself will be perceived as more simple, interesting and pleasing than content presented on paper or on a computer screen. This study examines that possibility.

After exposure to news, sports and entertainment stories presented in three different modalities, each subject rates the simplicity, interestingness, and pleasingness of the modality in general (paper, computer, multimedia), of the text, and of the image. Finally, the experimenter collects 1) open-ended responses about the subjects' memory for the digitized videos they had seen and heard in the multimedia modality, and 2) comments about each modality.

Self-report measures of using different modalities may provide evidence of the effectiveness of the human-computer interface (Borgman, 1984; Clarke, 1986; Kerr, 1986; Leung, 1989; Moran, 1981; Teshiba & Chignell, 1988). In other words, the post-test should provide an answer to: What modality is most user-friendly?

This study intended to advance theoretical understanding of the communication process by applying cognitive psychology, psychology of reading, educational psychology, information science and human factors (study of the human-computer interface) to mass communication research.

Results of this study may provide a baseline for cross-modality mass communication research that assesses the human-computer interface.

Research Question & Method

This paper reports results of a post-test questionnaire, the "soft" measures of exposure to and use of different modalities. Other portions of the study that measure reading time, memory, and information location (search time and search errors) are reported elsewhere (Thompson 1993, 1994a, 1994b).

After using each modality (paper, computer, multimedia) to perform reading tasks and information location tasks, the subjects were asked to respond to a questionnaire.

No directional predictions were made. The research question for this study was: What do subjects' responses tell us about the three modalities?.

The first part of the questionnaire has been adapted from Price (1972) whose study examined "the effect of newspaper design complexity on readership, comprehension, interestingness and pleasingness."

Items asked the subject to rate the simplicity (complexity), interestingness, and pleasingness of each modality on a scale of 1 (not at all) to 99 (very). Other items measured the same aspects of the image or "movie" (digitized video) and text. So, the independent variables were subject (to control for individual differences) and modality (paper, computer, multimedia). And the dependent variables were modality simplicity (complexity), modality interestingness, modality pleasingness, image simplicity, image interestingness, image pleasingness, text simplicity, text interestingness, and text pleasingness.

The last part of the questionnaire consisted of two open-ended questions that encouraged subjects to write out their reactions to the experiments. The first question was a free recall item that asked about the movies -- what did you see? what did you hear? The second question simply encouraged comments about the three different methods of presenting news content.

With this questionnaire completed, the experimental session was terminated and a debriefing statement was issued to the subject.

Here is a description of the study's design, materials, and procedure. This provides an overview of what the subject -- the media user -- encountered. The full description of the study has been included to provide background for the subjective measures -- the post-test questionnaire.

Experimental Design

A randomized 3 X 3 Latin Square design was used. The cells of the Latin Square were constructed by combining modality (paper, computer, multimedia) and story type (news, sports, lifestyle).[1] The rows of the Latin Square were treated as experimental orders. (See Figure 1.)

Figure 1. The Latin Square design

Order 1	C + N	P + S	M + E
Order 2	P + E	M + N	C + S
Order 3	M+ S	C + E	P + N

Modality	Story Type
P = Paper	N = News
C = Computer	S = Sports
M = Multimedia	E = Entertainment

This Latin Square was treated as a within-subjects design. Each subject saw each modality and each story type. The orders determined the combination of story type and modality to which each subject was exposed, and subjects were randomly assigned to orders.

Subjects

Seventy-five individuals participated in this study. Fifty-five of those were U.S. undergraduate students enrolled in journalism classes who participated for course credit. Twenty subjects were university library employees, recruited as "expert" searchers (necessary to test information location measures). These subjects volunteered their time. All subjects were debriefed about the purposes of the study afterwards.

Materials

A selective sample of stories was used in order to accommodate the multimedia condition. The multimedia condition required a short (5-8 second) "sound bite." This method was used to avoid the expense of producing news stories.

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[1] Story type is not a factor in this portion of the study. Story type was included as a control factor, to control for prior knowledge of content domains. Actually, significant effects were found for reading time, memory, search time and search errors as a function of story type.

The source of the stories was CNN "Headline News," January 10-14, 1993 (Sunday - Thursday). For the reading time and memory tasks, three stories from a sample of 48 were selected -- one for each story type (news, sports, entertainment). For the information location tasks, twelve stories were used -- four for each story type. These 12 stories were different from the three stories used for the reading time and memory tasks, so no practice effects or learning effects occurred. Stories considered for selection included enough information to write a 180-word print story and had a 5-8 second audio-video segment that could stand alone as a sound bite.

Following Oborne & Holton's (1988, pp. 4-5) suggestions for experimental controls, stimulus materials used in this study were written by the researcher. See Figure 2 for an example of a story layout used in this experiment. Each story unit included a headline, text, photo, and photo caption. This story format was based on a review of mass communication literature (Bain, 1980, p.2; Barnhurst, 1991, pp. 21-22; Dillon, Richardson, & McKnight, 1990, p. 224; Kolers, Duchnicky, & Ferguson, 1981, p. 525; Matazzoni, 1992, pp. 18-19; Pasternack & Utt, 1986, p. 33; Pipps, 1985, p. 1; Tinker, 1966, p. 169; Van Nes, 1986; pp. 116-117).

All stories were the same length, about 180 words. All stories were tested for equivalence in readability. Story format and size was held constant across all stories and modalities -- except when multimedia brought the images to life with video and audio.

One story per page or computer screen was used. Page turns and "jumps" to another page were considered confounding variables and were avoided in this research. A landscape (horizontal, 11 x 8-1/2) format was used. The story was set in three columns -- two even columns of text with the image and caption in the third, right-hand column.

Headline type was set flush left/ragged right in 30-point Helvetica bold. Body type was set flush left/ragged right in 12-point Palatino. Caption type was set flush left/ragged right in 10-point Palatino. Upper- and lower-case letters were used. And, the layout used ample white space, so the page or screen would not be filled with text.

Pictures (four-color process) and graphics windows were placed in the same location on the page and were the same size. This minimized confounding between experimental conditions.

To construct the multimedia condition, the video clip was digitized for storage as a computer file. The video was captured on VHS tape. The video output of the videocassette recorder was plugged into a video spigot card on a Macintosh computer. The VHS audio output was plugged into the built-in audio input on a Macintosh Quadra 950.

Dolly Wins CMA Award

Dolly Parton was the guest of honor Wednesday at the Country Music Association's award ceremony. Parton received the Country Music Honors Award. This is the first time such an award has been given.

The singer and sometime actress was cited for her outstanding achievements and upstanding character.

"This is a dream come true. I don't believe it. I'll take it, but I don't believe it," Parton said as she accepted the award.

"No one deserves it more," Loretta Lynn said.

Garth Brooks, Tammy Wynette, Randy Travis and K.T. Oslin were on hand to congratulate Parton.

Parton said, "This deserves a celebration. The rides are free tomorrow at Dollyland." Dollyland is Parton's theme park near her hometown of Daleville, Tennessee,.

The event was held at the Grand Ole Opry in Nashville. CBS broadcast the event.

One viewer in Parton's hometown, Daleville, said, "It's about time. Dolly has done a world of good for herself and her fans. We just love her to death around here."

Dolly Parton appears in the movie "Straight Talk."

Figure 2. An example of the stories used as stimulus materials

The application Screen Play was used to record the video clip and to save it on the computer. Then, the QuickTime Movie Player application was used to edit the digitized videos. The edited videos were then saved as self-contained QuickTime movies.

The digitized video files were not compressed. This avoided degradation of the quality of the images.

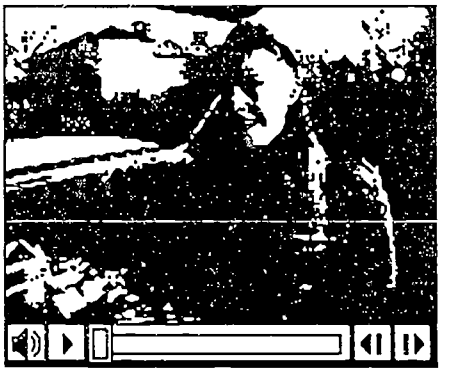
Each video was then stored in a separate file on a reloadable hard disk. A HyperCard command loaded the proper image or video into each story as needed.

HyperCard allowed the use of hypertext linkages. Hypertext is "a computer-based system that allows immediate, nonsequential access to linked items of information" (Marmion 1990, p. 7).

This study did not test hypertext. However, the linkage between information nodes[2] applied in hypertext provides a foundation for multimedia applications.

A story template in HyperCard determined the size and placement of the image. In the multimedia condition, the video clip appeared as a still frame. This was actually the first frame of the QuickTime movie. A "play" icon (a thin vertical bar near the botton left-hand corner) appeared in the QuickTime control strip at the bottom of the image. (See Figure 3.) A click of the mouse on this button activated the video. The subject controlled this interactive interface.

Figure 3. Movie control bar used to activate the QuickTime movie in the multimedia condition



This was the multimedia condition.

The computer condition was the same -- except there was no video control strip. The same still image that was the first frame of the video served as a photograph in the computer condition.

The paper condition was the same as the computer condition -- except it was a high-quality color laser print.

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2 Slatin (1990, p. 877) defines link and node. "Linkage, in hypertext, plays a role corresponding to that of sequence in conventional text. ... A node is any object which is linked to another object."

The information location task required subjects to: "Find [this] specific information." To test for differences in search performance across search experience, modalities, and story types, new stimulus materials were used. The search involved three information location tasks in "stacks" of each type of story -- one task per story type. Each stack contained four stories.

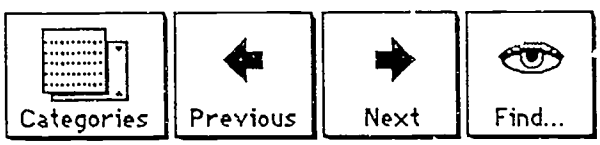
This means, for example, that Subject #1 was asked to find: 1) specific information about a news story from a stack of four news stories presented in the computer modality; 2) specific information about a sports story from a stack of four sports stories presented in the paper modality; and 3) specific information about an entertainment story from a stack of four entertainment stories presented in the multimedia modality.

Story order in each stack was randomized in each of the three experimental orders.

In the computer and multimedia modalities, the subject navigated by using four search functions: 1) "Category" -- A list of the titles of the four stories in the order that they appeared in the stack. The subject could select the title by clicking the mouse, click on "Okay" and jump ("go to") directly to that story. 2) "Previous" -- By clicking on this function, the subject could move backward in the stack one story at a time. 3) "Next" -- By clicking on this function, the subject could move forward in the stack one story at a time. 4) "Find" -- By clicking on this function, the subject could type in a keyword for which the computer would search. If the word was found, the story with that word would appear and the word would be highlighted.

These search functions were based on Gittins (1986, p. 519) and Guastello & Traut (1989, p. 99). Figure 4 demonstrates the mixed modality icons used to activate the search functions.

Figure 4. Search function icons used for this experiment



When the subject used the mouse to "click" on the categories icon, a list of the titles of the four stories appeared. From here, the subject could go directly to a particular story by selecting it with the mouse. The "Previous" and "Next" icons were used to move backward or forward one story at a time through the stack of four stories. The "Find" icon allowed the subject to type in a keyword for which the computer would search.

Apparatus

The multimedia and computer conditions were presented on a Macintosh iiCI with 16-bit color using System 7 and QuickTime extensions.

The QuickTime movies were digitized from VHS videotape using a videocassette recorder and a Macintosh Quadra. Two Cyquest drives were used to accommodate the reloadable hard disks required to store the video clips.

The paper condition was produced by printing the computer condition using an Apple color laser printer.

Hypercard was used to program the experimental orders and control the images and movies.

The Post-Test Questionnaire was a pencil-and-paper instrument.

Procedure

After signing a Consent Form and completing a Search Experience Questionnaire (to assess the subject's level of expertise in searching for information, necessary for analysis of the information location task), the subject began the portion of the study that measured reading time and memory. The subject was directed toward three different news stories (one per story type -- news, sports, entertainment). Each story was presented in a different modality (paper, computer, multimedia).

Determined by experimental order, the experimenter told the subject which story to read first, second, and third.

The word "read" was avoided in the instructions to avoid biasing the subject toward the text. Because the subject controlled starting the video, the word "read" might have pre-empted any motivation to "view."

Reading time was recorded by stopwatch.

A sample story was provided. The subject was informed about the possible presence of the QuickTime movie. The subject practiced starting the video. A practice session was conducted, including sample recall questions.

The subject was told the number of correct responses. Then, the subject had an opportunity to ask questions.

The experiment began. After exposure to the three stories, a short distractor task was administered. The distractor task asked for the subject's gender, ethnicity, and age. Then, the recall task was administered.

After that, the subject was instructed that the next portion of the study involved finding specific information from three different stacks of stories, each stack containing four stories. The subject was told he or she would be evaluated on how fast and how accurately the information was found.

As determined by experimental order, the experimenter directed the subject to the stack to search first, second, and third.

The subject was reminded that some stories included a movie that could be activated with the mouse.

A training session was conducted to familiarize the subject with the computerized search functions and to practice different strategies of finding specific information.

To begin, the experimenter asked a question (the search task) and said "Go" to begin each search. The subject pointed at the answer and said the answer out loud to stop the search. A stopwatch was used to time the search.

Three search tasks were administered -- one per stack. Each stack contained four stories of one story type.

The subject could ask the experimenter to repeat the question at any time. And, if the subject gave an incorrect answer, the experimenter said, "Continue your search."

The experimenter recorded the search path on paper. The search path was evaluated later to determine the number of search errors (incorrect story choice, incorrect answer, errors using the search functions).

Finally, the post-test questionnaire was administered. The results of that questionnaire are the focus of this paper. These results provide a baseline for future cross-modality research that assesses the "user-friendliness" of presentation format, or modality, of mass media messages.

The questionnaire asked subjects to rate the simplicity (complexity), interestingness, and pleasingness of each modality on a scale of 1 (not at all) to 99 (very). Other items measured the same aspects of the image or "movie" (digitized video) and the text.

Two open-ended questions that encouraged subjects to write out their reactions to the experiments were also included. The first question was a free recall item that asked about the movies -- what did you see? what did you hear? The second question simply encouraged comments about the three different methods of presenting news content.

Results

Remember, the results of the reading time, memory, search time, and search error tasks are not reported in this paper. The full description of the study has been included to provide background for the subjective measures -- the post-test questionnaire.

SPSS (version 4.0) was used for the data analysis.

Analysis of variance was used to analyze the results. The analysis of variance tested for main effects. This allowed the researcher to make statements such as: The effect of modality on (perceived) simplicity was [this].

Because the Latin Square design was not fully factorial, "Contrasts" were run to test differences between the levels of the experimental factors. A Contrast is a one degree of freedom F-test performed from within the ANOVA that allowed the researcher to specify a hypothesis to compare one set of means versus another set of means. This allowed the researcher to make statements such as: The paper modality was significantly different than the computer modality for effects on image pleasingness. Contrasts have been reported in tables as "[this level of a variable] vs [that level of a variable]."

Analysis of questions regarding simplicity, interestingness and pleasingness

Here is an example of a post-test question: How pleasing do you feel the computer screen (with no video) method of presenting news stories is? Use a scale of 1 (not pleasing at all) to 99 (very pleasing).

Analysis of the questions regarding simplicity, interestingness and pleasingness revealed the following.

No main effect was found for simplicity as a function of modality ($F(2) = .25$, $p > .05$). The computer condition ($M = 71.99$) was reported as slightly more simple than the paper condition ($M = 69.79$) and the multimedia condition ($M = 68.87$).

A significant main effect was found for interestingness as a function of modality ($F(2) = 12.20$, $p < .001$). The multimedia condition ($M = 82.73$) was reported as most interesting, followed by the computer condition ($M = 68.91$) and paper ($M = 54.65$) in that order.

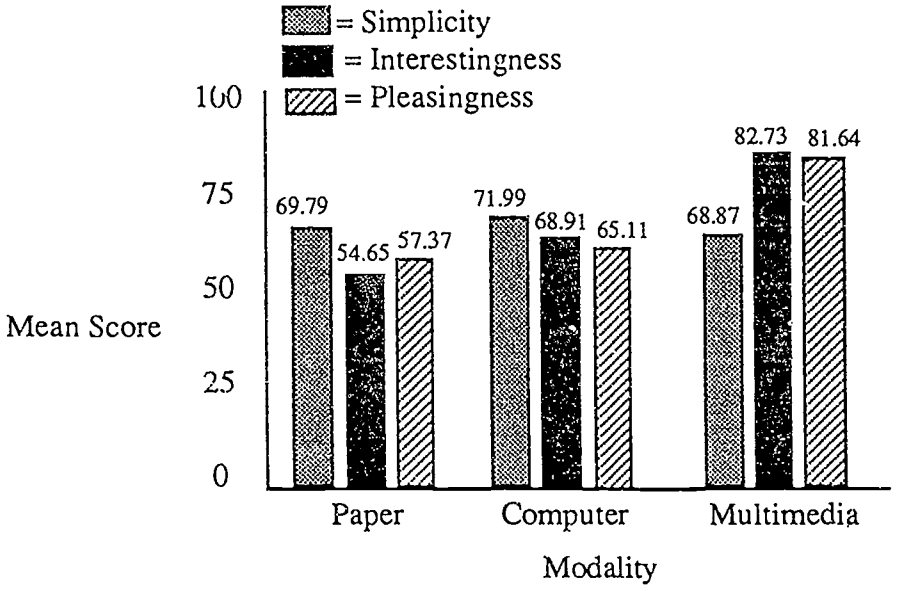
For the interestingness measure, significant differences were found between each level of modality: 1) paper vs multimedia ($F(1) = 24.36$, $p < .001$), 2) computer vs multimedia ($F(1) = 5.26$, $p < .05$), and 3) paper vs computer ($F(1) = 2.06$, $p < .01$).

A significant main effect was found for pleasingness as a function of modality ($F(2) = 8.91$, $p < .001$). The multimedia condition ($M = 81.64$) was reported as most pleasing, followed by computer ($M = 65.11$) and paper ($M = 57.37$) in that order.

For pleasingness, significant differences were found between the paper and multimedia conditions ($F(1) = 17.27$, $p < .001$) and between the computer and multimedia conditions ($F(1) = 7.40$, $p < .01$). No difference was found between the paper and computer conditions.

To demonstrate the perceived simplicity, interestingness and pleasingness of the three modalities, the mean scores these subjective responses are shown together in Figure 5.

Figure 5. Mean scores of subjective responses for simplicity, interestingness and pleasingness as a function of modality



Analysis of questions regarding image simplicity, image interestingness and image pleasingness

The simplicity, interestingness and pleasingness measures examined subjective (self-reported) responses to the modalities as a whole. Now, the researcher attempted to assess subjective responses to two components of the stimulus materials -- image and text.

Subjective responses to the images (photographs and "movies") used in the stimulus materials were collected and analyzed. Image simplicity, image interestingness, and image pleasingness measure the subjects' reactions to the images themselves.

Subjects were asked, for example: How complex or how simple do you feel the image (the "photo") presented on paper is? Use a scale of 1 (very complex) to 99 (very simple).

No effect was found for image simplicity as a function of modality ($F(2) = .65$, $p > .05$). The paper condition ($M = 69.11$) yielded the higher score for image simplicity. Image simplicity scores for the computer ($M = 61.62$) and multimedia ($M = 61.41$) conditions were nearly equal.

A significant main effect was found for image interestingness as a function of modality ($F(2) = 10.29$, $p < .001$). The multimedia condition ($M = 82.88$) was reported as having the more interesting images, followed by computer ($M = 65.19$) and paper ($M = 57.87$) in that order.

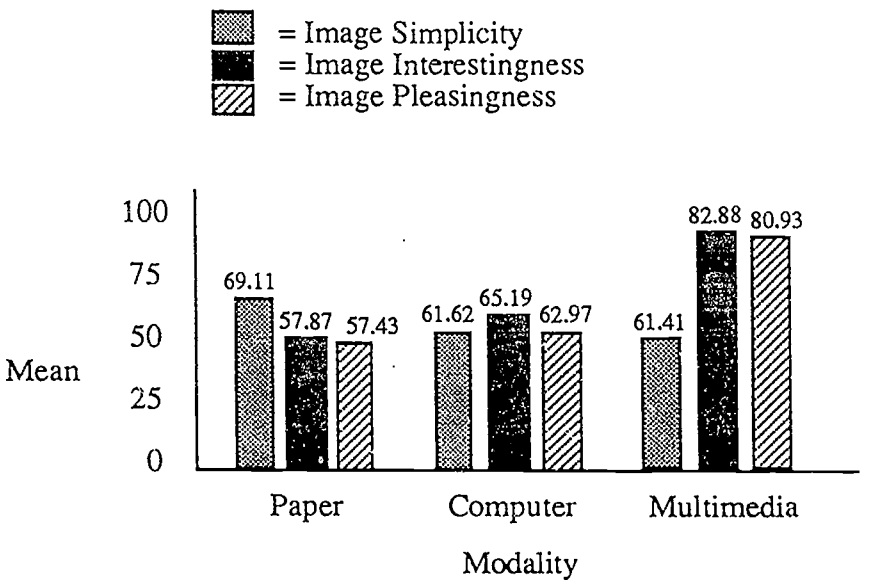
For image interestingness, differences were found between the paper and multimedia conditions ($F(1) = 19.59$, $p < .001$) and between the computer and multimedia conditions ($F(1) = 9.47$, $p < .01$). But, no difference was found between the paper and computer conditions.

A significant main effect was found for image pleasingness as a function of modality ($F(2) = 11.65$, $p < .001$). The multimedia condition ($M = 80.93$) was rated as higher in image pleasingness that the computer condition ($M = 62.97$) and the paper condition ($M = 57.43$).

For image pleasingness, significant differences were found between the paper and multimedia conditions ($F(1) = 21.35$, $p < .001$) and between the computer and multimedia conditions ($F(1) = 12.40$, $p < .01$). No difference was found between the paper and computer conditions for image pleasingness.

The mean scores of subjective responses for image simplicity, image interestingness and image pleasingness as a function of modality are shown in the following figure.

Figure 6. Mean scores of subjective responses for image simplicity, image interestingness, and image pleasingness as a function of modality



Analysis of questions regarding text simplicity, text interestingness and text pleasingness

To further analyze components of the stimulus materials, the perceived simplicity, interestingness and pleasingness of the text (the "typed" words) were assessed for each modality. This was done to examine possible differences in perceptions of the text across modalities.

No main effect was found for text simplicity as a function of modality ($F(2) = .07$, $p > .05$). The means for text simplicity were nearly the same across all levels of modality: 1) paper ($M = 74.19$), 2) computer ($M = 73.12$), and 3) multimedia ($M = 72.13$).

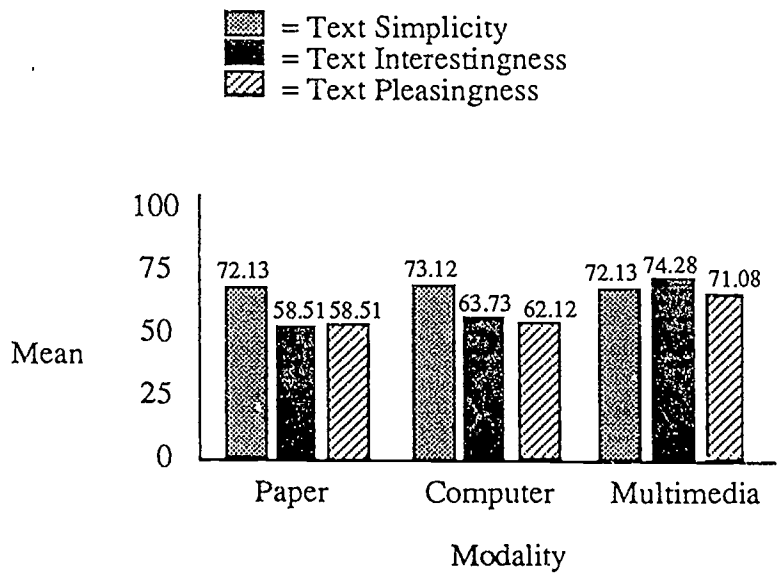
For text interestingness, a significant main effect was found as a function of modality ($F(2) = 6.04$, $p < .01$). The multimedia condition ($M = 74.28$) was rated higher for text interestingness, followed by computer ($M = 63.73$) and paper ($M = 58.51$) in that order.

A significant difference was found between the paper and multimedia ($F(1) = 12.03$, $p < .01$) conditions of modality by text interestingness. The difference between the computer and multimedia conditions ($F(1) = 3.66$, $p = .058$) was approaching significance. No difference was found between the paper and computer conditions for text interestingness.

No main effect was found for text pleasingness as a function of modality ($F(2) = 2.46$, $p > .05$). The multimedia condition ($M = 71.08$) was rated higher for text pleasingness, followed by computer ($M = 62.12$) and paper ($M = 58.51$) in that order.

The mean scores of subjective responses for text simplicity, text interestingness, and text pleasingness as a function of modality are shown together in the following figure.

Figure 7. Mean scores of subjective responses for modality by text simplicity, text interestingness and text pleasingness



Analysis of open-ended questions

Two open-ended questions encouraged subjects to make comments regarding the video in the multimedia condition and the modalities in general.

Comments were categorized; then, frequencies of comments were tablulated by category. Some subjects made more than one comment per category.

This is baseline data. This information may be used to construct subjective measurement instruments for future research.

Comments about the "movie"

To analyze the open-ended questions, the researcher simply counted the frequencies of positive statements, negative statements, comments about the ease of seeing and hearing the video, comments about the difficulty of seeing and hearing the video, comments on the ease of finding information in the vi.), and comments on the difficulty of finding information in the video.

The first question asked about the "movies." Subjects were asked to write about what they remembered from the digitized videos they had seen and heard. The question was:

> What do you remember about the "movies" you saw and heard? Please be specific. What images did you see? What did you hear (music, announcers, people interviewed, sound effects, etc.)?

The following table summarizes the results.

Table 1. Frequencies of subjective responses about the "movies"

Positive comments	Negative comments	Easy to see and hear	Difficult to see and hear	Easy to find information	Difficult to find info
15	4	17	16	0	4

Examples of "positive comments" were: 1) "The sound was interesting." 2) "The motions were better than I had expected for a video on a computer screen." 3) "The movies re:mphasized [sic] what was said in the article so the important information could be remembered."

These statements were scored as "negative comments": 1) "I don't care for computer voices." 2) "Kill the movie idea." [with four underlines] 3) "If I wanted to listen to the news, I would turn on the television."

Statements like the following were scored as "easy to see and hear": 1) "The picture was easy to see for being so small, and very clear." 2) "The movie was so pretty and colorful. It was eye-catching." 3) "The main thing I remember is the clarity of sound. Especially the clear, easy-to-understand pronunciation of the voice. I know that hearing the words provided information that I more easily recalled later."

The following is an example of a statement scored as "difficult to see and hear": 1) "The picture wasn't as clear as I had hoped. I wanted to reach over and tune something." 2) "The images were rather jerky, the sound a little unclear." 3) "The animated quality of all these

motion pictures is jumpy, resembling one of those flip books you used to get with monster bubble gum."

A few subjects said it was "difficult to find information" in the video. For example: 1) "I did not want to use [the video] because you cannot go back and relocate information in a visual way." 2) "Found my answers before needing to look at [the video]." 3) "I didn't activate the movies -- I was anxious about doing things quickly and I know that waiting for the movies to finish would have aggravated me -- I depended on my own speed."

Comments about each modality

The second question asked subjects to comment on each of the three modalities. The same categories were used to count frequencies of response. The question was:

> What comments would you like to make regarding the three different ways of presenting news stories -- 1) ink-on-paper, 2) computer screen, 3) computer with a "movie"?

The following table summarizes the results.

Table 2. Frequencies of subjective responses about each modality

	Positive comments	Negative comments	Prefer this medium	Easy to read/ view	Difficult to read/ view	Easy to find info	Difficult to find info
Paper	15	25	13	12	1	3	1
Computer	30	10	4	8	8	7	0
Multimedia	60	14	7	11	4	1	0

Some examples of "positive comments" were: 1) "I liked the computer with movie, that was interesting to use because of the interaction." 2) "I feel that the most interesting and effective way of presenting news would be on a computer with a 'movie.' This helps to give visual aid, and keep the reader interested in the story and what it is about." 3) "I like to pick up and hold the paper."

"Negative comments" included: 1) "Just text on screen didn't trip my trigger." 2) The paper modality "seemed almost primitive." 3) "I did not enjoy or particularly find ink-on-paper interesting because it made me fall asleep." 4) "Ink on paper is very blank [sic] -- needs spice." 5) Ink on paper is "stale and old-fashioned."

Some subjects expressed a preference for a particular modality. For example: 1) "I like the computer screen the most." 2) "I didn't think the 'movie' was worth much in terms of

getting facts. I still like ink on paper better, but computer screen isn't far behind."
3) "It's more likely for hearing-impaired people to prefer on-print information than voiced."
4) "I always enjoy paper best because it's more available and accessible at the moment."
5) "I really liked the computer with a 'movie' because it is easier, more convenient, and more interesting to watch, read, listen to."

Each modality was considered "easy to read/view" by some subjects: 1) "I paid more attention to the ink-on-paper stories because it is easier for me to read." 2) "Type seems easier to read" on the computer screen. 3) With the computer screen and computer with movie, "the words are easier (bigger) to read."

Only one subject found the paper modality "difficult to read/view." This subject said: "It was hard to comprehend the articles without reading them twice.".

Others found the computer modality "difficult to read/view": 1) "I had to re-read a lot" with the computer story. 2) "You cannot eat while reading" a computer screen. 3) "The computer screen was good but at times it was hard to read." 4) "I found the words on computer screen less than clear. In other words, it takes longer to read than on print."

And a few found the multimedia modality "difficult to read/view." For example: The videos "seemed to call too much attention to themselves." Another subject said, "Computer with 'movie' is more appealing, but since it is not in text something can be missed, especially vital information."

Comments about modalities in which it is "easy to find information" included: 1) "Ink on paper is easiest for me. You can look and find with your own eyes instead of having to look for what you want to find on a computer." 2) Paper is "easier to find information on." 3) The computer is "interesting because you can access other data very quickly." 4) "Computer screen is easier to find specific information. Computer screen with movie has the same advantages as the screen without movie, with the added benefit of sound and motion, making it interesting and more like television." 5) "I think it's easier to find information on paper rather than on a screen." 6) "It occurs to me that finding information typed on a computer screen is easier than finding it typed on paper."

Only one subject indicated that it was difficult to find information in the paper modality. The subject said, "I hate to find information in paper. It takes too long!"

Discussion and Future Research

The results of this study provide some evidence of the effects of using different modalities (ink-on-paper, computer, multimedia). What does this suggest to media designers, publishers, and researchers about presenting mass media messages in different modalities, particularly multimedia and, by extension, other new media?

Several subjects expressed surprise when introduced to the digitized video. Future research may include assessments of "level of experience" for multimedia use. This would account for novelty effects.

In this study, surprise, fascination or curiosity about the multimedia condition did not seem to lead to use of the digitized video (the video was only activated by an interactive mouse click). Less than 70 percent of the subjects chose to see the video during the reading time task. The experimenter was aware of a possible confound, so subjects were instructed to "go through" the story, not "read" the story. For the information location task, only 14 percent of the subjects chose to view the video.

Content factors did seem to affect the decision to view the digitized video. Two subjects commented that news on paper was more trustworthy. Several subjects indicated that the videos lacked substantial information.

By design, the videos supported the text. Many of the videos did not contain information that was not in the text. Future studies may include more substantial information that can be found only in the interactive videos.

The post-test questionnaire revealed that all the modalities were perceived as nearly equally simple. This includes the modalities in general, the images used for each modality, and the text used for each modality.

The interestingness measure revealed significant differences between all comparisons of modality conditions. The multimedia condition was highly rated for interestingness.

The mean score for interestingness of the text jumped up almost 20 points from the paper condition to the multimedia condition. The presence of the video apparently enhanced the text. A few subjects commented that the video helped bring the story to life. And several subjects mentioned that news on paper is "boring" or "old-fashioned."

For the multimedia condition, a few subjects indicated "surprise" that the audio was so clear. They seemed to expect a computer-generated voice.

But, one subject reminded the researcher that hearing-impaired persons prefer ink-on-paper. This subject found the computer-based audio difficult to hear.

In general, these results suggest little resistance to computer-based multimedia presentations of mass communication content. These subjects appeared to give the "digital daily" a sign of approval and encouragement.

One subject said, "If I was at work and had this capability at desktop -- to read, see and hear the latest stories from around the world, it would be quite a service."

Another subject said, "I liked the 'movies.' It was very interesting to see a news story come alive on a computer screen. I hope to see things like this on the market some day."

The findings of this study may be applied to further challenges of the primacy of print theory. If, by extension, researchers argue that messages that are simple, interesting and pleasing also may be easy to read and memorable, then multimedia presentations deserve a closer look. Future research may address this issue.

This research applied existing technology to investigate future implications for 1) publishers who are adapting to electronic technology, including multimedia, 2) consumers who are adjusting to new media in order to obtain the most recent news, and 3) researchers who are seeking to develop cognitive models for design and use of interactive media.

Researchers may begin to notice less and less resistance to computerized information delivery systems ... and more resistance to ink-on-paper. Yesterday's students have grown up with television in the home. Today's students are growing up with computers in the home and in the classroom. Tomorrow's media consumers may expect interactive multimedia systems to deliver news and information.

Researchers must anticipate and examine "readers'" expectations of efficient and effective interactive multimedia systems and content. The results presented in this paper may be used as a baseline for future studies of the transition from print to electronic media.

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