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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. <u>Barbara S. Chaparro</u>, Editor

# Examining the Legibility of Two New ClearType Fonts

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**Summary**: This article introduces six new ClearType fonts developed by Microsoft. Legibility of two of the serif fonts, Cambria and Constantia, is compared to the traditional serif font Times New Roman. Results show that the legibility, as measured by the number of correct identifications of briefly presented characters, was highest for the new font Cambria, followed by Constantia, and then Times New Roman. Old style digits, such as 0,1, and 2, used in Constantia resulted in confusion with the letters o, I, and z. Times New Roman symbols were confused with both letters and other symbols.

## INTRODUCTION

The release of Microsoft Windows Vista later this year will include six new fonts. The new fonts include 3 sans serif fonts (Corbel, Candara, and Calibri), 2 serif fonts (Constantia and Cambria), and 1 monospaced font (Consolas). Samples of the new fonts are shown in Figure 1. These fonts are designed specifically to take advantage of Microsoft's ClearType subpixel rendering technology that enhances text quality on LCD displays.1 Table 1 shows the intended uses of the new ClearType fonts (see Table 1.)

Cambria Constantia Corbel Candara Calibri Consolas

#### Figure 1. Six new ClearType fonts.

#### Table 1. Prescribed Uses for the New ClearType Font (Berry, 2004)

Font Name	Designed for:		
Cambria	Business documents, email, web design		
Constantia	Book typesetting, email, web design, magazines		
Corbel	Business documents, email, web design		

Candara	Email, web design, magazines, informal settings
Calibri	Documents, email, web design, magazines
Consolas	Programming environment

Given the anticipated prevalence of these fonts on the Web, we were interested in comparing them to some of the traditional fonts used today for business documents, email, and websites. Previous SURL research investigating user performance with different fonts on web pages has shown few differences in reading efficiency or performance (Bernard, et al., 2002) for approximately 1000-word text passages. Reading performance tends to be a very robust measure and typically differences across fonts are not observed unless they differ radically in appearance (e.g., Rage Italic vs Verdana.)

To compare the new ClearType fonts to traditional fonts, we used an objective measure of legibility. Participants were presented individual characters from each font at very short durations and asked to verbally identify the character. We examined the percent correct identification for each character for each of the new fonts along with two traditional fonts, Times New Roman and Verdana. This article reports the findings of the serif fonts only, Times New Roman, Cambria, and Constantia.

Times New Roman is currently the default font used in Microsoft Word and has been a standard for printed business documents. Cambria was designed to be the 'new' Times New Roman. It is described to "have very even spacing and proportions" and targeted for "on-screen reading and to look good when printed at small sizes" (Berry, 2004). Bosma, the designer of Cambria, refers to it as a "robust, all-purpose workhorse text face." Constantia is a serif font that was designed "primarily for continuous text in both electronic and paper publishing" (Berry, 2004). The font uses a small x-height, long ascenders and descenders, and is intended for use in electronic journals. Figure 2 shows a character set of the three serif fonts.

Times NR:	abcdefghijklmnopqrstuvwxyz 0123456789
Cambria:	abcdefghijklmnopqrstuvwxyz 0123456789
Constantia:	abcdefghijklmnopqrstuvwxyz 0123456789

## Figure 2. Examples of the three fonts examined in this study.

# METHOD

## **Participants**

Ten students (5 male, 5 female) between the ages of 18 and 35 from Wichita State University participated in the study.

## Materials

The experiment was conducted using a Dell Pentium IV laptop with ClearType<sup>™</sup> font rendering technology enabled. The screen resolution was 1400 x 1050 at 60 Hz refresh rate and 120 dpi resolution. A program written in Visual C# was used to display the characters in 8-point font size. A Dell Logitech mouse was used to start and stop trial sessions. The laptop screen was positioned at a 90° angle and the text was presented at eye-level for each participant. The laptop was positioned at a distance such that the characters subtended a visual angle of .14° (the x-height of each font's "w" character was used to determine the appropriate distance for each font). Characters were displayed using an exposure time of 34ms and a blanking time of 1.5 seconds. Participants used a chinrest to stabilize the head and control the viewing distance from the monitor.

Twenty-six lowercase letters were used in combination with the digits 0 through 9 and 17 symbols frequently found in mathematical or scientific documents. Tinker's (1928) study on the relative legibility of letters, numbers, and symbols provided guidance in symbol selection. The symbols used included the following:  $\pi \sigma \div = + \Delta$ ? % ±  $\sqrt{\Sigma}$  \$ # @ & !  $\infty$ .

# Procedure

The order of the fonts was randomized across participants. Five trials were completed for each font after an initial practice period. Participants were provided a sample of the symbols to study before beginning a set of trials with that font. Participants initiated each trial by pressing a START button. Each trial began with a dot (`.') followed by the random presentation of each character and ended with a dot (`.'). Participants read each character name aloud and completed 230 trials per font.

# RESULTS

Table 2 shows overall performance by font. Cambria resulted in the highest average percent correct followed by Constantia and then Times New Roman. Legibility of all three fonts was best with the letter characters, followed by digits, and then symbols. Constantia had more errors with its digits and Times New Roman had more errors with its symbols. Table 2 also shows the percent of trials skipped for each font. A skipped trial was one that the participants simply could not identify the character at all. Times New Roman had the highest number of skipped trials.

Table 2. Percent Correct Character Identification by Font
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FONT	Total	Digits	Symbols	Letters	% Skips
Cambria	92.87	91.5	89.2	95.8	1.4
Constantia	87.80	74.4	80.5	97.7	1.4
Times NR	87.55	84.9	75.6	96.4	2.8

Further analysis of each font at the character level resulted in a series of confusion matrices. Table 3 shows a summary of the characters most confused for each font. Figures 2-4 show this data graphically in the form of a sunflower plot. In these graphs, only those characters confused more than 3 times are shown in the x and y axes. The characters presented are shown on the x-axis and the characters reported by participants are shown on the y-axis. The number of extensions, or 'petals', on each sunflower signifies the number of times a presented character was confused with another character. Each plot is segmented into nine sections signifying the type of character confusion (S = Symbol, N = Numbers, L = Letters). For example, SS denotes symbols confused with other symbols, NS are numbers confused with symbols, LS are letters confused with symbols and so on.

Constantia showed the most confusion between symbols and letters (SL) and numbers and letters (NL). Times New Roman showed the most confusion with symbols and other symbols (SS), symbols and letters (SL), and numbers and letters (NL). Confusion within Cambria was limited to the symbol ! and the letter I, the symbol  $\div$  and +, the symbol \$ and s, and between the number 1 and the letter I. The higher number of skips among the symbols and digits with Times New Roman is also evident in Figure 4.

FONT	CHAR	CHAR CONFUSED	% CORRECT
Cambria	!	l (letter)	60%
	÷	+	62%
	1	l (letter)	75%
	\$	S	78%
Constantia	o (zero)	o (letter)	٥%
	1	1 i	9%
	\$	s	16%
	÷	+	42%
	√	v	47%
	#	=	51%

## Table 3. Characters Confused Most by Font

	2	7	62%
	+	7	72%
	<u> </u>	2	73/0
Times New Roman	#	=	24%
	±	=	27%
	+	÷	35%
	$\checkmark$	v	49%
	8	S	51%
	1	1	53%
	÷	+	53%
	\$	s 5	64%

#### LC - Cambria



Figure 2. Sunflower plot of character confusion for Cambria.



LC - Constantia







LC - TNR

Figure 4. Sunflower plot of character confusion for Times New Roman.

Table 4 shows the individual character sets that were most confused in each font along with the percent correct identification. The squareness of the exclamation point in Cambria made it appear more like the letter 'l' than the exclamation point in Constantia and Times New Roman. The use of the old style numbers (which tend to be smaller as shown in Figure 2) in Constantia appears to be responsible for confusion of the number 2 and the letter 'z' and the number 0 and the letter 'o'. The small size of the \$ in Constantia resulted in higher confusion with the letter 's' than in Cambria or Times New Roman.

	Cambria	Constantia	Times New Roman
	!1	!1	!1
Dercept Correct	600%	940/-	010/2

## Table 4. Characters confused in one or more of the fonts.

Foreche correce	0070	0170	21.0
	2z	<b>2</b> Z	2z
Percent Correct	89%	62%	98%
	00	00	00
Percent Correct	89%	0%	89%
	\$s	\$S	\$s
Percent Correct	78%	15%	64%

# DISCUSSION

This study sought to investigate and compare the legibility of two new ClearType fonts, Cambria and Constantia, to the traditional serif font Times New Roman. Results show the legibility, as measured by the number of correct identifications of briefly presented characters, was highest for the new font Cambria, followed by Constantia, and then Times New Roman. Percent correct identification was high for the letter characters for all three fonts. Old style digits, such as 0,1, and 2, used in Constantia resulted in confusion with the letters o, I, and z. Symbols, which were confused with both letters and other symbols, were the most confused characters in Times New Roman. Overall, the findings were positive for the new ClearType fonts.

While it has been advised that the legibility of individual characters is not predictive of overall readability of a font (Tinker, 1963), the method used in this study allowed us to identify those characters that may be confused with other characters in a given font. Contextual cues when reading text may override letter confusion; however, there are instances where single character confusion could be problematic. For example, users trying to remember username and passwords for online accounts may confuse some letter-number combinations, such as zero and the letter 'o'. International zip codes, inventory part numbers, and other mixed character values may also be impacted by such confusion. Character confusion may also play a role in safety. In a recent near-accident, an air traffic controller was reported to misread character codes on his monitor and accidentally sent an aircraft to a wrong location (BBC News, 2002).

This article only reported the results of two of the six new ClearType fonts. Further investigation of the remaining fonts will be presented in the next issue of Usability News.

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[1] See <u>http://www.microsoft.com/typography/ClearTypeInfo.mspxUTH</u> for more information on ClearType.

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