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ARTICLE

# A study of the effect of letter spacing on the reading speed of young readers with low vision

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ABSTRACT The aims of this study were two-fold: firstly, to establish a method of applying consistent letter spacing to documents using MS Word, and secondly, to investigate the effect of increased letter spacing on the reading speeds of readers with low vision. Tests on 14 readers with low vision showed that increased letter spacing benefited their reading speed and also reduced the critical print size of the majority of subjects tested. These findings could have a significant impact on the format of modified large print material used by low-vision readers in mainstream schools and lead to more inclusive practise in the classroom. Additionally, a simple to follow table has been produced to quantify the effect of increased letter spacing in MS Word. Although MS Word is almost universally used in mainstream schools to modify teaching resources, for low-vision readers, the method of applying letter spacing and its effect are not clear.

KEY WORDS *children, education, low vision, reading*

## INTRODUCTION

The production of braille follows a set of universal rules that operate for any proficient (Grade 2) reader of braille. The same cannot be said for the production of reading material for readers with low vision; when modifying print for low-vision readers few quantitative guidelines exist. This would appear to be an anomaly; The Royal National Institute for the Blind (RNIB, 2003) estimates that in Britain's mainstream schools there are approximately 9400 pupils who are readers with low vision. The same figures suggest that only four per cent of the population of pupils with visual impairment (approximately 850 individuals) are braillists and yet they receive most of the coverage in text books when modification of teaching material is considered.

Teachers of students with visual impairment (TVIs) are responsible for training teaching assistants in the preparation of modified print material and it was during a discussion about the establishment of easy to apply guidelines that a chance reference to the effects of kerning (letter spacing) was made. It was suggested that this effect could increase reading speed of readers with low vision and may even decrease their critical print size (CPS). CPS is defined as the smallest font size that can be read with maximum speed (Mansfield et al., 1994). Such claims had to be investigated.

The intention of this study is to try to establish two points:

- Is it possible to establish quantitative guidelines about letter spacing that can be easily applied to benefit the reading speed of young readers with low vision in mainstream schools?
- At print sizes at or below the reader's established CPS, is there a significant effect of changing letter spacing on the reading speed of young readers with low vision?

An extensive trawl through the literature relating to typographical settings and readers with low vision has revealed three key issues. First, there is confusion over terminology. Second, the majority of the studies have not replicated the circumstances that young readers with low vision might experience at school. Third, there is a paucity of studies that have considered the relationship between letter spacing and reading speeds of low-vision readers.

## TERMINOLOGY

The inconsistent use of terms in earlier, related studies about the relationship between letter spacing and low-vision reading made comparison very difficult.

Kerning is a typographical device to make the layout of text more aesthetically appealing and for reducing confusion between certain letter pairs. Obvious examples of this are the 'cl' pair, which could be read as 'd' or the 'nn' pair that could be read as 'm'. Typographical software allows for certain letter pairs to be 'kerned' but this is not the facility offered by MS Word in the formatting menu as the spacing is applied to *all* letter pairings. Tracking is the correct term for the effect achieved in MS Word as it describes the application of consistent letter spacing to all letters. As this term could be confused with the scanning processes involved in reading it has been avoided in this study. Throughout this study the term *letter spacing* will be used to describe the application of spacing between all letters.

## THE APPROPRIATENESS OF EXISTING STUDIES FOR YOUNG READERS WITH LOW VISION

Perera (2004) cites evidence that 90 per cent of all people with visual impairment are over 60; with macular degeneration and cataracts being the main cause of visual impairment. Only seven per cent of all low-vision research (Goodrich and Arditi, 2004) focuses on reading and it seems reasonable to assume that the majority of these studies will be directed towards the older reader with low vision. Elderly subjects will probably have been proficient readers before their sight loss; in general, young readers with visual impairment lack this proficiency. Young readers with low vision will have visual impairments for a variety of reasons; older readers will tend to have central vision loss as a result of the conditions previously identified

A lot of the studies involving low-vision reading do not use print; rapid serial visual presentation (RSVP) is used. This is when words and text are presented in a continuous flow on a computer monitor. Extrapolating the findings of these studies to young low-vision readers of print in mainstream schools is probably best avoided.

With the notable exception of a Scottish study (Buultjens et al., 1999) it would appear that little appropriate research has been done on this population in relation to the typographical factors that affect their reading speed. A study of reading errors made by young readers with low vision (Douglas et al., 2004) indicated that the reading strategies deployed differs from those used by young readers with 'normal' vision of the same reading ability. With this knowledge we should question the application of adult studies to the circumstances that young readers with low-vision experience.

## PAUCITY OF STUDIES ABOUT THE EFFECT OF LETTER SPACING AS A TYPOGRAPHIC VARIABLE

It is hard to escape the conclusion that the typographical adjustments that have been shown to achieve clear print for readers with 'normal sight' has had a huge influence on the advice that is given when producing print for readers with low vision. The guidelines for legible typography are rarely referenced, so it is difficult to know if the recommendations are based on verifiable research or on pure whimsy and aesthetics. For readers with low vision, it seems as though the same rules are applied except that the text is made bigger. A lack of scientifically sound investigations has led to ignorance and uncertainty about the possible benefits of altering letter spacing. A few specific examples from the literature review illustrate some of the confusion that exists.

Studies cited by Mansfield et al. (1996) appear to show that letter spacing can work miracles; some subjects that had been unable to read text with normal letter spacing (no values given) were able to read the same text with wider letter spacing. Conversely, Gill and Perera (undated) found that adult readers of large print books stated a preference for 'normal spacing' (again, no value given).

Arditi (2003) and the American Foundation for the Blind (2005) have each produced guidelines about reducing reading difficulties for readers with low vision. They recommend that letter spacing should be wide, but just how wide and how it might be applied is not mentioned.

Mansfield et al. also cite studies carried out by Prince in the middle of the last century that suggest that spacing of 20 to 40 per cent of the letter width could be beneficial to improving reading speeds.

One of the few comprehensive, published studies of the effect of font for young readers with low vision (Buultjens et al., 1999) also fails to identify a value for letter spacing. It is also difficult to draw conclusions from this study about the effect of expanded letter spacing because the effects of combinations of font variables were studied.

Farnsworth (2004) claims that letter spacing of 15 to 35 per cent could reduce a reader's critical print size by 50 per cent; it is not the intention of this study to verify this assertion, but it does provide a ball park figure on which to base the test material.

## PRELIMINARY STUDY TO DETERMINE A METHOD OF APPLYING CONSISTENT LETTER SPACING IN MS WORD

By printing lines of text using Arial font at different font sizes and character spacing points using MS Word it was established that:

- MS Word software has been designed to take account of the universally accepted belief in typography that small font sizes need larger letter spacing than larger font sizes to make them more legible (see Figure 1).
- The number of 'kerning points' spacing to achieve an additional space of 10 per cent of the letter width was shown to be proportional to font size (see Figure 2).

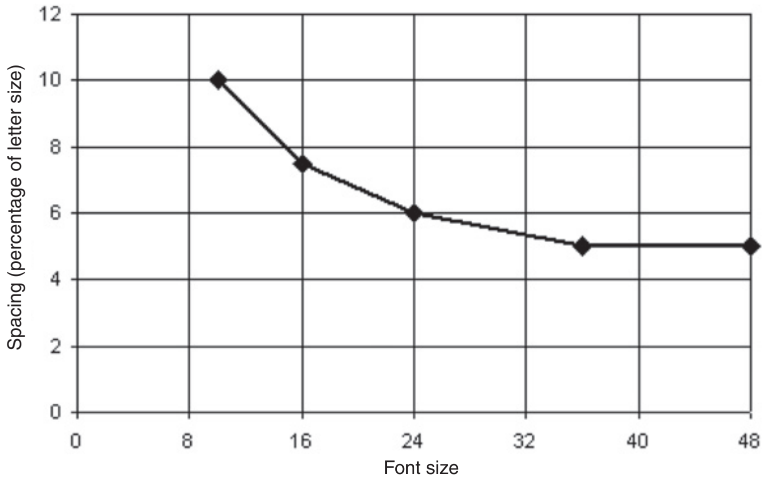


**Figure 1. 'Normal' letter spacing for different font sizes in Arial expressed as percentage of character size**

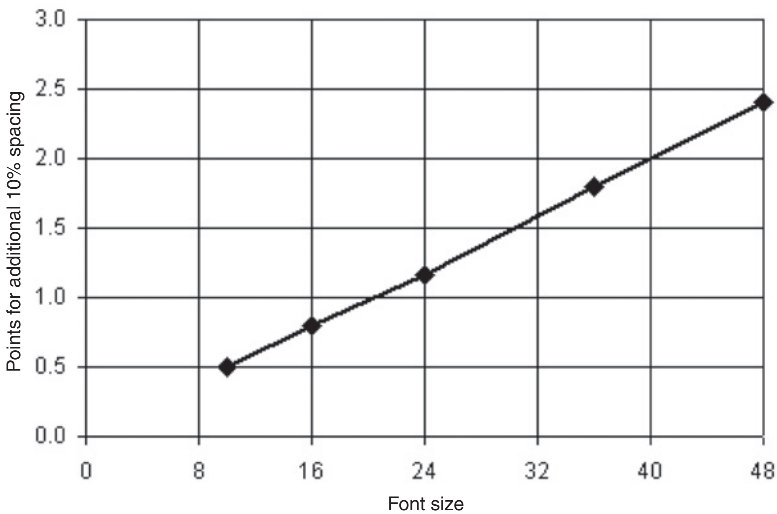


**Figure 2. Points spacing required to give 10% additional spacing for various font sizes**

Table 1 below gives the character spacing (kerning) points that need to be selected in MS Word for a range of print sizes to give defined character spacing. Having completed this part of the study it was possible to prepare reading cards with letter spacing of 'normal' (which depends on font size but is in the range 5 to 10 per cent of letter width), and 'normal' plus ten per cent, 20 per cent, 30 per cent and 40 per cent for each font size.

**Table 1. Character spacing (kerning) points that need to be selected in MS Word for a range of print sizes to give defined letter spacing**

| Required letter spacing as % of character width | Character spacing (kerning) points that need to be selected in Microsoft Word for each of the following print sizes | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **8** | **12** | **16** | **20** | **24** | **28** | **32** | **36** | **40** | **44** |
| Normal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Normal +10 | 0.4 | 0.6 | 0.8 | 1 | 1.2 | 1.4 | 1.6 | 1.8 | 2 | 2.2 |
| Normal +20 | 0.8 | 1.2 | 1.6 | 2 | 2.4 | 2.8 | 3.2 | 3.6 | 4 | 4.4 |
| Normal +30 | 1.2 | 1.8 | 2.4 | 3 | 3.6 | 4.2 | 4.8 | 5.4 | 6 | 6.6 |
| Normal +40 | 1.6 | 2.4 | 3.2 | 4 | 4.8 | 5.6 | 6.4 | 7.2 | 8 | 8.8 |
| Normal +50 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Normal +60 | 2.4 | 3.6 | 4.8 | 6 | 7.2 | 8.4 | 9.6 | 10.8 | 12 | 13.2 |

Incidentally, it is worth noting that photocopy enlarged or LVA (low-vision aid) magnified print will have increased letter spacing compared to that of large print text.

## ESTABLISHING A PUPIL'S CPS

A reading study to determine the CPS of each subject was carried out on a cohort of 14 pupils with varying degrees of low vision that are supported in their local mainstream schools by their Visually Impaired Service (VIS). The age range of the subjects was 10 to 15 years old, and all were considered to be of at least average ability with no other learning difficulty.

Ten reading cards were prepared. Each card had 50 individual five-letter words taken from the 'Dolch' list of words with which one would expect a nine year old to be familiar (Dolch, 1948). By using these words it was anticipated that word recognition would not be a limiting factor when establishing a pupil's reading speed.

To reduce the likelihood of changes in reading speed being attributable to practise or fatigue effects, the reading cards were presented to the pupil in a 'random' order, i.e. not in progressively increasing or decreasing order of letter spacing. Font sizes ranged from 8 to 44, a plot of the subject's reading speed at each of the ten print sizes should, according to Mansfield et al. (1994), make a pupil's CPS easy to identify.

Establishing an individual's CPS was not as clear cut as Mansfield et al. (1994) had suggested. Their work suggests that there is a clear point on a graph of reading speed versus print size where the reading speed shows significant deterioration. Mansfield used adults in his studies and it may be the case that adult readers give more reliable and consistent reading performances than younger readers. In this study the graphs for many of the subjects that were tested showed no clear elbow, consequently, the determination of some readers' critical print sizes relied upon qualified 'guesswork'. Where the CPS could be established, a 'test print size' for investigating the effect of letter spacing of four points less than the CPS was chosen. For those subjects that showed no deterioration in reading speed, as print size is reduced, font size 12 was used as the test print size.

It should also be noted that increasing print size did not give consistent increases in reading speed. In some cases at print sizes greater than the CPS reading speeds inconsistently varied as print size increased. Possible explanations for these inconsistencies, for all the subjects, could be lack of concentration, complexity of the words used, distractions within the testing environment, fatigue and the test not being carried out according to specifications despite efforts being made to control these variables.

## INVESTIGATING THE EFFECT OF INCREASED LETTER SPACING

Choosing the range of letter spacing was largely dictated by pragmatism. As seen in Figure 1, all letters have some degree of spacing; otherwise the letters would be touching. With Arial, font size 12 the 'normal' spacing is nine per cent and for font size 30 it is 5.75 per cent. It is suggested that letter spacing of between 15 and 40 per cent of letter width is beneficial to reading performance, so the following range was chosen: normal spacing + 10 per cent to normal spacing + 50 per cent. This maximum spacing was set as it was anticipated that very large letter spacing will interfere with the perception of word boundaries and cause the letters in individual words to be so spread out that they cease to be recognized as single words. The range chosen should help to ascertain the optimal range and also determine if larger letter spacing is detrimental to reading speed. The same standardized method of testing and recording was used as for testing the CPS; subjects were tested at their selected test print size with letter spacing ranging from normal + ten per cent to normal + 50 per cent letter spacing.

A scatter graph showing the percentage change in reading speed (based on normal letter spacing) for increasing letter spacing (as a percentage of character size) for all subjects was plotted (see Figure 3).

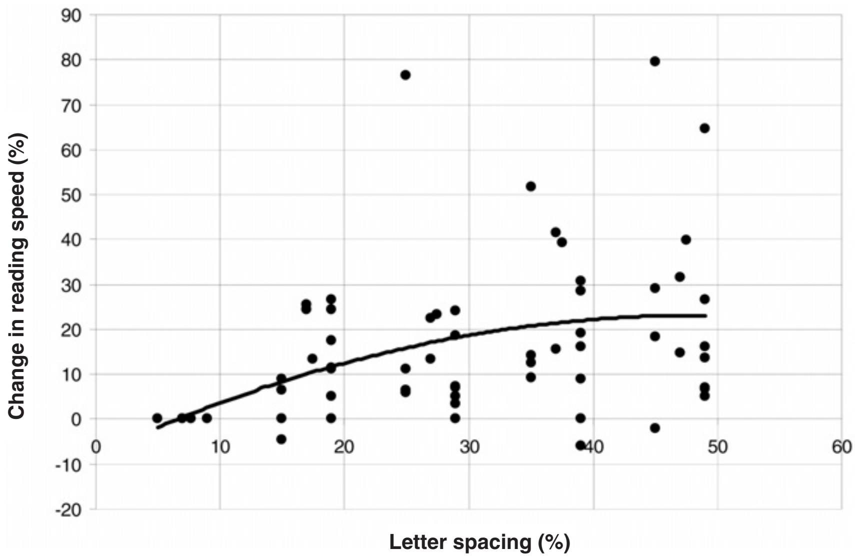


**Figure 3. Results for all 14 subjects, showing % change in reading speed as letter spacing is increased**

The results confirm that increasing letter spacing tends to increase reading speed. A best fit curve through the points shows that ongoing improvement in reading speed is less pronounced at larger letter spacing.

One obvious feature of the data collected is that some individual's reading speeds improve much more than others. This could be a result of a number of factors including the age of the subjects, the size of the test print and the normal reading speed of the subject. Whilst care was taken to standardize the testing procedure it was inevitable that there would be a great diversity in the test cohort. Their ages ranged from 10 to 15 years old, the test print sizes used by each subject varied from font size eight to font size 44 and there was great variability in their 'normal' reading speeds.

An analysis of each of these factors for each subject to establish if there was any correlation with their improvement in reading speed was made. In summary:

- There appears to be no correlation between either the age of the subject and their improvement in reading speed or between the test print size used by the subject and their improvement in reading speed.
- There appears to be a clear negative correlation between a subject's initial reading speed at normal letter spacing and their maximum improvement in reading speed with letter spacing (see Figure 4). This

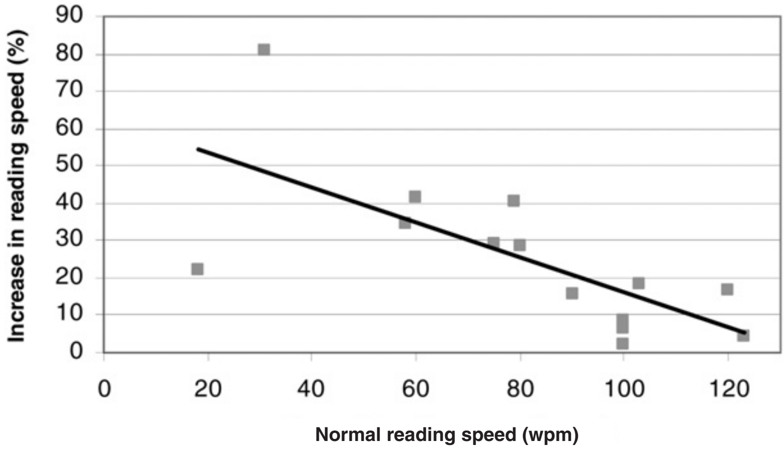


**Figure 4. An analysis of the correlation between the normal reading speed of a subject and their improvement in reading speed with increased letter spacing**

may be because readers with slow reading speeds have the most to gain from the benefits of increased letter spacing.

## CONCLUSIONS AND DISCUSSION

There were two objectives of this study. Firstly, to establish a clear procedure for applying letter spacing to large print documents. Table 1 should be a useful tool for teaching assistants and low-vision technicians who prepare large print documents using MS Word. The conversion table allows per cent values of letter spacing to be achieved using the character spacing option.

The second objective was to determine if increased letter spacing improved the reading speed of low-vision readers. This study has clearly demonstrated that this is the case. The findings for the small and diverse test cohort suggest that increased letter spacing may be beneficial to most low-vision readers whatever their visual condition.

Further analysis of test data suggests additional benefits of increasing letter spacing:

1. It may reduce the print size that a pupil needs; most of the subjects test print sizes were less than their CPS.
2. Comparison of the effects of large print and letter spacing suggest that larger letter spacing (at a pupil's CPS) enhances a pupil's reading

speed better than increasing the print size. This has implications for classroom practice; pupils with visual impairment could be using teaching materials which are more like that of their peers. (i.e. smaller print size with larger spacing).
3. Pupils with the slowest reading speeds appear to gain the most benefit from increased letter spacing. This may simply be that they have the most to gain.

Perhaps it is inevitable that such a time limited study raises more questions than answers. For many years the accepted wisdom has been that magnification of print will provide access to reading for most low-vision readers. This magnification is frequently achieved by the use of LVAs such as lenses, closed circuit televisions and screen magnification software. LVAs are useful tools and their use is to be encouraged but for protracted periods of reading they have one major disadvantage, research has shown that their use reduces the reader's reading speed (Bevan et al., 2000). In a fast moving English lesson at High School or during an examination, a reader with low vision must be able to maintain their maximum reading speed if their potential is to be achieved. It is my experience, working with readers with low vision, in these situations that large print is the preferred method of magnification.

Clearly, large print is needed for those readers who cannot read small print but once a reader's CPS has been reached are there other typographic variables such as letter spacing which can provide equal if not better enhancement of reading speed? Further research that builds on these encouraging findings and other factors that affect the clarity of large print will help teachers to influence the production of large print teaching materials.

A frequently heralded belief is that pupils with visual impairment should not be provided with optimal learning resources because they would not get this in the 'real world' and during examinations. Modification of examinations currently only gives a pupil a choice of three font sizes. As we learn more about the typographical effects that optimize the reading speed of young readers we might decide that this approach is inappropriate.

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