Usability News

July 2002, *Vol. 4 Issue 2*

| Volume 4 Issue 2 | Past Issues | A-Z List |

Usability News is a free web newsletter that is produced by the Software Usability Research Laboratory (SURL) at Wichita State University. The SURL team specializes in software/website user interface design, usability testing, and research in human-computer interaction.
Barbara S. Chaparro, Editor

The Effects of Line Length on Children and Adults' Online Reading Performance

By Michael Bernard, Marissa Fernandez, & Spring Hull

Adults, as well as children these days often read an extensive amount of information online. For example, of the 25-to-34-years-old age group, it is reported that 25 percent read online newspapers, compared to only 19 percent who read from printed newspapers (The Digital Edge, 2000). Even young children are now spending progressively more time reading online documents, including being tested online in schools. Thus, the need to address the ergonomic issues associated with this type of medium has become even more important. As discussed in previous editions of Usability News, certain textual factors can affect user performance and preference when reading online text. The purpose of this study was to examine the effects of line length on online reading performance by both adults and children. Unfortunately, little research has been conducted investigating line length and online reading with respect to both actual and perceived reading efficiency, as well as preference; and, to date, no research has included children in its investigation.

Studies investigating line lengths have thus far produced mixed results. For example, Dyson and Kipping (1998) found that longer lines (approximately 75-100 characters per line or CPL) were read faster than very narrow ones (25 CPL), with no difference in perception of reading efficiency. Moreover, Duchnicky and Kolers (1983) found that full-screen (187 mm) line lengths resulted in 28 percent faster reading times over 1/3 screen (62 mm) line lengths. In addition, the full and 2/3 screen (125 mm) line lengths were read significantly faster than the 1/3 screen line lengths. Duchnicky and Kolers concluded that longer line lengths are read more efficiently from computer screens than narrower ones.

Yet, conclusions have mostly favored short to medium line lengths. For example, it has been recommended by researchers that shorter line lengths (about 60 CPL) should be used in place of longer, full-screen lengths, since longer line lengths require greater lateral eye movements, which makes it more likely to lose one's place within the text (Horton, 1989; Mills & Weldon, 1987). Horton (1989) points out that longer line lengths are more tiring to read and recommends limiting line lengths to around 40 to 60 CPL. Huey (1968) generally supports this recommendation by finding that narrower line lengths (approximately 4" or 10 cm) are more accurate on the return sweep than longer line lengths. Gregory and Poulton (1970) maintain that people with poor reading ability performed better when the line length was approximately seven words. This suggests that young readers who have not mastered online reading, as well as readers who have vision deficits, may benefit the most from narrower line lengths.

Moreover, Youngman and Scharff (1999) found that with 0.5-inch (12.5 cm) margins, the fastest reaction times were for the shorter, 4-inch (10 cm) lengths over the 6- and 8-inch lengths (15 and 20 cm, respectively). The 4-inch lengths were also preferred over the other lengths. With no margin lengths, the 8-inch line lengths had the fastest overall reaction times. Similarly, a recent study by Dyson and Haselgrove (2001) found that medium line lengths (55 CPL, which is approximately 4-inches) facilitated more effective reading at normal reading speed than shorter line lengths (24 CPL).

METHOD

Participants

Forty participants (20 adults and 20 children) volunteered for this study. The adults ranged in age from 18 to 61, with a mean age of 29 (S.D. = 12 years) and the children ranged in age from 9 to 12, with a mean age of 11 (S.D. = 1 year) and attended 4th, 5th, or 6th grade. All adults reported reading text on computer screens a few times per week or more. Seventy-five percent of the children reported reading text on computer screens a few times per month or more. The children received $5.00 for participating in this experiment. All participants had 20/40 or better unaided or corrected vision as tested by a Snellen near acuity chart.

Materials

A Pentium II based personal computer, with a 60 Hz, 96dpi 17" monitor with a resolution setting of 1024 x 768 pixels was used.

The passages consisted of three line-length conditions. These conditions consisted of passages that had a line length that spread the full distance of the screen, which was 930 pixels (245 mm, 132 CPL; see Figure 1) wide; passages that had a line length of 550 pixels (approximately 145 mm, 76 CPL; see Figure 2); and passages that had a line length of 330 pixels (approximately 85 mm, 45 CPL; see Figure 3). As with typical online passages, the narrower the passage, the more scrolling was required to view the entire passage.

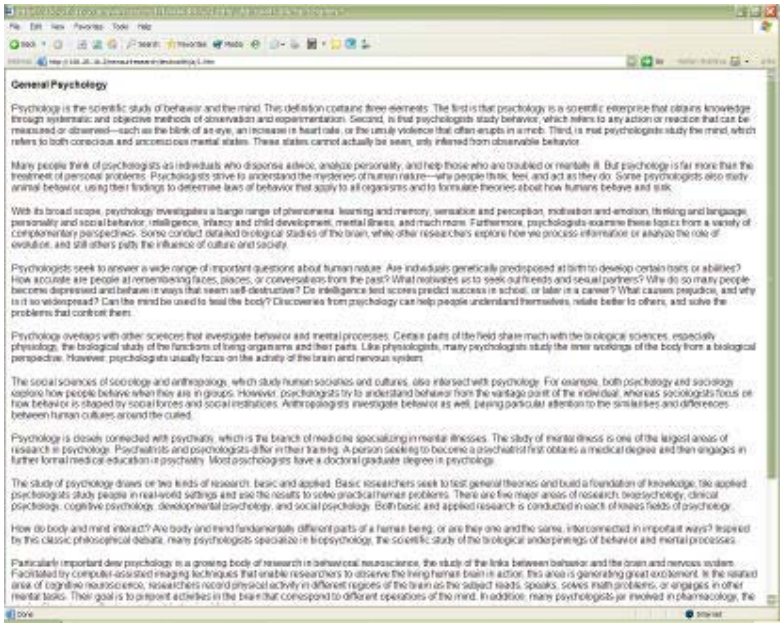
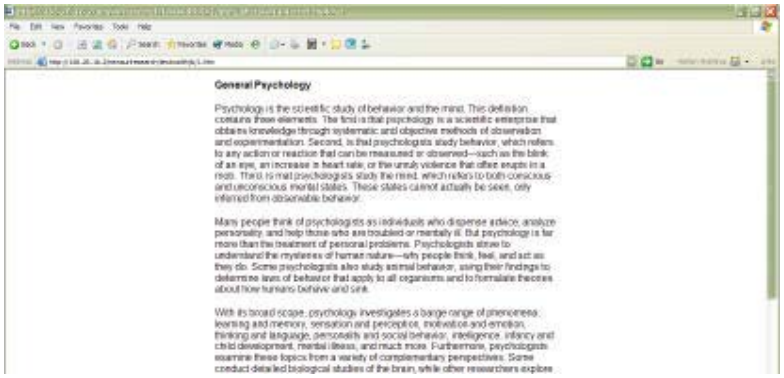


Figure 1. Full-length example



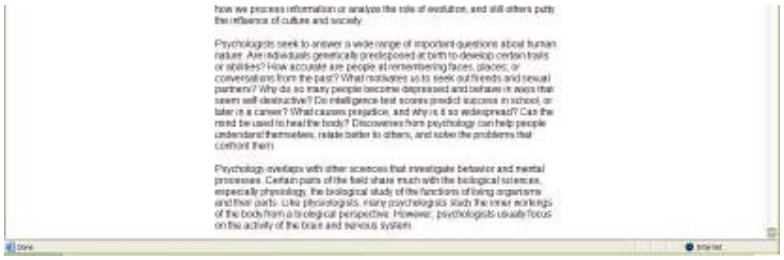


Figure 2. Medium-length example

Figure 3. Narrow-length example

Task Design

Line conditions were compared by having participants read three passages, each with different line lengths. The conditions were counterbalanced by means of a Latin square design. Both the adults' and children's passages were 12-point Arial, which was black on a white background.

The adults read passages from Microsoft's electronic library, Encarta™, which were written at approximately the same reading level and discussed similar material (all dealt with psychology-related topics). The passages were adjusted to have approximately the same length (an average of 1028 words per passage, S.D. of 18 words)

The children's passages were short children's stories drawn from Whootie Owl's Fairytales™, which were written at the 4th and 5th grade reading level. The passages were adjusted to have approximately the same length (an average of 573 words per passage, S.D. of 13 words)

Procedure

Participants were positioned at a distance of approximately 57 cm from the computer screen. They were then asked to read "as quickly and as accurately as possible" the passages, which contained 15 randomly placed substitution words for the adults and 10 for the children (they were not told the number of substitution words). The substitution words were designed to be clearly seen as inappropriate for the context of the passages when read carefully. These words varied grammatically from the original words—for example the noun "cake" being replaced with the adjective "fake." The

participants were instructed to identify these words by stating the substituted words aloud. This was designed to insure that participants actually read the passages, instead of just skimming over them.

To accurately determine font readability and its associated effect on reading time, an effective reading score was used. The score was derived from obtaining the time taken to read the passages divided by the percentage of accurately detected substituted words in the passages—which was registered by a stopwatch.

After reading each passage, participants answered a perception of readability questionnaire. The questionnaire consisted of a 6-point Likert scale with 1 = "Not at all" and 6 = "Completely" as anchors. The questionnaires consisted of statements regarding their ease of reading for each line length condition. When all questionnaires were completed, they ranked the three line length condition for general preference.

RESULTS AND DISCUSSION

A within-subjects ANOVA design was used to analyze objective and subjective differences between the line lengths. Post hoc comparisons were done using the Bonferroni test. Ranked font preference was measured by means of a Friedman X^2.

Reading Time and Effective Reading

Examining the mean reading time for each line length surprisingly found no significant differences for both children and adults [p = .40; p = .88, respectively]. It is possible that the benefits of reduced scrolling for the wider condition was offset by its increased line length and, thus, negating any positive effects due to the decrease in its line length. The means and standard deviations for both adults and children for the three conditions are presented in Table 1. Examining the effective reading score (reading time/reading accuracy) also revealed no significant differences in reading time/accuracy between the three line lengths for both children and adults [p = .10; p = .60, respectively, see Table 2].

Table 1. Means and Standard Deviations for reading time

Means (SD)	Full-length	Medium-length	Narrow-length
Adults	370 (107) sec	363 (103) sec	366 (109) sec
Children	276 (76) sec	279 (68) sec	266 (68) sec

Table 2. Means and Standard Deviations for effective reading score

Means (SD)	Full-length	Medium-length	Narrow-length
Adults	425 (138) sec	463 (211) sec	443 (189) sec
Children	362 (102) sec	359 (66) sec	330 (94) sec

Adults' Perception of Reading Efficiency

Accessing adults' perception that the amount of scrolling was optimal for a particular line length condition found significant differences [$F(2, 38) = 6.70$, $p < .01$]. Post hoc analysis revealed that the Full-length condition was perceived as being more optimal than both the Medium- and Narrow-length conditions (see Figure 4).

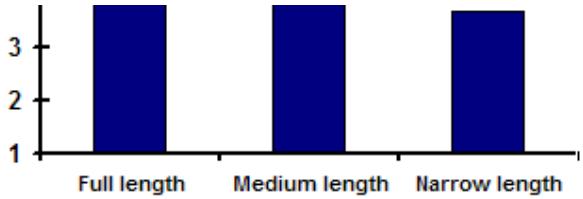


Figure 4. The amount of scrolling was optimal (1 = Not at all, 6 = Completely)

Accessing adults' perception that the length was optimal for a particular line length condition revealed no significant differences [p = .19]. Accessing adults' satisfaction with the ease of concentration for a particular line length condition revealed significant differences [F (2, 38) = 5.41, p < .01] in that the Narrow-length was perceived as promoting easier concentration than both the Medium- and Full-length conditions (see Figure 5).

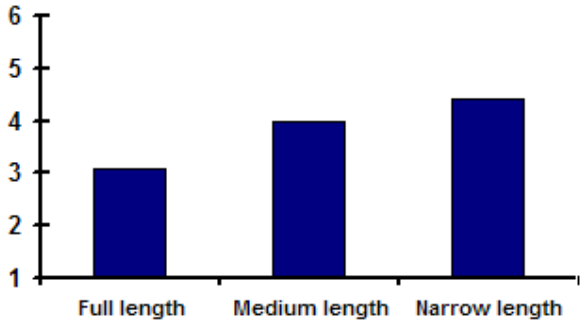


Figure 5. Ability to concentrate on the passages (1 = Not at all, 6 = Completely)

Accessing adults' perception that the layout was optimally presented for a particular line length condition revealed significant differences [F (2, 38) = 6.26, *p* < .01] in that the Medium-length was perceived as promoting easier concentration than the Full-length condition (see Figure 6).

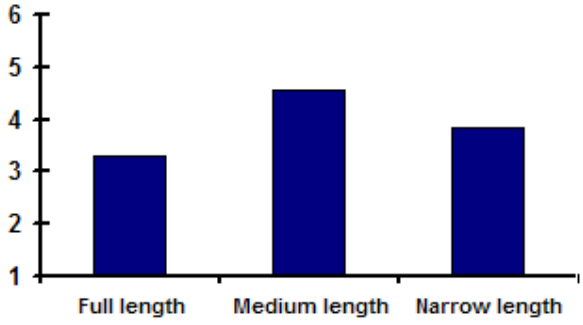


Figure 6. The layout was optimally presented (1 = Not at all, 6 = Completely)

Children's Perception of Reading Efficiency

Assessing children's perception that the amount of scrolling was optimal for a particular line length condition found no significant differences between any of the line length conditions [p = .39]. No significant differences were also found for the perception that a particular line length was preferable or, a particular length was perceived as promoting easier concentration [p = . 61, p = .33, respectively].

General Preference

Examining the first-choice preference indicated that the Medium-length condition was most preferred by adults (Figure 7) and the Narrow-length condition was most preferred by children (Figure 8). The Full-length condition was the least preferred by both adults and children.

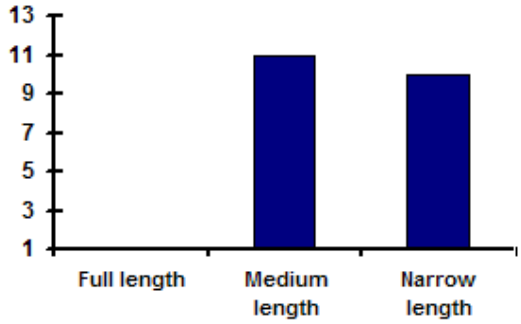


Figure 7. Adults' line length 1st choice (no adult chose the Full length condition as their 1st choice)

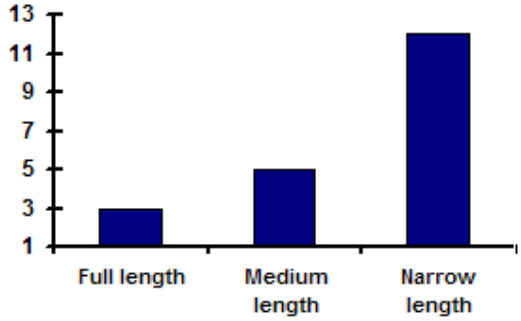


Figure 8. Children's' line length 1st choice

CONCLUSION

This study found no significant differences in reading time or reading efficiency between the three line length conditions for both the adults and children. However, the results did support the finding that shorter line lengths are preferred more than full-screen line lengths. As far as the perception of reading efficiency, the results were mixed. For adults, the Full-length condition was perceived as providing the optimal amount of scrolling in comparison to the two other conditions—presumably because this condition required the least amount of scrolling. The Narrow-length condition was perceived as promoting the highest amount of concentration, while the Medium-length condition was considered to be the most optimally presented length for reading.

When examining children's perceptions of reading efficiency for each of the line lengths, no significant differences were found. It is possible this is due to the fact that children at this age-range are still not fully skilled at reading and, thus, are concentrating more on simply reading the passages than on any reading efficiency differences in line length.

From this study, as well as the studies mentioned above, it is suggested that full-screen line length should be avoided for online documents, especially if a large amount of text is presented. For adults, it is suggested that medium line lengths should be presented (approximately 65 to 75 CPL). Children, on the other hand, indicated their preference for the narrowest line length (45 CPL) and, thus, it may be beneficial to use narrow line lengths when possible.

REFERENCES

Duchnicky, J. L., & Kolers, P. A. (1983). Readability of text scrolled on visual display terminals as a function of window size. Human Factors, 25, 683-692.

Dyson, M. C., & Haselgrove, M. (2001). The influence of reading speed and line length on the effectiveness of reading from screen. International Journal of Human-Computer Studies, 54, 585-612.

Dyson, M. C., & Kipping, G. J. (1998). The effects of line length and method of movement on patterns of reading from screen. Visible Language, 32, 150-181.

Gregory, M., & Poulton, E. C. (1970). Even versus uneven right-hand margins and the rate of comprehension reading. Ergonomics, 13, 427-434

Horton, W. (1989). Designing and writing online documentation: Help files to hypertext. John Wiley & Sons: New York.

Huey, E. B. (1968). The psychology and pedagogy of reading. Cambridge, MA: MIT Press.

Mills, C. B. & Weldon, L., J. (1987). Reading text from computer screens. ACM Computing Surveys, 4, 329-358.

The Digital Edge. (2000). Print and online components bring strength to newspapers. Newspaper Association of America. Retrieved 7/13/02: http://www.digitaledge.org/monthly/2000_01/synergize.html

Whootie Owl's Fairytales® Whootie Owl Productions, LLC. Retrieved 7/13/02: http://www.storiestogrowby.com/

Youngman, M., & Scharff, L. (1998). Text length and margin length influences on readability of GUIs. Southwest Psychological Association. Retrieved 7/13/02: http://hubel.sfasu.edu/research/textmargin.html

---