

# Congruent versus Incongruent Display: The Effect of Page Layout on Critical Reading in Print and Digital Formats

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## Abstract

With the proliferation of online information and the increasing amount of online books and articles, we face two major trends of reading: (1) converting books, newspapers and journals "as is" from print to online-digital display, and (2) printing online texts by the users and reading them from paper. In both cases, the text is being read in an incongruent situation (i.e. it is not read in the original display it was designed for). This study investigated the effect of converting text from print to digital and vice versa, on the ability of consumers to read it critically. A group of 80 11th graders were asked to read news items in congruent and in incongruent reading situations. Results show a negative effect of converting text from one display to another without adjustment. The effect was strongest in converting texts from print to digital display. The findings illustrate the critical importance of format-specific text-design in converting text from print to digital and vice versa, and suggest that universities, information repositories and other text providers should consider format adjustments in making their texts accessible for readers.

**Keywords:** Information literacy, critical thinking, information representation, disinformation and bias, human computer interaction.

## Introduction

In recent years, we face an exponential growth in the amount of online digital information, which by the year 2020 is expected to make about 70% of the world's information (e.g. Pew Research Center Report, 2006; Romano, 2000; Saranto & Hovenga, 2004). At the same time, there are research indications regarding the growing amount of manipulative or biased information in information resources, mainly on the Internet, which utilize elaborate textual or multimedia manipulations to hide their biased or falsified nature (Dor, 2001; Eshet-Alkalai, 2004). These indications are coupled by alarming reports on the inability of most information consumers, especially the young ones, to consume information wisely by identifying biased and manipulative elements (Dunn, 2002; Eshet-Alkalai & Amichai-Hamburger, 2004; Eshet-Alkalai & Geri, 2007; Tenner, 2006), and raise the need to develop critical thinking skills among information consumers (Browne, Freeman, & Williamson, 2000), especially in light of the recent study of Eshet-Alkalai and Chajut, (2008), which reported a significant drop in critical thinking skills among young users during a period of five years.

These findings, regarding the lack of critical information skills, have led to extensive research efforts, which compared readability and critical thinking in print versus digital formats, (e.g. Baker, Bernard, & Riley, 2002; Bernard, Fernandez, & Hull, 2002; Eveland & Dunwoody, 2000; Hargittai, 2002; Morahan-Martin & Anderson, 2000; Shaikh, 2004), in order to establish standards for proper information design formats (Brady & Philips, 2003). In their comparative study of critical thinking skills in print versus digital formats, Eshet-Alkalai & Geri (2007) found that the younger participants (16 years old) were more critical in reading digital text, whereas the older ones (26 years old) were more critical in the digital format. Most studies of reading from print versus digital formats suggest that readers prefer long academic texts in print, and short, news-like texts, in digital (Spencer, 2006).

Mayer (2001) described congruent and incongruent learning environments as environments in which either conflict or harmony exist between their original design and their actual use, showing that incongruent situations harm, whereas congruent ones support learning. The proliferation of online texts in recent years has led to the introduction of two common modes of incongruent consumption of information: (1) reading texts which were converted "as is" from print to the Internet, without adapting their design to the new platform (as in most e-books and journal articles in digital libraries), and (2) printing texts that were designed originally for a digital display and reading them in print, as most users do for long academic texts (Spencer, 2006).

This study investigates the effect of the type of congruency (congruent or incongruent) in text display on the level of critical reading among information consumers. This research is a follow-up of the Eshet-Alkalai and Geri (2007) study, in which critical reading was tested in congruent situations only (texts which were designed for print were read from a printed page and texts which were designed for digital display were read from a computer screen. Our hypothesis was, following Eshet-Alkalai & Geri (2007), that in incongruent reading situations, critical reading will be lower than in congruent ones.

## Methodology

### Participants

80 people participated in the research, all from the 11th grade of a public school in Jerusalem, Israel (average age: 17.6), 40 boys and 40 girls. All participants read a newspaper at least four times per week; they all had a computer and Internet connection at home, and they used it to read the news on a daily basis. All were proficient in other basic computer skills such as using Office programs and surfing the Internet.

### Tasks

A task-oriented research approach, in which participants were required to perform with real-life authentic tasks (Wiggins, 1992; 1993), was employed to compare critical thinking skills in print and digital news formats. Participants were divided into four equal groups of 20 participants (10 boys and 10 girls in each group), which received a task that required reading in either congruent or incongruent situations, as follows:

#### Congruent situations:

- **Print to Print Group (PP):** Reading from a printed page of a newspaper 5 news items which were designed originally to be read in print.
- **Digital to Digital Group (DD):** Reading from a computer screen 5 news items which were originally designed to be read in a digital format.

**Incongruent situations:**

- **Digital to Print Group (DP):** Reading a printed version of 5 news items from a newspaper website, which were originally designed to be read digitally.
- **Print to Digital Group (PD):** Reading from a computer screen a scanned version of 5 news items which were designed originally to be read in print, scanned "as is" and read from the computer screen.

Each group received the same set of five news items that were published in the national newspaper Haaretz, and appeared in both printed and digital formats ([www.haaretz.co.il](http://www.haaretz.co.il)). The news items belonged to five different subject areas (one item from each area): politics, science, economy, sport and art. According to their group, participants read the text, in one of the following formats: (1) original print design (the newspaper), (2) original digital design (the newspaper's website), (3) print that was scanned to a digital, JPG format, and (4) a digital design that was printed.

After reading the five news items, participants were asked to write a short critical summary that reports on all the biased, false or manipulative treatment of information they could identify in each item, and to give an overall, justified, assessment of the item's reliability. The News Manipulation Model of Dor (2001; 2004) was used for the critical analysis.

**Grading**

Participants' performance in each task was assessed and graded by one of the authors, aided by a list of evaluation guidelines, which were used and validated before by Eshet-Alkalai and Geri (2007). Table 1 presents the grading guidelines used by referees to grade the reports on the analyzed news items. Grades represent the overall assessment of the report by the referees, based on these guidelines. A random selection of 20% of the reports was graded independently by two additional expert referees who used the same guidelines for evaluation, to test the validity of the grading guidelines. The close similarity between the referees' grades and the grades given by the authors (Pearson Correlation range 0.765 to 0.982, all significant at the 0.01 level, two-tailed) suggests a high coherence of the evaluation criteria utilized in this research.

**Results**

**Reading in congruent situations (PP vs. DD):** Results from the congruent reading situations, i.e. PP (print-designed text which is read in a print format) and DD (digitally-designed text which is read in a digital format) indicate that the DD group performed significantly better than the PP group in all the five subject areas (see Table 2). This supports the findings of Eshet-Alkalai and Geri (2007) that high-school students, who were of the same age as the present study's participants, perform in digital formats better than print ones.

**Table 1. Grading guidelines**

	<b>Principle</b>
<b>General</b>	<ul style="list-style-type: none"> <li>• Overall assessment of report.</li> <li>• Manipulative use of readers' misconceptions and prejudice.</li> <li>• Manipulative use of readers' common knowledge.</li> <li>• Manipulative use of readers' schemas and mental models.</li> </ul>
<b>Text</b>	<ul style="list-style-type: none"> <li>• Manipulative use of headlines.</li> <li>• Manipulative use of specific words to create bias.</li> <li>• Manipulative use of sentence structure to create bias.</li> </ul>
<b>Graphics</b>	<ul style="list-style-type: none"> <li>• Using photographic manipulations to create bias (angle of photography; selecting a specific image).</li> <li>• Manipulative use of page or screen layout to create bias (e.g. proximal placement of text and image).</li> <li>• Manipulative use of visual design elements to create bias (e.g. color, centering; emphasizing).</li> <li>• Manipulative use of principles of message design.</li> </ul>

**Table 2. Analysis of variance results: Congruent situations (PP vs. DD)**

<b>Subject area</b>	<b>Group</b>	<b>N</b>	<b>Mean</b>	<b>Std. D.</b>	<b>F</b>	<b>Sig.</b>
Politics	Print-Print	20	55.6	8.0	4.6	0.039
	Digital-Digital	20	60.6	6.8		
	Total	40	58.1	7.7		
Science	Print-Print	20	70.9	9.2	8.0	0.007
	Digital-Digital	20	78.3	7.2		
	Total	40	74.6	9.0		
Economy	Print-Print	20	36.5	8.7	14.9	0.000
	Digital-Digital	20	46.5	7.5		
	Total	40	41.5	9.5		
Sport	Print-Print	20	77.5	7.0	20.8	0.000
	Digital-Digital	20	87.4	6.7		
	Total	40	82.4	8.5		
Art	Print-Print	20	74.5	7.0	4.3	0.044
	Digital-Digital	20	79.4	7.7		
	Total	40	76.9	7.7		

**Comparing reading in congruent with incongruent situations (PP vs. PD and DD vs. DP):**

In analyzing the results, we compared the performance between congruent and incongruent reading situations. Results clearly indicate the superiority of congruent reading situations as follows:

- PP-PD (comparing reading a text which was designed for print and read in print, with reading a text which was designed for print and read in digital): Results indicate that in all five subject areas, participants performed significantly better in the congruent (PP) compared to the incongruent (PD) reading situation (see Table 3).
- DD- DP (comparing reading a text which was designed for digital and read in digital, with reading a text which was designed for digital and read in print): Results indicate that in all five subject areas, participants performed significantly better in the congruent (DD) compared to the incongruent situation (DP) (see Table 4).

**Table 3. Analysis of variance results: Congruent vs. incongruent situations (PP vs. PD)**

Subject area	Group	N	Mean	Std. D.	F	Sig.
Politics	Print-Print	20	55.6	8.0	46.8	0.000
	Print-Digital	20	40.2	6.2		
	Total	40	47.9	10.5		
Science	Print-Print	20	70.9	9.2	108.8	0.000
	Print-Digital	20	45.2	6.0		
	Total	40	58.1	15.1		
Economy	Print-Print	20	36.5	8.7	48.6	0.000
	Print-Digital	20	20.1	5.9		
	Total	40	28.3	11.1		
Sport	Print-Print	20	77.5	7.0	110.7	0.000
	Print-Digital	20	55.5	6.2		
	Total	40	66.5	12.9		
Art	Print-Print	20	74.5	7.0	122.9	0.000
	Print-Digital	20	54.0	4.4		
	Total	40	64.3	11.9		

**Comparing reading in incongruent situations (DP vs. PD):** We compared the performance of our participants in two different incongruent situations: (1) reading a digitally-designed text which is read in print (DP), with (2) reading a print-designed text which is read in digital (PD). Results clearly show the superiority of digitally-printed text, as indicated by the significantly better performance of the DP group compared to the PD group in all five subject areas (see Table 5).

**Table 4. Analysis of variance results: Congruent vs. incongruent situations (DD vs. DP)**

Subject area	Group	N	Mean	Std. D.	F	Sig.
Politics	Digital-Digital	20	60.6	6.8	9.5	0.004
	Digital-Print	20	53.0	8.6		
	Total	40	56.8	8.6		
Science	Digital-Digital	20	78.3	7.2	27.3	0.000
	Digital-Print	20	65.9	7.9		
	Total	40	72.1	9.7		
Economy	Digital-Digital	20	46.5	7.5	17.7	0.000
	Digital-Print	20	35.4	9.1		
	Total	40	40.9	10.0		
Sport	Digital-Digital	20	87.4	6.7	41.4	0.000
	Digital-Print	20	74.9	5.5		
	Total	40	81.2	8.8		
Art	Digital-Digital	20	79.4	7.7	30.0	0.000
	Digital-Print	20	68.3	4.8		
	Total	40	73.8	8.5		

**Table 5. Analysis of variance results: Incongruent situations (DP vs. PD)**

Subject area	Group	N	Mean	Std. D.	F	Sig.
Politics	Digital-Print	20	53.0	8.6	29.4	0.000
	Print-Digital	20	40.2	6.2		
	Total	40	46.6	9.9		
Science	Digital-Print	20	65.9	7.9	86.5	0.000
	Print-Digital	20	45.2	6.0		
	Total	40	55.5	12.5		
Economy	Digital-Print	20	35.4	9.1	39.8	0.000
	Print-Digital	20	20.1	5.9		
	Total	40	27.7	10.8		
Sport	Digital-Print	20	74.9	5.5	111.4	0.000
	Print-Digital	20	55.5	6.2		
	Total	40	65.2	11.4		
Art	Digital-Print	20	68.3	4.8	96.5	0.000
	Print-Digital	20	54.0	4.4		
	Total	40	61.1	8.5		

There was no significant interaction between gender and reading format. However, significant differences between males and females, regardless of the format, were found in all the subgroups. These differences are beyond the scope of this paper and are not discussed here.

## Discussion

The significant differences found in the research shed light on our understanding of the effect that the transformation of text from print to digital displays and vice versa has on reading in general and on critical reading in particular. Results have special importance in light of the exponential growth in the amount of books and academic articles, which are transformed from print to online display (Birkerts, 1994; Romano, 2000) and in the amount of online texts which are printed by the users (Nila, Sathe, Grady, & Nunzia, 2002). Results indicate a significant negative effect in all the incongruent reading situations, in which text is not read according to its original design. The largest negative effect was found in reading a print-designed text in a digital format. These findings suggest that text should not be converted "as is" from one reading platform to another without making special adjustments, and indicate the pivotal role of format-specific text-design in order to minimize the "cost" of the change in the reading platform. Our findings should be interpreted in terms of Mayer's (2001) multimedia design principles (especially the Coherence Principle), according to which best learning is achieved when text and pictures are designed to support each other. Along the same line, we suggest here that text-design should support the reading format, and that any deviation from this principle would result in harming the reading quality.

Findings of the present study provide valuable guidelines for information designers (Baker et al., 2002; Bernard et al., 2002; Hillsund, 2008; Nelson, 2008), researchers and educators (O'sullivan, 2002; Grafstein, 2002; Johnston & Webber, 2003). Results also reinforce former findings (Eshet-Alkalai & Geri, 2007) that young people (high school students) are more critical readers in digital compared to print formats.

## Conclusions

Our findings suggest the following conclusions:

- When converting text for reading in a different format than it was originally designed for (i.e. from print to digital or from digital to print), text-design should ensure that a harmony exists between the text display format and the reading situation.
- Incongruent or disharmonic reading situations harm the quality of reading
- The biggest negative effect on reading quality was found when text which was designed to be read in print, was scanned and read "as is" in a digital format. A slightly smaller, but yet significant, negative effect was found when text, which was designed to be read in a digital format, was printed and read from print.
- Findings suggest that text should not be converted "as is" from one reading platform to the other without making special design adjustments.

Conclusions of the present study are limited by the relatively small group size, and a further, larger-scale study, is necessary in order to corroborate our findings. However, the fact that results of the present study for the congruent reading situations support former findings of Eshet-Alkalai & Geri (2007), suggest the coherence and validity of the present study results.

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