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Research Article

The Comparative Rate of Reading Speed Test (CRST): The Importance of Comparing the Rate of Individual Character Recognition (Static Tracking Speed) in Serif and Non-Serif Fonts

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Abstract

Background: Stress in the visual system can have a profound effect on societal development and deprivation, predisposing to ocular, systemic and psychological morbidity. Reading difficulties are becoming more prevalent as the demands of education and information technology increase. It is therefore increasingly important to be able to measure the extent of these difficulties and if possible to attribute them to a cause.

Objective: It is generally accepted that a Serif font will be harder to read than a Non-Serif font. This study seeks to show using a new measure of reading speed that this is because of the Serif Font's relatively higher spatial frequency and an association with pattern glare, visual stress and binocular deficiency.

92 year 7 children (11-year-olds) were screened using a new measure of the comparative rate of individual character recognition. Two different lines of 60 random letters were used, one in a serif font (Times) and the other in a non-serif font (Gills Sans). The Times font was printed in black and the Gill Sans font in a Teal colour.

Results: The results showed that the non-Serif font (Gill Sans) was read faster than the serif font (Times) N = 92 p = 2.19E-09, due to it is argued a high degree of binocular deficiency in this group.

A more detailed analysis of the data showed that 65 of the subjects were contributing to the significance of this result (p = 6.84E-16). The remaining 27 subjects read the Gill Sans slower or the same (p = 0.00045) due to the lower contrast of the teal Gill Sans letters, which confounded their lower (easier) spatial frequency. This is likely to be seen in subjects with reduced contrast sensitivity and by implication poor visual development rather than a binocular dysfunction.

Keywords: *Reading Speed; Tracking; Binocular Vision; Amblyopia; Visual Stress; Eye Dominance; Sport Vision; Reading; Aiming; Irlen; Spatial Frequency; Motor Skills; Fixation Disparity; Panum's Areas; Pattern Glare; Colour Preference Depth Perception; Crowding*

Abbreviations

UV: Ultraviolet; UK; United Kingdom; ASvP: Association of Sport and Schoolvision Practitioners; SVUK; Sport and School Vision UK; BV: Binocular Vision; FD: Fixation Disparity; CRST: Comparative Rate of Reading Speed Test; MCOptom: Member of the College of Optometrists; M.ASvP: Member of the Association of Sport and Schoolvision Practitioners; Mech Eng: Mechanical Engineering

Introduction

This paper is based on research in Moreton School in Wolverhampton (2006) in which the proposed test of reading speed was first used [1].

The Moreton study was set up to demonstrate a new battery of tests to screen children in school for those at risk of educational deficit due to visual problems. This battery of tests was evolved from research in sport and founded on the measurement of eye dominance [2].

The primary visual skills

The research identified two primary visual skills common to all occupations: aiming and anticipation (based on depth perception) and that:

- Aiming (positional sense) depends on the dominant eye
- Anticipation (based on depth perception) is more dependant on the non-dominant eye.

It is proposed that in all occupations performance is based proportionally on these two primary visual skills.

Sport

In sport for example, tennis relies mainly on depth perception [3], which allows the player to judge the distance of the ball and therefore to anticipate its arrival at the racket face. The proportion of the skills of Aiming: Anticipation might be 20:80. Aiming is done subliminally and relies on peripheral awareness of the net and court markings to judge body position.

In clay target-shooting aiming is the predominant skill [3], which allows the shooters to relate the position of the target (clay) to their own position. Depth perception is required to judge how far the clay is away and therefore how fast it is moving, but this is secondary to the skill of aiming. The proportion of the primary skills in clay shooting might be estimated as 70:30 Aiming: Anticipation.

Driving

In driving it could be argued that aiming and depth perception (anticipation) are equally important; we need to know the distance of the car in front, as well as its position on the road when we aim to overtake it.

Reading

In the occupation of reading, distance is usually fixed in an individual for a specific task (computer use or reading a book), so the skill of aiming is likely to predominate. The proportions of the primary visual skills might be estimated as 100:0 Aiming: Anticipation. If aiming is important in the occupation of reading it is likely that a binocular deficiency which affects the stability of the aiming dominant eye will make reading (or more exactly tracking from one letter to the next) more difficult. If this were the case then reading speed (tracking) is likely to be affected.

Binocular vision (BV)

A consideration of eye dominance may help to understand the way the two eyes work together. For instance how a binocular vision deficiency could lead to reading and therefore learning difficulties and even general clumsiness, depending on the severity and direction of the (physiological) paresis or the distance of the object of regard.

Stability of the aiming eye

When reading binocular stability is likely to be important. The role of the dominant aiming eye is to maintain the position of the two eyes as they track from one letter to another or from one word to another. It is proposed that an unstable dominant eye could cause words to jump on the page. If the dominant eye loses it position as it struggles against fatigue caused by (say) a decompensated exophoria or

Mallet Fixation Disparity (FD) [4], attention will swap to the non-dominant eye. In that moment of swapping the apparent position of the word or letter will jump, it can be up or down or to the side, depending on the direction of the paresis, so losing the place on the page.

Development of motor skills

When learning to write, if the hand holding the pen keeps apparently moving it becomes more difficult to learn the fine motor skills (eye-hand coordination) on which neat, legible hand writing depends. If the same thing happens in the distance, objects, which should be avoided, like the edge of the table or door-frames will be bumped into (eye-hand and body coordination); catching a hard cricket ball is very difficult and hurts if it is not where it appears to be (leading to poor development in gross motor skills).

Visual stress

People with migraine or Meare's Irlen syndrome [5] (visual stress) are especially prone to pattern glare. This occurs at specific spatial frequencies (cycles per degree of visual angle) and is characterised by river patterns in the body of the text or a confusing mingling of closely arranged lines. The frequency at which the pattern glare occurs varies from one individual to another and can be measured using the Evans Stevenson pattern glare test [6].

The literature suggests that these people are likely to have visual stress in everyday life and may benefit from interventions designed to alleviate visual stress, such as precision tinted lenses measured on the colorimeter [7]. The cause of visual stress, which may be associated with migraine is not clear, but researchers have suggested that it is due to hyper excitability in the visual cortex, a "congenital phenomenon," which may confer an evolutionary advantage.

Increased sensitivity to light (photophobia) or intolerance to loud or sudden noise may not necessarily be useful; it is unlikely that migraine sufferers would see this as an evolutionary advantage.

Fixation disparity (FD)

Fixation disparity is due to a physiological binocular deficiency. It is a measure of the efficiency of cortical fusion and is corrected with prisms using the Mallet test, with or without focusing lenses. It represents the degree of dissociation between the two retinal images within Panum's areas [8] (so no diplopia), but beyond the normal dissociation required for depth perception. In normal vision the greater the dissociation the nearer the object will appear to be. This will be corroborated by proprioceptive feedback from the extra-ocular muscles, a hint of the complexity and sensitivity of the visual system.

Visual stress - Another explanation

Unstable eye dominance may provide another explanation for visual stress. Uncontrolled movement of the eyes due to binocular deficiency measured by FD could cause a mingling of letters or closely arranged vertical lines as fixation shifts. It is possible that at a particular distance apart (spatial frequency) the letters or lines could give rise to the same swimming effect in large bodies of text or the shimmering effect when looking at stripped patterns, which appear to merge and unmerge.

Increased activity (excitability) in the visual cortex, particularly the binocularly driven cells, might be a reflection of the degraded visual images being transmitted from two poorly coordinated eyes.

This binocular understanding does raise the possibility of a non-palliative approach to pattern glare, which stabilises the binocular deficiency, using prism in the traditional way (Mallet [4]).

It is a proven effect that many people can read better with precision tinted lenses [7] so there needs to be another explanation of the Irlen phenomenon. A small feasibility study has shown that subjects previously corrected with plano precision tinted lenses have similar tracking times when binocularly balanced with prismatic correction and corrected at near with ophthalmic lenses [9].

It does raise the possibility that darkly tinted lenses reduce visual stress by causing the weaker eye to suppress, thereby eliminating the cortically confusing binocular image. If this were the case then a positive Colorimeter test would be diagnostic of a correctable (with spectacles and /or contact lenses) binocular deficiency and not congenital cortical hyper-excitability.

Accommodation

A simple understanding of visual stress could also be related to an overworked cilliary muscle. Most adults around the time of presbyopia will understand this description of visual stress. Traditionally the RAF rule is used to measure the amplitude of accommodation [10].

Empirical measurement

In practice after a very few early tests post qualification most practitioners revert to an empirical measure of accommodation. There is surprisingly little unity in those who have written about the subject on the best measure of accommodation [11]. Monocularly the near point of blur can be difficult to gauge and depends on the subject's perception of blur. Binocularly muscle balance can influence the result and produce good results with maximum effort (over-accommodation in convergence insufficiency).

This suggests that the RAF Rule is itself stressful. It would seem more logical to measure accommodation in its relaxed state to give a more reliable indication of how it can be sustained. It is likely that this is what empirical measurement does.

Accommodation in the young

It is generally thought that most young people have normal accommodation [12]. The National Health Service (NHS England) examination does not require the amplitude of accommodation in children to be measured and anecdotally traditional school vision screening is limited to a measure of monocular distance vision. In the Moreton study against expectation a significant number of the students responded positively to a +1.00 empirically measured binocular addition when looking at the near test type.

Accommodation facility

For this reason, the test defined as accommodation facility was measured with a binocular +1.00 addition, as the subject held the text at their normal reading distance. When the addition was placed in front of their eyes they were asked "Is this better or worse?" A positive response was taken as a significant sign of reduced accommodative facility in the context of the screening.

Measurement of reading speed

The measurement of reading speed is not taught or routinely measured in optometric practice. The effect of visual correction in all occupations remains a scientifically grey area, for example in driving [13,14]. Return visits to the optometrist are largely based on anecdotal feedback from patients who have found their spectacles helpful. However, reading speed is being used as a specialist measure of the effect of tints, for example the Wilkins Rate of Reading, which measures the rate of reading random words [15].

The effect of colour and font

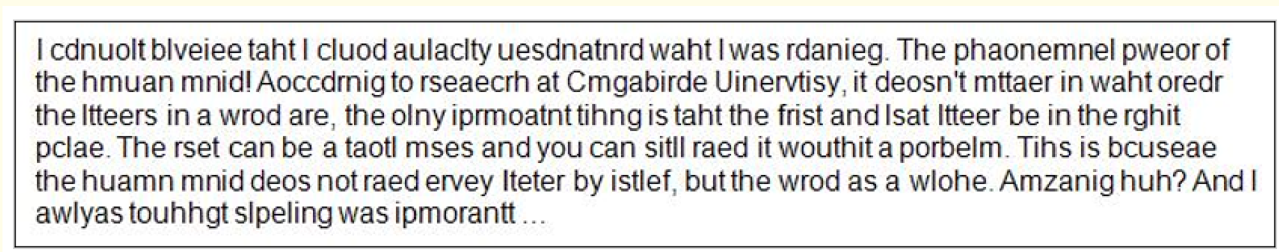
It is often reported by patients that print is easier to see at high contrast or in different colours and backgrounds and it is common for people with reading difficulties to say that uncomplicated (non-serif) type faces like Gill Sans and Arial are easier to see [16] This suggests that reading speed should be an important test in the standard eye examination for children (and adults).

This could be accompanied by a simple measure of colour preference, which gives an indication of light sensitivity [17]. Loving blue and hating yellow for example: blue filters absorb yellow light, which is at the peak sensitivity of the human visual system, which makes it particularly problematic for light sensitive people. Coloured overlays work this way. Blue reduces the reflected light from the white page. Yellow increases the contrast between the black print and the white paper by absorbing light scatter within the eye caused by blue and ultraviolet radiation.

Black print against a yellow background also gives a higher contrast than black against white because of the visual system is most sensitivity to yellow. The choice of coloured overlay depends on the cause of the visual problem, Blues and greens, poor binocularity, yellow and orange developmental loss of contrast sensitivity [17].

The nature of the reading matter

Words or sentences in context may measure the ability to extrapolate and guess. Random words can also be guessed from the first and last letters even when the letters within the word cannot be seen in order because they jump out of place (See figure 1).



I cdnuolt blveiee taht I cluod aulaclty uesdnatnrd waht I was rdanieg. The phaonemnel pweor of the hmuan mnid! Aoccdrnig to rseaecrh at Cmgabirde Uinervtisy, it deosn't mttaer in waht oredr the ltteers in a wrod are, the olny iprmoatnt tihng is taht the frist and lsat ltteer be in the rghit pclae. The rset can be a taotl mses and you can sitll raed it wouthit a porbelm. Tihs is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrod as a wlohe. Amzanig huh? And I awlyas touhhgt slpeling was ipmorantt …

Figure 1: *Typoglycaemia to demonstrate that spelling may not affect comprehension.*

It could be concluded that if letters cannot be seen in the correct order, the words themselves may also jump out of order making it difficult to perceive sentences and paragraphs as syntactically correct constructions of an argument, that is, understand (and remember) the sense of what is being read. Similarly, if the letters in an individual word jump from side to side, learning to spell would become difficult.

Tracking speed

It may be that to measure the effect of binocular instability, reading individual, random characters will be the test of choice; in effect we need to measure the ability (speed) to track accurately from one individual character to the next.

If unstable eye dominance is a characteristic in people with reading difficulties then it is likely to be more difficult to read letters which are close together because of their tendency to merge with the next letter, a manifestation of the crowding phenomenon [18]. This may explain why serif fonts (for example Times) are more difficult to read.

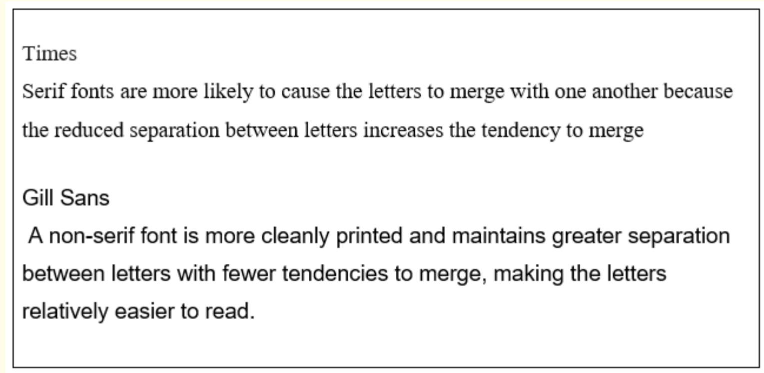
If people with reading difficulties have unstable eye dominance the projections and finishing off strokes in a Times font are more likely to make letters merge with one another (See figure 2). The proximity of one letter to another could be expressed as a spatial frequency where the serif font of Times has a higher spatial frequency than Gill Sans [19].

High and low contrast

High and low contrast LogMAR charts demonstrate the effect of poor contrast on the ability to see detail. They highlight subjects whose low contrast vision, as they present, is disproportionately worse than their high contrast. This can give an indication of poor contrast sensitivity which may be due to refractive error or developmental problems (amblyopia).

Measuring reading speed

It follows that a test for reading ability should not be measuring reading speed (normal sentences or even random words) but individual characters, which cannot be guessed or anticipated; The effect of spatial frequency is also important so it would be useful to make this a comparison between two fonts of higher and lower spatial frequency to test the significance of spatial frequency at the same time.


Times
Serif fonts are more likely to cause the letters to merge with one another because the reduced separation between letters increases the tendency to merge

Gill Sans
A non-serif font is more cleanly printed and maintains greater separation between letters with fewer tendencies to merge, making the letters relatively easier to read.

Figure 2: *The difference between a Serif and a non-serif font.*

These characters should be letters and not numbers. Numbers are easier to read because there are only nine. Twenty-six letters make the visual search more difficult [20] and may increase test sensitivity. For a similar reason embedding the characters in the body of a paragraph will exaggerate the crowding phenomenon and increase the difficulty in those affected.

To incorporate the criteria discussed above; font and colour, two reading or character recognition tasks were proposed, which vary the typeface at a normally comfortable angular subtense (font size):

- Times (a serif N12 optotype, black on white)
- Gill Sans (non-serif N12 optotype teal {a blue green colour} on white).

The Times font was made black on a white background and the Gill Sans teal on a white background.

Significance of teal

The teal colour of the Gill Sans font was used as a concession to light sensitive subjects who often prefer quiet tints like grey, blue and teal [17]. Teal tints gain their effect by eliminating the veiling background haze caused by blue light (focuses in front of the retina) and ultraviolet (UV), which causes fluorescence in the healthy human eye [21]. Individual colour preference related to the degree of binocular difficulty [17] may explain why the colours of precision tints vary.

The Moreton study showed that hue (colour) is related to the degree of the binocular deficiency, the greater the deficiency the shorter the transmission wavelength of the tint that is preferred, that is the further away it is from the peak sensitivity yellow (570 - 590 nm). Loving blue and hating yellow is diagnostic of clinically significant light sensitivity because blue maximally absorbs yellow light irrespective of its effect on contrast [17].

It was expected that teal would increase the sensitivity of the test by making the Gill Sans font even easier to read.

The variable

Based on the findings of the Dyslexia Association a non-serif font will invariably be read faster or the same as a serif font, so font is only a comparative measure. The true variable in CRST is then the colour of the font. The question remained that the teal colour confuses the effects of tints and pigments and whether its effect can be separated from spatial frequency.

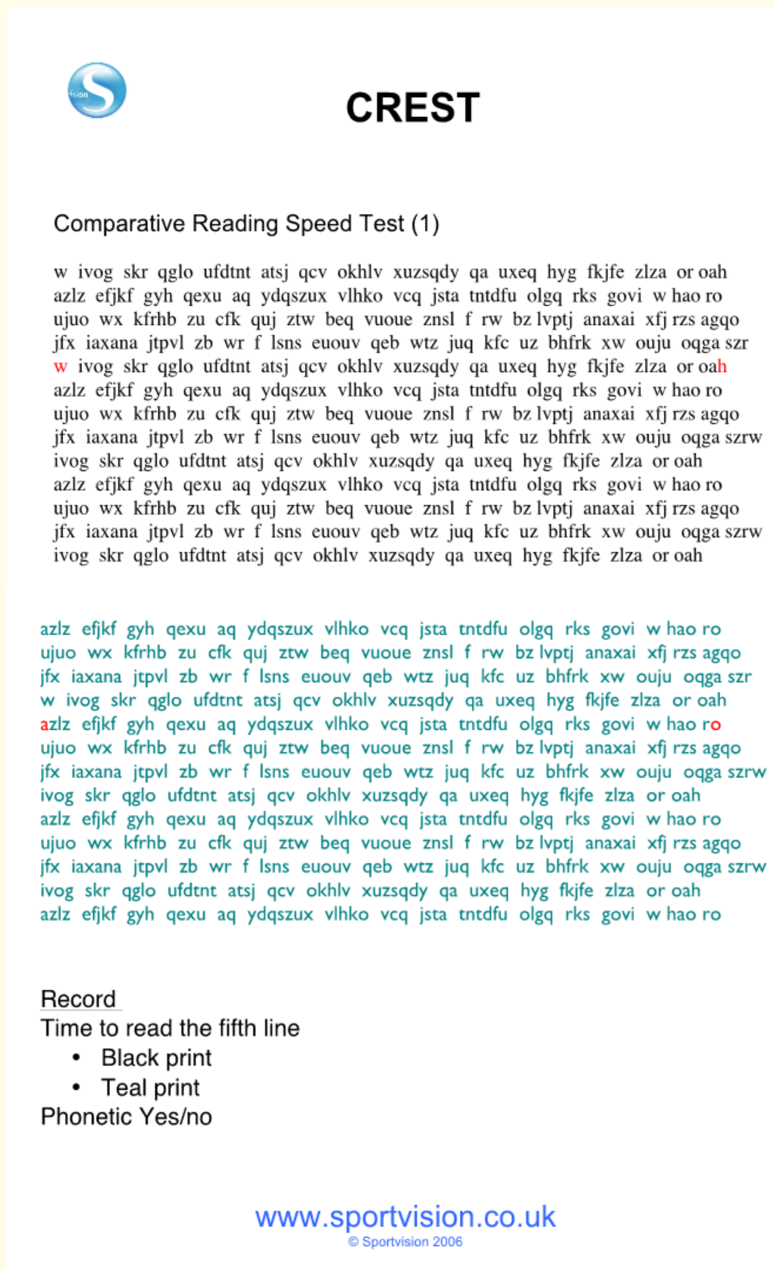
Hypothesis CRST

According to the prevalence of binocular vision problems the non-serif font will be read faster or at the same speed as the Times font. The null hypothesis was that all subjects boys and girls, would read both lines (fonts) at the same speed.

Apparatus and Methods

Apparatus

The comparative rate of reading speed test (CRST see figure 3) has random groups of letters arranged into two paragraphs (Times and Gill Sans) of 13 lines with 60 characters in each line. A red character marks the beginning and end of the two lines to be read.



CREST

Comparative Reading Speed Test (1)

w ivog skr qglo ufdtnt atsj qcv okhlv xuzsqdy qa uxeq hyg fkjfe zlza or oah
azlz efjkf gyh qexu aq ydqszux vlhko vcq jsta tntdfu olgq rks govi w hao ro
ujuo wx kfrhb zu cfk quj ztw beq vuoue znsl f rw bz lvptj anaxai xfj rzs agqo
jfx iaxana jtpvl zb wr f lsns euouv qeb wtz juq kfc uz bhfrk xw ouju oqga szr
w ivog skr qglo ufdtnt atsj qcv okhlv xuzsqdy qa uxeq hyg fkjfe zlza or oah
azlz efjkf gyh qexu aq ydqszux vlhko vcq jsta tntdfu olgq rks govi w hao ro
ujuo wx kfrhb zu cfk quj ztw beq vuoue znsl f rw bz lvptj anaxai xfj rzs agqo
jfx iaxana jtpvl zb wr f lsns euouv qeb wtz juq kfc uz bhfrk xw ouju oqga szrw
ivog skr qglo ufdtnt atsj qcv okhlv xuzsqdy qa uxeq hyg fkjfe zlza or oah
azlz efjkf gyh qexu aq ydqszux vlhko vcq jsta tntdfu olgq rks govi w hao ro
ujuo wx kfrhb zu cfk quj ztw beq vuoue znsl f rw bz lvptj anaxai xfj rzs agqo
jfx iaxana jtpvl zb wr f lsns euouv qeb wtz juq kfc uz bhfrk xw ouju oqga szrw
ivog skr qglo ufdtnt atsj qcv okhlv xuzsqdy qa uxeq hyg fkjfe zlza or oah

azlz efjkf gyh qexu aq ydqszux vlhko vcq jsta tntdfu olgq rks govi w hao ro
ujuo wx kfrhb zu cfk quj ztw beq vuoue znsl f rw bz lvptj anaxai xfj rzs agqo
jfx iaxana jtpvl zb wr f lsns euouv qeb wtz juq kfc uz bhfrk xw ouju oqga szr
w ivog skr qglo ufdtnt atsj qcv okhlv xuzsqdy qa uxeq hyg fkjfe zlza or oah
azlz efjkf gyh qexu aq ydqszux vlhko vcq jsta tntdfu olgq rks govi w hao ro
ujuo wx kfrhb zu cfk quj ztw beq vuoue znsl f rw bz lvptj anaxai xfj rzs agqo
jfx iaxana jtpvl zb wr f lsns euouv qeb wtz juq kfc uz bhfrk xw ouju oqga szrw
ivog skr qglo ufdtnt atsj qcv okhlv xuzsqdy qa uxeq hyg fkjfe zlza or oah
azlz efjkf gyh qexu aq ydqszux vlhko vcq jsta tntdfu olgq rks govi w hao ro
ujuo wx kfrhb zu cfk quj ztw beq vuoue znsl f rw bz lvptj anaxai xfj rzs agqo
jfx iaxana jtpvl zb wr f lsns euouv qeb wtz juq kfc uz bhfrk xw ouju oqga szrw
ivog skr qglo ufdtnt atsj qcv okhlv xuzsqdy qa uxeq hyg fkjfe zlza or oah
azlz efjkf gyh qexu aq ydqszux vlhko vcq jsta tntdfu olgq rks govi w hao ro

Record

Time to read the fifth line

- Black print
- Teal print

Phonetic Yes/no

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Figure 3: *The Comparative rate of reading speed test.*

The idea of random groups of letters was based with thanks on the reading matter used in the intuitive colorimeter [22], which is used as a background to measure a subjective response to colour rather than reading speed.

Method

CRST was used to measure the rate of individual character recognition in 92 students (55% boys) year 7 students (aged between 11 and 12 years) at Moreton School in Wolverhampton in September 2005.

The students were asked to read the embedded lines of letters in the Times and Gill Sans paragraphs as they presented on the day, with spectacles or without, depending on what they wore normally at school. Speeds were recorded using a stopwatch to the nearest 100th of second, starting and stopping as the first and last red characters were read.

In addition the students were screened for any deficit in seven diagnostic elements of vision including eye dominance and accommodation facility as well as checking symptoms and history (See table 1 Vision screening battery). When CRST speeds are reduced it should be attributable to a problems with one or more of these elements of occupational visual performance.

No	Test
1	Measurement of LogMAR vision at high and low contrast
2	Refractive error estimated with the retinoscopy (near and distance)
3	Dominance, eye and hand
4	Muscle balance - cover test
5	Colour preference and light sensitivity
6	Accommodation facility (+ 1.00DS test)
7	Fixation disparity

Table 1: *The Screening Battery also included the following tests.*

Results

CRST speed results

The mean speed for the whole group on the black font was 40.53 seconds and the teal font 34.81 seconds, teal was read significantly faster (p = 2.19E-09). Statistical test was one tail T test, equal variance.

When the subjects were divided into two groups where:

1. Teal was read faster than black
2. Teal was read slower or the same as black.

The difference in the speeds was significant in each group (See table 2).

Condition	N	%	Teal (Gill Sans)	Black (Times)	p
1. Teal faster	65	70.7	34.95	41.38	6.84E-16
2. Teal slower	27	29.3	35.11	33.11	0.00045

Table 2: *Comparison of mean speeds on the Gill Sans and Times fonts (N = 92).*

There was no difference between the mean Gill Sans (teal) speeds in the two groups (p = 0.96).

Discussion

The effect of font on rate of individual character recognition

As a whole the group read the teal font (Gill Sans) faster than the black font (Times), p = 2.19E-09. It was hypothesised that the higher spatial frequency font (Times) would be more difficult to read if there were binocular instability. This suggests that there was a high prevalence of binocular deficiency.

A more detailed analysis of the data showed that 65 of the subjects were contributing to the significance of this result (p = 6.84E-16). The remaining 27 subjects read the Gill Sans slower (p = 0.00045). The finding of the smaller Group 2 was unexpected.

The hypothesis was that Gill Sans would invariably be read the same or faster than black because of its lower spatial frequency and some undefined benefit of being printed in a teal colour.

Curiously there was no significant difference in Gill Sans speeds between the groups so the effect seems to be entirely due to the Times font.

Unexpected anomaly

The hypothesis that the Gill Sans font would be read faster than Times is statistically true for the whole group (p = 2.19E-09), but a significant minority (Group 2) read the Gill Sans font slower than the Times font.

When the data was separated into groups 1 and 2 the significance of the difference between the Times and Gill Sans speeds increased (p = 6.84E-16) in Group 1. This implies that the test is measuring something different in Group 2 and this group is not as susceptibility to pattern glare.

The original proposal based on the different spatial frequencies for Times (higher) and Gill Sans (lower) predicted that everybody would be faster on Gill Sans or about the same. It did not predict that some people would be slower.

Reason for the reduced speeds on gill sans

If it is accepted that the Gill Sans font will be invariably read faster or the same as Times, then the variable is colour not font. The teal font made it harder for some subjects to read and not easier as first thought.

In other words the cause of their poor speed on the non- serif font has a different aetiology to a reduced speed on the Times font.

In general contrast has a significant effect on the ability to see. In the initial screening using the high (90%) and low contrast (10%) LogMAR charts showed that low contrast was almost always harder to see (p = 1.007E-52 N = 166 eyes).

If the Gill Sans font had been printed at 10% contrast it is likely many more, if not all the subjects would have had poorer Gill Sans speeds.

The Gill Sans font was printed in teal (a default saturation on an Apple computer) because the Teal filter is popular with light sensitive subjects. Despite confusing the effects of pigment and filters it was thought this would make this font even easier to read.

Effect of colour on contrast

It is possible that the significance of the colour of the Gill Sans font is not its colour but a marginal reduction in contrast.

The subtlety of the difference in contrast between black and teal seems to be important. The level of contrast had to be such that those with relatively normal contrast sensitivity would not be affected. In those with even subtly reduced contrast sensitivity the easier to read Gill Sans font would tend to be confounded by the effect of reduced contrast, for this reason subjects with the same speed were included in group 2 (reading the reduced contrast Gill Sans letters at the same speed as Times suggests that the subject was affected by the reduced contrast otherwise they would have read them faster). If the subject could not overcome the problem of reduced contrast with the help of an easier font, it would suggest the real problem was more contrast sensitivity (amblyopia) than spatial frequency.

Normative data

Initially practitioners may find a table of normative data useful to determine which students are outside the normal range of speeds (See table 2) and at risk of binocular vision (BV) or visual development problems. These students can be referred back to the diagnostic screening tests to see in which one or more they are deficient.

The most likely cause of reduced low contrast speeds are hyperopia or accommodative insufficiency in the absence of binocular vision problems.

It is quite likely however that some subjects will suffer from both causes. A binocular deficiency, which is sufficiently severe, will itself affect visual development. These subjects might be expected to have poor speeds on both fonts where the slower of the two speeds indicates which is the greater problem. Referring back to the diagnostic screening tests should confirm this and define the course of action.

Conclusion

The CRST test measures the comparative rate of individual character recognition between a serif font (Times) and a non-serif font (Gill Sans). Using the CRST test it is possible to distinguish between subjects who have a poor rate of individual character recognition either due to binocular instability or development effects causing reduced contrast sensitivity.

If binocularity is sufficiently weak then it may also affect visual development, so speeds will be poorer on both fonts. The relative speed on each font will indicate which is the greater problem visual development or binocular function. Poor contrast sensitivity (reduced speed on the teal font) is likely to be due to reduced accommodation and / or latent or manifest hyperopia in the absence of binocular instability.

In either case the normal correction of vision (the deficient diagnostic elements of occupational visual performance) should show an improvement in measured CRST speeds. Particular attention needs to be applied to performance at the near point including the measurement and correction of accommodation facility and fixation disparity using prism.

The significance and variation of the Times speeds was higher that expected. If the higher spatial frequency of this font makes it more difficult to see when binocular vision is unstable, then the prevalence of these binocular issues is high in this school (71%).

It may not be a coincidence that Moreton School is in a deprived area of Wolverhampton where many of the children come from broken homes, where poor nutrition, alcohol and drug abuse is common.

An association between this and binocular vision problems in children could have implications for the nature of social deprivation. Rate of individual character recognition has implications for the ability to read and write in otherwise bright children, which will be a constant drag on their career development. It is likely that many of their parents will have suffered from the same problems with the profound effect this can have on the ability to sustain full employment maintain good health and keep free from a debilitating dependency on state support.

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Conflict of Interest

There are no conflicts of interest.

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