Memory for Advertising and Information Content: Comparing the Printed Page to the Computer Screen

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ABSTRACT

An experiment was used to test memory for two forms of information—ad copy (persuasive) and consumer information (nonpersuasive) presented in print and screen media. For both forms of information, print outperforms screen on recall but not on recognition. The results suggest that print information is easier to retrieve but also that screen information is available in memory. Differences between print and screen media are persistent and not readily explained by any of the obvious individual factors—comfort/familiarity, preference, and reading time. Other results with implications for marketing communication decisions show that brand name is poorly recalled from the screen relative to the printed page and that the nonpersuasive consumer information is better remembered than is persuasive ad information. © 2005 Wiley Periodicals, Inc.

With the rise in the use of the Internet as a communication medium, one wonders how the Internet compares to other marketing media with respect

to traditional measures of communication effectiveness, such as memory, attitude, intention to buy, and purchase. Various studies over the years have demonstrated that consumer responses to persuasive communication differ across media and depend on surrounding context (Aaker & Brown, 1972; Belch, Belch, & Villarreal, 1987; Soldow & Principe, 1981). Researchers (Pavlou & Stewart, 2000; Rodgers & Thorson, 2000) have argued that electronic media possess physical and consumer processing characteristics that warrant new frameworks to account for those factors. Two such frameworks for research on online advertising emphasize three key factors—consumer-driven interactivity (Pavlou & Stewart, 2000; Rodgers & Thorson, 2000), consumer control (Pavlou & Stewart, 2000; Rodgers & Thorson, 2000), and consumers' intentions (Rodgers & Thorson, 2000)—that make on-line learning different from off-line. Similarly, Hoffman and Novak (1996) posited that hypermedia possess special characteristics, such as machine and person interactivity, temporal synchronicity, breadth of communication, feedback symmetry, and linked sources, that may make on-line communication different from off-line. Despite the unique consumer factors and hypermedia factors, traditional measures of advertising effectiveness, including memory for information (Hoffman & Novak, 1996; Pavlou & Stewart, 2000; Rodgers & Thorson, 2000), retain importance in this new medium.

Differences between on-line and off-line media effects constitute a growing issue for the effectiveness of marketing communications. Increasingly, companies rely on the Internet to deliver persuasive content (e.g., banner ads, pop-up ads) as well as to provide nonpersuasive information to consumers (Dreze & Zufryden, 1998). British Airways, for instance, provides information for healthy travel as well as updated arrival and departure times. The benefits of broad, fast access to target audiences are great, but few studies have investigated differences for identical content and layout disseminated in a paper versus an on-line form. Newspapers, for example, are finding success by running display ads from the paper version in the on-line version of the news with only minor alterations (Sullivan, 2002), and nonpersuasive information on-line often takes on the appearance of an ordinary printed page.

Informal polls imply that people strongly prefer to read from paper and, even in the literature comparing print media to screen media, the impact of the display medium itself remains insufficiently explored. Further, responses to advertising—a persuasive communication—have not been clearly distinguished from responses to product use or other consumer information, and many firms today view the Internet as a key way to disseminate information that allows them to provide better customer service and also to enhance the image of their brands. Thus, it is unclear whether one medium is superior to another for evoking consumer responses and whether this would differ depending on the type of message—persuasive or informational.

THEORY

To date, mass media research has centered on the differences among traditional mass media, such as radio, television, and print (Stewart, Pavlou, & Ward, 2002), and the most common approach has been to compare across sensory mode (visual versus auditory) but occasionally comparing within sensory mode (visual versus visual). Print information, for instance, has been shown to result in better comprehension than auditory information (Jacoby, Hoyer, & Zimmer, 1983). Investigating memory and persuasion, Wright (1974) characterized media in terms of four attributes: sensory mode(s) used, the number of sensory modes used in the medium, temporal rate of communication flow, and the ease of reviewing the information. Although no consistent memory differences were found across media for these attributes, variables that mediate the relationship between the medium and the measures promised better explanations. For instance, higher information load, such as one might find in auditory communication where the temporal control and ability to review are constrained, should decrease the opportunities to process or elaborate the information (Wright, 1974), reducing memory. However, Furnham and Gunter (1989) show evidence for superior print recall (versus auditory) for news items even when duration was held constant, suggesting that temporal flow and its impact on information load is a weak contributor to the differences between auditory and visual media. Several other studies have failed to find evidence for more learning in modalities that offer greater self-pacing, such as print over TV (Byrne & Curtis, 2004; Corston & Colman, 1997), or user-controlled Web over print or static Web (Eveland & Dunwoody, 2002).

Studies across media offer evidence for media providing different opportunities and incentives to elaborate on information. Russell (2002), in fact, found evidence that the auditory mode produced better brand-name recognition than the visual image of the brand in tests of the effectiveness of product placements. Visually, a brand only generated elaboration when it was "out of place" in the image, but in auditory mode the conversation would likely revolve around the brand, yielding more information to elaborate. Unnava, Burnkrant, and Erevelles (1994), comparing memory for print ads to memory for identical radio ads, found that recall for radio ads was strongly ordered. It was hypothesized that medium altered the retrieval strategy used to access memories. Processing strategy also is thought to play a role in the amount of elaboration brought to a medium. Print, for example, commonly attracts more effort than television because print is believed to require more processing effort (Beentjes & van der Voort, 1993). In the studies that compare across media, elaboration is a common explanation for the storage and retrieval differences prompted by different media.

Norris and Colman (1992) tested the hypothesis that ads viewed in the context of involving content (a television program or a magazine arti-

cle) would be less effective. In contrast to the mixed results for broadcast, Norris and Colman (1992) found that article involvement was negatively related to memory for embedded print ads. They speculate that magazine articles command the reader's attention—to the detriment of surrounding ads—and some of the positive results for broadcast can be attributed to a positive correlation between program choice and accompanying ads. Thus, the advertiser's choice of the medium–ad combination may make a difference in how much information would be encoded and stored from the ad. The distraction hypothesis (Byrne & Curtis, 2004; Corston & Colman, 1997) further suggests that characteristics of the audio-visual media, such as the communicator's voice and peripherally related images, take attention away from the core information.

Comparisons between media in the *same sensory mode* have a different emphasis, chiefly examining the effects of context on measures of evaluation. Magazine images produced effects on beliefs about advertised brands (Aaker & Brown, 1972), the context provided by article content produced effects on attitude (Yi, 1990), and program-induced affect influenced ad and brand attitudes (Coulter, 1998). Taking a different tack, Grabe, Zhou, Lang, and Bolls (2000) anticipated that the structural differences (camera angles, editing pace, shot length, music) between broadcast formats (traditional-style versus tabloid-style), as well as the story differences, would provoke arousal that led to better memory, but found no such effect.

Research on the memory effects of a print versus a screen presentation comes from two broad streams. A stream arising largely in the human–computer interaction, education, and communication literatures emphasizes the difference between display media without attention to hypermedia effects (De Bruijn, De Mul, & Van Oostendorp, 1992; DeFleur, Davenport, Cronin, & DeFleur, 1992; Dillon, McKnight, & Richardson, 1988; Faccoro & DeFleur, 1993; Gould, Alfaro, Barnes, Finn, Grinschkowsky, & Minuto, 1987; Gould, Alfaro, Finn, Haupt, & Minuto, 1987; Gould & Grinschkowsky, 1984; Hansen & Haas, 1988; Mills & Weldon, 1987; Muter & Mauretto, 1991; Piolat, Roussey, & Thunin, 1997). A second relevant stream arises largely in the communication and marketing literatures. It compares print presentation to a screen presentation that allows the user to interact with and select screen information (Bezjian-Avery, Calder, & Iacobucci, 1998; Eveland & Dunwoody, 2001, 2002; Gallagher, Foster, & Parsons, 2001; Gallagher, Parsons, & Foster, 2001; Sundar, Narayan, Obregon, & Uppal, 1998). Although the stream that compares print to an interactive screen purports to offer a more natural comparison (one that might even show a superiority for the interactive screen), results show consistently better memory for print media (Bezjian-Avery et al., 1998; Eveland & Dunwoody, 2001; Eveland & Dunwoody, 2002; Gallagher, Foster, & Parsons, 2001; Gallagher, Parsons, & Foster, 2001; Sundar et al. 1998)—the same result found for the more basic question about the relative value of paper versus screen posed in the

human–computer interaction literatures. Considering the persistent superiority of print media, Dillon (1994) posits that print superiority arises from a combination of physical, perceptual, and cognitive differences between the page and the screen. Other such factors are cognitive load (Eveland & Dunwoody, 2001), sense of text (Eklund, Fatton, & Romberger, 1996), usage context (Muter, 1996), and individual differences (Muter, 1996).

Existing research on differences between print and screen does not map well onto marketing issues. Comparisons of screen presentation to print presentation have focused on measures such as performance, feelings, and vision (Gould & Grinschkowsky, 1984); speed, accuracy, fatigue, comprehension, and preference (Dillon et al., 1988); and skimming (Muter & Mauretto, 1991); and an assortment of differences is found between the two media. These are all variables of immediate consequence for knowledge workers and educators, but mostly variables that are likely to mediate traditional measures of consumer responses to media stimuli. The marketing literature addresses memory and attitude and shows evidence for differences in the processing of ad, and other, information from the two media (Bezjian-Avery et al., 1998; Gallagher, Foster, & Parsons, 2001; Gallagher, Parsons, & Foster, 2001; Sundar et al., 1998), but does not explore the basic difference between display media.

Screen versus print presentation has been compared on memory and learning measures. Results have been mixed, with some researchers finding differences between paper and computer screen (Eveland & Dunwoody, 2001; Faccoro & DeFleur, 1993; Gallagher, Parsons, & Foster, 2001; Hansen & Haas, 1988; Piolat, Roussey, & Thunin, 1997) and others finding marginal or no differences (De Bruijn et al., 1992; DeFleur et al., 1992; Eveland & Dunwoody, 2001; Gallagher, Foster, & Parsons, 2001; Mills & Weldon, 1987; Sundar et al., 1998).

Ability and willingness to learn information (encoding effort) has long been known to be influenced by variations in tasks, for example, to learn or to choose (Biehal & Chakravarti, 1982), or factors that might be affected by usage context (Muter, 1996), for example, to browse or to find target information. Stimulus characteristics such as vivid language (Kisielius & Sternthal, 1984) and pictorial imagery (Childers & Houston, 1984) also bear on encoding effort. Commonly examined physical screen factors (Dillon, 1994) such as display quality, motion, design, and layout provide examples of stimulus characteristics that could affect encoding effort. Similarly, experience and preference might influence the effect of print versus screen on a user's ability and willingness to learn information. Experience is an individual factor widely explored in marketing (e.g., Johnson & Russo, 1984). Greater effort yields better memory, recognition, and recall of information, chiefly through the elaboration and storage of a more detailed network of associations (Craik & Lockhart, 1972). Similarly, retrieving stored information successfully has been associated with deeper processing that creates a rich network of elaborations (Craik

& Lockhart, 1972). Motivation (Biehal & Chakravarti, 1982) and the cues present at retrieval (Tulving & Thompson, 1973) also influence retrieval. Thus, the challenge is to determine what memory differences exist and what factors might be influencing processing differences between these two media.

Some argue that learning differences are diminishing and can be attributed to improved computer display (De Bruijn et al., 1992) and higher computer familiarity (Faccoro & DeFleur, 1993). Other research predicts that screen learning is facilitated by the similarity of an interactive screen to cognitive structure (structural isomorphism), but in fact cognitive load and disorientation remain high, offsetting the advantage and keeping screen learning below print levels (Eveland & Dunwoody, 2001). Despite improved computer displays and greater computer experience, results show that screen effects are complex (Dillon, 1994), and traditional paper still is suspected to produce stronger learning results.

People often comment that they must print out a hard copy of a document that has been written on the computer in order to thoroughly read and evaluate what has been written. A study from an on-line market research firm, Insight Express, reports that even though most respondents agree that on-line content is more timely, only 22% of on-line magazine readers claim to prefer the screen medium and 72% would not give up their hard-copy version even if the on-line content was available for half the price (Greenspan, 2002). Results show that only 22% think that on-line magazines provide higher quality, and such factors as lack of convenience, distraction, and eyestrain were cited as reasons not to read on-line content. It is speculated that such factors as portability and the inconvenience of scrolling and clicking suppress on-line readership. In another recent study, Murphy (2000) found that computerized essays were deemed harder to understand, and less persuasive, and attributed one of the causes to the fact that readers have to contend with the challenge of following computer text as they scroll through the document to read it. If this is the case, readers should not be expected to gain the same knowledge from screen texts as they would from printed texts, and reactions (e.g., liking, frustration) to the medium would have an impact on users' learning.

The notion that people prefer printed material was confirmed in a study that assessed consumer preference for and use of printed manuals versus on-line help documentation for software applications (Smart, Whiting, & Detienne, 2001). Ninety-two percent of users indicated they referred to the printed documentation at least once a month, compared with 52% referring to the on-line help during the same time period. Moreover, 83% of respondents had been using the software for less than 6 months, suggesting that a user's skill level is important. Numerous marketing studies and frameworks point to the effect of familiarity and expertise on the use, elaboration, and recollection of information (e.g., Alba & Hutchinson, 1985). Experienced users, but not

novices, might retain the capacity to elaborate on screen-displayed information—a moderator.

Relative to a printed page, reading from a computer screen presents several challenges for the reader. Tests of reading text from computer screens show that reading speed is by far the most common difference between screen and print (Dillon, 1992; Dillon et al., 1988; Mills & Weldon, 1987), with reading from screen being significantly slower than reading from print (Gould & Grinschkowsky, 1984; Muter, Latremouille, Treurniet, & Beam, 1982; Smith & Savory, 1989; Wright & Lickorish, 1983). The length of time it takes to read from a computer screen (compared to paper) has been reported as being from 20% to 30% slower (Dillon et al., 1988; Gould, Alfaro, Barnes et al., 1987; Smart et al., 2001), even after acknowledging the possibility of intervening variables such as the size, type, and quality of the VDU (Dillon, 1992; Dillon et al., 1988). Thus some property of a screen other than physical legibility seems to cause screen readers to read more slowly, potentially reducing the quantity of information that they view.

Information Versus Advertising

Memory differences between nonpersuasive consumer information and persuasive ad information have not been well documented. Most research on differences between print and screen has been for information that is not persuasive in nature, but there is a rich tradition of study on resistance to advertising and persuasion (cf. Phau, Holbert, Zubric, Pasha, & Lin, 2002; Wright, 1975) that suggests that consumers process persuasive communication (ads) differently from the way they process neutral consumer information. Thus, it is expected that the pattern of memory differences between print and screen for informative text might be different from the pattern of memory results for advertising.

Research on memory differences for informative (news) content shows no difference between print and screen (Sundar et al., 1998). Other evidence for memory for news found that print media (both newspaper format and computer screen) were superior to broadcast media (TV, radio) in both recall and recognition (DeFleur et al., 1992) but that newspaper format, while directionally better, was not significantly better than the computer screen (DeFleur et al., 1992; Sundar et al., 1998).

The results for ad content are, however, conflicting. Sundar et al. (1998) found a strong difference between hard copy and screen disply for a consolidated measure of recall and recognition for an ad embedded in a newspaper format. Gallagher, Foster, and Parsons (2001) and Gallagher, Parsons, and Foster (2001) also found no recall or recognition differences for Web ads compared to print ads for lab subjects, but did find a difference in the field among the less-experienced computer users (Gallagher, Parsons, & Foster, 2001). The subjects in studies from Gallagher, Foster, and Parsons (2001) and Gallagher, Parsons, & Foster (2001) handled

both media as they normally would—turning pages for print and clicking links for screen—and saw ads embedded in a brochure that they read with the goal of planning a specified vacation. It is not clear how directly the memory results from these studies bear on the effects of a screen versus a page.

Recall Versus Recognition

Recognition is trusted to be a test of whether or not the traces exist in memory, whereas recall may be affected by (a) decay, (b) information replacement, and (c) the cues present at retrieval (Tulving & Pearlstone, 1966). Without instructions to remember items for a specific memory task, subjects would not be expected to process items differently in anticipation of a recall versus a recognition task (Tversky, 1973), and differences in recognition and recall would likely be governed by those factors that affect recall. Lang, Newhagen, and Reeves (1996) posit that a structural feature that occurs in one medium will divert processing capacity from the elaboration necessary for subsequent recall; thus, the structural, task, or contextual factors of a screen might alter the allocation of processing capacity.

Hansen and Haas (1988) proposed a variety of factors (page size, legibility, responsiveness, and "sense of text") that may account for diminished user performance on memory for information read from a computer screen, but De Bruijn et al. (1992) were able to show that better computer display (larger and/or better organized) continues to show differences in reading time but no difference in recognition for the material, implying that elaboration could be responsible for differences in recall memory.

Summary and Hypotheses

In general, print media should be a more powerful way than screen media to deliver both persuasive and nonpersuasive communication. The preponderance of evidence for nonpersuasive information suggests that, when appearance, content, and interactivity are held constant across media, print recall will be superior to screen recall. Limited research on memory for advertising also suggests that print will outperform screen.

H1: Print recall will be higher than screen recall for ad claims.

H2: Print recall will be higher than screen recall for nonpersuasive information.

Evidence suggests that persuasive communication, at least on some occasions, invokes resistance. In the few studies where both persuasive and nonpersuasive information have been tested, it appears that the

pattern of results is different and subjects might be more receptive to non-persuasive information. Subjects might process screen information more thoroughly when they view nonpersuasive information than they do when they view an instance of persuasion (an ad).

H3: Memory for nonpersuasive information will be greater than for persuasive information (ad claims).

H4: Differences between paper and screen will disappear for nonpersuasive information.

Another issue to be tested is whether the results for recall are different from recognition. A difference in recall, without a corresponding difference in recognition, suggests that screen display affects memory at the retrieval rather than the encoding stage and raises the prospect that either elaboration or cues are responsible for any differences in memory. A difference in recall with an accompanying difference in recognition suggests that, because screen-quality differences have largely been resolved, screen readers have applied a different technique to reading from the screen and/or they do not like to read from the screen.

METHOD

The research questions were examined in an experiment where identical ad and information content were viewed in either print or a screen display. A branded cold and flu tablet that was unfamiliar to the test group was the advertised product. A cold and flu tablet was deemed to be both a unisex and a non-age-discriminating product, making the test product relevant to a diverse sample. Ads for OTC medicines (pain relievers and stomach remedies) have been included among a variety of test products in other ad studies (e.g., Keller, 1991; Kent & Kellaris, 2001) and information about the flu disease has been used in comparisons of memory for print versus interactive screen displays (Eveland & Dunwoody, 2001). All subjects were exposed to an advertisement (designed to be roughly the same size as a pop-under ad and/or a half-page magazine ad) for the cold and flu tablet together with a one-page health information sheet about the common cold.

The ad made claims for the effectiveness of the product, provided instructions, and listed active ingredients, and the health information sheet presented information regarding the common cold's definition, description, symptoms, and contagiousness. The brand name and logo appeared on both the ad and the information sheet. The print and screen versions of the stimulus were identical in content, size, and layout. The only real difference was that the printed version required subjects to turn a stapled page while the screen version required viewers to click on a "next" button to see the second page of materials.

The 48 experimental subjects were recruited by convenience. Some participants were university students who were approached within the confines of the Business and IT schools at a small private university. Other participants were working adults who were approached in their homes and workplaces away from the university campus. A variety of ages and occupations were represented by the subjects. No rewards were used to attract participants. Although subjects were selected by convenience, they were randomly assigned to the experimental conditions in the lab. The experiment included both between-subjects and within-subjects factors. The between-subjects factor was whether subjects saw a print or screen version of the materials. The within-subjects factor was the two forms of information—an information page about colds and an ad for a cold remedy. The viewing order of the two documents was counterbalanced, yielding a second between-subjects factor.

Experimental participants first viewed the ad and information sheet (viewing time was recorded), and then subjects put the stimulus materials in an envelope (or turned off the computer screen) and completed the questionnaire. Memory for ad copy points and for information items about the common cold were assessed separately in direct-recall tests (Krishnan & Chakravarti, 1999) that asked subjects to think about what they had just viewed. The first test was a free-recall exercise; subjects were first asked to write down as many points from the ad as they could remember, and then they wrote down as much as they could recall from the information sheet. The recognition test was a true/false test about ad claims and information items. Subjects finally reported some demographic details, technical usage characteristics (PC use, Internet use, preference for print versus screen), and recency of experience with colds and purchasing cold medications.

Recalled copy points and information items were coded in two ways. They were coded as completely correct, semantically correct, or wrong, whereas recognition answers were coded as either right or wrong. Recalled items were also coded for content—whether the item was a general or specific item—and for the category of information covered by the recalled item.

RESULTS

General Profile of the Sample

Subjects ($n = 48$) were nearly evenly split by gender (45.8% male) and were predominantly native English speakers (64.6%). The average age was 27 years ($SD = 9.63$) with a range from 19 to 60 years old. Table 1 shows the demographic profile of the sample.

Most subjects ($n = 31$) reported having had a cold infection and exactly 50% ($n = 24$) had purchased a cold/flu medication in the last 6–12 months.

Table 1. Sample Characteristics.

Demographic	Frequency	Percent
Sex		
Male	22	45.8
Female	26	54.2
Total	48	100.0
Preferred language		
English	31	64.6
An Asian language	1	2.1
A European language	14	29.2
An Indian language	1	2.1
Another language	1	2.1
Total	48	100.0
Education		
Less than a high school degree	3	6.4
A high school degree	3	6.4
Vocational/technical School	12	25.5
Some university	15	31.9
A university degree	9	19.1
Some graduate education	5	10.6
Total	47	100.0
Missing	1	

Thus the level of interest should have been moderately high, and the product was appropriate for the subject group. Only three subjects reported being aware previously of the brand used in the study. This suggests that prior knowledge of the brand name did not influence the results.

Subjects also reported their use of and comfort with the PC, reading a screen, and using the Internet. Most users were experienced with the PC (81%, 4+ years) and many with the Internet (43%, 4+ years). Daily screen use was high, with 49% reporting 3+ hours daily. Forty-eight percent, however, said they preferred paper to screen reading. Overwhelmingly, they were comfortable with the PC (91%), the Internet (81%), and on-line learning (80%), but only 29% said they usually use the Internet to read about products. None of these proved to be related to treatment conditions; there were no systematic differences between conditions in experience, preference, or comfort.

Recall for Ad Claims and Health Information

Table 2 shows the means for the various measures of memory for both ad claims and health information points. A t test between print and screen media for *recall for ad claims* is significant ($t = 3.59$, $df = 46$, $p < .01$). Print recall shows a far larger mean than screen recall, even within a small sample. The results also show that print viewers attempted to recall significantly more items than screen viewers ($t = 2.88$, $df = 46$,

Table 2. Means for Recall and Recognition.

Medium	Recall Correct Items		Attempts		Percent		Recognition Correct Items		Percent
Ad claims									
Print	4.46	(1.82)*	4.67	(1.81)	0.96	(0.10)	6.71	(1.12)	0.84
Screen	2.71	(1.55)***	3.25	(1.60)**	0.82	(0.21)**	6.63	(1.21)	0.83
Total	3.58	(1.89)	3.96	(1.83)	0.89	(0.18)	6.67	(1.16)	0.83
Nonpersuasive information									
Print	5.42	(2.92)	5.50	(2.86)	0.98	(0.07)	7.29	(1.40)	0.81
Screen	3.25	(1.65)***	3.54	(1.74)**	0.93	(0.16)	6.96	(1.23)	0.77
Total	4.33	(2.59)	4.52	(2.54)	0.96	(0.12)	7.13	(1.32)**	0.79

* Mean (*SD*). ** $p < .05$. *** $p < .01$.

$p < .05$) and even had a significantly higher percentage of success ($t = 2.79, df = 31, p < .05$). Thus, Hypothesis 1 is supported.

For *nonpersuasive information*, print also produces significantly more recall than screen ($t = 3.17, df = 36, p < .01$). The results also show that print viewers attempted to recall significantly more items than screen viewers ($t = 2.87, df = 46, p < .05$) but did not show a higher percentage of success for print relative to screen ($t = 1.25, df = 25, p > .05$). Print was directionally higher; subjects may have taken the health information quite seriously as the percentage of correct attempts is nearly 100%. Hypothesis 2 is supported.

Aside from examining the difference between print and screen, there was also an interest in whether the results for information content would be different from ad content. With regard to Hypotheses 3 and 4, a repeated-measures analysis (see Table 3) shows that significantly more nonpersuasive information is remembered than persuasive (ad) information. The materials that subjects viewed were counterbalanced; half the subjects saw the ad first and half the subjects saw the information sheet first. There is no significant main effect for order. Recall for nonpersuasive information ($p < .05$) and the accuracy of recalled nonpersuasive information ($p < .05$) are both significantly higher than those measures for ad claims. There was no evidence that subjects made more attempts to recall the nonpersuasive information than to recall ad claims. Thus, Hypothesis 3 is largely supported. Hypothesis 4 was not supported; there was no significant interaction between the presentation mode—print versus screen—and the type of information—on-persuasive versus persuasive (ad) information. The pattern for percentage recalled correctly, however, suggests that information content viewed on a screen is nearly as likely to be remembered correctly as the same content in print form. In contrast, ad content shows a marked advantage for the print form relative to the screen.

Table 3. Repeated Measures Results for Nonpersuasive Information Versus Ad Claims.

		Tests of Within-Subjects Contrasts				
Source	Measure	Type III SS	df	MS	F	Sig.
Info. type						
	Recall	15.01	1	15.01	5.91	.02
	Recall attempts	7.62	1	7.62	2.94	.09
	Recall percent	0.13	1	0.13	6.25	.02
	Recognition	3.10	1	3.10	2.23	.14
Info. type * medium						
	Recall	2.35	1	2.35	0.93	.34
	Recall attempts	3.07	1	3.07	1.19	.28
	Recall percent	0.04	1	0.04	1.67	.20
	Recognition	0.60	1	0.60	0.43	.52
Info. type * order						
	Recall	1.87	1	1.87	0.74	.40
	Recall attempts	2.87	1	2.87	1.11	.30
	Recall percent	0.01	1	0.01	0.62	.44
	Recognition	5.74	1	5.74	4.13	.05
Error (info. type)						
	Recall	101.68	40	2.54		
	Recall attempts	103.51	40	2.59		
	Recall percent	0.85	40	0.02		
	Recognition	55.61	40	1.39		

		Tests of Between-Subjects Effects				
Source	Measure	Type III SS	df	MS	F	Sig.
Intercept						
	Recall	1,461.45	1	1,461.45	340.33	.00
	Recall attempts	1,693.34	1	1,693.34	405.13	.00
	Recall percent	71.36	1	71.36	3,664.45	.00
	Recognition	4,038.26	1	4,038.26	2,598.31	.00
Medium						
	Recall	77.46	1	77.46	18.04	.00
	Recall attempts	53.13	1	53.13	12.71	.00
	Recall percent	0.21	1	0.21	10.65	.00
	Recognition	2.99	1	2.99	1.92	.17
Order						
	Recall	8.19	1	8.19	1.91	.17
	Recall attempts	3.95	1	3.95	0.94	.34
	Recall percent	0.07	1	0.07	3.65	.06
	Recognition	0.04	1	0.04	0.03	.87
Error						
	Recall	171.77	40	4.29		
	Recall attempts	167.19	40	4.18		
	Recall percent	0.78	40	0.02		
	Recognition	62.17	40	1.55		

Recognition for Ad Claims and Nonpersuasive Information

Subjects answered a series of true-or-false questions about the ad claims and information they viewed; the total correct items were summed separately for the ad and the information sheet. There were eight recognition items for the ad claims and nine recognition items for the information items.

Table 2 also shows the results for recognition of ad and nonpersuasive information items. All recognition results were in the correct relationship to recall, that is, higher, implying that subjects recalled only a portion of what they had really stored in memory. No significant difference was found between print and screen display on either recognition for ad claims ($t = 0.25$, $df = 46$, $p > .05$) or for recognition for nonpersuasive information items ($t = 0.88$, $df = 46$, $p > .05$). The percentage of responses correct was not different between print and screen for either ad claims or nonpersuasive information. Also, there are no more items recognized for nonpersuasive information than for ad claims (Table 3).

In an effort to understand why there would be such persistent recall differences between two visual media such as print and screen, the following analyses explore the some of the possible explanations for those differences.

Media Effects on Content and Order of Recall

Modality has been shown to affect the content, and order of recall (Unnava et al., 1994) demonstrated differences in recall order across media from different modalities, radio versus visual sources. Eye tracker research has shown clear differences between the reading styles of print and screen and that when reading news on screen, screen users tend to look first at text and then at pictures and graphics (Stanford Poynter Project, 2000). Thus, the question is whether or not there are differences in the content as well as the quantity of what was remembered from the print materials versus the identical screen materials. Two routes were explored. On the grounds that screen reading is less familiar and subjects were more likely to be distracted by the novelty of the screen, it was speculated that subjects might process in a more general way and that would lead them to report general information rather than specific information from the screen stimuli. It was also speculated that there might be differences in the topics and types of information remembered between the two stimuli. Specifically, the Stanford Poynter (2000) findings suggest that screen viewers would be less likely to look at the graphic information contained in the ad, and practitioners report that there is considerable anecdotal evidence for the superiority of text-based relative to graphics-based ads (Quick Backgrounder on Google's New Ad Options, 2003). Chi-square tests to determine if remembered information (and whether that was information or graphical images) somehow differed by whether it was viewed on the screen versus the printed hard copy show no rela-

tionships between medium and what was remembered. There was no bias either toward or away from specific details, no bias toward any particular topic, and even no bias toward reporting the appearance of the ad or package.

Memory for Brand Name

Memory for brand name, however, was addressed separately. Subjects were asked to recall the brand name of the advertised product, and they were also tested on their recognition for the brand name of the product. McConnell (1970), the only other study testing brand name memory across media, found no difference in recall for brand name across three media (television, print, and radio). In the current study, subjects were asked to recall the brand name of the test product and subjects who were able to quote an exact or nearly exact brand name for the product were coded to have a correct answer. Table 4 shows these results. After only one exposure, 79% of subjects who viewed the ad in print form were

Table 4. Memory for Brand Name.

| | Recall* | | |
	Print	Screen	Total
Correct			
Count	19.0	11.0	30
Expected	15	15	30
% of column	79.2	45.8	62.5
Wrong			
Count	0	3	3
Expected	1.5	1.5	3
% of column	0	12.5	6.25
Nothing written			
Count	5	10	15
Expected	7.5	7.5	15
% of column	20.8	41.7	31.25

| | Recognition** | | |
	Print	Screen	Total
Correct			
Count	21	19	40
Expected	20	20	40
% of column	87.5	79.2	83.3
Wrong			
Count	3	5	8
Expected	4	4	8
% of column	12.5	20.8	16.7
Total			
Count	24	24	48
% of column	100	100	100

$*\chi^2 = 6.8, df = 2, p = .03. **\chi^2 = .6, df = 1, p = .44.$

able to recall the brand name, compared to 46% for a screen format. Chi-square analysis shows that whether a subject viewed print or screen materials is significantly related to brand-name recall but not related to brand-name recognition. Especially noteworthy is the proportion of screen viewers who wrote nothing or who wrote an incorrect brand name on the recall task and for recognition, the number of respondents who did recognize the brand name. These results suggest retrieval, not storage, is responsible.

Post Hoc Analyses—Mediation and Moderation of the Medium–Memory Relationship

Additionally, there is a need to explore whether or not reading time mediates the relationship between medium and memory and to explore whether comfort, familiarity, and preference moderate the relationship between medium and memory. If slow screen reading reduces the amount of information examined, then all of the memory effects will be related to time and not to the medium per se. If familiarity and comfort enable people to read and learn just as effectively from a screen as from paper, then screen-familiar respondents should remember just as much as paper respondents. If preference is responsible for lack of learning from a screen, then screen readers who prefer (or at least do not prefer paper) screen should remember just as much as those who see paper.

Prior examinations of learning from print versus learning from screen found reading from screen was slower than from print (Gould & Grinschkowsky, 1984; Muter et al., 1982; Smith & Savory, 1989; Wright & Lickorish, 1983). Looking only at screen materials, Bezjian-Avery et al. (1998) found that the interactive ads received less time than the linear ads that are comparable to traditional print ads. She concluded that interactivity inhibits processing. In contrast, the results of the current study found that subjects spent more time with the materials printed on paper than reading even an ordinary linear ad from the screen ($\bar{\chi} = 3.79$, $SD = 0.98$ versus $\bar{\chi} = 3.42$, $SD = 0.88$; $t = 1.40$, $df = 46$, $p = .17$) but this difference was not significant. This does not directly address the question of whether the reading time was slower from the screen, but does allow examination of whether more time was related to better memory.

It could be hypothesized that viewing time mediates the relationship between medium and recall. Greater depth of processing that can occur during extra time should result in better memory (Craik & Lockhart, 1972). Better recall is associated with the print medium that elicited the longer time, and it could be argued that the print is either more desirable or easier to use, so that more time will be spent on that medium. Alternatively, if the screen was read more slowly it might have resulted in careful reading of fewer items, and the expectation was that recognition would be less for screen, and that recall would equal the recognition level.

These results do not meet the first criterion for mediation (Baron & Kenney, 1986)—that there is a significant relationship (*ns*, $p = .17$) between the independent variable (medium) and the hypothesized mediator (time). Although the medium was significantly related to every measure of memory but one (see Table 5), it did not significantly predict viewing time, and the hypothesized mediator, viewing time, was not significantly related to any of the measures of memory or recall effort. Further interpretation of the nonsignificant results shows that using viewing time as a mediator does reduce slightly the significance of the print–screen effect on recall. Viewing time is nearly significant for the ad stimulus, and, in a larger sample, it is likely that viewing time would mediate the medium–memory relationship for advertising. Such an effect would not be anticipated for nonpersuasive information—viewing time is nowhere near significant in this sample. The extra time may not make a difference to recall for information deemed truly informative, but may be needed for ad claim.

Previous research suggests two factors might moderate the relationship between medium and measures of memory for ad claims and health information—familiarity/comfort with the screen and preference/liking for the screen. Familiarity and comfort with the computer screen (Faccoro & DeFleur, 1993) have been posited to overcome the processing shortcomings that have traditionally been associated with reading information from a screen. Subjects in this study responded to three items meant to measure their comfort with using a screen:

1. I am not at all comfortable using a PC.
2. I am perfectly comfortable using the Internet.
3. I am completely satisfied with my skills for using the Internet to learn.

This scale showed acceptable levels of reliability (alpha = 0.778) and was used to create a summed measure of screen comfort, likely result-

Table 5. Test of Viewing Time as a Mediator.

| | Main Effect Medium | | Mediated Model Medium | | Time | |
Dependent Variables	*b*	Sig.	*b*	Sig.	*b*	Sig.
Viewing time (mediator)	−0.188	0.169				
Ad recall	−0.875	0.001	−0.784	0.002	0.483	0.071
Ad recall attempts	−0.708	0.006	−0.629	0.014	0.423	0.119
Ad recall percent	−0.069	0.007	−0.060	0.023	0.038	0.187
Info. recall	−1.083	0.003	−1.085	0.004	−0.010	0.978
Info. recall attempts	−0.980	0.006	−0.974	0.008	0.027	0.943
Info. recall percent	−0.023	0.210	−0.025	0.202	−0.007	0.736

ing from familiarity. Anecdotal evidence as well as commercial market research suggests that difference in results from screen versus print may be attributed to relative liking and preference for the two media. Subjects reported answers to these measures of preference:

1. I strongly prefer to read important information from a piece of paper rather than a computer screen.
2. I don't ever mind reading from a screen.

The two-item scale to measure preference for reading from paper versus screen also showed acceptable levels of reliability (alpha = 0.776) and the items were used to create a summed measure of print/screen preference.

With the use of the Baron and Kenny (1986) guidelines for testing continuous-scaled moderators in a regression analysis, the moderating effects of screen comfort and preference were tested. To make the regression coefficients directly interpretable as main and interaction effects, the variables were transformed with the use of the West, Aiken, and Krull (1996) procedures. The independent variable, medium, was coded for unweighted effects (-1, $+1$), whereas the continuous moderators, comfort/familiarity and preference, were converted from their summed scale values to deviation scores ("centered"). Table 6 shows the results of the moderator analysis for comfort/familiarity and preference.

The results reiterate the strong main-effect differences found between print and screen and already shown in Tables 2, 3, and 5. There is no three-way relationship between medium, preference, and print–screen comfort, and no interaction between preference and comfort. It also appears that preference does not moderate the relationship between medium and recall for either ad claims or nonpersuasive information; there is no significant interaction between medium and preference on any measure of recall or recall effort. Screen comfort/familiarity shows nearly significant ($p < .10$) interactions with medium for ad recall and ad recall attempts; there is also a significant ($p < .05$) interaction for recall hit rate for nonpersuasive information. This suggests that comfort/familiarity might make a weak contribution to explaining differences between print and screen—potentially by letting users generate the cues needed for recall.

Screen preference shows a main effect on recall for ad claims and the hit rate for nonpersuasive information; however, the small sample does not permit a firm conclusion because some cells at higher screen preference ratings did not contain any respondents who saw the print stimuli—likely artificially inflating the difference in means.

CONCLUSIONS AND IMPLICATIONS

The overarching hypothesis that print media would be better than screen media for delivering persuasive ad information and for delivering non-

Table 6. Tests of Screen Comfort and Screen Preference as Moderators.

Model	Ad Claims						Health Info.					
	Recall		Recall Attempts		% Correct		Recall		Recall Attempts		% Correct	
	b	t	b	t	b	t	b	t	b	t	b	t
(Constant)	3.45	13.19***	3.80	15.14***	0.89	29.88***	4.21	11.04***	4.41	11.57***	0.94	46.72***
Print-screen	−0.78	−3.00***	−0.61	−2.43**	−0.07	−2.48**	−1.25	−3.28***	−1.15	−3.01***	−0.04	−1.96**
Screen preference	−0.24	−1.91*	−0.36	−2.96***	0.02	1.12	−0.14	−0.76	−0.10	−0.55	−0.02	−2.00**
Screen comfort	0.00	0.01	0.09	0.40	0.00	−0.18	0.45	1.38	0.31	0.96	0.05	2.66**
Medium × preference	−0.02	−0.18	0.03	0.22	−0.02	−1.12	−0.01	−0.07	−0.03	−0.15	−0.01	−0.58
Medium × comfort	0.39	1.73*	0.43	2.00*	0.00	0.16	0.21	0.65	0.10	0.32	0.04	2.18**
Preference × comfort	0.10	1.00	0.09	0.92	0.00	0.29	0.08	0.52	0.08	0.52	0.01	1.11
Medium × pref. × comfort	−0.11	−1.05	−0.09	−0.92	−0.01	−0.44	0.13	0.88	0.16	1.05	0.00	0.26

* $p < .10$, ** $p < .05$, *** $p < .01$.

persuasive information was supported in a variety of ways. Although the sample size is small, strong results imply that there is a difference between the printed page and the screen that should not be ignored, and it makes a difference, at minimum, to memory for information. Unlike other studies, the physical stimuli in this study were directly comparable across the two media and were not confounded by any of the special properties of hypermedia or differences in content. Print is consistently better for recall than screen and, moreover, print is consistently associated with more attempts to retrieve information than is screen, possibly a signal that print carries more motivating properties. Griffith, Krampf, and Palmer (2001) make a similar point about the physical differences between a print catalogue and its direct reproduction on a screen. They attribute inferior performance for screen to an inability to stimulate involvement with the content.

The results show that, generally, memory for nonpersuasive information is better than for ad claims. The *percentage* of nonpersuasive information correctly recalled did not differ across the media and, notably, it was nearly 100% for both print and screen. Such a high accuracy rate for nonpersuasive information (compared to ad claims) suggests that users can be quite motivated to process nonpersuasive information from a screen. In view of companies' widespread use of their Web sites for providing usage, educational, and other information, this is a promising result and signals that there is merit for investigating the differences between the way persuasive and nonpersuasive information are processed on a screen relative to printed pages.

Examination of the recall and recognition results suggests that, in an incidental learning environment, respondents stored the same contents in memory, and the differences are due to an inability to retrieve. Several results point to this conclusion. There are no recognition differences; thus, the volume of available information is likely to be the same across media. There is also no difference in recognition for brand name, a specific item. Further, there are no differences between media in either the specificity of recalled items or the topics of recalled items. This implies that further examination of screen versus print should explicitly address retrieval issues.

Brand-name recall was substantially lower for screen respondents. Finding a difference in brand-name recall (with no corresponding difference in recognition) carries some clear managerial implications. Not being able to recall a brand name reduces the likelihood that a brand will be included in a consideration set; this is more likely to be an issue when someone shops on-line and buys off-line than when shopping and buying both occur on-line.

Reading time does not appear to mediate the relationship between the display medium and recall, although in a large sample it might prove to be important for persuasive (ad) information, but not for nonpersuasive information. Nonpersuasive information may be easier to relate

and/or to elaborate, and, in this case, one could surmise that some of the health information was already well known. Screen comfort is loosely based on prior experience with the computer screen and Internet use; it does appear to improve screen users' ability to remember information that they are already motivated to learn, that is, nonpersuasive information. This raises the need to explore perceptual factors (Dillon, 1994) as well as usage context (Muter, 1996) in future studies of print versus screen.

The conclusions for this test are limited to print versus screen media, in contrast to the Gallagher, Foster, and Parsons (2001); Gallagher, Parsons, and Foster (2001); and Bezjian-Avery et al. (1998) studies, which mimicked the interactivity and layout of a Web site in their screen stimulus. As a test of on-line advertising or the value of the rich media options on-line, this study suffers because subjects did not have the control and interactivity that would normally be presented on-line. It would be useful to examine these factors—display format and the impact of interactivity—separately, in a future study.

The recall differences between print and screen were strong. Although subjects could have confused the stimuli—ad and information sheet—at retrieval, care was taken to direct people to respond for the correct stimulus, and visual inspection suggests that respondents named appropriate items for each stimulus. One might wonder, however, if recall differences might have been influenced by the print-condition subjects recalling with the same cue (paper) as the original encoding, whereas screen subjects recalled without a matching cue. The impact of retrieval-cue modality shows mixed results, with some evidence for retrieval-cue specificity (Costley, Das, & Brucks, 1997) and some against retrieval-cue specificity (Furnham & Gunter, 1989). Whether a modality effect of retrieval cue would hold for the memory differences between screen and print is not known.

The central theme to emerge from this study is that individuals have a better ability to recall after viewing materials in print rather than on screen. A secondary theme is that persuasive information appears to differ from nonpersuasive information. These results are important for addressing marketing goals in an era where firms wonder how to blend electronic media into their existing programs. For marketing goals, which require consumers to remember information off-line at a decision point or purchase point, print should outperform screen. Where being able to retrieve information from memory matters less, such as in on-line shopping, screen and print seem equally suitable. Similarly, it seems entirely reasonable to believe that the Internet will do a good job disseminating time-dependent or other important factual information about products and services.

This study raises many questions for future exploration. The conflicts in memory results across several previous studies point to some valuable refinements for this research stream. One, stronger tests of the pro-

cessing explanations for such differences would be valuable, particularly as regards the differences between print and screen. For instance, an explanation to be investigated is that people who read from a screen assume they can go back on the screen/on-line environment and therefore do not need to process very deeply. Processing differences that are not due to display quality and familiarity may not go away easily, leaving ongoing effectiveness differences for print and screen. Two, the focus on the noticeable functional qualities (i.e., interactivity) has directed attention away from the unexplored structural qualities of the screen. The screen medium itself may alter processing either by the effects of the structural properties (Lang et al., 1996) on encoding or by the meanings that are imparted to the content (persuasive or nonpersuasive) or the act of using the medium (McCracken, 1987; Sherry, 1987).

An area that remains completely unexplored for on-line media is the long-term effect of the medium on memory and attitude. Comparing print to auditory delivery, Unnava et al. (1994) found clear long-run effects for medium, refuting the idea that presentation mode is only a superficial characteristic that alters representation in memory. As on-line marketers increasingly realize, much of the value of the on-line ad lies in branding, not direct purchase incentive. Thus, the long-run implications for attitude formation are of interest. Stewart et al. (2002), for example, show that attitude toward medium affects attitudes and beliefs about brands and is not necessarily an influence on memory.

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