Supporting Memory for Spatial Location while Reading from Small Displays

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ABSTRACT

Research has shown that when people read paper documents, they develop an incidental memory for the location of information within those documents. However, this kind of spatial memory is undermined in conventional on-line scrolling interfaces. We report on an experiment in which we show that careful design of the interface can reinstate memory for spatial location. As we will show, this has particular implications for the design of interfaces for small screen displays.

KEYWORDS

Reading, spatial memory, small displays, mobile devices.

INTRODUCTION

Research has shown that when people read paper documents, they can often recall the approximate location of information within those documents [1, 2]. For example, they can recall that a certain item of information was in the top right hand corner of a page, or just to the left of a diagram, and so on. This memory appears to be incidental in that it is a by-product of the reading process, rather than something readers intentionally set out to do.

Awareness of spatial location is important for readers and writers for a number of reasons. Most obviously, it supports search and retrieval of information since even knowing the approximate location of information can narrow the search space. But research has shown that it also increases comprehension while reading, both by supporting the understanding of a document's organisational structure [3] and by facilitating the recall of a document's content [2].

While readers are able to develop this incidental memory when reading paper documents, there is evidence that it is hindered when reading on-line [3]. There are at least two possible explanations why on-line interfaces fail to support spatial memory: First, limitations in screen size mean that information is not viewed within the visual context of a whole page. This makes it difficult to establish spatial relationships between one part of a page and another.

Second, scrolling means there is a dynamic relationship between the location of the information and reference points such as window boundaries. This can be contrasted with paper where there is a fixed relationship between text and the pages on which they are displayed.

Such problems are exacerbated on smaller displays where even less of the document can be displayed legibly and where there is an increasing need to scroll to read. Given the increasing popularity of handheld devices with small displays (e.g. PDAs, digital document cameras), an important design question arises as to how to support spatial awareness while reading from small screens.

A class of interface techniques that have been shown to be useful in presenting information within limited screen space have been called "focus+context" techniques (e.g. [4, 5]). In these interfaces, the focus of attention is presented in full detail while the surrounding context is presented with minimal detail. This paper uses a new version of a focus+context interface for small displays to present legible text within the context of the visual page. An experiment is reported to test whether reading with this interface produces better memory for spatial location of information than a traditional scrolling interface.

METHOD

Subjects

Subjects were 20 volunteers from Xerox Research Centre Europe, Cambridge Laboratory.

Experimental Design and Set-up

The experiment was a single factor, between-subjects design comparing incidental memory in two different interfaces.

Ten subjects read a document using a simple "focus + context technique" (Figure 1a) in a 3X5 inch window meant to simulate a portable device. A portion of legible text was presented one sentence at a time above a thumbnail image of the current page. Within the thumbnail, the sentence being viewed was highlighted to show the location of that sentence within the page. Readers moved forward to the next sentence or back to the previous one using forward or backward buttons.

Nb. This work was carried out while the authors were at Xerox Research Centre Europe, Cambridge Lab

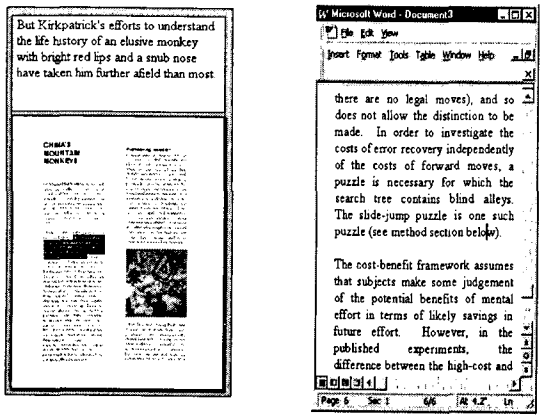

Figure 1(a). The "focus+context" interface. The highlighted sentence is the one shown in readable detail at the top of the screen. (b). The scrolling interface.

The other 10 subjects read the same document using a standard scrolling interface in Microsoft Word presented in the same size window using 12 point font.

Procedure

Subjects were given the same 5 page document to read in either condition. They were asked to read it for general understanding with nothing said about subsequent testing. After reading it, they were given a test consisting of 27 verbatim extracts (either sentences or short phrases that were considered meaningful units of information) from the source document. They were then asked to mark on 27 different pages with blank columns marked out where they thought each of the items was located in the document they read.

RESULTS

Subjects' within-page location judgements were categorised into a 2 (**R**ight, **L**eft) x 3 (**T**op, **M**iddle, **B**ottom) matrix of equally sized page sections. The frequency of judged location were then compared to their actual locations. For each combination of judged location versus actual location, a ratio (P_r/P_s)was calculated as a measure of within-page location accuracy (cf. [1]). P_r is calculated for each location category by summing all judgments across subjects for any given actual location and dividing by the total number of judgments. P_s is the proportion of actual items from a particular location.

This ratio accounts for two biases that distort a simple frequency-based measure of within-page location accuracy: (1) that the actual locations of the test items were not distributed evenly across the 6 page sections; (2) that subjects' response preferences were not distributed evenly across the 6 page sections. The ratio P_r/P_s is equal to 1.0 when performance is at chance levels so ratios above 1.0 can be considered to be indicative of above chance performance.

For evidence of incidental memory for within-page spatial location, the score for the correct judgement should be the largest. This *is* the case for location judgement RT, RM RB, and LT but *not* for LM and LB (note, though, that for LB it is the second largest). The probability of this being the case in 4 out of 6 of the location categories is $^6C_4 = (1/6)^4 (5/6)^2 = 7.9 \times 10^{-3}$ which is significant.

Actual \ *Judged*	RT	RM	RB	LT	LM	LB
RT	1.6	0.9	1.1	0.4	1.2	0.8
RM	1.1	1.5	1.1	0.7	0.7	0.8
RB	0.7	1.0	2.2	1.1	0.6	0.6
LT	0.6	0.8	0.5	1.7	1.2	1.0
LM	0.8	0.7	0.4	1.3	1.1	1.8
LB	1.2	0.9	0.3	0.7	1.4	1.3

Table 1. The scores for judged vs. actual locations for the focus +context interface.

In the scrolling interface, the score for the correct judgement was largest for location judgement LM only. The probability of this being the case in 1 out of 6 categories is $^6C_1 = (1/6)\ (5/6)^5 = 0.4$ which is not significant.

DISCUSSION AND CONCLUSION

The findings show that using a focus+context interface technique in a small display can support readers' incidental memory for spatial location of information within documents. Further, it shows that a scrolling interface for the same size display does not. Since we know that spatial location is important in reading, we can conclude that this alternative technique may well confer some benefits to the reader in terms of better comprehension, content recall and information retrieval when reading from small screens. In short, this technique appears to be successful to some degree in providing readers with some of the "sense of text" they get when reading from paper.

In presenting this study, we are not necessarily advocating this particular implementation of a focus+context interface. Rather, our intention is to point toward a class of techniques which designers might consider as an alternative approach to reading and viewing documents on small displays.

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