Examining children’s reading performance and preference for different computer-displayed text

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Abstract. This study investigated how common online text affects reading performance of elementary school-age children by examining the actual and perceived readability of four computer-displayed typefaces at 12- and 14-point sizes. Twenty-seven children, ages 9 to 11, were asked to read eight children’s passages and identify erroneous/substituted words while reading. Comic Sans MS, Arial and Times New Roman typefaces, regardless of size, were found to be more readable (as measured by a reading efficiency score) than Courier New. No differences in reading speed were found for any of the typeface combinations. In general, the 14-point size and the examined sans serif typefaces were perceived as being the easiest to read, fastest, most attractive, and most desirable for school-related material. In addition, participants significantly preferred Comic Sans MS and 14-point Arial to 12-point Courier. Recommendations for appropriate typeface combinations for children reading on computers are discussed.

1. Introduction

Today, elementary school children have the potential of reading considerable amounts of text on computer screens, either in the classroom in the form of online lectures and tests or for general leisure. In fact, in many schools throughout much of the industrialized world there is a drive to supplement or even supplant traditional pen and paper lectures and tests with computer-based ones (Becker 2000). Placing text online is done at least in part to stimulate a child’s interest by making the presentation more current, interactive and enjoyable than a print-based medium. Yet, many of the challenges that are present for the more traditional, print-based medium also holds true for computer-based text presentation. That is, the difficulty for educators today is to entice young readers to actually read the text, along with interacting with the document. This can be an arduous task if the text is difficult or is regarded as being uninviting to read (Sassoon 1993). Therefore, it is important that children’s text is not only readable and perceived as such, but also appealing to read.

The need for text presentation to be readable and appealing may be particularly true for children who are inexperienced with reading from computer screens. That is, children who are not regularly exposed to computers may not be accustomed to the particular display characteristics that are associated with computer-based text. Computer novices also tend to have higher levels of computer anxiety (Colley et al. 1994), which could initially adversely affect their reading. This, of course, should be a concern when testing children’s reading abilities on a computer. Conversely, children who are experienced with computers may expect them to be entertaining, due at least in part by the fact that computer games are now very prevalent in households with children (Shields and Behrman 2000). For instance, one survey found that 33% of boys and 10% of girls aged eight and nine in the USA reported playing computer games as their primary leisure activity (Harell et al. 1997). Moreover, a growing percentage of children (particularly young females) are communicating via online chat groups (Jupiter Communications 2000). Importantly, this communication medium allows for a large variety of fonts, which have not gone unnoticed by children. For example, it is common to see children ‘playing’ with fonts by selecting particular types to fit their current mood. Also a large variety of typefaces are commonly displayed in computer-based programs that are designed for young children in order to make them appear more playful (Druin 1999).
1.1. **Text characteristics**

As with print, computer-based text has certain features that may influence a child’s reading performance and attraction to the text, such as the size, shape and weight of a particular letterform, as well as its line and character spacing. Unfortunately, only a few empirical studies have examined these factors as they relate to elementary school children (Watts and Nisbet 1974). The studies that have been conducted generally recommend text sizes of either 12- or 14-point type (height of 4.2 and 4.9 mm, respectively) for children’s books, depending on their age. For example, Kerr (1926) and Burt (1959) suggested that the minimal text size should be 14-point for children approximately nine years of age. For ages ten to twelve, Burt suggested that the optimal text size should be 12-point. Moreover, Tinker (1959) recommended that for children of approximately nine years of age the text size could be 12-point, or possibly even smaller.

However, using ‘points’ as a sole determinate of type size does not take into account the size of the body of the text, or x-height—which often differs considerably for typefaces, even for ones with the same point size. The x-height, which is the height of the torso for lower-case letters, will affect the appearance of the type by making it look larger or smaller. Thus, a 12-point typeface with a large x-height may often have the same appearance in size as a 14-point typeface with a rather small x-height.

Having a large x-height enables typefaces to have greater relative area within the body of their letterforms—such as the letters ‘c’ and ‘c’—which has been found to increase text readability in some studies (e.g. Burt 1959, Tinker 1965). This may be particularly important for children, since they often have difficulty discriminating between letters that are similar in appearance (Watts and Nisbet 1974). Consequently, researchers (e.g. Labuz 1988) have pointed out that a typeface’s x-height is often a better determinant of its true or ‘readable’ size than its point size.

However, in addressing the issue of readability, research has not been so clear-cut. For instance, Poulton (1965), who compared the same Univers typeface at different x-heights of 1.6 and 1.9 mm (point sizes of 9.5 and 10.5, respectively), found no significant differences between them in terms of reading comprehension—probably because the difference in x-heights was only 0.3 mm.

Conversely, having too large of an x-height may, in some cases, decrease text readability by proportionally reducing the height of the letter’s extenders (which are part of the letterform that rise above and below the typeface’s x-height, such as with ‘d’ and ‘p’) to a degree that it does not appropriately distinguish the letters that are characterized by these shapes (Monk and Hulme 1983, Paap et al. 1984). For example, the distinction between the letters ‘o’ and ‘d’ is mostly derived from the d’s top extender, or ‘ascender’. A comparatively large reduction in the length of the extenders may consequently negatively affect young readers’ ability to distinguish various letters from one another (Burt 1959, Watts and Nisbet 1974). What is not known is the degree to which x-height, in proportion to the extenders, contributes to the reading of computer-based text. Since computer-based text is characterized by lower resolution than print, it is contended that having a medium to large x-height allows for easier detection and discrimination of letters (Mills and Weldon 1987, Rudnick and Kolers 1984).

Another important factor in considering the readability of children’s computer-based text is the type’s shape. For instance, it has been argued by Burt (1959) and others that serif typefaces, which have small finishing strokes at the end of the stem of a letter, are not merely ornamental, but have a specific function, namely to help discriminate individual letters and numbers from each other. Burt maintained that this type of discrimination is particularly important for young readers in order to aid in the process of letter and word distinction. Conversely sans serif typefaces, which do not have serifs, are said to lack the discriminative ability of serif typefaces. In fact, Burt has argued that the sans serif typeface is ‘insufficiently legible in terms of “word recognition” and it can only be read in comfort for short notices and then in capitals but not, of course, for long’ (p. xiv). However, studies comparing serif and sans serif typefaces in print have typically found no significant differences between them in terms of readability (e.g. Paterson and Tinker 1932, Poulton 1965). The general parity in readability between common typefaces has led some researchers to the conclusion that recommendations for a particular style of typeface is based more on opinion than on readability issues (Watts and Nisbet 1974).

Yet, the studies that have examined typography’s effect on reading mostly involved adults reading on paper. Understanding the factors affecting the presentation of text on computer screens may prove to be even more difficult, since they introduce additional variables that influence reading performance. For example, the screen resolution, the degree of flicker, and the amount of text aliasing (the ‘stair-casing’ that causes certain letterforms to look jagged) all may affect the actual and perceived readability, as well as preference in favour of a particular size and style of type that is different from print. Furthermore, it has also been argued by researchers (e.g. Dillon 1992, Sassoon 1993) that the
evaluation of type should do more that just examine reading performance. Assessments should also include such things as the participants’ perception of text readability, as well as text preference in order to address the full range of issues surrounding readability.

To date little empirical research has been conducted that is specific to a younger population, investigating the effects of typology when read on a computer screen. Therefore, the primary goal of this study was to explore how common online typefaces affect the reading of elementary school-age children by examining the actual and perceived readability of four computer-displayed fonts at 12- and 14-point sizes. In addition, this study investigated which types were most desired for computer-use in schools, perceived as most attractive, and generally most preferred.

2. Method

2.1. Participants

Twenty-seven participants (10 males, 17 females) from a mid-western city in the USA volunteered for this study. They ranged in age from 9 to 11 years old ($M = 10$, $SD = 0.7$ years) and attended 4th, 5th or 6th grade. All participants read English fluently as a first language. Seven participants wore corrective lenses. All had 20/20 or 20/20 corrected vision as measured by a Snellen near acuity test for 20/20 vision at a distance of 16 inches (406 mm). Most participants (96%) had at least some experience reading text on computer screens. The participants received $10.00 for participating in this experiment.

2.2. Equipment

A Pentium II based PC computer, using a 60 Hz, 96dpi 17-inch high-resolution RGB monitor with a resolution of 1024 x 768 pixels was used. The light sources were located overhead and to the participants’ side in order to reduce glare on the screen. The computer operating system used was Microsoft’s Windows 98. The format of the text was presented as a HTML web page. The browser used was Microsoft’s Internet Explorer 5.0, which was configured to display only the URL address bar.

2.3. Size/typeface combinations

This study investigated typefaces that are commonly seen in children’s online text. Examined were the serif typefaces, Times New Roman (Times) and Courier New (Courier) and the sans serif typefaces, Arial and Comic Sans MS (Comic), at 12- and 14-point sizes and at their respective x-heights, with 14-point of leading. Times and Arial are very common typefaces for their respective type families. In fact, most computer operating systems today are pre-configured to have Times as a default type, whereas Arial is a common sans serif default alternative to Times. Courier is a common monospaced typeface (has fixed character widths), whereas Comic, which is based on the lettering of comic book magazines, has become a very popular font for child-related reading material. All typefaces studied are included within most Microsoft’s Office software suites. The examined typefaces and sizes (point and x-heights at tested resolution) are shown in Table 1.

The text combinations were compared by having participants read eight passages. The text of each passage was comprised of one of the eight size/typeface conditions, which were counterbalanced across participants. The passages were short children’s stories drawn from Whootie Owl’s Fairytales (Whootie Owl Productions 2000). Each passage was tested to be at the 4th or 5th grade reading level (typically ages 9 and 10) by using the Flesch-Kincaid Grade Level assessment (Kincaid et al. 1975). Each passage was left justified; its horizontal margin was set at 640 pixels (184 mm), a typical width for online text, which was located within the centre of the screen. The number of words per line varied within this margin as a result of the width of the different size/typeface combinations. The passages were modified to have approximately the same number of words ($M = 581$ words per passage, $SD = 16$ words). The text was presented in a dot-matrix format, which was black on a white computer screen.

2.4. Task design

To determine the effects of typeface on reading performance, several measures were initially considered. Detection of spelling and typographical errors were ruled out because these types of tests tend to promote
skimming behaviour (Creed et al. 1987, Gujar et al. 1998). Moreover, studies have found that readers typically differ in their ability to detect spelling and typographical errors (Monk and Hulme 1983, Jorna and Snyder 1991), particularly children at this age range (Gibson 1965). Thus, these types of tests may introduce unacceptably high amounts of variability across conditions, thereby masking any experimental effects that are derived from a particular condition.

Using an established post-reading comprehension test, such as the Nelson-Denny Reading Test (Brown et al. 1981), was also rejected because of concerns that the participants would only scan the passages (i.e. reading for just the main points) in order to answer the post-reading questions. In addition, the large degree of variability associated with reading comprehension at this age (Watts and Nisbet 1974, Smith 1994, Oakhill and Cain 1997) made post-reading comprehension questions unsuitable for examining young readers.

Thus, in the present study reading performance was investigated by both examining reading accuracy, as well as using an effective reading speed measure. To assess accuracy, a modified proofreading task similar to the method used by Jorna and Snyder (1991) and Gujar et al. (1998) was adopted in which 15 substitution words were randomly placed throughout each passage. Each substitution word was exchanged for an original word in the passage. The substitution words were designed to be inappropriate for the context of the passages when read carefully—for example the word ‘sea’ being replaced with the word ‘bee’. In addition, each substitution word rhymed with the original word as an extra cue for the participants that the substituted word was, in fact, an intended substitution word (Gujar et al. 1998). Both the words in the original passage and the substituted words used common, but not colloquial English. This type of task provided an accurate measure of size/typeface differences by insuring that participants read the entire passage in order to recognize the substituted words. This also reduced skimming behaviour because unlike spelling or typographical error detection, the substituted words did not ‘stand out’ as errors by quick visual inspection. The substitution words also did not rely on the readers’ ability to determine if words were spelled correctly, but instead relied on recognition of the entire word, thereby increasing the chance of error detection (Jorna and Snyder 1991).

The effective reading measure was employed to account for the trade-off that may occur when participants slow their rate of reading to achieve greater accuracy. This measure consisted of the ratio of time (in seconds) taken to read a passage divided by the accuracy (percent correct) in detecting substitution errors in that passage. For example, a reader with a mean reading time of 300 seconds and a reading accuracy of 90% will have an effective reading score of 333 for a particular typeface. Another reader with the same mean reading time, but with a reading accuracy of 75% would have an effective reading score of 400. As with reading time, the lower the score resulted in higher reading performance.

2.5. Procedure

Participants were individually tested in a quiet room with dimmed lighting. Each participant was initially positioned at a distance of approximately 57 cm from the computer screen before reading. They were instructed to read eight passages ‘as accurately and as quickly as possible’. They were told there would be substitution words that were randomly presented throughout the passages. Participants were not told the number of substitution words in the passages, however. They familiarized themselves with the passage format by first reading a sample passage containing three substituted words. Participants were then instructed to identify the substitution words as they saw them by stating the substituted words aloud. As with the procedures established by Gujar et al. (1998) undetected and detected substitution words were recorded. This was done by matching the words called out by the participants with the correct list of substituted words. Any called-out word that was not on the list was written down.

Each passage was approximately 1½-screen pages in length. In order to equate the amount of text on a ‘typical’ computer document, users were required to scroll to view the entire passage. Participants were instructed to scroll through the passage by clicking the down arrow button on the scroll bar as they read. They began reading immediately after they were instructed to begin. Participants read until they came to the bolded word ‘END’ at the end of each passage. When they read this word, they were instructed to say the word ‘end’ aloud. The time taken to read each passage was registered by a stopwatch, which started when the participants were instructed to being and ended when they said the word ‘end’ at the conclusion of the passage. The order of each condition and passage was counterbalanced by means of a Latin square design.

After reading each passage, participants answered a perception of readability questionnaire, which took approximately four minutes to answer and which gave them a period of rest between each passage. The questionnaire items used a forced-choice, 6-point Likert scale with statements 1 = ‘Not at all’ and 6 = ‘Very Much’ as anchors. The four questionnaire items were as follows: ‘The story’s print was easy to read’; ‘I feel that I
can read fast with this type of print'; ‘The story’s print was nice looking'; and ‘I would like my schoolbooks to have this type of print’. After the participants read all eight passages and answered the respective questionnaires, they ranked the text combinations for general preference. The total testing time lasted approximately 50 minutes.

To examine whether the fatigue associated with reading each text was equally distributed, participants answered a 6-point Likert scale with statements 1 = ‘Not at all’ and 6 = ‘Very Much’ as anchors for the question, ‘My eyes feel uncomfortable from reading’ after each passage. The participants did not indicate any significant difference [F (7, 175) = 0.82, p > 0.05] in the amount a fatigue associated with reading any particular passage.

2.6. Experimental design

A 4 x 2 within-subjects analysis of variance was used to assess actual and perceived typeface readability. There were two independent variables: typeface (Times, Courier, Arial, Comic) and type size (12- and 14-point). The dependent variables were: objective text readability (effective reading and reading speed), subjective text readability (perceptions of: ease of reading, reading faster, typeface attractiveness, desire for computer-use in schools), and general typeface preference. Objective text readability was also compared across the typefaces’ x-heights (2.0, 2.5 and 3.0 mm). The Dunn method (Kirk 1982) involving the within-subject factor was used for evaluating the pairwise planned comparisons. It was believed that the larger, 14-point text and the sans serif typefaces would have higher levels of actual and perceived reading performance. Preference was measured using a Friedman 2.

3. Results and discussion

3.1. Typeface readability

Analysing the percentage of detected substituted words for each size/typeface combination revealed no significant difference in accuracy for point size [F (1, 26) = 0.38, p > 0.05], typeface [F (3, 78) = 0.49, p > 0.05], or any interaction between them (see table 2 for means and standard deviations). A possible explanation for this outcome is that participants did, in fact, slow their rate of reading for more difficult text combinations to achieve roughly the same level of accuracy. To test this, the participants’ effective reading speed was examined.

Using the effective reading speed measure, a significant typeface main effect was found [F (3, 78) = 3.94, p < 0.01]. Pairwise comparisons revealed that Courier had a significantly higher score, indicating less effective reading than the other typefaces across both text sizes (see table 2 for means and standard deviations). It is believed that the poorer performance of Courier was mostly due to its fixed character width and its wide letter spacing. That is, each character is given the same amount of horizontal space regardless of its actual width, which may make it more difficult for elementary school-age children to resolve individual characters into words. Indeed, fixed-width text has been found to be less legible than variable-width text for adults (Beldie et al. 1983). It is likely this applies to children as well. The wide letter spacing may also make it more difficult for children to distinguish words by making them less visibly cohesive (Sassoon 1993).

The finding that point size did not significantly affect participants’ reading performance was in agreement with other studies (e.g. Burt 1959, Tinker 1963) that have found that, in general, moderate-sized text (around 10- to 12-point) is typically read relatively quickly and accurately. This may be true for online reading as well. For instance, Boyarski et al. (1998), using a screen resolution of 640 x 480, found that 10-point serif and sans serif typefaces were equally readable at this text size (a 10-point typeface has a character height close to 4 mm at this resolution, or approximately a 12-point size at 1024 x 768 pixels). Yet, as with print, if the text size is reduced to a certain degree, there will typically be a corresponding reduction in reading performance (Bouma 1971). For instance, Tullis et al. (1995) found no differences in reading speed or text accuracy between several online serif and sans serif typefaces at around 9.75 point (resolution of 1024 x 768 pixels). However, typefaces at smaller sizes had significant decrements in reading speed and accuracy.

As discussed previously, several factors in addition to text size should be taken into consideration when assessing a typeface’s effect on reading performance. For example, Sanocki (1991) found that reading accuracy was predicted by both typeface and size factors, such that the shape and size of letters increased its discriminability. Indeed, a number of researchers (e.g. Burt 1959, Tinker 1963, Poulton 1965, Paap et al. 1984) have concluded that increasing character distinction—which can be facilitated by increasing the text size, especially the x-height—is an important factor in increasing text readability. In fact, investigating the three x-height sizes (i.e. 2.0, 2.5, and 3.0 mm) of the typefaces examined in this study revealed a significant [F (2, 52) = 3.37, p < 0.05] reading efficiency difference (425.6, 397.9, 372.8, respectively) between text with the
3.2. Reading speed

Analysing the reading times for each size/typeface combination, irrespective of their accuracy, revealed no significant size \([F (1, 26) = 1.43, p > 0.05]\) or typeface differences \([F (3, 78) = 1.06, p > 0.05]\) in the time taken to read the passages (see Table 2 for means and standard deviations). A possible reason for the lack of significance could be that the variability in the participants’ reading speeds were so great as to ‘wash-out’ any effects due to the conditions, thus reducing the probability of detecting significant differences at \(\alpha = 0.05\). To test for this, an analysis of the statistical power (1- \(\beta\)) was performed (Cohen 1988). The results indicated that increasing the number of participants would not appreciably increase power (\(\eta^2 = 0.05, 0.04, \) for size and typeface, respectively) unless this increase was substantial (i.e. \(n = 70\) or greater).

Other researchers (e.g. Watts and Nisbet 1974, McNamara et al. 1953) have noted, and anecdotal evidence from this study suggests that for the most part, the greatest factor in a child’s speed of reading is the individual reading strategies and motivation of the child. It is expected that some children at this age-range will have reading strategies that will promote the reading of text in a continuous and relatively quick progression, while others will not have yet developed these strategies. In addition, at this age-range the motivation of the child to simply read will help determine their amount of reading experience and, to a certain extent, the degree to which they adopt new reading strategies (Watts and Nisbet 1974). Thus, it is quite possible that the best way to tease out any other readability differences is to examine the subjective perceptions of readability related to particular typefaces.

3.3. Perceptions of ease of reading

Analysing the eight size/typeface combinations for perceptions of ease of reading revealed a significant main effect for size \([F (1, 26) = 16.07, p < 0.001]\) and typeface \([F (3, 78) = 6.56, p < 0.001]\). Pairwise comparisons indicated that the 14-point size was perceived as being easier to read than the 12-point size, which at the examined resolution is consistent with previous size recommendations for children’s printed text at this grade level (e.g. Kerr 1926, Burt 1959). Moreover, comparisons revealed that Arial and Comic were perceived as being significantly easier to read on a computer screen than Times (see Table 3 for a comparison of means).

A number of factors could account for participants perceiving the larger-sized text as more readable on the computer screen than the smaller-sized text. First, typefaces with larger-sized text are generally more readable because they allow for easier detection of individual characters and therefore may require less effort to read (Bouma 1971, Rudnicky and Kolers 1984). Second, the larger character height associated with this

Table 2. Reading performance.

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<thead>
<tr>
<th></th>
<th>12-point</th>
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<th>14-point</th>
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<tr>
<td></td>
<td>Times</td>
<td>Courier</td>
<td>Arial</td>
<td>Comic</td>
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<tr>
<td>Accuracy</td>
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</tr>
<tr>
<td>M</td>
<td>0.80</td>
<td>0.79</td>
<td>0.83</td>
<td>0.81</td>
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<tr>
<td>SD</td>
<td>(0.14)</td>
<td>(0.23)</td>
<td>(0.14)</td>
<td>(0.15)</td>
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<td>Effective reading speed(^1)</td>
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<tr>
<td>M</td>
<td>394.2</td>
<td>457.0**</td>
<td>388.2</td>
<td>401.1</td>
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<tr>
<td>SD</td>
<td>(188.3)</td>
<td>(364.5)</td>
<td>(191.5)</td>
<td>(188.5)</td>
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<tr>
<td>Reading speed(^1)</td>
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<tr>
<td>M</td>
<td>296.9</td>
<td>302.9</td>
<td>300.9</td>
<td>306.1</td>
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<tr>
<td>SD</td>
<td>(101.0)</td>
<td>(122.9)</td>
<td>(110.0)</td>
<td>(109.3)</td>
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Notes: Mean (SD) scores for reading performance. Accuracy is determined by the mean percentage of times participants correctly detected substitution errors. The effective reading score is determined by the ratio of time (in seconds) taken to read a passage divided by the accuracy (percentage correct) in detecting substitution errors in that passage.\(^1\) Lower means indicate higher reading effectiveness and faster reading times. **\((p < 0.01)\). Significant differences were only found for effective reading speed in which Courier had higher scores (indicating lower effective reading) than the other typefaces.
size is usually seen in elementary-school textbooks and therefore children may be more accustomed to this size. Thus, larger text size may be more familiar to the children and somewhat easier to read, as evidenced by the greater perception of typeface readability.

The finding that the sans serif typefaces, Arial and Comic were perceived as being easier to read than Times is contrary to the assertions of Burt (1959) and others in the superiority of serif typefaces in regard printed material. However, because of the characteristics of computer screens, the serifs may stop acting as letter distinguishers and start becoming visual ‘noise’, thereby making the letterforms harder to discern. Indeed, studies that examined people’s reading from computer screens have found performance (e.g. Tullis et al. 1995) and preference outcomes (e.g. Bernard et al. 2001a, 2001b) that favour sans serif typefaces.

Another possible reason why Arial and Comic were perceived as easier to read than Times is that both of them have a proportionally large x-height in comparison to Times. In fact, it was revealed that 14-point Arial and Comic (which have an x-height of 3.0) had a significantly higher perception of ease of reading \( F(2, 52) = 22.07, p < 0.001 \) than typefaces with x-heights of 2.5 and 2.0 mm (mean of 5.6, 4.9, and 4.5 respectively). Moreover, Times has very narrow character spacing, making them less distinct from each other. Arial and Comic also have proportionally greater character weight than the other typefaces that were studied. Character weight in moderate proportions is believed to aid young readers in distinguishing individual letterforms (Burt 1959).

Familiarity and informality of the typefaces may also help explain the preference for the Arial and Comic typefaces. For instance, since children are more accustomed to writing in a style that is more akin to a sans serif typeface (Sassoon 1993) they may be more familiar with this form of lettering, and thus perceive sans serif typefaces as easier to read than the serif typefaces. In fact, it has been argued that children may benefit if there is a match between the text they read and their style of handwritten print in order to have the greatest transfer of learning between the two media (Watts and Nisbet 1974). However, Sassoon (1993) has argued that school-age children are now accustomed to seeing various forms of print through advertising, and therefore this match may not be as critical as once thought. Another likely possibility is that the participants are simply responding to the greater informality and playfulness of the Arial and Comic typefaces.

3.4. Perceptions of reading faster

Analysing the participants’ perceptions reading speed for a particular size or typeface revealed a significant main effect for size \( F(1, 25) = 12.07, p < 0.01 \) in that the 14-point size was perceived as being quicker to read on a computer screen than the 12-point size (see table 4). This perception may have been due to the fact that this point size was also perceived as being easier to read than the smaller, 12-point size. There were no significant perception differences for typeface.

3.5. Perceptions of typeface attractiveness

An analysis of the perceptions of typeface attractiveness found a significant main effect for size \( F(1, 26) = 16.9, p < 0.001 \) and typeface \( F(3, 78) = 5.4, p < 0.01 \). Pairwise comparisons revealed that the 14-point size was perceived as being more attractive than the 12-point size. Moreover, Comic was perceived as being significantly more attractive on a computer screen than Times (see table 5). Again, the size preference is probably due, at least in part, to having a larger x-height and character weight, making it easier to read.

Moreover, Comic, which has a character style that was designed to resemble comic book handwriting, may
be perceived as more attractive because children may enjoy the novelty of reading a comic-like font. Alternatively, children may prefer text that more closely resembles their own writing, at least on computer screens. As discussed by Sassoon (1993), there is some evidence that children actually do prefer text letterforms that are similar to their handwriting.

3.6. Desire to use text size/typeface in schools

Analysing the font combinations for the desire of a particular typeface to be used on computer screens for school-related material found a significant main effect for size \( F(1, 26) = 42.7, p < 0.001 \) and typeface \( F(3, 78) = 2.4, p < 0.001 \). Once more, it was revealed that the 14-point size was preferred to the 12-point size. Comic was also significantly more desired than either the Times or Courier typefaces (see table 6). This is not to say that Comic is the ‘best’ typeface for children to read on computer screens in classrooms. It is simply the most preferred. It has been argued by researchers (e.g. Sassoon 1993) that children can easily read, and should be exposed to different forms of type (i.e. serif and sans serif types) when reading. However for extended reading, researchers such as Prince (1967) and Sassoon—as well as the results from this study—suggest that text more akin to sans serif typefaces are more preferred by children, which may be particularly true for online reading.

3.7. Typeface preference

Analysing participants’ mean preference choice for each text size/typeface combination indicated a significant difference in ranking from most to least preferred \( [2 (7, n = 26) = 43.9, p < 0.001] \). Post hoc analysis revealed that 14-point Arial and 12-point Comic were significantly preferred over 12-point Times and Courier (see table 7), which have the smallest x-height (2.0 mm) of the typefaces studied. In addition, 12-point Courier was significantly less preferred to 14-point Comic. Examining participants’ percentage of first and second preference choice further indicates the popularity of Comic and the 14-point size. Importantly, Comic received the highest percentage of first and second preference choices for both the 12- and 14-point sizes (see figure 1).

4. Conclusions

The purpose of this study was to examine the actual and perceived reading performance of four computer-
displayed fonts at 12- and 14-point sizes by elementary school-age children. In addition, participants indicated which typefaces were most desired for use in schools, most attractive, and the most preferred.

Although no significant differences in actual readability (accuracy or effective reading speed) or reading speed were detected for text sizes, the 14-point size was generally reported as being more 'readable' and was perceived as being faster to read than the 12-point size. This suggests that the larger 14-point size does, in fact, subjectively aid in the quality of reading. A readability difference (speed/accuracy) for typeface was found only for Courier in which participants had significantly less effective reading than the other typefaces. It is believed this is due to its wide letter spacing and its fixed character width, accompanied with a small x-height. Courier, along with Times also was rated lower in perceived legibility and preference. That is, Times was perceived as being significantly more difficult to read than Arial or Comic, and was considered less attractive than Comic. In addition, Times and Courier were significantly less desired to be used for school-related material than Comic. It is interesting that the typefaces examined in this study that have either very wide or narrow letter spacing (Courier and Times, respectively) were disliked.

In assessing typeface preference, the sans serif typefaces Comic and Arial were preferred to the Times and Courier serif typefaces. In addition, the 14-point Arial and the 12-point Comic were the most preferred text combinations. Comic also received the highest percentage of first and second preference choices for both 12- and 14-point sizes. It is, therefore, reasonable to suggest that the optimal typeface for children reading on computer screens is a sans serif typeface with a medium to large x-height, and with a modest amount of letter spacing and character weight.

One should be cautioned, however, in generalizing these results to other sizes or typefaces. For example, typefaces designed for the computer, such as Georgia and Verdana, or for children, such as Sassoon Primary, were not examined simply because they are not as commonly used as the types addressed in this study. As with all studies that examine reading performance, many factors should be taken into account, such as individual font characteristics, the line and character spacing, the computer settings, as well as the user characteristics.

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